

A Comparison of Changes in the Upper Elementary School (grades 6-8) Geometry Learning Area After the Educational Reform in Turkey

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Abstract: This paper aimed to present the changes in the upper elementary school (grades 6, 7, 8) geometry learning area in Turkey after the reform movement of 2004. The methodology of the study was descriptive and included content analysis in terms of objectives, geometry content, and time allocation in geometry before and after 2004. A general conclusion of the study was that changes in the Turkish geometry education at the upper elementary level have been mostly limited with the rhetoric after 2004. The most prominent change was that the notion of “drawing” was replaced by the notion of “constructing” in order to be consistent with the constructive approach of the post-reform mathematics program.
Anahtar Kelimeler: Geometry learning area, geometry education, reform movement, turkish education.

Özet: Türkiye’deki eğitim reformu hareketinden sonra ilköğretim ikinci kademesi (6-8 sınıf) geometri öğrenme alanında olan değişikliklerin karşılaştırılması. Bu makale, 2004 reform hareketinden sonra ilköğretimin ikinci kademesindeki (6.,7. ve 8. sınıflar) geometri müfredatında olan değişiklikleri sunmayı amaç edinmiştir. Çalışma betimleyicidir ve 2004’ten önce ve sonra geometri alanı için tanımlanan amaçların, içeriğin ve müfredatta ayrılan zamanın içerik analizinden oluşmaktadır. Makalenin genel sonucu, 2004’ ten sonra geometri müfredatında olan değişiklikler büyük ölçüde geometrinin içeriğinden çok nasıl öğretileceğiyle alakalı olduğudur. En önemli değişiklik, müfredatın yapılandırmacı anlayışına uygun olarak, “çizme” ifadesinin “inşa etme” ile değiştirilmesidir.

Key Words: Geometri öğrenme alanı, geometri eğitimi, reform hareketi, Türkiye’de eğitim.

Introduction

The curricular reform movements aim to improve the quality of schooling but the implementation of these reforms is also rooted in social, cultural and economic needs (Flouris & Pasiyas, 2003; Huang, 2004). According to Huang (2004), to achieve its ends, China’s curriculum reform should concentrate on establishing the new curriculum philosophy, developing educational objectives, renewing educational content, reconstructing a model of curriculum organization, innovating in curriculum materials, establishing an active mode of teaching and instruction, and establishing a new system of curriculum evaluation. Huang also addressed six strategies to accomplish these goals. These strategies include improving the system of curriculum management, redeveloping the mechanism of curriculum reform, promoting school-based curriculum development, integrating information technology with curriculum, emphasizing teachers’ professional development, and encouraging the whole nation’s participation in the reform.

In their critical appraisal of curricular reform movements, Flouris and Pasiyas (2003) reported that the curriculum reform efforts were based on textbooks, teaching practices, teachers’ scientific and pedagogical preparation, usage of multiple instructional resources and media, and evaluation processes. Similarly, the new Turkish school curriculum reform was built on a set of fundamentals, essential elements, and components of the teaching and learning process (Koc, Isiksal & Bulut, 2007). The reformist wave in education, Turkey’s long lasting ambitions to be a full member state of the European Union, and hopes for raising Turkish students’ low academic performance have helped the country to reform its political, economic, institutional and educational structures.

In general, mathematical reform movements are processes of gradual evaluation of scope and sequence and sometimes interrupted by the need for more fundamental changes in content or delivery. Under the influence of the 2004 mathematics reform movement in Turkey, mathematics curricula and standards at Turkish primary schools (grades 1-8) have gradually changed. Until 1997, secondary education in Turkey consisted of two stages: middle school and high school. With Law No. 4306, which became effective in 1997, the term for compulsory education was extended to 8 years. Thereafter, middle schools were

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included under the structure of primary education and were named “upper elementary schools.” Hence, this study will define “upper elementary education” as refer to the grades 6 through 8.

Benavot et al. (1991) examined primary school subjects that have been required in the official curricula and their percentage of total curricular time devoted to each subject across three periods of time (1920-1944,1945-1969, 1970-1986) and from different countries with state-administered educational systems (the study coded information for 65 countries for the first period,105 for the second, and125 for the third). The study proposed that the content of officially sanctioned primary school curricula around the world has been showing a tendency to converge since the content of the curricula was “closely linked to the rise of standardized models of society ... and to the increasing dominance of standardized models of education” (p. 86).

Geometry, an important subject in the school curriculum, is highly represented by many international studies such as TIMSS and PISA as well as national standardized achievement tests like the university entrance examinations (OSS) and the secondary education institutions student selection and placement examination (OKS). In TIMSS 1995, 1999, and 2003, for example, about fifteen percent of the mathematics questions were in the learning area of geometry (Martin & Kelly, 1996; Mullis et al., 2000; Martin, Mullis & Chrostowski, 2004). In addition, geometry problems covered about 35% of all mathematics problems in the OSS and the OKS examinations (OKS, 2005; OSS, 2005).

Turkish students’ lack of knowledge is evident from considerable research (Olkun & Aydođdu, 2003). In TIMSS 1999 and TIMSS 2007, as was the case with other four content areas (fractions and number sense, measurement, data representation, analysis and probability, and algebra) Turkish eighth grade students, ranking 34th out of 38 countries in TIMSS 1999 (Mullis et al., 2000) and 36th out of 49 countries in TIMSS 2007 (Mullis et al., 2008), presented poor performance in geometry, whereas among the top five achievers (Chinese Taipei, Republic of Korea, Singapore, Hong Long SAR, and Japan), only Republic of Korea curriculum included same amount of TIMSS 8th grade geometry topics intended to be taught up to and including eighth grade than the curriculum in Turkey (Mullis et al., 2008, p.202). Turkish eighth grade students also face mathematics topics at the same level with or earlier than and have been instructed in the smaller size of classrooms than the top five rankers (p.270). Upon consideration of these facts, evaluating the current geometry curricula in Turkey would be beneficial. To this end, this study aimed to investigate how upper elementary school (grades 6, 7, 8) geometry learning area in Turkey developed after the reform movement of 2004 and sought to answer the following research question.

“How has the upper elementary geometry learning area in Turkey changed after 2004?”

- a. What changes took place in the goals of upper elementary mathematics education in Turkey after the reform movement of 2004
- b. What changes took place in the goals of the upper elementary geometry learning area in Turkey after the reform movement of 2004?
- c. What changes took place in the content of the geometry learning area (grades 6-8) in Turkey after the reform (2004)?

Methodology of the Study

This study was descriptive in nature and employed content analysis methodology that “can be used in any context in which the researcher desires a means of systematizing and (often) quantifying information that is not previously organized to the researcher’s purpose” (Fraenkel & Wallen, 2000). In order to provide evidence for changes made in upper elementary school geometry education in Turkey from 1991 through 2010, a curriculum review in terms of objectives, content, and time allocation in geometry before and after 2004 was introduced. Analysis of the upper elementary school geometry learning area was divided into two periods: the pre-reform period (1991-2003) and the post-reform period (2004 and thereafter).

