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Abstract

This study carries out a comparative analysis of primary mathematics curricula put into practice during Turkish Republican period. The data for this study are composed of official curricula documents which are examined in terms of teaching principles. The study adopts a qualitative approach and employs document analysis method. The official documents are examined via content analysis technique. The analysis distinguishes a set of teaching principles envisioned to achieve effective mathematics instruction. A historical comparison of the principles indicates certain variations in the prescriptions of curricula documents as well as several features that remain unchanged throughout the Republican period. The importance of these principles for an effective mathematics teaching is discussed and certain suggestions for future curriculum development efforts have been presented.

Introduction

One of the primary objectives of today's schools is to equip students with mathematics skills and curriculum plays a central role in achieving this objective. Curriculum prescribes and proscribes certain approaches to teaching in order to make instruction effective so that students achieve a certain level of mathematical understanding. According to Fennema and Romberg (1999), effective teaching involves, among other things, helping students make connections between the procedural and conceptual knowledge, apply mathematics in different contexts (including daily life), evaluate what they know and do not, reflect on their mathematical experiences and construct their own mathematical understanding. Effective teaching hence requires teachers to make necessary arrangements in the teaching-learning environment to reach such educational outcomes. To make appropriate arrangements, teachers need to be aware of individual differences among students, develop an understanding of how students learn mathematics, and make choices about tasks and strategies that will increase learning (van de Walle et al., 2010). In this process, teachers are to make decisions about, at least, what to teach and how, and which strategies, methods and techniques to use in order to perform teaching in the most effective way.

Teaching principles are useful in guiding teachers through this complicated decision-making process (Acero et al., 2000). Teaching principles could be considered as general guidelines which shape the practice towards the knowledge and skill acquisition and which aim to overcome potential difficulties encountered during learning process (Aggarwal, 2009). These principles give a direction to the teachers in choosing activities, operating techniques and governing actions; in reflecting on their teaching, in organizing the way of teaching on the basis of their abilities and hence shape their practices (Tiberius & Tipping, 1990; Yelon, 1996). Acero et al. (ibid, p.56) in this respect note that "an accepted principle becomes one's philosophy which serves to determine and evaluate [one's] educational aims, activities, practices and outcomes."

The adopted principles in a curriculum show variations depending on the philosophy, teaching and learning theories, and epistemological perspectives. One of the main reasons behind these variations is almost always related to the achievement of an 'effective' instruction. Historical analyses of mathematics curricula provide opportunities to get a detailed understanding of the (nature of) such variations and hence the envisioned ways of effective mathematics teaching. It also gives an opportunity to observe how the principles change from one curriculum to the other and hence to understand the vision of curriculum developers. It is through historical analyses that we, as researchers and curriculum developers, can understand the quality and content of change and hence learn from the past experiences to give a meaningful direction to the futures efforts. Research efforts in this regard had already made some progress in international arena (see Lester, 2013; Schoenfeld, 2004; Kilpatrick & Stanic, 2004). Kilpatrick and Stanic (ibid.), for instance, examine basic precollege mathematics curriculum in the USA and identifies two main reform efforts by the turn of 20th century: unified and applied mathematics and the modern mathematics movements. They criticize these movements on the grounds that reform is viewed as technical rather than moral and ethical process, resulting in a neglect of basic issues of curriculum discourse. Schoenfeld (ibid.) also focuses on the reform efforts steered by National Council of Teachers of Mathematics' Curriculum and Evaluation Standards for School Mathematics and call it as "the math wars". He, in a historical context, opens a debate on such contested issues as whether mathematics is for the elite or for the masses; on tensions between "excellence" and "equity"; and on the issue of whether mathematics is a democratizing force or a vehicle for maintaining the status quo.

In Turkey, however, there appears little research focusing on historical examination of mathematics curricula (e.g., Özmantar et al., 2016). In a recent study, Özmantar and Öztürk (2016) investigated primary mathematics curriculum applied during the Turkish Republican period and they identified several teaching principles. They compared the curricula documents in this period to see which of these principles were emphasized and discuss the effect on the assumed (by the curriculum developers) mathematical development of children at early ages.

