An Analysis of the Turkish New Elementary Mathematics Curriculum and Textbooks in terms of the Presentation of Geometric Concepts

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Abstract

It is widely accepted that learning becomes more enduring and deeper if geometric concepts are presented in various orientations and dimensions in textbooks. The purpose of this study was to examine how geometric concepts are presented in the Turkish elementary mathematics curriculum and the textbooks in terms of sizes and orientations. For this purpose, the elementary school mathematics curriculum and two sets of textbook series were examined. Results showed that the presentation of the geometric shapes and concepts in both curriculum and textbooks was not systematically handled. It seems that a more systematic approach could be applied in designing the activities for geometry learning. Implications for mathematics education, curriculum design, and textbook writing were discussed.

Key Words: curriculum, geometry, textbooks, dimension, orientation, representations

Introduction

Major international studies such as TIMSS (1999), PISA (2003) have shown that the Turkish Educational System did not work well in producing a quality mathematics and science education at the elementary level. Such international indicators as TIMSS, PISA, and other internal indicators such as some national exams forced the educational system to undergo a major curricular change at both elementary and secondary levels. For 4 years now, the Turkish Ministry of National Education has been in the process of a massive curricular reform in school curricula especially at the elementary level (Babadogan & Olkun, 2006). The curricular change at the elementary level comprises of five different content areas including mathematics. According to the national and international comparative studies, the Turkish students are less successful in mathematics, especially in geometry.

Geometry, which is frequently used in real life, is an important sub domain of Mathematics. To illustrate, the shapes of the rooms, buildings and structures, shapes used for decoration and ornaments are all geometric (Baykul, 2002). Additionally, if a student has good knowledge of geometry, it becomes beneficial for other disciplines as well. According to Strutchens, Harris and Martin (2003), students start to express and understand the world around them, analyze and solve the problems by means of geometry, and they can express the abstract symbols by shapes in order to understand them better. It is suggested that children examine the direction of objects in space, their positions and orientations and perspectives, related forms and sizes of the shapes and objects and the relation of a change of an object to the change on the dimensions (Adam & Powel, 1995) since these types of experiences focusing on the geometrical relations develop the spatial abilities of the children. In fact, learning school geometry has two main functions: one is to improve humans' spatial ability which is a generic skill in many academic and professional fields. The other is to enable the students learn further geometry, mathematics, and other subjects.

Spatial abilities are related to the use of space and geometrical forms (Olkun, 2003). Based on the psychological tests, three sub-factors of the spatial ability have been defined. These are spatial relations, spatial visualization, and mental orientation (Mc Gee, 1979; Burnett and Lane, 1980; Elliot and Smith, 1983; Pellegrino, Alderton and Shute, 1984; Clements and Battista, 1992). When the standards tests that are used to measure these abilities are examined, for the questions related to the spatial relations, the student is required to decide which object given from a group of objects on a piece of paper is the same with the object which is shown but rotated or flipped-over version (Pellegrino et al., 1984). In other

words, it is seen that this is about the capability and ability for a student to rotate or flip over two or three dimensional geometric forms as a whole in his mind and to recognize them in different positions. In short, this factor measures the ability to mentally rotate an object seen from a different angle. Furthermore, it is also expected from the students to respond quickly as well as to decide correctly in these tests (Olkun & Altun, 2003).

The abilities to visualize new conditions of the two and three dimensional objects and the images of these objects consisting of one or more elements formed by moving them in three dimensional spaces are also dealt within the spatial visualization (Burnet & Lane, 1980; Olkun, 2003). Spatial visualization may include the activities such as folding the segments, refolding them (Mc Gee, 1979), covering the surface (Battista, Wheatley and Talsma, 1989; Smith, Olkun & Middleton, 1999), etc. When the items in the standard tests of spatial visualization are examined, it is seen that mental activities such as converting from two dimensional forms into three dimensional ones by means of complex figures consisting of moving parts and/or mental folding or mental integration are required (Pellegrino, *et al*, 1984). In these tests, the accuracy of the items are attached more importance rather than the speed contrary to the ones in spatial relations (Olkun & Altun, 2003).

Mental orientation is on the other hand is to imagine oneself in a relatively larger environment and finding your way based on the visual information given in the picture, map, or other representational tools. However, it is questionable to measure the mental orientation ability with a paper and pencil test.

