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ORIGINAL ARTICLE

A brief history of mathematics education in Turkey: K-12 mathematics curricula

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Abstract In this study, we survey the history of mathematics education in Turkey starting with its historical roots in the foundation of the republic. The changes in mathematics education in Turkey over the last century are investigated through an analysis of changes in curricular documents for K-12 schools. We consider the factors and reasons affecting curriculum developments, changes in philosophy and structure in terms of standards, objective and instructions. This article utilizes archival research techniques by examining original sources and illustrates the nature of the changes benefiting from a historical perspective. As a result of such analysis of the aforesaid sources, we have seen that the main reasons for changing mathematics curricula are: to build up a modern civilization in Turkey; the reports of John Dewey and the recommendations of Kate Wofford, William C. Varaceus and Watson Dickerman; the desire to become a member of the European Union; international factors and political situations.

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1 Introduction

Every country has its own history of education despite some similarities with others. Generally, the educational history of a nation mainly deals with instructional and educational activities from a historical perspective. In this paper, our purpose is not to detail the whole history of Turkish education, but to give a snapshot of the history of Turkish mathematics education in the last century. In this context, it is necessary to underline some important events and eras that has affected the national education movements in Turkey from the curriculum development perspectives, since one of the main goals in this issue of ZDM is to share some prototypical examples of research conducted in Turkey in mathematics education. For this reason, the editors planned an issue that revolved around the themes of creativity, cognition and curriculum, areas which have been researched extensively in Turkey. We think that the articles included in this issue can be understood more deeply if we give a brief history of mathematics education in Turkey. In this regard, knowing more about the historical background of Turkish education system (in general and specific to mathematics) and having a solid understanding of such a background would guide the reader in making sense of certain aspects of the studies presented in the other articles of this issue. Therefore, the present study aims to provide the reader with a general perspective of the historical development of K-12 mathematics curricula with respect to their philosophies, goals, objectives, instruction and assessment as opposed to a comprehensive analysis of mathematics education in Turkey. However, we give brief

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analyses of these developments as needed. Briefly, the research problem of the present article is as follows:

1. What is the historical development of school mathematics curricula after the revolution in the Republic of Turkey?
2. What are the factors that guided and impacted on such a development?

To pursue these research questions, the authors used archival research methods and analyzed a variety of activities included in the curriculum documents, articles, texts produced by the Ministry of National Education (MoNE) and Web sites. There are also a lot of printed media, newspaper columns and informal reports that are impacted by political events, culture and international relations, which might have helped us highlight the developments and changes in the unified Turkish curricula. However, since it is unlikely to accept all of these materials as scientific resources, in collecting and analyzing data we mostly referred to articles, published and unpublished curriculum textbooks, reports, 5-year national development plans, electronic databases and Web sites as the data.

2 A brief description of K-12 education in Turkey

Pre-school education in Turkey involves children in the age group of 3–5 years on an optional basis, whereas primary education involves the education and training of children in the age group of 6–14 years since 1997. Primary education is compulsory for all citizens, boys and girls, and is free in public schools. Previously, primary education (called, elementary school) was compulsory for 5 years and, since the proclamation of the decree of Tanzimat in 1839, grades 6–8 were called "middle school". In 1997, new legislations combined primary (grades 1–5) and middle schools into one sect and made grades 1–8 compulsory.

Secondary education includes all education institutions of general or vocational and technical high schools (grades 9–12) and lasts for at least 4 years (previously 3 years) following primary education since 2005. It is not compulsory, but free to all in public schools. There are various kind of high schools depending on their emphasis areas such as Anatolian High Schools, Multi-Programmed High Schools, science and social science high schools, Anatolian Teacher High Schools and sports and fine arts high schools. There are also various kinds of vocational and technical high schools. To enroll in a specific high school, students apply to MoNE based on their grade 6–8 GPAs.

If students want to continue their academic career in higher education, they need to take an examination when they are about to get their high school degree. This examination (ÖSS, "Student Selection Examination") is a centralized one administered by ÖSYM (Student Selection and Placement Center) that has been in effect since the late 1960s, and it has been the main venue to enter a university in Turkey. ÖSS has strongly affected secondary education in Turkey unofficially and in an unwilling way. Thus, as in most other parts of the world, testing plays a key role in the education of Turkish students.

3 Curriculum development efforts in Turkey

Before the foundation of the republic in Turkey, institutions of education were far from having a national character. Schools were organized in three separate channels, which were independent of each other. The first and the most common schools in such organization were the district schools and Madrasah having Koran and Arabic as the main curricula. The second type consisted of reform schools and high schools supporting the revolution, which covered a series of political, legal, cultural, social and economic reforms that were implemented to transform the young Republic of Turkey into a modern, democratic and secular nation state. The third type of schools included colleges and minority schools with foreign language education. With three different channels of education, it was not possible to raise future generations who accepted national sovereignty as a lifestyle, reinforce national culture and ensure national unity. Within the process of change that started with the republic, the Law of Integration of Education was issued on 3 March 1924. With this law, these three separate channels were modified, the first one was closed, the second was developed and the third one was taken under the inspection and monitoring of MoNE. This law has two important characteristics: democratization of the education system and transforming and applying secularism in the area of education. Basically, this law provided the following new arrangements:

- All schools can be opened with the permission and agreement of the MoNE.
- The curricula of the secondary education institutions which were working under the other ministries shall be organized by the MoNE (including military high schools).
- Higher education institutions shall be operated and approved in consultation with the opinion of the MoNE (2001).