Although the study is helpful in determining a set of teaching principles existent in the curricula and provides important information as to the identification of principles in official documents, the cited principles are only analyzed at a descriptive level with general terms. Hence, the study is lacking in sub-categorical details. Due to this deficiency, it becomes difficult to effectively compare the curricula documents to see how developers tend to shape instruction through the use of principles in a historical context.

To fill this gap, the aim of the study is determined as an examination of primary mathematics curricula applied during Turkish Republic history in terms of teaching principles. This examination will also focus on a historical comparison of curricula documents. This examination, I believe, will provide detailed information concerning the paradigm changes in mathematics teaching-learning approaches, struggles to achieve an effective mathematics teaching, practices that were maintained or abandoned, and whether new mathematics teaching movements brought along any progress to the curriculum development efforts. I also believe that future curriculum development efforts have much to learn from our past experiences and hence this study provides a useful source for that matter.

To this end, the paper is structured as follows. First, brief background information concerning primary mathematics curricula during the Republic history will be presented. Then the method of analysis is explained and the principles detected in the documents with sub-categories are shared with exemplifying citations from the official documents. Teaching principles are then compared in a historical basis. The paper ends with a discussion of the observed teaching principles along with educational implications.

Primary Mathematics Curricula during the Republican Period

During the Republican period, 10 different primary mathematics curricula have been issued. The years that the changes took place are as follows: 1924, 1926, 1936, 1948, 1968, 1983, 1990, 1998, 2005 and 2015. The 1924 curriculum was issued immediately after the foundation of the Republic and has a transitory nature. After being applied for a short period, it was renewed in 1926 (TCMV, 1930). The renewal efforts focused on the principles of comprehensive education. The 1926 curriculum however was often criticized on the grounds that the content was not successfully connected across grade levels. A new curriculum was issued in 1936 with an aim to eliminate the criticisms. Nonetheless, the 1936 curriculum (TCKB, 1936) paid much of its attention to listing the topics to be covered at each grade level and the transition in and among the mathematical topics was often neglected. 12 years later, in 1948, a new curriculum was put into practice. It was much concerned with the cognitive developments of students and introduced a heavy content load. Despite harsh criticisms, the 1948 curriculum (MEB, 1948) has been in use for the longest period (for about 20 years) until 1968.

The 1968 curriculum (MEB, 1968), which was one of the first outcomes of the scientific program development endeavors, brought along many changes. Among these, preparation and planning for the units and subjects, the emphasis put on the investigative learning, responsibility given to the students on their own learning process, integration of the concepts of argumentation and evaluation into the system can be counted (Gözütok, 2003). The mathematics teaching program based on the model published in the 2142 issue of the Journal of Notification in 1983 was prepared in the same year, and after a period of piloting, it was put into effect beginning from the academic year of 1985-1986 (Demirel, 2011). The 1983 curriculum (MEB, 1983) had a volume incomparable to the previous ones. It was the first time that the learning outcomes of each grade level were stated in terms of behaviors in order to make them measurable and also units were created for the first time.

1990s were the years when the focus was on curriculum development for an eight-year primary education as a whole. The 1990 curriculum (MEB-TTKB, 1990) regarded primary education as a whole of eight years; subjects and units were organized based on this total period. After primary education became continuous and obligatory in 1997, a new curriculum was formed in 1998. The 1990 and 1998 curricula were very similar to the 1983 program in terms of content and teaching approach. However, the number of behavior statements in the 1998 curriculum (MEB-TTKB, 1998) decreased. The programs that were developed in 1990s were criticized for some important reasons: (1) they had significant similarities with the 1968 curriculum, (2) they did not reflect scientific and technological developments, and (3) objectives and teaching-learning arrangements were not in line with recent developments (Karakaya, 2004). By taking these criticisms into account, the efforts to construct a new program regained momentum in early 2000s.