As understood from the explanations given for these three abilities, it is seen that spatial thinking is related to the ability of the individual to make mental manipulations and changes on the images belonging to the objects. It is generally claimed that spatial thinking has a high level and positive relation with mathematical thinking (Battista, 1994). Therefore it can be considered that intuitively a development in spatial thinking can form an appropriate ground for the development of mathematical thinking. Although there are contradictory findings in the literature on this issue, some researchers (Ben-Chaim, Lapan, & Houang, 1988; Lord, 1985; Burnett & Lane, 1980) claimed that spatial thinking could be improved by some appropriate tools and activities. These tools and activities generally include playing with two and three dimensional objects and their pictures, measuring them, solving certain problems, forming various structures and drawing their pictures (Olkun & Altun, 2003).

Since Geometry is built on abstract concepts and relations, it is a field of study to be offered with care in the first grade of the elementary education (Toptaş, 2007). Learning the meanings of abstract geometric concepts is directly related to the development and thinking level of the students. Because the concepts are abstract, the method of teaching them to the elementary school students who are in the concrete operational period is highly important. At this point, it is necessary to provide maximum variety in order to form the concept better. For example, while teaching the concept of "triangle" with pictures, providing pictures of triangles at various sizes, angles, and positions is necessary for creating a more rigid and vivid concept of triangle.

The content of the reform based program is an important milestone in the change of the common mathematics education reform (Sherin & Drake, 2006). Considering that the contents of the textbooks consist of the concepts in the curriculum. The way to present students the concepts both in the curricular documents and the textbooks is directly related to the learning of these concepts by the students. Novak and Gowin (1984) express that the concepts should be given in an organized way, they should be meaningful, free from any misunderstanding and be facilitator for learning while students learn the concepts.

The mental formation of the concepts and conceptual relations is realized by giving opportunities to the students for modeling of their own conceptual worlds and by supporting this process (Glasersfeld, 1991). In order for associating different mathematical concepts in learning mathematics, it is necessary to well structure the mathematical content in curricular materials such as textbooks. The teaching of concepts should be developed in a way which will develop the mathematical thinking abilities of the students (Yeşildere & Türnüklü, 2004).

The mathematics education programs should show interest and concern in geometry and spatial relations, so that all the students could analyze the properties and qualities of the two and three dimensional geometric objects; furthermore they should select and use the properties and qualities of the two and three dimensional geometric objects, and different representative systems (NCTM, 2000). Moreover, the teaching of these concepts by associating them with each other is directly related to the presentation of the concepts.

Therefore, it is necessary and important to determine the appropriateness of the presentation of the geometric concepts in the curricular documents, textbooks, and students' workbooks to the geometrical thinking levels of the students. The purpose of this research is to examine the presentation of the geometric concepts in the new mathematics curriculum and mathematics textbooks printed by the Ministry of National Education and by a private publisher for grades 1-5.

Methods

In this research, a case study methodology was utilized. The constant comparison technique was adopted for the analysis and interpretation of the data.

Data Collection Tools

During the research process, written documentation analysis technique has been used (Cohen & Manion, 1992; Ekiz, 2003; Yıldırım & Şimşek, 2005). The written documentation includes the curriculum itself, textbooks and student workbooks prepared in line with the new mathematics curriculum (MEB, 2005).

Analysis of Written Documentation

When observation and interviews are not possible to conduct in the qualitative research, research can be conducted by using written and visual materials. That means document examination or analysis by itself can also work as a research method (Yıldırım and Şimşek, 2005; p.187–188).

The curricular document and text books form the written documents of the research. The way of presentation of the geometric objects and figures in these written documents consist the data resources of this research. The analysis and interpretation of the written documents have been done by directly quoting from when needed or by referring to the written document.

The analysis of the written document has been done in the following stages: First of all, target points in the program have been determined. According to these determinations, the curriculum and the textbooks have been examined. During the examination process, the content of the activities provided in the curricular document and the cases in the textbooks have been compared. The information related to the presentation of the geometric objects and figures given in the curricular document and in the textbooks prepared in accordance with the

curriculum have been documented in writing. The written documentation obtained has been classified by categorizing them according to the sub problems of the research.

Data Analysis and Interpretation

"Constant Comparison Method" which is explanatory for the subject researched in the analysis and interpretation of the data, and enables high level of data interpretation has been adopted. The constant comparative data analysis method was first introduced by Glasser and Strauss (1967), and was developed and used by many researchers (Lincoln and Guba, 1985; Strauss and Gorbin, 1990, 1998; Merriam, 1998). The inductive method has been used in many qualitative data analyses. In other words, the individual reaches to the whole through events or phenomena.

Generally explaining, the constant comparative data analysis includes the codification of the data examined as inductive category and at the same time, the process of the continuous comparison of the data examined. When there are not any data which are similar or covering the similar meanings in this comparison process, a new category is formed. In such cases, some categories formed are eliminated due to the fact that some categories do not exactly reflect the data (Strauss and Corbin, 1998).