3.1 First landmark in the history of Turkish education system: Atatürk's contribution to curriculum development

After passing the law of the unity of education (Tevhid-i Tedrisat) and establishing the MoNE, the schools named

"Rüştiye and İdadi" were modified to middle and high schools, respectively, by another regulation. According to this regulation, secondary education was reconstructed with two levels (each of these lasted for 3 years) based on primary education. Thus, the terms "Ortaokul" and "Lise" were used for the first time in the history of Turkish education in place of "middle school" and "high school", respectively. After this regulation, MoNE invited the first "Heyet-i İlmiye (scientific Shura)" to solve the problems related to schools and school curricula. Many essential decisions were made after this meeting such as preparing of textbooks for the primary and middle schools by the competitive way, bringing out guidelines for the lessons that had no textbooks and giving books free of charge in public high schools.

Four years after the aforesaid law, on 1 November 1928, the new Turkish alphabet was introduced by the *Language Commission* at the initiative of Mustafa Kemal Atatürk who was the founder of the Turkish Republic, replacing the previously used Arabic scripts. The adoption of the new alphabet (influenced by Latin scripts) and the modernization of language by removing adapted words were part of Atatürk's revolution for the modernization of Turkey (Fig. 1).

1926 was a landmark in the Turkish education system because of such a revolution in alphabet. For this reason, the starting point of our analysis was the 1926 curricula, which were written with Arabic scripts, whereas the revised form was written with Latin scripts in 1934. In 1936–1937, Mustafa Kemal Atatürk[1] wrote a geometry book including some definitions of the main geometry concepts in new terms in Turkish (Atatürk, 2000). This book has served as a guide to learners and textbook writers and, though some changes have occurred, most of the terms are still in use at the present time. It also opened a conceptual style for the learners of geometry. This transformation[2] also affected the 1938 curricula as it was written based on new terminology. Instead of the old Turkish words "Riyaziyat" and "Hendese", which are of Persian–Arabic origins, the new terms "Matematik" and "Geometri" (having Latin origin) were used, respectively, and the language used in the curriculum is more understandable in today's Turkish.

[1] Numerous biographies of Atatürk note that his middle name "Kemal", which translates to perfection, marvel and maturity in Turkish, Farsi and Hindustani, was given to him by his mathematics teacher for his precocious abilities in mathematics.

[2] Again, this transformation was primarily due to Atatürk's vision for modern Turkey, his formative experiences as a child forced to attend Madrasah on the insistence of his mother Zübeyde, his dislike for the outdated religious mode of learning and his later realization of the contradictions inherent in policies implemented by the Ottoman leadership (Kinross 1964).

Fig. 1 Atatürk was in a geometry class in Sivas High school on 13 November 1937

According to Atatürk, the young Republic of Turkey must be powerful and it is possible only if it modernizes itself in line with the western countries. As a result, he initiated a series of reforms that would change Turkey and the Turkish people within a few years. To build up a modern civilization in Turkey, it was important to reconsider the 1930 curricula, and as a result the 1938 curricula were developed. To understand the rest of this article, it is important to state here that the these changes in school curricula were guided by constitutional secularism, positive sciences and western civilization (Varış, 1976, p. 70).

3.2 Second landmark in the history of the Turkish education system: John Dewey's impact

At the beginning, curriculum development efforts started with the cooperation of district schools and the director of education in each city district, and then they were continued in the central body of the MoNE. In 1924, Turkish MoNE invited John Dewey to observe and analyze the Turkish education system and make recommendations for reconstructing and reorganizing the existing system of education. After spending 2 months, he analyzed the Turkish education system and prepared two reports. In the first report, he recommended better teacher training and better funding scheme for education, whereas in the second report he offered the formation and execution of an overall education plan, development of schools as community centers and reorganization of the MoNE (Turan, 1997). After John Dewey's first report, the first and second meetings of Heyet-i İlmiye (scientific council/Shura) were held in 1924 and 1926, respectively, and it was decided to increase the number of teacher training schools and general and vocational high schools, and to make middle schools compulsory for all students. The curricula of 1930 and 1938 were a consequence of all these efforts.

3.3 Third landmark in the history of Turkish education system: impact of policy changes at the national and international level

After World War II, Turkey had followed a neutral policy between the Axis powers (e.g., Germany, Italy, Japan) and the Allies (e.g., USA, Britain, France, Australia) and had been subject to a Soviet threat. During the same era another important change was related to Turkish politics. Turkey decided to move from the previously authoritarian mono-party system to a democratic multi-party system in 1946 and became a member of NATO in 1952. Meanwhile, Turkey was in search of a role model for its civilization. Since the USA has been the most powerful western country in the world and since its strength is a consequence of its social, economic, political, military and educational institutions, Turkish politics has taken it as the model country of western civilization. Thus, the main source of inspiration for Turkey in cultural and educational matters was from the USA (Ünder, 2008).

In this atmosphere, educational contacts and cooperation between the two countries developed very rapidly. First, the United States Educational Commission was established in Turkey. Second, the Turkish Fulbright Commission was founded in 1949. Finally, well-known educators, V. Kate Wofford, William C. Varaceus and Watson Dickerman, were invited to Turkey to give their recommendations about village education, teacher training and adult education, respectively. After their report, the curriculum development efforts became more systematic and formal. In the meeting of The National Education Council/Shura, curricula were reconsidered in 1953. A discussion ensued on the necessity to further develop the 1948 curricula and as a consequence of this meeting, curriculum development became a major focus in the central body of MoNE.

3.4 Fourth landmark in the history of the Turkish education system: increasing role of MoNE and academics in curriculum development

In parallel to these efforts, in the 1954–1955 academic year, a school program was developed by the İstanbul Atatürk Kız (girls) High School Program Development Commission and had the distinct feature of leading curriculum development studies for secondary education curriculum.

By the 1960s, curriculum development studies were started again by the MoNE. The "Primary Education and Education in General" law accepted in 1961 under article no. 222 brought out some regulations, which forced the MoNE to reconsider the 1948 curricula. In this sense, a primary education curriculum was developed and constituted by the MoNE in the 1968–1969 academic years for the whole country. The curricula 1948 and 1968 were a consequence of all these efforts.