The curriculum developed in 2004 and piloted for a year was put into effect nationwide in 2005. The term behavior was removed from the 2005 program (MEB-TTKB, 2005) and objectives were determined instead. Exemplary activities for several topics were provided and a variety of (alternative) assessment and evaluation methods were presented. In 2012, basic compulsory education was extended to 12 years and rearranged as 4 years for each school level (known as '4+4+4'). Following this, Head Council of Education and Morality (07.28.2015, issue 55) arrived on a decision to gradually abolish the 2005 curriculum. A new curriculum was developed in 2015 and put into effect starting from the academic year of 2016-2017 in line with the new 4+4+4 compulsory education. The 2015 program (MEB-TTKB, 2015) is the first and only program since the proclamation of the Republic in which primary education was regulated for a four-year period. Moreover, unlike other programs formed since 1983, this curriculum outstands with its compact structure.

Method

The aim of this study, as mentioned before, is to examine comparatively primary mathematics curricula documents applied during the Republican period in terms of teaching principles. Hence a qualitative approach was the obvious choice in designing the research. In this research, document analysis method was used. Document analysis method helps in constructing an understanding of changes and progress in comparative studies (Bowen, 2009). In this study, comparative analysis was performed by examining official curricula documents issued in respectively 1926, 1936, 1948, 1968, 1983, 1990, 1996, 2005 and 2015. Please note that 1924 curriculum was not the subject of analysis as it was a transitional program which was fully developed later in 1926.

The data set used in the current study is composed of general explanation parts of the documents used in the primary mathematics curricula. The data were analyzed through the content analysis technique. In the analysis process, initially a literature review (Tiberius & Tipping, 1990; Yelon, 1996; Acero et al., 2000; Aggarwal, 2009) related to teaching principles was conducted. In this context, distinctive theoretical background knowledge related to teaching principles and their indicators, and related to what can be regarded as teaching principles was gathered. Based on the literature review, teaching principles are operationalized as the rules that aim to make the teaching and learning process more efficient and effective; and the statements that act as guides to teachers in choosing activities, governing actions and operating techniques. This operational definition guided the content analysis.

During the analysis process, explicit and selective coding (Strauss & Corbin, 1990) which are the first steps in the process were followed. In line with the objective of the study, codes were formed through the use of immediately emerging meanings. These codes were converted into categories of teaching principles based on their similarities and differences. As a result of the analysis, 10 teaching principles as life-like situations, from concrete to abstract, motivation, repetition-consolidation, individual differences, active participation, collaboration, making connections, meaning-making and transfer; and 38 related codes at sub-categorical level were identified. In this study, the "from known to unknown" principle observed by Özmantar and Öztürk (2016) was not included, as sub-categorical codes could not be generated.

In order to ensure reliability, the codes were reviewed by two different experts. In the course of the review process, curricula documents were submitted to a field expert. Similarities and differences between the views of the expert and the codes created by the researcher in line with the research objectives were determined. The researcher and the expert negotiated over the differences in the codes. The teaching principles categories, related codes and exemplary citations from the curricula documents are provided in Table 1.

Table 1. Teaching principles and exemplary citations

Teaching principles	Teaching principle codes	Exemplary citations
Life-like situations	Developing skills to solve real life problems	The main objective of mathematics is to get students gaining the skills to solve everyday life problems (1990, p. 27)
	Creating a real life learning context	Working on real life situations and with real objects (1968, p. 4)
	Making connections between real life and immediate environment	…situations that are actual and related to daily life are considered while making activity plans and applying them (2005, p.9)
From concrete to abstract	Structuring teaching-learning process from concrete experiences to abstract thinking	Every new concept presented at 3rd, 4th, and 5th grades should initially be dealt with concrete and finite models and then should be abstracted (2005, p.28)
	Providing learning experience through concrete objects	Children should be given opportunities to work with concrete objects directly (1968, p. 3)
	Structuring teaching on students' prior knowledge and experiences	Student's knowledge, skills and ideas should be used to make sense of new experiences and situations (2005, p.18)
Motivation	Encouraging students to make use of mathematical knowledge and skills	[Students]…should be encouraged to predict and discover, and to think creatively, and to solve problems through different ways (1968, p.3)
	Making students enthusiastic to learn mathematics	Problems should be interesting … so that the child feel a desire to solve them (1936, p.158)
	Making mathematics learning an enjoyable experience	…mathematics ceases to be a frightening lesson and becomes longed and entertaining activities (1968, p.3)
	Giving the students the option to choose learning tasks	It is very useful for students to choose the problems to be solved… they have pleasure by solving the problems they encounter, and they seek for problems to solve around themselves (1948, p.18)
Repetition and consolidation	*According to the means*	
	Through drill-and-practice	After teaching the children certain rules, they will be repeated in a variety of ways. Repetition is one of the main processes of calculation (1936)
	Through homework	Students should be given homework on a variety of problems until they have enough (1948, p.182)
	According to rate	
	Frequently	After teaching the children a certain rule, habits should be formed through the use of numerous repetitions (1926, p.49)
	Intermittently	Drills should be practiced not at once but with time intervals (1948, p.184)
	According to objective	
	To recall previous learning while dealing with new topics	During summer holidays, students lose some of the knowledge they acquired…whenever a new topic is being dealt with … there should be a place for suggestive and reinforcing practices (1968, p.8).
	To overcome learning difficulties.	…generally, enough time should be spent on difficulties and plenty of drills should be practiced (1983, p.5)
	To achieve a comprehension	At the fifth grade, through the use of symbols for the relationships between becoming sub-sets and subsuming, domain related behavior reinforcing practices will be performed (1990, p.5)
	To gain fluency	After the comprehension of the related calculation, studies to enable accurate and fluent calculations should be performed. Drills are practiced and problems should be solved (1990, p.10).