Results and Discussion

The findings related to the presentation of the geometric concepts in the Elementary Mathematics (grades 1–5) Education Curriculum are presented in 3 sub titles. These are the presentations of the geometric figures and shapes about orientation and size in the curricular document, the presentations of the geometric figures and shapes about orientation and size in textbooks and workbooks published by the government, the presentations of the geometric figures and shapes about orientation and size in textbooks and workbooks published by a private publisher.

I. Geometric figures in the curricular document

When the presentation of the geometric concepts in the curriculum for 1st grade is examined, it is seen that the presentation of the concepts related to the geometric objects (cube, prism, cylinder cone and sphere) are given by sample activities. In the sample activities, it is asked from students to form models by using geometric objects in different sizes. This means that the size of the geometric objects is taken into account as a variable. No sample activity or explanation related to the orientation was found in the curriculum. In other words, the orientation of the objects is always the same in the 1st grade.

When the presentation of the 2nd grade geometric concepts in the curriculum is examined, when looked at the activities related to the geometric objects, it is seen that two dimensional geometric figures are given together with the print-making activity, getting use of the surfaces of the three dimensional geometric figures in order for two dimensional figures to be perceived as figural, and orientation and size are not mentioned here. It is seen that there was no emphasis related to the orientation and sizes of the geometric objects.

When the presentation of the 3rd grade geometric concepts in the curriculum is examined, the size of the shapes is emphasized by asking the students the use of the objects in their living environment. Furthermore, it is seen that different models are selected for the

surfaces of the geometric objects given in order for the fact that geometric objects can be in different orientations to be perceived. It is seen that different sizes are paid attention at the symbols and models related to the point, and that the different orientations are given. Related to the angle, different angles are given by giving examples from any status of the hour hand and minute hand. In the same way, examples of the right angle formed by the edges of two and three dimensional geometric objects (cube, square models) are provided in different orientations and sizes. That different orientations and sizes are taken into account is understood from the objects and figures used in the classification of the angles. It is seen that illustrative examples in different orientations related to the two dimensional geometric figures (triangle, square, rectangle and circle) are given.

When the presentation of the 4th grade geometric concepts in the curriculum is examined, it is seen that size and orientation are taken into account while explaining properties related to angle. While giving triangle, rectangle and square, they are monotonically (as traditional method) located horizontally on the plane. No information related to the size has been found. It is seen that no explanation or sample activity is given related to the different sizes and orientations of the three dimensional geometric objects.

The curriculum for the 5th grade has some sample models from the living environment of student and in-school and out-school environment. These geometric objects might have been given in order to show the figures in different sizes and orientations. However, that the figures are given horizontally in the plane in order to explain the properties of the geometric objects (cube, rectangular prism, square prism and triangular prism) shows that these are as before presented in a conventional approach. That is to say, it is seen that the presentation is done disregarding the variations in size and orientation of the geometric objects and figures.

II. Geometric figures in government text books and student work books

Regarding the presentation of the geometric figures in the Elementary (1-5) Mathematics Text Books published by the Ministry of National Education; while the size variation is given for all the geometry concepts in the 1st and 2nd grades, it is seen that orientation difference is not presented for the triangular prism in the 1st grade and for the cube, cylinder, cone and circle in the 2nd grade. But it is seen that orientation is paid attention for the other figures in the text books of 1st and 2nd grades. When the text books are examined, it is clear that orientation and size differences are not considered for triangular prism, cylinder and rectangular prism in the 3rd grade; furthermore orientation difference is not considered for cube, sphere, cylinder and cone at this grade, as well as triangle, quadrilateral, rectangle, and square. On the other hand, it is seen that orientation and size differences are given for the geometry objects that constitute the other shapes such as line, ray, line segment, types of lines and point. While size and orientation differences are given for the geometry figures, sample pictures are used. It is even stated that students are required to make models of these concepts by using certain tools and materials. Further, it is seen that size and orientation differences with respect to the concepts are given with sample models. It is also seen from the studies of the text books of 4th and 5th grade the models given as samples are selected from the everyday life of the students (See Appendix 1 Table 1).

As for the presentation of the geometry concepts in the Elementary (1-5) Student Work Books published by the Ministry of National Education, it is seen that the size difference is taken into account in the 1st, 2nd, 3rd, 4th and 5th grades. However, while orientation difference is not given for cube, cylinder, sphere, cone and circle of the geometric

objects in the 2nd grade, and for rectangle and square in the 3rd grade, it is seen that orientation difference is taken into account for the other geometric concepts in the student work book. In the 4th and 5th grades, on the other hand, it is observed that orientation and size differences in the geometry concepts are presented. When the student work book is examined, one can notice that the models given as samples and tools and materials used are rich in diversity and they are specifically relevant to the size. Yet it is seen that the models presented in the student work book regarding the orientation are limited, and at the same time, students are required to make use of pictures as tools and materials (See Appendix 1 Table 2).