In the 1970s, studies for combining elementary schools with middle school as 8-year primary education and, in addition, primary education curriculum development studies were accelerated and a curriculum development commission, which consisted of nine members, was set. But this commission could not complete the planned studies of curriculum development. Modern mathematics (new mathematics) was introduced to all high schools since the 1976–1977 academic year and the high school system was changed to a credit-based system in 1991–1992.

In the 1980s, MoNE and academicians began to pursue a new approach to develop school curricula. The reason behind such a pursuit was that Turkey had been using the secondary education curriculum developed by the İstanbul Atatürk Kız (girl) High School Program Development Commission, which was not based on strong learning and teaching theories. Also, there were a lot of weaknesses in this curriculum. In 1982, the MoNE organized a sequence of meetings to find a useful and scientific curriculum development model. As a result of these meetings, a new curriculum development model was established in cooperation with universities. This model was shared with other institutions, which were asked to develop their own secondary education programs. At the beginning of 1984, the principles which had to be followed to develop new school curricula were described once more by the government and announced publicly throughout the country. This model brought out the principles that regulate the understanding of curriculum development based on courses with the dimensions of goals, practices and assessment.

The rapidly changing nature of the public, technology and culture paved the way for curriculum changes in a new atmosphere. As a result, at the beginning of 1990s, curriculum development efforts were resumed in the scope of the "Development of National Education Project" supported by World Bank. Among the aims of this project were the development of the 1988 curricula and improvements in the quality of teaching materials and textbooks. In this sense, a curriculum development model was built by the MoNE and using this, new curricula were developed for 22 courses of primary and secondary education. The studies related to these developments took more or less 6 years and only two of them were approved by the MoNE. Meanwhile, another important point was the restructuring process of education faculties, which provided opportunity to do more research in mathematics education. The number and the quality of the researches in education (in particular, in mathematics education) increased remarkably.

In the next sections, we elaborate on a brief history, structure and curricula on which the Turkish mathematics education system is based. Attention is paid to details to

make the remaining articles in this special issue more contextualized. To see the whole picture related to the curriculum development efforts after the foundation of the republic in Turkey, we will give brief information on pre-school education.

4 Pre-school education

Among the numerous philosophers in the Turkish–İslamic world, Keykavus (–1220), Gazali (1058–1111) and İbrahim Hakkı (1703–1780) emphasized the importance of child development and child education (Tufan, 2006). Gazali brought to the attention of families and teachers the importance of early childhood education and stressed that public should take on the responsibility of caring for children in their early years (Yavuzer, 1999). The first official pre-school education establishment was founded in the historical period of the second constitutional monarchy (1908–1923) during the time of the Ottoman Empire. In this period, the famous educator Nami Duru visited Austria and Hungary to investigate "kindergarten schools". After coming back, he established a kindergarten school in Salonika (the birth place of Atatürk). In addition, he translated the book entitled "The guide for Kindergarten" (Bektaş, 2001). As a result of these efforts, the temporary statute "Tedrisat-ı İptidaiye Kanun'u Muvakkati", consisting of 101 substances, was adapted for the resolution of pre-school education in 1913 with many minor changes. It was validated for a while (Ültanır, 2000). Besides the regulation, "Ana Mektepleri Nizamnamesi (the kindergarten law)" was made and it was promulgated immediately. All these arrangements and efforts were not sufficient to increase the number of kindergarten schools because of the conjuncture of the Ottoman Empire (Oktay, 2000) during that time period.

After a while, with the two issue circular letters that were sent to schools by the government on 25 October 1925 and 29 January 1930, the budget reserved for kindergartens was transferred to primary schools to increase the quality of primary education. As a result of these letters, all existing kindergarten schools were closed except the ones situated in the big industrial and agricultural districts.

The necessity of pre-school education was again discussed in the fourth meeting of the council of MoNE in 1949 and some regulations, oriented toward opening schools for pre-school education, were prepared. But the main progress was to open the department of "child improvement and child education" in the composite schools for girls. After 10 or 11 years of this progress (1960), the Child Development and Child Education Department was instituted for pre-school teacher training in Kız Teknik Yüksek Öğretmen Okulu (School of Girls Technical Teacher Education). Nearly 2 years later, an issue named "Anaokullar and Anasınıflar" was constituted and, as a consequence of this regulation, the efforts for pre-school education were accelerated. From that time until now, the importance and prevalence of pre-school education have been handled in government programs, national development programs, education committees and meetings of the National Education Council/Shura. In this sense, pre-school education was integrated to the formal education system at the instance of the Fundamental National Education law no. 1739 and, a pre-school education branch office was built up in the structure of the head office of primary education in 1970.

In the ninth meeting of the council of MoNE, accrued in 1974, some goals were added to the general goals of national education. These goals (Bektaş, 2001) were to:

- prepare children for formal education and to improve children mentally, physically and emotionally;
- establish appropriate common halls and schools for the children who do not have a social and secure life;
- prepare children to speak and use the Turkish language well.

Almost within the same period (1977–1978), the other important development was the seminar which was organized by the UNESCO National Committee in Ankara. As a consequence of this seminar, pre-school education was to be conceptualized as a project by the MoNE. Finally, in 1992, the general director office was constructed in accordance with the law no. 3797 (Aral, et al., 2002). Although many decisions were made about pre-school education in the studies, it was examined for the first time in detail and many regulations were arranged in the 14th meeting of the council of MoNE held in 1993.

Nowadays, the importance of pre-school education is well understood by the society, universities and government, and the pre-school education developments have continued steadily. Most of the education faculties in Turkey currently have a "pre- school education department". On the other hand, the MoNE has already decided within the framework of the "Compulsory Kindergarten Project" that compulsory education will last for 12 years in the 31 cities of Turkey starting from the 2009–2010 academic year and this project will be extended in the next 2010–2011 academic year to the whole country. Pre-school has a curriculum containing objectives toward mathematics integrated within the other goals; these objectives are not included here due to space limitations.