The description of upper elementary school education in Turkey from 1991 to the present time was based on documents published by the Ministry of National Education after 1991; these documents can be obtained from Talim Terbiye Kurulu (Council of Education Policy) at Ankara. General goals and objectives of upper elementary education were defined in MEB (1990), MEB (1997), MEB (2002) and MEB (2005a) printed by Milli Egitim Basimevi (National education publication house). MEB (1991) and MEB (2005b) provided weekly class schedules.

Upper Elementary School Geometry Education during the Pre-reform Period (1991-2003)

During the years 1993-1996, the Ministry of Education developed plans to make the eight years of primary education mandatory for all. Until the academic year of 1997-1998, secondary education in Turkey

consisted of two stages: middle school and high school. When Law No. 4306 became effective in 1997, the term for compulsory education was extended to 8 years. Thereafter, middle schools were included under the structure of primary education and were named “upper elementary schools.”

Between 1991 and 2003, the length of secondary school education was three years or four, depending on the type of high school. Each academic year consisted of two semesters. In 2002, a preschool curriculum for 36-72 months-old children was developed.

During 1991-2003, the weekly course schedule for upper elementary education schools included compulsory and elective courses. Among compulsory courses were Turkish, mathematics, science and technology, social sciences, citizenship and human rights education, T. R. history of reforms and Kemalism, foreign language, religious culture and ethics, visual arts, music, physical education, work education, traffic and first aid. Electives included computer, dramatization, eloquence and calligraphy, second foreign language, agriculture, tourism, and regional crafts. The number of weekly overall course hours at each grade level was 30 hours including 28 hours of compulsory courses and 2 hours of electives, and the number of weekly mathematics contact hours for upper elementary schools was 12 hours, consisting of 4 hours for each grade level.

Goals and Objectives of Mathematics Education

The general objectives and goals of the mathematics curriculum in primary schools were to produce students with positive attitudes towards mathematics, who would contribute to the needs of the society, who had thinking skills to solve mathematical problems, who had the ability to apply mathematical knowledge and skills to real life, and who had creative, critical, and reflective thinking skills. For each mathematics unit, considering the general aims and objectives of mathematics education, the grade level, and the level of students’ mental and physical development regulated objectives and behaviors.

Improving students’ problem solving ability was defined as “the first goal of education” (MEB, 2002, p. 15). Mathematics problems should be related to daily life and appropriate to students’ levels of development, and the problems should progress from easy ones to more difficult ones. Students, while solving a problem, were to give preference to the shortest route to a solution and, therefore, improving the students’ capacity for mental computation was stressed.

The relation between mathematics and daily life was also highly emphasized. Mathematics was seen as a tool for facilitating real life; mathematics classes were responsible for developing rote computation and basic arithmetic (addition, subtraction, division, multiplication) skills needed for daily life, skills to use mathematical tools (such as graphics), and skills to compute some routines of daily life (such as percent, interest, discount).

The other objectives of mathematics were to develop knowledge of geometric shapes and their interrelationships, to acquire skills to calculate the area and volume of geometric shapes, to apply the properties of geometric shapes to the problems of real life, and to gain a basic knowledge of trigonometry, probability and statistics. The mathematical methods of analysis, deduction and induction were also highlighted as important skills to be achieved by the students.

The mathematics program of 2002 recommended that mathematics teachers integrate technological tools into mathematics classes, that teachers use group study activities (under guidance of the teacher) besides individual learning techniques, and that teachers connect mathematics to other subjects. The assessment part aimed to evaluate the level of students’ progress in attaining the goals and objectives defined in the program. Examinations, homework assignments, and classroom observations were offered as tools for teachers to evaluate and assess students’ progress.

From 1997 to 2004, even though the goals of the mathematics curriculum did not change at all, the organization of the mathematics curriculum underwent some changes. After 1997, teachers were recommended to employ more motivating questions to improve students’ understanding. The topics of combinations and permutations were added to the mathematics curriculum. For each unit, the curriculum of 2002 included lesson plans that were enhanced activities from daily life.

In the primary school mathematics program of 1990, the number of behaviors defined for each topic in mathematics was deemed to be too large and was reduced by omitting some repeating ones (MEB, 1997). Table 1 indicates the fact that the number of behaviors, except for the eighth grade in the primary school mathematics program of 2002, tended to decline from the program of 1990 to the one in 2002. On the other hand, from 1990 through 2002, the number of goals tended to increase or was stable.

Table 1. Total Number of Goals and Behaviors in Mathematics for Grades 6-8

Grade Level	1990		1997		2002	
	# of goals	# of behaviors	# of goals	# of behaviors	# of goals	# of behaviors
6 th	45	488	50	424	53	393
7 th	45	436	45	393	45	379
8 th	33	292	37	262	37	269

Goals and Objectives of the Upper Elementary School Geometry Learning Area

The main goal of geometry education was “the comprehension of the geometric shapes and their relation to each other and to real life because the knowledge of the geometric shapes was deemed to be helpful in developing students’ critical thinking and problem solving abilities and in helping them to relate geometry to other fields of mathematics” (MEB, 1997, p.7).

The use of concrete objects was suggested as the best approach to teaching geometry since it is easier to perceive concrete objects than abstract ones. At the beginning, students were taught the general characteristics of the shapes, such as the number of vertices, and were expected to make some inferences without using formulas, such as computing the circumference of a circle without using π , and then students were expected to discover formulas by making general assumptions from the solutions. It was also suggested that the terms “point, line, line segment, ray, plane, space” be explained with figures and examples before their definitions were given. The objectives of geometry education included the following (MEB, 2002).

At the sixth grade level,

- Comprehension of the concepts of a point, a line, a plane, and a space;
- Comprehension of the concepts of a line segment, and a ray;
- Comprehension of the relations between a point, a line, and a plane;
- Comprehension of angles and the classification of angles;
- Drawing perpendicular, acute, obtuse, straight, and whole angles;
- Comprehension of complementary, adjacent complementary, supplementary, and adjacent supplementary angles;
- Drawing complementary, congruent complementary, supplementary, and congruent supplementary angles;
- Comprehension of the regions separated by a triangle in the plane;
- Comprehension of classification of triangles.

At the seventh grade level;

- Comprehension of congruent angles;
- Basic drawings by using a compass and a ruler;
- Comprehension of components of a triangle;
- Drawing components of a triangle;
- Comprehension of the relationships between the angles and the sides of a triangle;
- Skill of computing angles of a triangle;
- Comprehension of the concept of polygons;
- Comprehension of the concept of quadrilateral, parallelogram, rectangle, rhombus, square, trapezoid, and deltoid (kite), and relationships among them;
- Computing the circumference of a parallelogram, a rhombus, a square, a trapezoid, and a deltoid;
- Computing the area of a parallelogram, a triangle, a rhombus, a trapezoid, and, a deltoid;
- Sketching the Turkish flag;
- Knowledge of circles and discs, and related terminology;
- Comprehension of the relations between a line and a circle;
- Comprehension of the concepts of arcs and angles of a circle;

- Skill of drawing a circle and a tangent line to a circle;
- Computing area and circumference of a disc;
- Comprehension of properties of a right circular cylinder;
- Computing area and volume of a right circular cylinder.