III. Geometric figures in the text books and student work books of a private publisher

Regarding the presentation of the geometric concepts in the Elementary (1-5) Mathematics Text Books prepared by a private publisher, it is seen that size difference is given in the 1st, 2nd, 3rd, 4th and 5th grades, yet contrary to this, the same is not done for the orientation difference. To illustrate, one can see that orientation difference is not provided for cube, cylinder, and cone in the 2nd grade. It is clear that other than these concepts, orientation and size difference are taken into account for the presentation of other geometric concepts in the 1st and 2nd grades. Two dimensional geometric figures are tried to be given by getting use of the surfaces and edges of the three dimensional geometric objects in the 3rd grade, but in these types of presentations, differences in orientation and size are not given. But it is seen that the geometric objects are defined. It is further seen that modeling has been utilized for the figures such as line, ray, line segment and point and that orientation and size differences are given in these models. In addition, it can be said that related to the orientation, inclined, horizontal and vertical lines are emphasized. When the Elementary Mathematics 4th grade Text Book is examined in terms of presentation of the geometric concepts, it is seen that orientation and size difference are taken into account. In the 5th grade, while presenting the polygons, regular polygons and quadrilaterals, the orientation and size differences are taken into account on a continues basis both in the tools-materials used, and models and pictures given. Likewise, this diversity is taken into account for the parallel lines, circle and disc in terms of orientation and size (See Appendix 1 Table 3).

The findings related to the Examination of the Presentation of the Geometric Concepts in the Elementary Mathematics (1 - 5) Student Work Book prepared by a private publisher indicate that open – closed figures are not mentioned at all. But it is clear that both orientation and size differences are considered for the other concepts. In the 3rd grade, orientation and size differences related to the intersecting, vertical, horizontal, inclined and parallel lines of the geometric figures; related to the types of angles (acute, wide and right angles); related to the cone, cube, cylinder and sphere of the geometric objects; likewise related to the triangular, rectangular and square prisms of the prisms are not presented. As for the 4th and 5th grades, it is seen that orientation and size differences in cube in the former and disc and pyramids in the latter are not given. At the same time, it is found out as a result of the examination that there is not a comprehensive diversity in the tools and materials and sample models used. On the other hand, orientation and size differences for the other concepts in the 3rd, 4th and 5th grades are given with enriched diversity in terms of tools and materials and modeling (See Appendix 1 Table 4).

The findings can generally be summarized as follows:

The presentation of the orientation and size difference in the government text books and student work books in the Elementary Mathematics Course (1-5) Curriculum for the 4th and 5th grades are parallel to each other. But this parallelism is the case in the 1st, 2nd and 3rd grades. It is seen that the orientation of the certain concepts are given at some grades, they are not presented in others. For example, while the triangular prism is given in the student work book of 1st grade, it is not presented in the text books. But as in the 4th and 5th grades, orientation and size differences are not paid attention in the 1st, 2nd and 3rd grades. As for the books by private publisher, while size difference is taken into account in all grades, orientation is disregarded as is the case in the curriculum and government books. It is also seen that even though certain concepts are included in the curriculum, the private publisher has covered those concepts in their books.

Discussion, Conclusions and Suggestions

The necessity to deal with the orientation and size difference systematically in the presentation of the geometric concepts is emphasized in the introductory parts of the Elementary 1 – 5 mathematics curricula; however this is disregarded in the content. Instead, it is seen that while randomly presenting in various size and orientation of some shapes in some grade, virtually no presentation has been made in some of them. It can be thought that this variety could be provided to some extent with the instructional materials and tools. However, the fact that utilizing the pictures in different size and orientations as well as the concrete materials in the representation of the geometric concepts can enable the formation of the concepts more firmly and sophisticated. From a Piagetian position, the development of more sophisticated spatial concepts involves increasingly systematic and coordinated action on geometric models (Clements & Battista, 1992).

Looking at the text books prepared and written in accordance with the new curricula, the following can be said. While giving the orientation and size difference in the 1st, 4th and 5th grade, it is seen that in some geometric concepts in the 2nd and 3rd grade this is paid attention and in some other, this is disregarded. On the other hand, in a text book prepared by a private publisher, it is seen that the geometry concepts in the 1st, 2nd and 4th grades are presented in different orientation and sizes, but in the 3rd and 5th grades, presentation of some of the geometry concepts are paid attention and some are not.