5 Elementary schools

In this section, elementary school mathematics curricula (grades 1–5) were compared for the years 1948, 1968,

1983, 1990, 1998 and 2004, by taking into consideration goals/objectives, contents, instructional approaches and measurement/evaluation techniques.

5.1 Comparison of curricula regarding goals and objectives

There were some common goals/objectives among the curricula of 1948 through 2004. These commonalities are related to daily life, connections in mathematics, problem solving, various thinking skills, having positive attitude toward mathematics and esthetic feelings. In the 1968, 1983 and 2004 curricula, the common goals were about problem posing, beliefs about mathematics and mental computation. Except for the 1983 curriculum, the use of mathematical language was among one of the goals. The connection of mathematics with other disciplines was included as one of the goals in all elementary school mathematics curricula except for the 1983 curriculum. In addition, conducting research was stated as a goal in the 1990, 1998 and 2004 curricula. The goals on estimation skills and questioning of decisions were written in the 1968 and 2004 curricula. Consequently, although the goals of all curricula were quite similar to each other, the curriculum of 2004 also had its own objectives on the development of psychomotor and self-regulation skills, self-confidence in mathematics, and the use of information and communication technology.

The 1948, elementary school mathematics curriculum was spiral in nature with connections within mathematics and between mathematics and other courses (MoNE, 1948). In the first three grade levels, the arithmetic strand consisted of numbers, operations, estimation, measurement and graphics. The numbers such as natural numbers, fractions, decimal fractions and Roman numerals; operations involved operational skills, mental computation, fractions, decimal fractions, arithmetic mean and real life problems; in measurement, there were objectives on measures of time, length, mass, volume and area. Estimation was included within problem solving, measurement and operations. Geometry was taught through life science courses and, in the fourth and fifth grade levels, geometry was one of the main strands. There were figure, bar and line graphs. It focused on the conceptions of point, line, line segment, area and perimeter of geometric figures, and surface area and volume of a variety of solids in the geometry strand. In both arithmetic and geometry strands, problem solving was very important. The class time to be spent was identified as 5 h for grades 1 through 3, whereas it was 4 h in grades 4 and 5 each.

In the first grade of the 1968 curriculum, the arithmetic strand included numbers, operations, measurement, recognition of objects and figures from the environment. In the second and third grades, arithmetic consisted of these topics and fractions. Although geometry was studied within the scope of life science course in these grade levels, it was studied as a separate topic in mathematics courses in grades 4 and 5. The topics of 1968 and 1948 mathematics curricula were similar to each other. However, their contents and distributions according to grade levels were different.

In the 1983 curriculum, the focus was on relations among entities, sets, natural numbers, fractions, basic operations, measurement and geometry. Grade 2 included all topics of first grade as well as division and graphics. Grade 3 had all topics of grade 2 in addition to relations among entities. In grades 4 and 5, there were all topics of grade 3 as well as counting by seven, eight and nine, and decimal numbers. The contexts of the 1983 and 1968 curricula were similar to each other. In the 1983 curriculum, there were more subcategories than in 1968. The places of some topics were in different grade levels in these curricula. In the 1983 curriculum, new topics were included such as sets and symmetry.

In the 1990 curriculum, there were natural number system, fractions, ratio, proportion, relationships among time, location and numbers, the interpretation of goods in the environment in terms of shape and size correctly, the relationships between shapes of goods and their functions, skills on algebraic operations, arithmetic mean and statistical graphics. The 1990 and 1998 curricula were quite similar to each other. The scope of some topics and their classes were different. In addition, some topics were not included in both curricula. For instance in grade 5, daily life applications such as percentage, interest, discount and surface areas and volumes of solid figures were found in the 1990 curriculum, but not in the 1998 curriculum. Moreover, there were objectives on geometric figures and solid figures in the 1998 curriculum, but not in the 1990 curriculum. The suggested amount of mathematics courses were 144 h in an academic year.

In the 2004 curriculum, there were four learning strands: numbers, geometry, measurement, and probability and statistics. Their contents and distributions are different from other curricula. However, new topics were included such as statistical graphics made up of concrete materials, probability, patterns, tessellations and construction of three-dimensional figures with manipulative and isometric drawings of three-dimensional figures. Again, the total number of instructional hours per academic year was 144.

As a result, although in all the elementary school mathematics curricula common topics could be grouped under one of numbers, geometry, measurement or statistics, their content and distributions according to grade levels were different. The concept of probability was introduced systematically first time in the 2004 mathematics curriculum.

5.2 Comparison of curricula with respect to instructional strategies

In the 1948 mathematics curriculum, the emphasis was on conceptual understanding, procedural skills, individual differences and active participation of students and teachers acting as a guide or as a facilitator. In this curriculum, teachers were suggested to stress the importance of mathematics by referring to students' environment and real life experiences. In addition, instructional materials were utilized to make mathematics as concrete as possible in the 1948 curriculum. For example, students learned the surface of circular region, circle and its center by investigating coins, gramophone records, round trays, clocks and goods like cylinders. They recognized the diameter and radius by drawing the circle, using thread, pin, stick and compass. The second example, the idea of decimal numbers, was recognized using meter and kilogram. The third one, base-ten numeration system, was taught using the material which consisted of a bunch of ten sticks, pencil or coin like base-ten blocks and these tools also were used for developing skills related to these operations.

There were some sample activities recommended in the 1968 curriculum. For example, π was taught by measuring circumferences and radii of bases of cylinders and by figuring out the relationship between circumference and diameter (MoNE, 1968). The second example, place value, addition and subtraction, was taught using plates that showed the tens, hundreds and thousands. The last example, comparison of 1 dm^3 and 100 cm^3, was taught using a box having a volume of 1 dm^3. One hundred cubes having 1 cm^3 volume were replaced with 1 dm^3 and put into this box. During the academic year, there were creative and decorative works.