Table 1 (cont.). Teaching principles and exemplary citations

Individual differences	Taking into account students' pace and capacity in the process of teaching	Since the learning periods are different, exercises need to be varied especially for those with learning difficulties (1998, p.15)
	Constructing the teaching and learning process on the skills and needs of the students	By taking into account students' individual differences, enabling them to progress according to their own skills and talents (1968, p.26)
	Structuring teaching according to level groups	Level groups should be formed and teaching materials should be prepared accordingly (1968, p.25)
	Taking into consideration cultural differences	Applying the curriculum, individual and cultural differences should be taken into account (2015, p.15)
	Taking the student levels into account	The problems that are presented to the students should be suitable to their development levels (1998, p.14)
Active participation	Enabling students to participate actively in the activities	Students' participation in the activities is essential (1968, p.26)
	Enabling students to construct knowledge through their own experiences	Before reaching main ideas, sufficient observations will be made and students will be encouraged to reach general ideas on their own and express these using their own words (1968, p.4)
Collaboration	Allowing collaboration among different level groups for knowledge sharing	Helping children at different levels to transfer their daily experiences and knowledge to one another (1968, p.25)
	Allowing collaboration among the same level groups for knowledge sharing	By putting the students with the similar features into the same groups students should be guided to work cooperatively (1968, p.25)
	Creating opportunities for students to work together	Assigning projects on which students work together (1968, p.24)
Making connections	Via comprehension of relations among numbers	We have to pay much more attention to the concept of number and the relationships among numbers (1948, p.178)
	Via comprehension of relations among calculations	The relationships among computations must be stated (Adding is quick counting, multiplication is quick adding of groups etc.) (1948, p.180)
	With other lessons	The topics in the calculation lesson will generally be related to the topics in the life sciences lesson of that week (1926, p.48)
	Between concept and computational knowledge	After the meanings of concepts are learned, they should be supported with computational knowledge. After that, the knowledge of concept-computation should be related (1998, p.5)
	Making connections among different representations	Explaining mathematical concepts with multiple representations (2005, p.16)
Meaning-making	Formation of new learning via relations to the previous ones	Students' interpretation of new knowledge by making associations with the previous ones should be essential (2005, p.18).
	Execution of mathematical calculations with comprehension	…that it is not enough to perform computations rotely, correctly and quickly; along with the knowledge about how they are performed, why they are performed should be sought for… (1968, p.2)
	Comprehension of mathematical knowledge	Meaningful learning should be the goal… Students should not only be able to remember and recognize what was learnt but they should be able to comprehend underlying reasons behind what they have learned (2005, p.18)
Transfer	Enabling students to use the knowledge and skills in daily life	Showing the practice of the geometry lesson. Teaching how to measure land, field and vineyard (1926, p.62)
	Enabling the use of knowledge and skills in other subjects	…using mathematics in other subjects and daily life… (2005, p.16)

Findings

Analysis revealed that in none of the curricula were teaching principles stated under a separate heading. Teaching principles and codes observed in Republican curricula documents are presented in Table 2 in terms of their existence. Ticks and dashes indicate, respectively, existence and non-existence of a code.