When looking at the student work books, the following points can be made. While the orientation and size difference are given in the 1st, 4th and 5th grades in the student work book prepared by the Publisher of the National Education, it is seen that orientation and size difference are paid attention in the presentation of some geometry concepts in 2nd and 3rd grades; in some others this is disregarded. In the student workbooks prepared by a private publisher, it is seen that the geometry concepts in the 1st, 2nd and 4th grades are presented in different orientation and sizes, yet in the 3rd and 5th grades, this was not paid attention in the presentation of some geometry concepts. Furthermore, it is seen that some concepts (open – closed figures) are not dealt with in the text books and student work books of the private publishing house. However, it is seen that some concepts (open – closed figures are given in the 3rd grade by the private publishing house though it is given in the 4th grade curriculum and in the publications of the national education) are given in different grades in the publications of the national education and private publishing house; moreover it is seen that the geometric objects are defined though not done so in the curriculum.

As a result, it can be said that a systematic method is not followed in the presentation of the orientation and size differences while the geometry concepts are represented with pictures both in the curriculum and in the textbooks and workbooks prepared according to this curriculum. Textbooks and workbooks play an important role in developing the geometric perception of students because mathematics textbooks are main resources for teachers and students. Therefore, it is claimed that the learning will be more flexible by presenting the geometric concepts in different orientations and size, and in a way which will suit the needs of students in the textbooks. They could identify familiar shapes singly, but not in complex configurations and sometimes not in different orientation. They had great difficulty with the concept of angle (Clements and Battista, 1992, p. 430). In order for the students to explore and learn the geometrical concepts in especially the 1st grade in a better way, as emphasized above, orientation and size differences should be taught systematically starting from the 1st grade as well as including tools and materials from the real environment. When this subject is disregarded, learning comprehensively and in a permanent can be prevented.

According to the NCTM (2000), in the curriculum, it is suggested that the students can select and use the properties and features of two and three dimensional Geometric objects and different representative systems, and convert them. According to the perceptional – visual variance principle of Dienes, if the students learn a concept by using more than one model, the conceptual understanding occurs in the highest level (Olkun and Toluk-Uçar, 2007). It can expressly be argued making use of pictures rather than the realia for the three dimensional objects and concepts restricts the learning of the students. This means not the repetition of the same activity over and over again, but the use of different representation and presentations. The use of different orientation and size representations in the presentation of the geometry concepts means that the concept represents not one example but more comprehensive cases. Therefore conceptual understanding and learning occur in the highest level as referred in Clements and Battista (1992, p. 443) numerous mathematicians and mathematics educators have suggested that spatial ability and visual imagery play vital roles in mathematics thinking. Perhaps underlying this position is the recognition that different modes of thought are used in mathematics.

According to Mathematical variety principle, during the process of generalization (abstraction) of a mathematical concept, while the relevant variable is fixed, the concept is formed by changing the irrelevant variables systematically. For example, while teaching the concept of parallelogram, the necessary properties; 4 vertices and being parallel, are maintained. From this point, one can reach to the definition that "parallelogram is a four-sided figure of which the sides are parallel" (Olkun & Toluk-Uçar, 2007). The fact that presenting the geometric figures in different orientations and sizes by maintaining the relevant properties of the concept constant in each grade level will form and strength the learning of the concept in a permanent and meaningful way.

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APPENDICES

Appendix 1: Geometric figures in the government text books

Table 1. Presentation of the Geometric Concepts in the Elementary 1st, 2nd, 3rd, 4th and 5th Grade Mathematics Text Books