At the eighth grade level;

- Comprehension of the line segment properties related to ratio and proportion;
- Comprehension of similar triangles;
- Comprehension of congruent triangles;
- Ability to solve problems related to similarity of triangles;
- Skill of drawing triangles;
- Comprehension of Pythagorean theorem and similar triangles composed by the altitude in a right triangle;
- Applying Pythagorean theorem to real life situations;
- Comprehension of trigonometric identities of acute angles;
- In a right triangle, comprehension of trigonometric identities of angles measuring 30, 60, and 45;
- Using a trigonometric table;
- Applying trigonometric ratios to mathematics problems;
- Drawing a line when its equation is given;
- Comprehension of slope;
- Comprehension of inequalities with two variables.

Contents of the Upper Elementary School Geometry Learning Area

In the area of geometry, starting from first grade, the definitions and properties of geometric shapes were given, and an understanding of the relationship between geometric shapes was to be achieved by the students. But, after 1997, the topics “point, segment, and line segment” were omitted from the first grade mathematics curriculum since the first graders’ abstract thinking abilities were deemed insufficient to grasp these topics. The contents included in the upper elementary school geometry learning area were defined in MEB (1990), in MEB (1997) and in MEB (2002) as follows.

Upper Elementary School Geometry Learning Area at the 6th grade (1991-2003)

Unit VI. Point, Line, Plane, Space, Line Segment, and Ray (6 lecture hours, 4%)

- Point, Line, Plane, and Space
- Line segment and Ray
- Interrelations between Point, Line, and Line Segment

Unit VII. Angles, Triangles, and Their Classification (9 lecture hours, 7%)

- Angles and classification of angles
- Complementary and Supplementary Angles
- Classification of Triangles

Total: 15 lectures.

Upper Elementary School Geometry Learning Area at the 7th grade (1991-2003)

Unit V. Angles and Polygons (18 lecture hours, 12%)

- Congruent Angles
- Basic Drawings
- Components of a Triangle
- Relationship Between Sides and Angles of a Triangle
- Polygons
- Quadrilaterals and Relations between Their Components
- Circumferences of Parallelogram, Rhombus, Square, Trapezoid, and Deltoid
- Areas of Parallelogram, Triangle, Rhombus, Trapezoid, and Deltoid
- Sketching Turkish Flag

Unit VI. Circle, Disc, and Cylinder (12 lecture hours, 9%)

- Circle and Disc
- Relations between Line and Circle

- Arcs and Angles in a Circle
- Computing Area and Circumference of a Disc
- Right Cylinder and Its Properties
- Computing Volume and Area of a Right Cylinder

Total: 30 lectures.

Upper Elementary School Geometry Learning Area at the 8th grade (1991-2003)

Unit III. Proportioned Line Segments and Similar Triangles (36 lecture hours; 25%)

- Ratio and Proportion of Line Segments
- Similar Triangles
- Congruent Triangles
- Problems Related to Similarity
- Drawing Triangles
- Pythagorean and Euclidean Theorems in Right Triangles
- Trigonometric Ratios in Right Triangles
- Problems Related to Trigonometric Ratios
- Line Formula
- Slope of a Line
- Inequalities with Two Variables

Total: 36 lectures

Table 2 presents the percent of the entire upper elementary school curriculum devoted to geometry lectures in 2002. The total number of geometry hours tended to increase from the sixth grade through the eighth grade. At seventh grade level, the students' exposure to geometry was doubled with 30 lectures of geometry courses composing 21% of the total number of lectures at the same grade level.

Table 2. *Percent of Upper Elementary School Curriculum Devoted to Geometry Lecture Hours in 2002*

Level	Total Geometry Lectures	Percent of all Lectures
6 th	15	11
7 th	30	21
8 th	36	25

Upper Elementary School Geometry Education during the Post-reform Period (2004 to the present day)

In 2005, with Law No.12438 dated 11/18/2003, the Ministry of Education decreed the testing of a new primary school (grades 6-8) mathematics program in pilot primary schools. The implementation process would be in stages: for sixth grades in the academic year 2005-2006, for seventh grades 2006-2007, and for eighth grades 2007-2008. One year after piloting, the curriculum was revised based on feedback obtained through the pilot administration and implemented nationwide.

Until 2005, primary schools and secondary schools were of eight years (five years of elementary school education and three years of upper elementary school education) and three years duration respectively. With Law No. 6232, which became effective in 2005, starting from the academic year 2005-2006, the length of secondary school education was extended to four years. As was the case in the pre-reform period, each academic year consisted of two semesters.

After 2003, the weekly course schedule for upper elementary education schools included compulsory and elective courses. Among compulsory courses were Turkish, mathematics, science and technology, social sciences, T. R. history of reforms and Kemalism, foreign language, religious culture and ethics, visual arts, music, physical education, technology and design, traffic and first aid, and guidance/social activities. Electives included foreign language, artistic activities, sportive activities, IT technologies, chess, thinking education (creative, critical, and reflective thinking), agriculture, folk culture, and media literacy (added in the 2007-2008 academic year). The number of weekly overall course hours at each grade level was 30 hours, including 28 hours of compulsory courses and 2 hours of electives, and the number of weekly mathematics contact hours for upper elementary schools was 12 hours, consisting of 4 hours for each grade level.

Goals and Objectives of Mathematics Education

The new mathematics program defined as the general objectives and goals of mathematics education at the upper elementary school level (MEB, 2005a) to produce students with

- an understanding of the mathematical concepts and systems, their interrelationships, and the ability to apply these concepts and systems in daily life and in other academic subjects,
- the mathematics knowledge and skills for their higher education,
- the ability to use *deductive* and *inductive* methods,
- the ability to use their own mathematical reasoning and thinking while solving problem,
- the ability to use correct mathematics terminology to explain their mathematical thinking,
- the ability to make efficient use of prediction and mental computation,
- the ability to develop problem solving strategies and apply them to real life situations,
- the ability to construct mathematical models,
- self-esteem and positive attitudes toward mathematics,
- a belief in the power of mathematics and the interconnected structure of mathematics,
- a comprehension of the historical development of mathematics, the role of mathematics in the improvement of human thinking, and uses of mathematics in other disciplines,
- scientific, attentive, patient and responsible attitudes,
- the ability to relate mathematics to the arts (p. 9).

According to *Elementary School Mathematics Teaching Program (Grades 6-8)* (MEB, 2005a), the fundamental principal of the mathematics program was the notion that “every child can learn mathematics” (p. 7). The new mathematics program placed a heavy emphasis on promoting teaching and learning environments in which students can share their ideas and actively participate. The mathematics program also emphasized improving students’ understanding of relations between mathematical concepts and improving their skills of problem solving, creative and critical thinking, decision making, using information technologies, entrepreneurship, investigation, communication, reasoning, and association. In the program, special attention was given to four of the mathematical skills: problem solving, reasoning, communication, and association. For each mathematics topic, examples of curricular activities with associations to the other topics and subjects were also provided in the mathematics program.