Table 2. Results of teaching principles

Teaching principle category	Teaching principles codes	1926	1936	1948	1968	1983	1990	1998	2005	2015
Life-like situations	Developing skills to solve real life problems	√	√	√	√	√	√	√	√	√
	Creating a real life learning context	-	-	-	√	-	-	-	√	-
	Making connections between real life and immediate environment	√	√	√	√	√	√	√	√	√
From concrete to abstract	Structuring teaching-learning process from concrete experiences to abstract thinking	√	-	√	√	-	-	√	√	√
	Providing learning experience through concrete objects	-	√	√	√	√	√	√	√	√
	Structuring teaching on students' prior knowledge and experiences	-	√	√	√	√	-	√	√	√
Motivation	Encouraging students to make use of mathematical knowledge and skills	-	-	-	√	-	-	-	√	√
	Making students enthusiastic to learn mathematics	-	√	√	√	-	√	√	√	-
	Making mathematics learning an enjoyable experience	-	-	-	√	√	√	-	√	√
	Giving the students the option to choose learning tasks	-	-	√	√	√	√	-	√	-
Repetition and consolidation	*According to the means*									
	Through drill-and-practice	√	√	√	√	√	√	√	-	-
	Through homework	√	√	√	-	-	-	-	-	-
	According to rate									
	Frequently	√	√	-	-	-	-	-	-	-
	Intermittently	-	-	√	√	-	√	√	-	-
	According to objective									
	To recall previous learning while dealing with new topics	-	√	-	√	√	√	-	-	-
	To overcome learning difficulties.	-	-	-	√	√	√	-	-	-
	To achieve a comprehension	√	√	√	√	√	√	√	-	-
	To gain fluency	-	-	-	-	√	√	√	-	-

Table 2. (cont.) Results of teaching principles

Individual differences	Taking into account students' pace and capacity in the process of teaching	-	√	√	√	√	√	√	-	-
	Constructing the teaching and learning process on the skills and needs of the students	-	-	√	√	√	√	-	√	√
	Structuring teaching according to level groups.	-	-	-	√	-	-	-	-	-
	Taking into consideration cultural differences	-	-	-	-	-	-	-	-	√
	Taking the student levels into account	-	√	√	√	√	√	√	√	√
Active participation	Enabling students to participate actively in the activities.	√	√	√	√	√	√	√	√	√
	Enabling students to construct knowledge through their own experiences.	-	√	√	√	√	√	√	√	√
Collaboration	Allowing collaboration among different level groups for knowledge sharing	-	-	√	√	-	-	-	-	-
	Allowing collaboration among the same level groups for knowledge sharing	-	-	-	√	-	-	-	-	-
	Creating opportunities for students to work together	-	-	-	√	-	-	-	√	-
Making connections	Via comprehension of relations among numbers	-	-	√	√	√	√	√	√	√
	Via comprehension of relations among calculations	-	-	√	√	√	√	√	√	√
	With other lessons	√	√	√	√	√	√	√	√	√
	Between concept and computational knowledge	-	-	-	√	-	-	√	√	-
	Making connections among different representations.	-	-	-	√	√	√	√	√	√
Meaning-making	Formation of new learning via relations to the previous ones	-	-	-	√	-	-	-	√	√
	Execution of mathematical calculations with comprehension	-	-	√	√	-	√	-	√	√
	Comprehension of mathematical knowledge	-	-	-	-	-	-	-	√	√
Transfer	Enabling students to use the knowledge and skills in daily life	√	-	√	√	√	√	√	√	√
	Enabling the use of knowledge and skills in other subjects	-	-	-	-	-	√	√	√	-

The findings related to teaching principles are presented under separate headings for the reasons of simplicity and clarity.