Geometry (Geometric objects)	Orientation	Size	Tools – Materials	Model	P. L. G. C.
1st Grade					
Sphere	Different	Different	Ball and fruits	Model of Earth	Classification of Geometric Objects
Prisms (Rectangular prism)	Different	Different	Picture	Coffee Table (End table), Gift Box	
(Triangular prism)	No Difference	Different	Lampshade Cake	House and tent	
(Square prism)	Different	Different	Coffee table	House model	
Cube	Different	Different	Household goods	Gift box	
Cylinder	Different	Different	Glass (Cup)	Trash Bin	
Cone	Different	Different	Paper pen	New Year's Hat	
2nd Grade					
Cube	No Difference	Different	Paper Scissors	Match box	Classification according to properties
Prisms (triangular and rectangular prism)	Different	Different	Given picture	Tent and House model	Classification according to properties
Cylinder	No Difference	Different	Given picture	Tower of Pisa Trash bin	Being able to tell properties
Cone	No Difference	Different	The figures given in picture	Night lamp	Being able to tell properties
Sphere	Different	Different	The figures given in picture	Global Aquarium and Earth	Being able to tell properties
Square, triangle and rectangle	Different	Different	Straw, play dough, scissors, ruler	----------	Classification according to properties
Circle	No Difference	Different	Rope, wire	----------	Identification
Open – closed figures	Different	Different	Rope, wire and matches	----------	Identification
3rd Grade					
Prisms (triangle, cylinder and rectangular prism)	No Difference	No Difference	Pencil, Paper	Match Box	Its property is given
Geometric objects (cube, sphere, cylinder and cone)	No Difference	Different	Boxes, Color Cardboard	Tin can and chocolate	Properties are given
Line, ray and line segment	Different	Different	Geometry board, packet, rubber band	Broomstick, road and hose	Identification
Types of line (horizontal, vertical and inclined lines)	Different	Different	----------	----------	Classification
Parallel intersection right lines	Different	Different	Ruler, scissors	Ladder, road	Classification
Point	Different	Different	Map, graph notebook	Earth, Moon city, bus-stop	Identification
Types of angles (acute, wide and flat angles)	Different	Different	Geometry strip, tangram segment, setsquare, A4 paper and wire	Position of fingers against arm and of arm against body	Definition
4th Grade					
Triangle	Different	Different	Wire, scissors and paper	Model of a house	Definition according to properties
Rectangle	Different	Different	Wire, scissors and paper	Model of a house	
Square	Different	Different	Wire, scissors and paper	Model of a house	
Angles (types of angle)	Different	Different	Geometry board and rubber band rope	Map and sketch	Definition according to properties and showing by symbols
Acute and right angles	Different	Different	Protractor, drawing pin scissors	Model of a scissors, vertices of a square	
Wide and flat angles	Different	Different	Geometry board and rope	Road	

5th Grade					
Polygons (three, four, five six edged polygons)	Different	Different	Geometry board, geometric figures Rubber bands	Rug patterns	Classification and definition according to properties
Regular polygons (equilateral triangle, square, pentagon and hexagon)	Different	Different	Matches, geometry board	Models given in pictures	Classification and definition according to properties
Quadrilaterals (parallelogram, equilateral quadrilateral and rapezoid)	Different	Different	Geometric strip and ruler	Baklawa slice and carpet patterns	Being able to tell and describe properties
Parallel lines	Different	Different	Ruler, paper and pencil	Ladder and road lines	Being able to tell and define properties
Circles and disc	Different	Different	Pencil, cardboard, notebook, compass and ruler	Bagel, bike tire, medal and dart board	Being able to tell and describe properties

P. L. G. C. = Presentation Level of Geometry Concept

Appendix 2: Geometric figures in the government Student Work Books

Table 2. Presentation of the Geometric Concepts in the Elementary 1st, 2nd, 3rd, 4th and 5th Grade Mathematics Student Work Books

1st Grade					
Geometry (Geometric objects)	**Orientation**	**Size**	**Tool-Material**	**Model**	**P. L. G. C.**
Sphere	Different	Different	Ball and Beads	Models consisting of fruit pictures	Classification of geometric objects
Prisms (Rectangular triangular prism)	Different	Different	Figures given in pictures	Models of refrigerator and tent	
Cylinder	Different	Different	Water glass	Can (Tin)	Identification and classification of objects
Cone	Different	Different	Household goods	New Year Hat	
2nd Grade					
Cube	No Difference	Different	Paper, Scissors	Match box	Classification according to properties
Prisms (triangular and rectangle prism)	Different	Different	Picture given	Model of house and tent	Classification according to properties
Cylinder	No Difference	Different	Picture given	Tower of Pisa, Trash bin	Being able to tell properties
Cone	No Difference	Different	Figures in picture	Night Lamp	Being able to tell properties
Sphere	No Difference	Different	The ones given in picture	Globe Aquarium and Earth Globe	Being able to tell properties
Square, triangle and rectangle	Different	Different	Straw, play dough scissors ruler	----------	Classification according to properties
Circle	No Difference	Different	Rope, wire	----------	Identification
Open-closed figures	Different	Different	Rope, wire and match sticks	----------	Identification
3rd Grade					
Lines (Intersecting, vertical, horizontal, inclined and parallel)	Different	Different	Seesaw and Swing	Dough and triangle prism	Classification according to properties
Rectangle	No Difference	Different	A4 paper Color pencil	Geometric figures in the picture	Identification
Square	No Difference	Different	A4 paper Color pencil	Geometric figures in the picture	Identification
Triangle	Different	Different	A4 paper Color pencil	Geometric figures in the picture	Identification
Point	Different	Different	Map and graph notebook	Models of Earth, moon, city and bus-stop	Identification
Types of angles (acute, wide and right angles)	Different	Different	Letters	Models of house	Classification
4th Grade					
Triangle	Different	Different	Geometry board and rubber band	Building	