In the 1983 and 1968 curricula, the explanations on instructions were different except for numbers and operations. While numbers were taught through the use of figures and symbols, the others were taught by referring to concrete materials or real life examples (MoNE, 1983). However, it was recommended that basic concepts should be taught using observation and investigation. Teachers were to guide their students to make generalizations and to explain concepts and relationships in their own words. The curriculum manual in 1983 included certain sample activities. For example, numbers and operations were taught through the use of sets, number line and figures. Another example was related to comparison of area measures. A frame was made with a stick or newspapers, which had an area of 1 m^2. They were partitioned into 1 dm^2 units, which showed that there were 100 dm^2 on this surface. It was also emphasized that 1 m^2 was equal to 100 dm^2 and 1 dm^2 was equal to 0.01 m^2. The approaches of the 1983 and 1990 curricula were quite similar in terms of teaching methods.

According to the 1998 curriculum, teachers were to teach concepts, procedures and relationship between concepts and procedures in an orderly fashion (MoNE, 1998a, b). The emphasis was to be on the idea that students should be active mentally and physically in mathematics courses. They were expected to work individually as well as in groups with the teachers' guidance.

The instructional approach in the 2004 curriculum was quite similar to the approach recommended in the 1948 and 1998 curricula. Throughout all the elementary school mathematics curricula, conceptual and procedural understandings were highlighted. As a result, the instructional approaches in all curricula were quite similar to each other. The reader will note that these recommendations in the 1948 curriculum are really avant-garde when compared to contemporary recommendations of organizations such as the NCTM. Though the 1948 and 1968 curricula were not research based per se, they included elements of constructivist principles, and effective, discovery and esthetic components that were remarkably similar to contemporary recommendations given in the curriculum documents in numerous parts of the world.

5.3 Comparison of curricula with respect to measurement and evaluation

According to the 1948 curriculum, evaluation had to be accomplished frequently by taking into account the outcomes of instruction and the alignments between activities and objectives of the course. These were to be accomplished by observations, interviews with students, reports and projects prepared by either a group or individually. The measurement and evaluation were to be done to diagnose students' difficulties, mathematics achievement, students' attitudes toward mathematics and the use of mathematics in daily life. It was expected that evaluation should be used to improve instruction by taking into consideration individual differences.

The measurement and evaluation techniques in the 1968 curriculum were similar to the 1948 curriculum. In the 1983 curriculum, the validities and reliabilities of measuring instruments were expected to be tested. It was expected that this could be used to assign grades and to obtain feedback to improve the effectiveness of instruction. In examinations, multiple choice and essay-type questions were recommended. The approaches of the 1983, 1990 and 1998 curricula were the same in terms of measurement and evaluation techniques. However, there were sample questions to measure each objective in 1998.

The purposes of measurement and evaluation in curriculum 2004 were quite similar with those of other curricula. The number of measuring instruments stated in these curricula was more than the ones in the other

curricula. They were written examinations, oral examinations, performance tasks, projects, portfolios, journal writing, homework, quiz, checklists, attitude scales, interviews, observations, posters, exhibitions, peer evaluations and self-evaluations. Teachers were also recommended to use analytic and holistic evaluation methods and scoring by general intuition. In the written examination, assessments could include essays, multiple choice, short answer and matching questions.

There were difficulties in analyzing the middle and high school mathematics curricula because of the following three reasons:

- the number and structure of the sources related to these curricula;
- most of the researches in mathematics education were for elementary schools;
- since the basis of mathematics education was formed in elementary schools, main goals, visions and philosophies of general mathematics education was included in elementary schools' mathematics curricula. Therefore, these goals, visions and philosophies of secondary mathematics education have been copied from the elementary schools' mathematics curricula, in general.

6 Middle schools

As mentioned above, a new school type called Rustiye was a kind of middle school after the proclamation of the decree of Tanzimat (reorders or revisions) in 1839 in the Ottoman Empire (Ozturk, 1996, p. 4). Until 1997, middle schools disseminated throughout Turkey. Since 1997, primary education covered the teaching and training of children in the age group of 5–14 years and hence the story of the middle schools ended in Turkey.

Now, we are ready to introduce and discuss the mathematics curricula developed in 1930, 1938, 1970, 1988 and 1998 based on their philosophies, goals and objectives, philosophies of instruction and assessment.

6.1 General views

In the middle school mathematics curricula of 1930, 1938 and 1970, mathematics courses were organized as 5 h for the first grade and 4 h for the second and third grades in a week. But in the 1988 curriculum, the time for mathematics courses was 110–120 h in total, while in the 1998 and 2004 curriculum it was 144 h in an academic year.

The 1930 and 1938 middle school mathematics curricula had been published as unique textbooks (all branches were banded together in these textbooks): the implementations, visions, philosophies of the curricula, all suggestions related to the teaching–learning methods, approaches, strategies, teaching tools, materials and the issues on evaluating student work had been stated and considered generally. One of the essential suggestions about teaching and learning mathematics was related to the use of students' experiments and logical reasoning. It was also suggested to increase and expand these students' experiences using mathematical knowledge, which was applied to several kinds of mathematical problems. Some opportunities to practice with concrete figures and a lot of examples, consisting of numeral calculations and drawing graphics related to the content of the curriculum, were to be provided. The content of the curriculum was to be taught using the tools outside schools, namely in daily life. There were a lot of examples in this curriculum, consisting of numerical calculations and drawing graphics. We noticed that there were no hints about measurement and evaluation in the curricula of 1930 and 1938.

When we look at the 1970 and 1988 middle school mathematics curricula closely, we see the main goals, objectives and some suggestions about teaching–learning methods, approaches, strategies, teaching tools, materials and the issues on evaluating student work. Some suggestions about teaching principles and objectives were: increase students' experiments by providing them some opportunities to work with environmental tools; enrich teaching activities by events and problems from daily life and the commercial environment and industry; prepare some activities to improve students' estimation and guessing skills; encourage students a fortiori to build up and discover mathematical ideas… These suggestions about teaching principles were also included in the curricula developed in the light of constructivism in recent years around the world. Therefore, we may assert that the 1970–1988 middle school mathematics curricula had some signs of constructivism.