Life-like Situations

All the Republican curricula paid a particular attention to this principle. In the scope of this principle, it is observed that “developing skills to solve real life problems” had a place in all the curricula documents from 1926 to 2015. The curricula insist on the use of real-life problems as an integral part of teaching process. Creation of a real-life learning context was included only in the 1968 and 2015 curricula. The 1968 curriculum is the first one suggesting arrangements in this respect and clearly points that mathematical knowledge and skills should be gained from the events taken from daily life in authentic situations. However, this principle was removed after the changes introduced in 1983 and it was reenacted with the 2005 program. In the 2005 program, it was mentioned that whenever possible teaching should be carried out to create real-life situations outside the school or at least real-life situations should be created in the classrooms. It is remarkable that this principle whose significance was realized and integrated into the 2005 program could not find a place in the 2015 program. It is also observed that since 1926, all the curricula have been concerned with connecting real-life with the learners’ immediate environment.

From Concrete to Abstract

This principle was one of the most referenced one in the curricula documents. The 1926, 1948, 1968, 2005 and 2015 programs suggest regulations to construct the teaching-learning process from concrete experiences to abstract thinking. It is also clear that from 1936 onwards, curricula documents strongly emphasize the use of concrete (e.g., marbles) or semi-concrete objects (e.g., pictures) along with models of mathematical concepts. It appears that curriculum developers had a conviction that teaching mathematics at early ages had to rely upon concrete materials whenever possible. It is also clear that since 1936 (with the exception of 1990 curriculum), curricula documents have seen real life experiences as sources to concretize mathematics.

Motivation

Student motivation to learn mathematics appears to find a firm place in the curricula documents, though with varying degrees of emphases and different dimensions. The main means that programs attempted to motivate students are encouragement to use their knowledge, giving opportunities to select tasks and making mathematics learning an enjoyable experience and hence increase the student enthusiasm to learn mathematics. It should be stressed that although the 2005 program emphasized that students should be motivated to learn mathematics under the title of affective skills, renewed curriculum of 2015 excluded this point and hence emphasis on motivation principle was weakened.

Repetition and Consolidation

Curricula documents until 2005 embraced this principle firmly. However, the 2005 and 2015 curricula do not even give passing-by citations to this principle. This principle explicated in terms of means, rate and objective in the curricula. The main means envisioned for this principle include drill-and-practice and homework assignments. Drill-and-practice was mentioned invariably until 2005 while homework with the purpose of consolidation was suggested until 1968. In terms of rate, frequent repetition was stressed in the 1926 and 1936 curricula. However, in the 1948, 1968, 1990 and 1998 programs emphasis on repetition was weakened and suggestions for intermittent repetition as appropriate were made. The purposes of repetition show variations among the curricula; yet it was mainly employed to have students recall previous learning, overcome difficulties, comprehend mathematics and gain fluency in execution of procedures. It is interesting to see that, until 2005, repetition was invariably seen as a way for achieving a comprehension of mathematics.

Individual Differences

The findings suggest that since 1936, individual differences found a place in all primary mathematics teaching programs. It was observed that beginning from 1936 until 1968 the variety of regulations made for this principle increased, and in the 1968 program individual differences was detailed under a separate heading. After the 1983 program, there was no separate heading for this principle and the emphasis was decreased. In the 2005 program, with the assumption that all children can learn mathematics, it was stated that in the teaching-learning process individual differences should be taken into consideration. Unlike the previous ones, in the 2015 program the need to consider cultural differences was highlighted for the first time, and it could be claimed that it was a remarkable development regarding this principle.

Active Participation

This principle has been mentioned in all programs since 1926, but there were differences about how this principle was put to work. All the curricula documents set students' active participation in the teaching-learning process as an objective. It is noteworthy, however, that the 1983, 1990 and 1998 programs placed the teacher in the center of teaching-learning process and envisioned students active participation answering (teacher directed) questions and taking notes. All the programs from 1936 to 2015 mentioned about students' knowledge construction through their own experience. In this respect, in the 1968 program, descriptions as to how the students would construct knowledge on their own and examples were provided. However, in the 1983, 1990 and 1998 programs, while students' knowledge construction through their active involvement was stated as an aim, this was not unfortunately reflected in the suggested regulations for teaching-learning arrangements. The 2005 and 2015 programs aimed to get students' active participation in knowledge construction via their own experiences and this intent was reflected to the suggested teaching-learning regulations.