Among the main concepts of the elementary school mathematics program of 2005, problem solving was emphasized: “Problem solving should be an inseparable part of mathematics course and mathematics activities” (MEB 2005a, p.10). Mathematics problems were recommended to be motivating and appropriate to the students’ lives. The emphasis while evaluating students’ work should be placed on the problem solving process rather than the final answer. According to the new mathematics program, success in problem solving increases students’ self-esteem; therefore, teachers were responsible for asking guiding questions when students could not find their way to a solution.

As far as mathematics teaching and learning was concerned, the mathematics program of 2005 stressed that teaching should begin with concrete experiences, that meaningful learning should be sought, that students should communicate using their mathematical knowledge, that mathematics teaching should be organized based on appropriate teaching phases (consisting of introduction, investigation, explanation, advancement, assessment), that an emphasis should be on association, student motivation, efficient uses of technology, and learning based on collaboration. For meaningful learning, the curriculum encouraged teachers to use realistic tasks and to consider the outside contextual elements, such as lifestyle and geographical factors, while designing classroom tasks.

While assessing students’ progress, teachers were recommended to take account of whether students can apply mathematics to daily life, whether students’ skills of problem solving, reasoning, association and communication abilities are improved, what behaviors students hold towards mathematics, and how much self-esteem students have in mathematics. The program also emphasized that previous knowledge affects the gains in the future, and this deficiency or inaccuracy in learning impedes constructing on it. In order to prevent these impediments, in-class examinations, discussions, presentations, experiments, exhibitions, projects, observations, conservations, portfolios, self-evaluation, and peer evaluation are suggested for use

in evaluating pupils' progress. Rubrics, checklists, and diaries are also among the tools for evaluating students' work.

Students were encouraged to be mentally and physically ready for active participation in the mathematics learning process; students were encouraged to be responsible for their learning, to negotiate and interrogate ideas, to ask questions, to listen, to establish and solve problems, to think, to argue, and to study in groups. On the other hand, among the responsibilities of teachers was improving their own professional knowledge and experiences through activities (such as conducting small-scale research projects), guiding and motivating students, interrogating, listening to students, and allowing students to ask questions. Teachers were also charged with developing and implementing instructional activities that promote mathematical understanding, regularly monitoring and assessing student learning, employing alternative assessment strategies such as observation checklists, portfolio and other performance-based assessments, using assessment and evaluation results to improve the quality of instruction effectively managing instructional time, and encouraging students to evaluate their own and their peers' progress. Furthermore, mathematics teachers should collaborate with parents, other school personnel, and the outside community to improve the quality of schooling.

Goals and Objectives of the Upper Elementary School Geometry Learning Area

The new upper elementary mathematics curriculum consisted of five learning areas: numbers, geometry, measurement, probability and statistics, and algebra. Each learning areas was supported by sub-learning areas. Learning outcomes, resembling the goals defined for each grade level in the previous mathematics program, were defined for each sub-learning areas.

From the first grade through the fifth grade, the main principle of the geometry course was to introduce and classify the geometric shapes and objects based on their visual characteristics. From the sixth grade until the end of the eighth grade, the geometry program aimed to improve the students' abilities to think geometrically, to determine the relations between the geometric shapes and objects, to classify geometric shapes and objects by using a minimum number of characteristics, to teach tessellations with planar shapes, to teach students to determine and use symmetry, and to teach students to use geometric tools and materials.

After the reports obtained from the pilot schools, the counseling studies implemented in the pilot schools, the textbook writing and evaluation committee, the program introduction and evaluation seminar, and the questionnaires given to the mathematics teachers, the learning outcomes of the mathematics program of 2005 had undergone some changes. The latest version of the learning outcomes defined for the geometry was the following;

At the sixth grade level students were expected to;

- explain the relationship between a line and a point;
- explain a line segment and ray and denote them by appropriate symbols;
- by using paper folding, or ruler and compass, construct a line segment equal to another line segment;
- identify parallel, intersecting, and perpendicular lines;
- identify the relationships (parallel, intersecting in one point, one contains the other) between a line and a plane in space;
- construct an angle that is congruent to another angle and divide an angle into two equal angles by using paper folding, or ruler and compass;
- explain the properties of adjacent, complementary, supplementary, and opposite angles;
- construct polygons (n-gons) by using paper folding, computer programs, or ruler and compass;
- classify triangles based on their angles and sides;
- identify the relationships among the angles, sides, and diagonals of squares and rectangles;
- explain the relationship between congruency and similarity;
- identify the side and angle properties of congruent and similar polygons;
- define translating a figure;
- construct the image of an object after translation;
- construct patterns using equality and similarity of polygons and polygonal areas;
- makes tessellations by translation;
- identify the basic elements of prisms;

- draw the images of the structures composed of congruent cubes from different aspects.
- At the seventh grade level students were expected to;
- construct the perpendicular bisector a line from a point on or external to the line by using compass and ruler;
 - construct the perpendicular bisector of a line by using compass and ruler;
 - construct a parallel to a line from a point external to the line by using compass and ruler;
 - determine and construct the conditions of three lines (all parallel, two of them are parallel and are intersected by the third one, any two intersect, all intersect in one point) in the same plane;
 - determine and name corresponding, interior, reverse interior, exterior, and reverse exterior angles;
 - determine the identical and supplementary angles which are formed by two parallel lines and a cutting line;
 - determine the diagonals, interior, and exterior angles of the polygons consisting of triangles, rectangles, squares, parallelogram, rhombus, trapezoid, deltoid;
 - determine the characteristics of the side, angle, and diagonals of the quadrilaterals;
 - compare polygons and determine whether they are equal, and construct polygons congruent to a given polygon by using computer programs;
 - define a circle is and construct circle models;
 - determine the possible relations of a circle and a line (tangent, intersects in two points, or outside);
 - determine the central angle, the perimeter angle, and the arcs of these angles in the circle and the disc;
 - determine the relations of the measure of the central angle and the perimeter angle which subtend the same arc;
 - determine, construct, and elaborate the major elements of the circular cylinder;
 - with the unit cubes, constructing an object based only on the image of its top, side or front view;
 - define reflection over a line;
 - define the action of rotation about a point;
 - draw figures by rotating them around a point in the plane according to a given angle;
 - cover an area with the polygonal area models and make tessellations;
 - determine codes of the tessellations which were constructed with regular polygonal area models;
 - make tessellations with the actions of reflection, transition, and rotation.
- At the eighth grade level students were expected to;
- explain the importance of the suggestions made by Ataturk in mathematics;
 - determine the relation of the sum or difference of the length of the two sides of a triangle and the length of the third side;
 - determine what relationship exists between the size of a triangle's side and the measure of the respective side's opposite angle;
 - construct a triangle given the measures of its sides, two angles and the included side, or two sides and the included angle;
 - build the median, angle bisector, and altitude of a triangle by using paper folding or compass and ruler;
 - explain the congruency theorems (SAS, ASA, SSS, AAS) of triangles;
 - explain the similarity theorems of triangles (AAA, SSS, SAS);
 - construct the Pythagoras relation;
 - determine the trigonometric ratios of the acute angles in a right triangle;
 - construct a triangular prism, specify its basic elements and draw the net of the surface;
 - construct a pyramid, specify its basic elements and draw the net of the surface;
 - specify the basic elements of a cone, construct it, and draw the net of the surface;
 - specify the basic elements of a sphere and construct it;
 - specify the intersection of a plane and a geometric object and construct it;
 - classify a polyhedral;