Some of the main goals stated in those documents were: developing a positive attitude toward mathematics; understanding the importance of mathematics in real life; developing skills on conducting research, producing and using information; explaining and sharing mathematical thinking logically and using mathematical language effectively… If we take a look at mathematics curricula of many countries around the world during the last decade, we can find a lot of similarities of the goals between these curricula and the 1970–1988 middle school mathematics curricula. It means that the 1970–1988 middle school mathematics curricula had many desirable and reasonable goals.

There were some notifications for teachers based on types of mathematical concepts and the ways of teaching these concepts. These hints were explained in the curriculum under the subtitles: operations, exercises, problem

solving, mathematical symbols and terms, and measurement and evaluation. For example, the aims of assessments were to: describe the time of period and level of understanding of the given mathematical facts; efficiency of teaching methods, teaching materials and tools; identify the concepts which were difficult to build up and understand; contribute to each student's development considering the level of student's ability and disposition; and organize the instructions considering this development.

If we examine carefully the teaching–learning principles and thoughts, which are included in Principles and Standards for School Mathematics (PSSM) and in the developed countries' mathematics curricula, we can find many similarities with the teaching principles and thoughts given here. To facilitate instruction, these two curricula suggested some ideas about teaching and learning methods, and some samples of lesson plans were provided after each unit. But the teaching and learning methods suggested in these lesson plans were very traditional, poor and limited. Finally, as a result of the "Development of National Education Project" supported by the World Bank, the 1988 curricula were developed for 22 courses (including mathematics) of middle and secondary education. But, they could not be put into practice because only two of them were approved by the MoNE.

6.2 Learning strands, standards and objectives

In this section, the learning strands and objectives of mathematics curricula of 1930, 1938, 1970, 1988 and 1998 are discussed and compared to each other. For this purpose, the standards and objectives of these curricula are lumped together in five categories, which can be called learning domains, although originally the 1930 and 1938 curricula were not categorized into these domains and standards. But in the 1970 mathematics curriculum, the content was organized into two learning domains. They were geometry and arithmetic. The objectives included in these two learning domains and the levels of standards were handled separately and explained clearly and in detail. In this respect, as we argued earlier, it seems that the representation of the standards included by these early curricula is parallel to PSSM. On the other hand, in the 1988 and 1998 mathematics curricula, the objectives were organized into five strands. The names of these domains were geometry, algebra, numbers and operations, measurement and statistics-graphics. As in the 1970 mathematics curriculum, the emphasis was on the importance of teaching and learning activities in light of standards and objectives included in this curriculum, such as lesson planning, development of teaching materials, the use and choice of instructional tools and evaluation of the quality of instruction in every phase of the implementation of this curriculum.

We analyze the objectives of different mathematics curricula surveyed so far using the content of the 1930 curriculum as a reference point. When we focus specifically on the standards and objectives about numbers and operations included in the 1930 mathematics curriculum for grades 6–8, we have the following:

In grade 6, the "topics" can be stated as natural numbers, operations, divisibility of natural numbers by 2, 3, 5 and 9, problems related to operations on natural numbers, fractions, the idea of fractional amounts to be explored with fractions, equivalent fractions, conversions of fractions, problems with related fractions, decimal fractions, decimals, general problems on fractions and decimals.

In grade 7, the "topics" can be stated as greatest common divisor and least common multiple of the natural numbers; factors; common factors of numbers; problems on fractions and decimal fractions; proportional quantities (directly, inversely); ratio and proportion; commercial matters such as interest, discount, credit, debt, running accounts and trade bills; description of a proportion of any whole number and decimals; calculations of square and cube root of a whole number or decimals; and rounding and calculations related with rounding.

In grade 8, the "topics" can be listed as addition, subtraction and multiplication of any whole numbers or any two decimals; the properties of the exponent of numbers, the ratio of any two numbers and proportional numbers; concrete knowledge, operations and applications on positive and negative numbers; relations between two quantities; change in quantities in relation to another quantity; drawing graphics of these relations and implementation of these graphics to real life situations.

If we compare the 1938 curriculum with the 1930 curriculum, there were no objectives and standards related to numbers and operations in the third grade in the 1938 curriculum and there were small differences between them in the topics of numbers and operations such as:

- divisibility of natural numbers by 2, 5, 3, 9, 4, 25, 8 and 125 instead of 2, 5, 3 and 9; repeating decimal fractions and decimals;
- the function notion and their graphics were moved in the 1930 curriculum from the third class to second grade in the 1938 curriculum.

When we compare the 1970 and 1988 curricula with that of 1930 and 1938, it is seen that there is no significant difference between them except that the 1970 curriculum included materials related to commercials, firms, cooperatives, banks and bills in grade 8. In addition, we see that concepts such as sets, equivalent sets, ordering of numbers, number line and intervention were added to the 1988 curriculum.

On comparison of the objectives included in the 1970 and 1988 curricula with the others, we have the following:

- concepts such as sets, equivalency of sets, ordering of numbers, number line and interventions were included in the 1988 curriculum, while the others did not have these;
- mathematical systems, modular arithmetic, properties of an operation such as closure property, having unit element, commutativity, having inverse of an element and being associative were added to the curriculum of 1988, while the others did not have these;
- the conceptions of rational numbers, irrational numbers, and real numbers and their properties appeared for the first time in the mathematics curriculum of 1988.

If we consider the measurement strands of the curricula 1930, 1938, 1970 and 1988, we see common standards such as metric system, length of objects, area of pieces of surface, volume of solids, heights of solid objects, time and measurement of the time of an event, the value of things and money. The only unique difference between the 1970 curriculum and the others is the existence of some objectives related to measurement such as reading of the electrometer, water meter, gas mater, etc. There were also some basic objectives related to time and money.