Collaboration

Among the Republican curricula, only the 1948, 1968 and 2005 programs adopted this principle to shape the teaching-learning approach. The 1948 curriculum mentioned collaboration among different level groups with the purpose of sharing knowledge. In the 1968 program, creating environments with an aim to enable knowledge transfer among both the same and different level groups was projected. Moreover, students' collaboration was mentioned even in the context of assessment-evaluation of the 1968 program; in this respect, the program included preparation of group work reports and projects. In the 2005 program, collaborative learning method in which students help each other to learn by working together was defined as a significant component. It is also observed that regulations were made in this respect in the teaching-learning process of the 2005 curricula. In the 2015 program, the bold emphasis on the collaboration principle was removed and only knowledge sharing among students was mentioned.

Making Connections

Since 1926, this principle has guided the teaching-learning regulations of the curricula. Connections appeared to be conceived of five different types: among numbers, among calculations, among representations, between concepts and computational knowledge, and with other lessons/subjects. Starting with the 1948 curriculum, number relations and calculation relations have always been the foci of attention. In the 1926 and 1936 programs, making connections with the other lessons was boldly highlighted. Similar highlights are also apparent in the other curricula documents. Although connecting mathematics to the other subjects was always a concern to the curricula, this issue has somehow superficially attended to in the programs. The 1968 curriculum was the first stressing the importance of concept and computational knowledge relationship. The relationship between concept and computational knowledge was boldly highlighted in the 2005 program; and this was explicitly stated in the 2015 program. It is interesting to see that establishing connections among different representations was taken as an important principle as early as 1968 and, later on, always found a place in any changing curricula.

Meaning-making

The first reference to this principle is seen in the 1948 curriculum. In that program, it was stressed that calculations should be performed with comprehension. Since then, except for 1983 and 1990 programs, this has been a repeatedly stressed feature of mathematics teaching. To achieve a meaningful learning experience, only three programs (1968, 2005 & 2015) focused on the construction of new learning on the basis of previous ones.

The 2005 and 2015 programs stressed that students should not only recall and recognize knowledge but also comprehend the meaning of mathematical concepts and structures.

Transfer

In all the programs between 1926 and 2015 (except for the 1936 curriculum) transfer principle was put to work and the aim was to realize transfer in two contexts: daily life and different lessons/subjects. Transfer into daily life was included in all the curricula, except for the 1936 program. It is interesting to see that the transfer of this kind has been stressed even as early as 1926. The use of mathematical knowledge and skills in other subjects was put to work only in the 2005 program. In the general descriptions part of the 1990 and 1998 programs, transfer into other subjects was mentioned; but in these programs, the relation of mathematics to other subjects remained at superficial connection levels.

Discussion

In this study, primary mathematics curricula of the Republican period are examined in terms of teaching principles which influence and shape teaching significantly. The analysis yielded 38 teaching principle codes under 10 different principles. The findings regarding each principle will be discussed in separate headings below.

Life-like Situations

All the curricula developed and applied during the Republican period insistently focus on teaching mathematics through the creation of life-like situations and with reference to daily life of children. The importance of teaching mathematics in relation to real-life has been widely accepted by researchers and practitioners. This is especially critical for development of mathematical literacy, an important skill that students need to gain for their adaptations as productive individuals in today's knowledge society. Mathematical literacy is defined as:

> An individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgments, and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen (OECD, 2003, p. 24).

PISA (Program for International Student Assessment) makes international comparisons of 15-year-olds in terms of reading, science and mathematical literacy skills. Realization of the central role that mathematical literacy plays in knowledge society as well as the results of PISA led many countries in Europe to make serious renovations to their curricula. With these efforts, more emphasis is now placed on the application of mathematics to daily life situations. Belgium, Spain, Estonia, the Czech Republic and the United Kingdom are examples of these countries (Parveva et al., 2011).

It can be said that the curricula of the Republican period appeared to well understand the importance of this issue and hence included regulations to this direction. However the extent to which life-like situations principle informed the classroom practice is open to debate. In fact, the results of PISA that examines the extent to which students can apply their mathematical knowledge to daily life situations (see Parveva et al., 2011) reveal that this principle is not effectively practiced in our classrooms.