- form the structures whose drawings are given by using cubes, and draw the views of structures that are formed by cubes;
- construct patterns by using lines, polygons and circles and draw these patterns, and specify fractal ones;
- specify and draw the views of polygons that are reflected according one of the axes, translated along a line, and rotated around the origin in the coordinate plane;
- specify symmetries of geometric objects;
- specify and construct the translated symmetry of figures;
- draw perspective views of a cube and prism from a given distance.

Contents of the Upper Elementary School Geometry Learning Area

The contents included in the new upper elementary school geometry learning area were defined in MEB (2005a) as the following:

At the sixth grade level;

- Line, Line Segment, Ray (8 lecture hours, 5%)
 - Angles (4 lecture hours, 3%)
 - Polygons (6 lecture hours, 4%)
 - Congruency and Similarity (2 lecture hours, 1%)
 - Geometry of Transformation (4 lecture hours, 3%)
 - Patterns and Tessellations (4 lecture hours, 2%)
 - Geometric Objects (4 lecture hours, 3%)
- Total: 32 lecture hours, 21%

At the seventh grade level;

- Lines and Angles (3 lecture hours, 2%)
 - Polygons (6 lecture hours, 4%)
 - Congruency and Similarity (3 lecture hours, 2%)
 - Circle and Disc (4 lecture hours, 3%)
 - Geometric Objects (3 lecture hours, 2%)
 - Geometry of Transformation (3 lecture hours, 2%)
 - Patterns and Tessellations (3 lecture hours, 2%)
- Total: 25 lecture hours, 17%

At the eighth grade level;

- Triangles (10 lecture hours, 7%)
 - Geometric Objects (10 lecture hours, 7%)
 - Patterns and Tessellations (2 lecture hours, 1%)
 - Geometry of Transformation (4 lecture hours, 3%)
 - Geometric Projection (2 lecture hours, 1%)
- Total: 28 lecture hours, 19%

Changes in the New Upper Elementary School Geometry Learning Area

The discussion of the upper elementary geometry education in Turkey during the pre-reform and post-reform period examined the general objectives of mathematics education, the goals and objectives of geometry education at upper elementary schools, and the contents of the geometry learning area at upper elementary grades. Changes appearing in the new upper elementary geometry learning area were also executed under four headings: goals and objectives of mathematics education for upper elementary schools, pedagogy, objectives of the upper elementary geometry learning area, and contents of the upper elementary geometry learning area.

Goals and Objectives of Mathematics Education

Mathematics education of the pre-reform period can be defined as behaviorist since the general aims of mathematics education were regulated by defining objectives and behaviors for each topic. On the other hand, during the post-reform period, the mathematics program followed a constructivist approach with the idea that students need to use their own mathematical reasoning and thinking while solving problems.

The general view behind the new program was that every child can do mathematics, and that students were responsible for their learning; in contrast, in the old mathematics program, teachers were appeared to

take all responsibility for students learning. The notion that the objectives and behaviors defined in the mathematics learning area during the pre-reform period were regulated by considering students' grade levels and their development suggests that one is not to teach the same mathematics to every student since these goals and behaviors of the old learning area determined the contents of the mathematics course.

Before 2004, mathematics was seen as a tool to facilitate daily life; mathematics classes were responsible for developing skills (such as basic arithmetic and memorization) for computing routines of daily life. On the other hand, starting from 2004, mathematics gained further meaning as a science, which is related to the other sciences and the arts, applicable to real life situations, and charged with improving human thinking.

Changes in process skills were also emphasized in the curriculum. For example, there was increasing emphasis on such macro skills as problem solving, reasoning, communications, association, and use of information technologies, as well as on such micro skills as computation, mental calculation and estimation. Among them, four skills were emphasized throughout the curriculum: problem solving, reasoning, communication, and connections. Both programs put high emphasis on problem solving but with different approaches to implementing problem solving in the mathematics curriculum. According to the old mathematics program, problems were to be applicable to real life and given in an order, starting from easy ones and gradually choosing more difficult ones. The upper elementary school mathematics program defined the central aim of problem solving as coming up with the final answer by employing the shortest method. But in the new mathematics program, problem solving, an inseparable part of the program, aimed to evaluate the whole process rather than the final answer. The program also required using motivating problems, which are related to real life. Teachers' guidance when needed was also stressed in the mathematics program of the post-reform period.

During the post-reform period, the mathematics program was based on the notion that students shall actively participate in the learning process. Students were required to negotiate and interrogate their ideas, to ask questions, to listen, and collaborate with other students. In order to elaborate these ideas, the new program provided activity samples for teachers to prepare effective teaching and learning environments. Although the mathematics program of the pre-reform period also identified the importance of reflective and critical thinking, group work, uses of technology, and classroom activities, the program did not provide activity samples for classroom instruction.

Pedagogy

The most prominent change lies in the way the content is delivered. Such constructivist pedagogies as active learning, use of manipulative, cooperative learning, and the use of realistic and authentic tasks were emphasized in the new curriculum. Therefore, students should not only be physically but also mentally active in the learning process. Such an approach required the teacher take new roles such as questioning, arranging, and organizing while reducing other roles such as telling, instructing, dictating.

The old curriculum perceived the teacher as the centre of the teaching and learning process. Teachers were responsible for students' learning. In particular, the teacher was identified as the only decision maker, the information provider and the authority in the classroom. The teachers were in charge of transferring knowledge to the students without placing emphasis on understanding. As a result, students were seen as passive receivers of the information. This philosophy of the old curriculum did not provide enough room for students to engage in essential thinking processes, including problem solving, multiple representations, communication, and making connections. On the other hand, the important characteristic of the new curriculum was to provide learning experiences for students with diverse intelligences and abilities. According to the new mathematics program, teachers were the providers of guidance in students' learning. In order to help students' learn, teachers were to prepare environments where students may research, discover, and communicate. Teachers were also responsible for emphasizing association, motivating students, efficiently integrating technology into the classroom environment, and employing collaborative learning strategies supported with tasks and activities. Additionally, the new program differed from the old program by placing an emphasis on alternative assessment strategies such as observation checklists, portfolio and other performance-based assessments.