When we examine the curricula of 1930, 1938, 1970 and 1988 in the light of algebraic standards, the learning objectives were the definition of a term, multi-terms, operations on two multi-terms, division of a multi-term with a term, equations of first order with one and two unknowns, equations of second order and their solutions, square root, solutions of fractional equations that can be organized as a first-order equation, problems that can be solved using first-order equations, the equation systems of first order and their solutions, and finding the values of multi-terms using the formula of perimeters, areas and volumes. Objectives such as inequalities of first order and their solutions, set, empty set, comparison of sets and representations of a set were included only in the curricula of 1988.

The standards and objectives related to algebra came up in grades 6 and 7. The standards and objectives related to statistics and probability did not appear in the curricula of 1930 and 1938. But there were some objectives in the 1970 curriculum, such as making basic graphics and reading graphics. On the other hand, there were some objectives in the 1988 curriculum such as ways of collecting data, samples of graphics, ways of deriving information from collected data, sampling, Pascal triangle, permutation, combination and probability.

Some of the geometric topics included in the curricula 1930, 1938, 1970 and 1988 can be listed as follows: line, plane, point, circle, disk, angles, triangles and segment; constructing a variety of triangles; convex polygons; partition of a segment by a given proportion; similar triangles; definitions of parabolas, ellipses and hyperbolas; edges and surfaces of solid equivalent faces; parallel face, angles between two faces of a solid; and definitions of prisms, pyramids and rotational surfaces such as cylinders, cones and balls. The 1938 curriculum also included additional objectives distinct from the others such as coordinate system and location of a point, the Pythagoras' theorem, and trigonometric identities of a right triangle including cosine, sine, and tangent of an angle. On the other hand, there were some additional geometric objectives such as symmetric figures, shapes with respect to a point and a line, maps, plans, map scale, and enlargement and constriction of a shape by a given a proportion. Similarly, the 1988 mathematics curriculum had some extra objectives such as half line, ray, line segment, lines, planes and Euclidean relations.

The approach, goals, skills and assessment techniques of the middle school curriculum of 2005 are the same as the elementary school mathematics curriculum of 2005 and contains new learning topics such as transformation geometry, orthogonal drawings, isometric drawings, perspectives, fractals, patterns, tessellation, geometric probability, experimental probability, subjective probability, histogram, standard deviation, range and inter-quartiles, and probability of dependent events. In the curriculum manual, there are also many sample activities. For example, the concept of equation is taught using a balance model and the volume of cones is taught using cones made of papers.

If we summarize briefly all the middle school mathematics curricula, we can state that these curricula include many essential and contemporary teaching goals, some signs of constructivism, many desirable and valuable suggestions for teaching principles, contemporary teaching and learning methods, teaching tools and methods for assessment. When we compare the middle school mathematics curricula of 1930, 1938, 1968, 1988 and 1998 with the 2004 grades 6–8 curricula, we see that there are no big gaps and difference between them.

7 High schools

In this section, we will consider the history of secondary mathematics education in Turkey through the analysis of high school curricula. High school (officially called "Lise" in Turkish) lasted 3 years: grades 9–11. During 2005, high schools became 4-year institutions. Grade 11 was divided into two branches: science and literature. Science students took more mathematics courses than literature students. After 1970, grade 10 was also divided into two branches as in grade 11: science and literature.

While considering the high school mathematics curriculum, the data we analyzed contained only the main goals and some suggestions for teachers. In contrary to the elementary and middle schools curricula, high school curriculum did not contain direct information about teaching techniques and measurement evaluation, except for the 2005 curriculum. But in this case, 2004 primary and 2005 secondary curricula contain almost the same information in this direction. The cross comparisons seem not to be available and give very little information.

The 1934 curriculum was a revision of the curriculum of 1924 and so it is our starting point and contains some variations. In the 1934 curriculum, mathematics courses were as follows:

- grade 9 (5 h/week): algebra, geometry;
- grade 10 (4 h/week): algebra, geometry;
- grade 11 (science): algebra (2 h/week), geometry (2 h/week), calculations (1 h/week), trigonometry (1 h/week), mechanics (1 h/week), cosmography (1 h/week);
- grade 11 (literature) (2 h/week): algebra

The learning strands were stated for each grade instead of main goals of the curriculum. There was also no information about instruction and assessment techniques.

Main goals and some suggestions for textbooks were included in the 1935 and 1939 curricula. The course hours were the same as in the 1934 curriculum. When we consider the main goals of mathematics education in this curriculum, we see that these goals focus on calculations, mathematical knowledge for other disciplines, reasoning, exercising memory systematically and mathematics for students who wish to be a specialist after graduation from high schools. Goals were presented in an encapsulated way and the hints give us information on the way in which calculations are quick, understandable and good. Also, upgrading the ability of reasoning and to construct the idea of abstraction were emphasized in this curriculum. The goals were also aware of the connection and integration between disciplines (physics and chemistry courses are particularly mentioned). The emphasis on reasoning, abstraction and calculation seems valuable to be in the late 1930s.

Now, we analyze the points that should be considered in mathematics classes and present as items. Actually, there appear two kinds of suggestions: the first is about the way of mathematics courses and the second is about students. The curricula suggest that: courses should be treated in a simple and clear way, the practical and numerical problems considered in class should be real and useful, and such problems should be chosen among the topics which are relevant to Turkey. Suggestions for problems in real life situations seem very useful (this was also emphasized in other sections of the curricula), but when we look at the applications such as textbooks and central examinations in the forthcoming years, we see that the courses and problems considered remain more theoretical.