Rectangle	Different	Different	Geometry board and rubber band	Building	Definition according to properties
Square	Different	Different	Geometry board and rubber band	Building	
Angles (Acute, right, wide and right angles)	Different	Different	Cardboard, protractor, ruler, scissors and rope	Car, airplane and building	Naming according to properties and symbolizing
5th Grade					
Polygons(triangle, quadrilateral, pentagon and hexagon)	Different	Different	Scissors, paper and Tangram	Transparent window, house and buildings	Classification according to properties
Quadrilaterals (square, rectangle, parallelogram, rhombus and trapezoid)	Different	Different	Match sticks, A4 paper and scissors	Building and window	Classification according to properties
Angles	Different	Different	Protractor, A4 paper and color pencil	Geometric figures	Classification
Circle	Different	Different	Pencil, cardboard, rope, compass and ruler	Bagel, bike tire, medal and dart board	Identification
Pyramids	Different	Different	Pictures given	Tent and house buildings	Identification of types

Appendix 3: Geometric figures in the text books of a private publisher

Table 3. Presentation of the Geometric Concepts in the Elementary 1st, 2nd, 3rd, 4th and 5th Grade Mathematics Text Books

1st Grade					
Geometry (Geometric objects)	**Orientation**	**Size**	**Tool-material**	**Model**	**P. L. G. C.**
Sphere	No Difference	Different	Ball and fruits	Model of Earth and Sphere models in the picture	Identification of the geometric figures
Prisms (Rectangular and Triangular Prism)	Different	Different	Match box, gift packet	Models in the picture, Roof of a house and tent	
Cube	Different	Different	Dice with numbers and dots on it	Model of cube consisting of little cubes	
Cylinder	Different	Different	Battery, paint tin, candle and pencil	Trash bin, spool and legs of table	
Cone	Different	Different	Funnel	New Year Hat, night lamp and ice cream cone	
2nd Grade					
Cube	No Difference	Different	Dough, match sticks	Match box and house	Identification of the properties
Prisms (triangular and rectangular Prism)	Different	Different	Pencil, paint, rope, ruler, dough	Models in the robot's land (a picture in the text book)	Identification of the properties
Cylinder	No Difference	Different	Potatoes and toys	Models in the robot's land	Being able to tell its properties
Cone	No Difference	Different	Pictures	Models in the robot's land	Being able to tell its properties
Sphere	Different	Different	Pictures	Globe Aquarium and Earth Globe	Being able to tell its properties
Square, triangle and rectangle	Different	Different	Pencil, paper, geometry board and rubber band	Music set (stereo) traffic signs, house and truck	Identification
Circle and disc	No Difference	Different	Picture	Clock, tire	Identification of properties
Open-closed figures	Different	Different	Scissors, pencil	Geometric figures	Identification
3rd Grade					
Line, ray and line segment	Different	Different	Rope, railroad rails, geometry board and rubber band	Tensioned rope, ruler, match box and game cube	Identification
Types of lines (horizontal, vertical and inclined lines)	Different	Different	Numbers and letters , wood strips	Window and table	Identification

Parallel and vertical intersecting lines	Different	Different	Ruler, scissors and wood strip	Ladder and road	Classification
Plane	Different	Different	Table	Tangram and table cloth with geometric figures	Identification
Point	----------	----------	Colors in traffic lights, graph notebook	Bus-stop and mark left on paper by pencil. Corner of Geometric figures	Demonstration
Type of angle (acute, wide and right angles)	Different	Different	Geometry strip, dotted paper and geometry board	Models made with clock	Identification
Triangle, rectangle, square and circle	Different	Different	Ruler, pencil and paper	Set-square and ruler	Classification according to angle and corners
4th Grade					
Triangle	Different	Different	Match sticks, spaghetti, pencil	House, car, envelop and triangle man	Definition according to its properties
Rectangle	Different	Different	Match stick, spaghetti, pencil	House, car, envelop and triangle man	
Square	Different	Different	Match stick, spaghetti, pencil	House, car, envelop and triangle man	
Angles (types of angles)	Different	Different	Geometry board and rubber band, rope	Map, sketch map and body figures	Definition according to its properties and showing by symbols
Acute and right angles	Different	Different	Protractor, drawing pin, scissors	Model of scissors, corner of square	
Wide and right angles	Different	Different	Geometry board and rope	Road, and the figures formed by the hour hand and minute hand	
5th Grade					
Polygons (triangles, quadrilateral pentagon, hexagon)	Different	Different	Geometry board, Geometric figures, Rubber bands	Patterns of rug and Tangram	Classification and identification according to properties
Regular Polygons (equilateral triangle, square, pentagon and hexagon)	Different	Different	Rope and wire	Models in the pictures and models that the kids make with rope	Classification and identification according to properties
Quadrilaterals (parallelogram, Rhombus, square and trapezoid)	Different	Different	Color pencil wire and pictures	Tangram	Being able to tell and identification its properties
Parallel lines	Different	Different	Ruler, paper and pencil	Ladder and road	Being able to tell and identification its properties
Circle and disc	Different	Different	Compass, ruler, piece of chalk	Bagel, bike tire medal and coin	Being able to tell and identification its properties
Pyramids	Different	Different	Pencil cardboard, notebook, compass and ruler		Being able to tell and identification its properties
Prisms	Different	Different	Medicine and milk boxes	Models in the pictures	Separation and spread