Goals and Objectives of the Upper Elementary Geometry Learning Area

During the pre-reform period, the aims of the upper elementary geometry learning area included the conception of geometric shapes and their relationships. In addition to these aims of the old curriculum, the new upper elementary geometry learning area of 2004 focused on improving geometric thinking and classifying geometric shapes and objects with a different approach: "classifying by using a minimum number of characteristics (MEB, 2005a, p.38)." The new mathematics program defined mathematics as a

“science of patterns” (p. 38), which was interested in patterns including objects and concepts rather than immanent nature of an object or a concept. The new program also stated that “tessellations, beside their roles in understanding concepts, properties and relations in mathematics and improving judgment and creative thinking, have an important role in improving aesthetic senses and gaining positive attitudes towards mathematics since they are included in Turkish culture (p. 38).” Therefore, starting from the sixth grade, understanding the concepts of “patterns and tessellations” with sub-learning areas of “symmetry, translation, rotation, reflection, and projection” was a new objective included in the upper elementary school geometry learning area. Without any explanation, the new curriculum did not include sketching the Turkish flag.

During the pre- and post-reform period, the mathematics program pointed out that geometry learning should start with concrete examples followed by definitions and properties. But, consistent with the view that the new mathematics program employs a constructivist model rather than the behaviorist model of the pre-reform period, the notion of “constructing” replaced the concept of “drawing.”

After the reform movement, some concepts of the previous geometry learning area were included in other learning areas. At the eighth grade level, comprehension of equations of lines and inequalities with two variables was included in the “algebra” learning area during the post-reform period whereas it was included under geometry during the pre-reform period. On the other hand, the comprehension of properties of a pyramid, a triangular prism, a cone, and a sphere was included in the new eighth grade geometry learning area; however, these concepts appeared in the measurement learning area in the old mathematics curriculum. But, the reasoning behind these changes was not stated in the new program.

The new geometry learning area for upper elementary schools underwent some adjustments in the order of topics by moving some topics to an earlier grade and by delaying some to later grades. At the sixth grade level, the new geometry learning area aimed for students to comprehend congruent angles, to identify the relationships among angles, to understand the properties of the diagonals of a square and a rectangle; those objectives appeared at the seventh grade level in the previous geometry learning area. But the students were expected to determine the relationships between sides and angles of a triangle, to draw an angle whose elements’ measurements were given adequately, and to build components of a triangle at the eighth grade level after the reform movement while these were done by the seventh graders before the reform of 2004.

Although it was not stated, the changes brought forth by the program imply that the new goals and behaviors of the geometry learning area for upper elementary schools were student oriented rather than teacher centered as in the past. In order to be consistent with the general aims of geometry defined in the new program, the geometry learning area was restricted by moving some topics to other areas. (For instance, comprehension of the line formula was included in algebra.) Some new concepts such as patterns and tessellations were added to the geometry learning area to empower the association of geometry with real life. The adjustments mentioned above were made to maintain meaningful learning and to demonstrate the interconnected structure of geometry. The new geometry curricula also aimed to classify geometric shapes with a minimum number of characteristics, in line with the general aim of producing creative and reflective thinking students. The idea of constructivism was also utilized to strive for meaningful learning through active participation.

Contents of the Upper Elementary Geometry Learning Area

The number of weekly overall hours did not changed during the reform movement: 30 hours including 28 hours of compulsory courses and 2 hours of electives. During the post-reform period, the weekly mathematics contact hours for upper elementary grades remained unchanged at 4 hours. The reform movement saw some changes in the weekly course schedule for upper elementary schools. The new schedule did not include the courses named Work Education, and Citizenship and Human Rights, which were among the compulsory courses in the old schedule. Technology and Design, and Guidance/Social Activities were the new compulsory courses included in the weekly course schedule released after the reform movement.

During the pre-reform period, geometry classes composed 11%, 21%, and 25% of all courses at the sixth seventh and seventh grades respectively. On the other hand, the percent of the entire upper elementary school curriculum devoted to geometry lectures was increased to 21 at the sixth grade level, decreased to 17 at the seventh and 19 at the eighth grades after the reform movement of 2004.

Figure 1 and Figure 2 present changes in the quantity of the geometry classes with the new geometry learning area. After the reform movement of 2004, the distribution of the geometry classes is more consistent. The huge gap related to the total number of upper elementary school geometry hours between sixth and seventh grade was reduced in favor of sixth graders; in contrast to the pre-reform period, the

sixth graders were exposed to the most geometry hours (32 lectures) during the post-reform period. The fact that the total number of weekly geometry lectures was decreased at the seventh and eighth grade levels after the reform movement can be explained by the fact that some topics of the past geometry curricula at these levels were moved to the other learning areas during the post-reform period. For example, the line formula for a line was included in the algebra learning area after the reform movement.

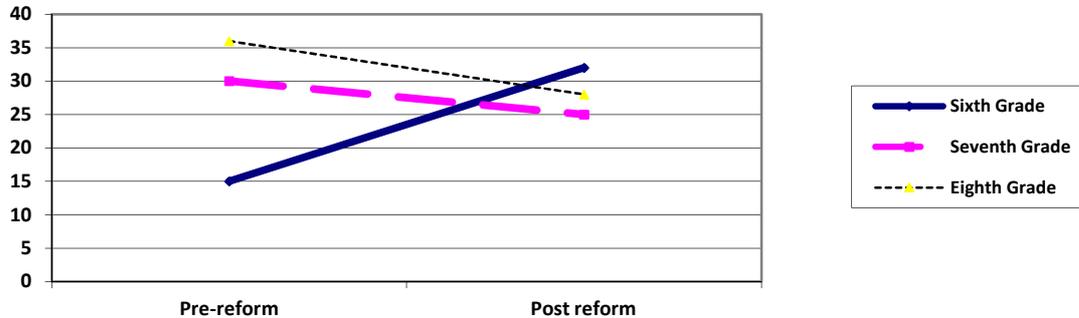


Figure 1. Pre-Reform vs. Post-reform: Total Number of Geometry Lectures

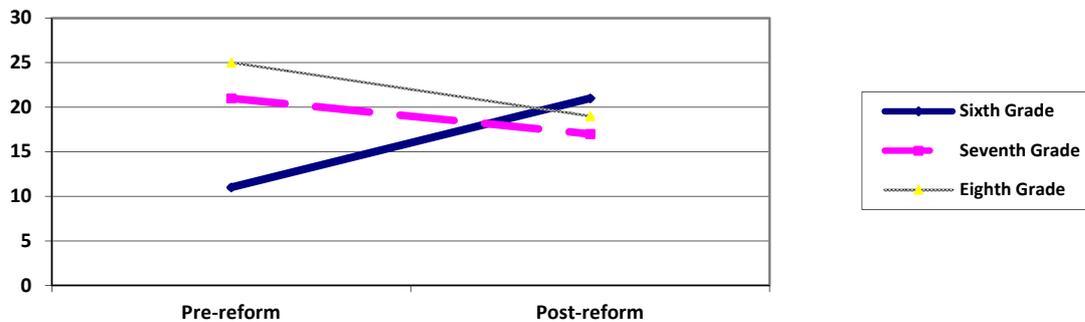


Figure 2. Pre-Reform vs. Post-reform: Percent of all Lectures Devoted to Geometry

As far as the content of new upper elementary school curriculum was concerned, Geometry was appeared to be presented at the introductory level for secondary school geometry education during both periods. Proofs using paper-scissor activities and informal definitions replaced rigorous proofs and formal mathematical definitions. “Geometry of transformations” (Translation, Rotation, and Reflection), “patterns and tessellations,” and “geometric projection” were among the new topics offered in the curriculum starting from the sixth grade. On the other hand, “sketching the Turkish Flag” was no longer offered.