The second kind of suggestions is directly related to students: The curricula suggest that problems should be figured out by students themselves and they should keep regular notes. This is to give the students an opportunity to solve problems themselves, rather than by teachers, and it seems valuable and may be considered as having the traces of constructivism. The following suggestion is also remarkable: it should be checked at every opportunity if the concepts were constructed and students had clear ideas about the definitions, axioms and theorems. The structure of the problems of centralized examinations in Turkey seems more procedural and forces students to memorize the definitions, axioms and theorems. Such an approach had not even been suggested in the 1930s as it stands out in the following suggestion: Students should be saved from memorizing and this situation should be frequently checked. It should not be forgotten that memorized rules and theorems cannot be kept in the memory for a long time.

It seems that the structure of the problems appeared in the curricula only as "long" and "complex" and not in other ways as well structured, semi-structured, ill structured etc.: Long and complex problems should not be given to students. The content and the structure of the given problems should be carefully checked. In the middle level, students in class should not be worried by the given complex problems which are related to many concepts and may be combined with the suggestion "students may feel anxiety of mathematics. It is very useful to motivate them continually".

While teaching geometry concepts, experimental and empirical techniques were also emphasized and the explanation of learning strands was given grade by grade.

In the 1938 curriculum, the course hours were the same for grades 9–10, but for grade 11 science was set 7 h a week and in literature students had cosmography courses in addition to algebra. Real life situations were also emphasized in the other sections of the curriculum.

In the 1956 curriculum, there were minor distinctions: the term "astronomi" was used instead of "cosmography". There were no hints for teaching techniques, assessment and goals specially mentioned for high schools.

The curriculum published in 1970 was a revision of the curriculum of 1956 and grade 10 was also divided into two branches, science and literature, as in grade 11. There were certain changes in the course hours.

In 1976, modern mathematics (new mathematics) had found its way into all high schools and this brought to debate distinctions between different generations in their view of mathematics.

The curriculum published in 1987 was presented in a very detailed form. Grade 11 was divided into three

branches as mathematics, natural sciences and literature. The number of course hours varied depending on the branches. Though the curriculum was detailed, the main goals were given as a list and the goals were stated as suggestions to the teachers containing the following main synopsis.

7.1 General views

These included basic knowledge, basic concepts, correct thinking of rules by axiomatic approaches, proof methods, axiomatic systems (mostly in geometry), analysis by deduction, reasoning by induction, thinking by generalizations, student's thinking level and performance. The topics were vectors in algebra, how to develop the number concept, relations of numbers, function concept and mathematical models.

Axiomatic systems and proof methods were mentioned among the goals as fundamentals of mathematics for the first time, mostly in geometry. Certain topics were emphasized particularly such as vectors, number systems, functions, and relations between numbers and the structure of geometry. Mathematical modeling was also suggested in a problem solving context.

The final suggestions to the teachers are about reasoning and thinking performance of the students:

- teach the students analysis, reasoning by deduction, induction and thinking by generalization;
- increase students' level of thinking performance by:
    - having students investigate, conduct research studies and criticize;
    - having students draw diagrams;
    - students being careful, patient and systematic;
    - having students cultivate the habit of expressing clearly the learned subjects.

View of the construction of scientific thinking. Scientific curiosity, objectiveness, avoiding biases, being open minded, sharing knowledge.

In view of the construction of scientific thinking of students, the curriculum suggests the teachers to stimulate students' scientific curiosity and to construct ethical feelings.

A view of the course of instruction. Usage of concrete examples, possible misconceptions, doing operations, individual differences, discovering the properties, problem posing, finding good solutions, creative and intuitive thinking, synthesizing ability and beauty of the relations of mathematical concepts. Misconceptions and individual differences are mentioned for the first time in this high school curriculum.

The skills in the 2005 elementary school curriculum are also important for the 2005 high school curriculum, such as problem solving, communication, etc. The 2005 curriculum is the final and most detailed one. It is mainly influenced by current contemporary approaches. It considers mathematics, teaching of mathematics and measuring and evaluation together. It motivates why we teach and learn mathematics and emphasizes on mathematics education, mathematical thinking, the nature of mathematics, mathematical modeling (empirical modeling, theoretic modeling, simulation modeling, dimensional analysis modeling), relations between concepts, generalization, mathematics and culture, rigor, conceptual thinking, connecting concepts, conceptual structure, obtaining results, etc.

As the readers notice, the topics of geometry do not appear in this curriculum. The complementary curriculum for geometry was prepared separately. It is expected that it will be completed in 2010 and serve as a contemporary geometry curriculum.

8 Concluding thoughts

In some countries such as the USA, Germany, Canada, Singapore and Turkey, curriculum development was realized as a consequence of reform movements. When we take into consideration curriculum studies in the Turkish Republic, it was mainly started in 1924. The main reasons for changing mathematics curricula were international factors and influences such as the reports of John Dewey, and the recommendations of Kate Wofford, William C. Varaceus and Watson Dickerman. The other three main reasons were: to build up a modern civilization in Turkey; political situations such as the position of Turkey after World War II and passing multi-party democratic system; and the development in science and technology. For the most part, mathematics curricula development was not based on systematic researches and experiences. They were also not considered as a continuous process. Many mathematics curricula only consisted of a list of standards, goals and/or textbooks. Some had goals, objectives, information on teaching methods, and measurement and evaluation, instructional material, and books for teachers and students. Several of them had a curriculum development model such as those that were released in 1985, 1998 and 2004. Turkey as of today has carried out a lot of curriculum development studies and has increasing experience in this field. But there does not seem to be a fruitful cooperation between the MoNE and higher education council of universities (YÖK) to develop efficient and contemporary school curricula. But, it seems that Turkey will gradually develop the education system in quality through scientific research and many other activities. To date, curriculum development studies have been initiated in the teaching and learning fields of geometry, chemistry and biology in Turkey.

According to the public opinion in Turkey, all curriculum development efforts have been far to be enough. But after all these analyses, we can say that the curriculum development efforts in Turkey so far are sufficient at least as compared to the efforts in many countries in the world during this period.

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