Appendix 4: Geometric Figures in the Student Work Books of a Private Publisher

Table 4. Presentation of the Geometric Concepts in the Elementary 1st, 2nd, 3rd, 4th and 5th Grade Mathematics Student Work Books

1st Grade					
Geometry (Geometric figures)	**Orientation**	**Size**	**Tool-material**	**Model**	**P. L. G. C.**
Sphere	No Difference	Different	Ball and beads	Globe of earth	Identification
Rectangular Prism	Different	Different	Figures in the pictures	Cube sugar, match box	Identification
Cylinder	Different	Different	Battery and flute	Tin can	Identification
Cone	Different	Different	Picture	Funnel and New Year Hat	Identification
Cube	Different	Different	Picture	Dice, number and letter dice	Identification
2nd Grade					
Cube	Different	Different	Color pencil	Cube models in robot	Identification of properties

Prisms (triangular and rectangular Prisms)	Different	Different	----------	----------	Identification of properties
Cylinder	Different	Different	Color pencil	Cylinder figures in robot	Being able to tell its properties
Cone	Different	Different	Pencil	Models in the pictures given book and in robot	Being able to tell its properties
Sphere	No Difference	Different	Painting pencils	Figures in the pictures and robot	Being able to tell its properties
Square, triangle and rectangle	Different	Different	Pictures given	Models in the pictures given	Classification according to its properties
Circle	Different	Different	Pictures	Models in the pictures	Identification
Open – closed figures	----------	----------	----------	----------	----------
3rd Grade					
Lines (Intersecting, vertical, horizontal, inclined and parallel)	No Difference	No Difference			The students are asked to make drawings
Rectangle	Different	Different	Ruler, set-square, pencil and match box	Geometric figures in the pictures	Classification according to properties
Square	Different	Different		Geometric figures in the pictures	
Triangle	Different	Different	Color pencil	Geometric figures in the pictures	
Point	Different	Different	Map and graph notebook	Models of places on the map	Identification
Types of angles (acute, wide, and right angles)	No Difference	No Difference	Set-Square	Clock	Identification according to properties
Geometric objects (Cone, Cube, Cylinder and Sphere)Prisms (triangular, rectangular and square Prism)	No Difference	No Difference	Pencil		Identification according to properties
4th Grade					
Triangle	Different	Different	Pencil and paper	Fish picture in geometrical drawings and models in the pictures given	Identification according to properties
Rectangle	Different	Different	Pencil and paper	Fish	
Square	Different	Different	Pencil and paper	Fish	
Angles (Acute, right, wide angles)	Different	Different	Geometric figures, pencil and paper	Car, aircraft and building	Identification according to properties and showing by symbols
Cube	No Difference	No Difference	Little Cubes		Identification of Different figures
5th Grade					
Polygons (triangle, quadrilateral, pentagon and hexagon)	Different	Different	Paper and pencil	Geometric figures and patterns on puff blanket	Identification according to properties
Quadrilaterals (square, rectangle, parallelogram, rhombus and trapezoid)	Different	Different	A4 paper and pencil	Geometric figures	Identification according to properties
Angles	Different	Different	Set-square, A4 paper and color pencil	Geometric figures	Identification according to properties
Circle	Different	Different	Pencil paper	Coin and ring	Identification
Disc	No Difference	No Difference		Disc in the picture	
Geometric figures	Different	Different	Paper and pencil		Identification by surface and vertices
Pyramids	No Difference	No Difference		Models in the pictures	Identification of types

The modifications involve the subject domains of mathematics, science, social science, and Turkish. The basic idea behind these curricula reforms is to change the curriculum from a subject-centered model to a student-centered one and change the pedagogies from a behaviorist approach to a constructivist approach (Babadogan & Olkun, 2006).Â During the interviews, the teachers provided their perspectives of the differences between the old and new curricula in terms of the philosophy, teaching strategies, alternative assessment techniques, and the roles of teachers and students.