After the reform movement, consistent with the changes in the objectives of the new geometry learning area, some topics of the previous geometry learning area were moved to other learning areas. Circumferences, Areas, and Volumes of geometric shapes were included in the “measurement” learning area in the new geometry learning area whereas these were included under the subject of geometry before the reform movement. At the eighth grade level, the topics Line Formula and Inequalities with two Variables were included in the “algebra” learning area during the post-reform period whereas they were included in geometry during the pre-reform period. On the other hand the topic Geometric Objects including pyramids, triangular prisms, cones, and spheres was offered in the new eighth grade geometry learning area; however, these concepts were included in the measurement learning area in the old mathematics curriculum.

The new geometry learning area for upper elementary schools had undergone some adjustments in the order of topics by putting some topics in earlier grades and by delaying some of them to later grades. At the sixth grade level, the new geometry learning area offered congruent angles, angle relations, polygons; those topics were offered at the seventh grade level in the previous geometry learning area. The new curriculum also introduced “similarity” for the first time at the sixth grade whereas the students had to wait to meet it until the eighth grade during the pre-reform period. On the other hand, the students were taught the relationships between sides and angles of a triangle, construction of an angle whose elements’

measurements were given adequately, and building components of a triangle at the eighth grade level after the reform movement while these were done by the seventh graders before the reform of 2004.

What could be the reasoning behind these changes during the post-reform period? Consistent with the general objectives of mathematics education, the new upper elementary school schedule included some new electives: Thinking Education for improving creative, critical and reflective thinking, IT Technologies for using new technological tools and investigating, and Media Literacy for exploring the world and negotiating ideas. In order to achieve the goals and objectives defined for upper elementary school geometry learning area, some curricular adjustments were made during the post-reform period.

The view that students should actively participate in their learning was supported with curricular activities and constructivist teaching methods. Adding new topics such as patterns and tessellations increased real life connections. Integrating technology into the classroom instruction was put into practice with the curricular activities.

The curricular adjustments were made to achieve meaningful learning and to support interconnected structure of the geometry learning area. For example, starting from sixth grade, the topic “congruency and similarity,” which had been included at the eighth grade before 2004, was included in the new geometry learning area.

Conclusions

The purpose of this study was to consider how upper elementary school (grades 6 through 8) geometry education in Turkey has evolved since the reform movement in 2004. The question was developed to examine changes in the upper elementary school geometry learning area. Differences in each period (the pre- and post- reform periods) of the upper elementary geometry learning area were described and compared in terms of goals and objectives of mathematics education, goals of and objectives of the geometry learning area and content of the geometry learning area. Based on the parts a, b, and c of the research question, a general conclusion was that changes in the Turkish geometry education at the upper elementary level had been mostly limited with the rhetoric after 2004.

During the pre-reform period, mathematics education appeared to be based on a behaviorist approach. For each topic, general objectives and behaviors to be gained were pre-defined in the curriculum. During the post-reform period, mathematics education, adapting a constructivist approach, stressed the responsibility of the students for learning mathematics and for using their own mathematical reasoning and thinking while solving problems. In the old program, students were to be passive receivers of information while teachers, as the center of the teaching and learning process, were loaded with all responsibility for students’ learning. On the other hand, the new program highly emphasized that every student can do mathematics. Teachers were seen as providers of guidance in students’ learning and responsible for preparing a classroom environment where students may research, discover, and communicate, while students were defined as active learners who negotiate, explore, critique, and collaborate.

The notion that geometry learning should start with concrete examples followed by definitions and properties was also championed in the new curriculum. The goals and behaviors of the new geometry learning area for upper elementary schools were student oriented rather than teacher centered as in the past. Geometry, presented at the introductory level for secondary school during both periods, employed proofs using paper-scissor activities and informal definitions rather than rigorous proofs and formal mathematical definitions. In order to be consistent with the general aims of geometry defined in the new program, the geometry learning area was restricted by moving some topics to other areas, by delaying some concepts to the later grades and by taking some others to the earlier grades. (For instance, comprehension of the line formula was included in algebra.) Some new topics such as “patterns and tessellations” and “geometry of transformations” were added to the geometry learning area to empower the association of geometry with real life. The adjustments mentioned above appeared to aim at maintaining meaningful learning and to demonstrate the interconnected structure of geometry. The new geometry curricula also aimed to classify geometric shapes with a minimum number of characteristics, in line with the general goal of producing creative and reflective thinking students. The idea of constructivism was also utilized to strive for meaningful learning through active participation. To this end, “constructing” replaced “drawing” in the objectives of the new geometry learning area.

Implications

This study analyzed changes in upper elementary school geometry education in Turkey after 2004. Those analyzing the curriculum of a country should make sure they don’t underestimate the amount of time needed to review documents in the education ministry. It is very tedious and time-consuming. Analyzing other countries’ mathematics education history, which has shaped present educational conditions and the

status of students' mathematical performance, will help to develop a broader understanding of mathematics education overall. Therefore, this study can serve as a useful source about upper elementary school geometry education in Turkey for those who are interested in comparative education as well as a valuable reference for educational policy makers in determining future reform in mathematics education.

Turkish teachers, required adapting new roles with the reform, suffer from lacks of attention given to the teacher training in the whole process of reform (Toptaş, 2006; Bulut, 2007). Teachers, most of whom were inexperienced using concrete materials in teaching mathematics, were also required to use manipulatives that were hard to find in a typical classroom in Turkey (Babadogan & Olkun, 2006; Toptaş, 2006). As a conclusion, the shortage of manipulatives and lack of teacher training may be considered among the barriers to the reform movement.

Finally, in improving the upper elementary school geometry education, this study recommends a continual study of geometry education in Turkey, taking into consideration the actual impact on students because some aspects of the new mathematics curriculum have not been implemented as intended. Association within a learning area and between learning areas, for example, was highly recommended providing students with meaningful learning. As shown in this study, however, such a goal has not been carried out since curriculum did not provide enough opportunities for making associations.

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Genişletilmiş Özet

Bu çalışma, eğitim alanında yapılan reformdan sonra, Türkiye’de ilköğretimin ikinci kademesinde (6., 7. ve 8. sınıflar) geometri öğrenme alanında ne gibi değişiklikler olduğunu araştırmaktadır. Bu amacı gerçekleştirmek için aşağıdaki sorulara cevap aranmıştır: “Türkiye’de, ilköğretimin ikinci kademesinde geometri öğrenme alanı nasıl değişmiştir?”; “2004 reformundan sonra, Türkiye’de ilköğretimin ikinci kademesinde matematik eğitiminin amaçlarında ne gibi değişiklikler olmuştur?”; “2004 reformundan sonra, Türkiye’de geometri öğrenme alanı eğitiminin amaçlarında ne gibi değişiklikler olmuştur?”; “Reformdan sonra, Türkiye’de geometri öğrenme alanının içeriğinde (6-8. sınıflar) ne gibi değişiklikler olmuştur?”

Bu çalışmanın açıklayıcı bir doğası vardır ve içerik analizi metodu kullanılmıştır. İçerik analizi “herhangi bir konuda, sistematize etmek ve araştırmacının amacına yönelik daha önce düzenlenmemiş bilgiyi nicelleştirmek” için kullanılabilir (Fraenkel & Wallen, 2000). Türkiye’de 1991’den 2010’a kadar ilköğretimin ikinci kademesi geometri alanında yapılan değişikliklere kanıt sağlamak için, araştırmada 2004 öncesi ve sonrası geometri alanının amaçları, içeriği ve müfredatta bu alana ayrılan zaman incelenmiştir. İçerik analizi iki döneme odaklanmaktadır: Reform öncesi dönem (1991-2003) ve Reform sonrası dönem (2004-günümüze).

İlköğretim ikinci kademe olan eğitimin 1991 den günümüze kadar olan tanımlaması, 1991 den sonra Milli Eğitim Bakanlığı tarafından yayımlanmış olan dokümanlara dayanmaktadır; bu dokümanlar Talim Terbiye Kurulundan elde edilmiştir. İkinci kademedeki eğitimin genel amaçları ve kazanımları MEB (1990), MEB (1997), MEB (2002) ve MEB (2005a)’da tanımlanmıştır. Haftalık ders programları MEB (1991) ve MEB (2005b) den elde edilmiştir.

Reform öncesi dönemde, matematik eğitiminin davranışsal bir yaklaşım sergilediği görülmüştür. Her konu için, genel amaçlar ve davranışlar müfredatta önceden tanımlanmıştır. Diğer taraftan, reform sonrası dönemde, matematik eğitimi daha yapılandırmacı yaklaşım izlemektedir. Bu dönem müfredatı, öğrencilerin matematik öğrenirken ve problem çözerken kendi matematiksel mantıklarını ve düşüncelerini kullanmada olan sorumluluklarını vurgulamaktadır.

Reform sonrası dönemde, geometri eğitiminin, tanımlar ve açıklamalar tarafından takip edilen nesnel örneklerle başlaması gerektiği vurgulanmaktadır. Yeni dönemde, geometri öğrenme alanının amaçları ve kazanımları, geçmişte olduğu gibi öğretmen merkezli olmak yerine öğrenci merkezlidir. Orta öğretme hazırlık için başlangıç seviyesinde verilen geometri, matematiksel formda verilen tanımlamalar ve kanıtlar yerine daha anlaşılır tanımlamalar ve kâğıt-makas etkinliklerini içeren kanıtlarla yapılmalı ifadesi kullanılmaktadır. Yeni matematik programında belirtilen genel amaçlara uyum sağlamak için, geometri öğrenme konularının içeriğinde ve işleniş sırasında değişikliklere gidildiği görülmektedir. Geometri öğrenme alanının günlük hayatla ilişkisini arttırmak için, Örüntüler ve Süslemeler ve Dönüşüm Geometrisi gibi bazı yeni konular müfredata eklenmiştir. Reform sonrası dönemde yapılan bu değişikliklerin anlamlı öğrenmeyi destekleyici ve geometri konuları arasındaki bağlantıları arttırıcı olduğu görülmektedir. Reform sonrası dönem müfredatının genel amaçlarından biri olan yaratıcı düşünceye sahip öğrenciler yetiştirme prensibiyle uyumlu olarak, yeni geometri müfredatı, geometrik şekillerin mümkün olan en az özelliği kullanarak sınıflandırmasını amaçlamaktadır. Ayrıca, yapılandırmacı görüş, öğrencilerin aktif katılımıyla anlamlı öğrenmeyi sağlamayı hedeflemektedir. Bununla bağlantılı olarak, reform sonrası geometri, öğrenme alanının kazanımlarında, “inşa etme,” sözcüğü “çizme” yerine kullanılmaktadır. Bu çalışmanın

genel sonucu şudur: Yeni dönemdeki geometri öğrenme alanı ile ilgili olan değişikliklerin çoğu geometrinin içeriğinden çok nasıl öğretileceğiyle ilgilidir.

Bu çalışmada, 2004 reformundan sonra Türkiye’de ilköğretim ikinci kademesi geometri eğitiminde olan değişiklikleri de incelemiştir. Bir ülkenin müfredatını incelenmek için o ülkenin resmi kurumlardan elde edilen dokümanlara ayrıntılı bakılması gerekmektedir. Bu iş oldukça meşşakatli ve zaman alan bir iştir. Günümüzün eğitim şartlarını ve öğrencilerin matematiksel başarı durumunu şekillendiren ülkelerin matematik eğitimi tarihinin analizi, matematik eğitiminin daha kapsamlı bir şekilde anlaşılmasına yardım edecektir. Bu yüzden, bu çalışma, eğitim politikacılarının gelecekte yapacakları matematik eğitimi ile ilgili reformun kararlaştırılması sırasında yararlanılabilecek değerli bir referans olacaktır. Bunun yanı sıra, bu çalışma eğitimsel karşılaştırmalarla ilgilenen araştırmacılar için de yararlı bir kaynak olarak kullanılabilir.

Reformla birlikte yeni roller yüklenen Türk öğretmenleri, tüm reform sürecinde öğretmen eğitimine verilen ilginin eksikliğine maruz kalmışlardır (Toptaş, 2006; Bulut, 2007). Matematik öğretiminde kullanılabilir çoğu materyalin kullanımı konusunda deneyimsiz olan öğretmenlerden sınıflarda bulunması zor olan materyalleri kullanmaları istenmiştir (Babadoğan & Olkun, 2006; Toptaş, 2006). Sonuç olarak, materyal eksikliği ve öğretmenlerin eğitimsiz olması reform hareketinin başarıya ulaşmasının önünde duran engeller olarak düşünülebilir.

Geometri eğitiminin kalitesini arttırmak için, reformun öğrenciler üzerinde olan etkilerini araştıran çalışmaların yapılmasını gerekmektedir. Müfredatta belirtilen bazı prensiplerin istendiği şekliyle uygulanıp uygulanmadığı ve uygulanıp/uygulanmama durumlarının öğrenci başarısı üzerine etkileri kapsamlı araştırılmalıdır. Örneğin, bir konu içinde veya konular arasında ilişkilendirme yapılmasının öğrencilerin anlamlı öğrenmesini sağlayacağı şiddetle önerilmektedir. Ancak, müfredatta ilişkilendirmeye yeterli derecede fırsat veren etkinlikler sağlanmadığı için bu amaç gerçekleştirilememiştir.