From Concrete to Abstract

Mathematics is traditionally perceived as an abstract field (van Oers, 2001), which is shown as one of the underlying reasons for student difficulties (Dossey, 1992). This perception classifies mathematics as a mental structure (see Piaget, 1970) that can only be learnt (and hence, taught, for that matter) through logical inferences (Dienes, 1963) (and reasoning being the main means to achieve this). When we look at the Republican curricula, the use of concrete objects (e.g., beans, balls, pens, rows) and semi-concrete objects (e.g., pictures, figures, points) have been commonly employed in mathematics teaching. Although this principle was narrowly addressed in 1926 and 1990 curricula, in all other programs this principle was put to work extensively.

The fact that curricula documents envision mathematical learning as a development ascending from the concrete to the abstract is historically consistent with the perception and developmental direction of concrete-abstract dichotomy (Noss & Hoyles, 1996). However, it has become a debated topic, especially in recent years, to what extent this approach explains mathematical learning and cognitive development (see Ozmantar & Monaghan, 2008). Nevertheless, it is important to observe that curricula throughout the Republic history have not reduced mathematics teaching-learning to a mere logical and mental experience.

Motivation

Research on motivation firmly establishes that it is an inseparable dimension of learning (Lord et al., 2005). In order for students to get involved in learning environment in schools, they need to be motivated and their motivations affect the outcomes of learning efforts. Though defined differently by many, the definition of Lord et al., (2005, p.4) is relevant to our discussion:

> a range of an individual's behaviors in terms of the way they personally initiate things, determine the way things are done, do something with intensity and show perseverance to see something through to an end

Studies on motivation distinguish between two motivational concepts: intrinsic and extrinsic motivation (Deci & Ryan, 1985). Individuals with extrinsic motivation need external rewards (e.g. teacher praise, family pressure, avoidance of punishment). Those who are motivated intrinsically wish to learn mathematics for their own interest, for the pleasure they get and/or for the satisfaction provided by knowing (Middleton & Spanias, 1999). Studies have shown that students with intrinsic motivation focus on mathematics learning conceptually, and hence intrinsic rather than extrinsic motivation is positively correlated with mathematics learning (Mueller et al., 2011).

Results of the curricula analysis show that they (apart from the 1926 curriculum) aim to intrinsically motivate students to learn mathematics. There were no explicit statements in the documents pointing to extrinsic motivation. It is hence possible to conclude that the curricula are concerned to make learning mathematics a pleasures and interesting experience for students. To ensure this, teachers are warned to make appropriate arrangements. However it should be noted that while the 1936 and 1990 curricula somehow fell much behind the others in terms of motivation principle; the most concerned ones regarding this principle are 1968 and 2005 programs.

Repetition and Consolidation

Historically, the curricula documents, except for 2005 and 2015, paid a particular attention to the consolidation of mathematical knowledge and skills. Repetition was seen as a way to achieve consolidation. The analysis shows that this principle has been put to work with different functions on the basis of means, rates and objectives. There observed two main means envisioned for consolidation: drill-and-practice and homework. While recourse rate to these means was frequent in the first two programs (i.e. 1926 & 1936), others suggested intermittent uses. Through drill-and-practice and homework, the programs until 2005 invariably aim to achieve a level of mathematical comprehension on the part of students. Drill refers to “repetitive, non-problem-based exercises designed to improve skills or procedures already acquired (van de Walle et al., 2010, p.69). There are benefits of drills (such as gaining fluency in executing procedures) as well as side effects (e.g., rote application of procedures) (see van de Walle et al, *ibid*. for more on this).

The principle of repetition and consolidation is often associated with drill-and-practice and it is probably due to the negative consequences that the 2005 and 2015 programs exclude this principle. However, studies conducted especially over the last fifteen years have shown that consolidation of newly constructed mathematical knowledge plays an essential role in future learning (e.g., Tabach et al., 2006, Monaghan & Ozmantar, 2006). These studies suggest the importance of consolidation through activities focusing on the use of newly constructed mathematical structures in different contexts and with different dimensions. Hence I argue that the 2005 and 2015 programs have important deficits in terms of consolidation.

In the scope of repetition and consolidation principle, another means has been homework assignments. Yet, this was only seen in the curricula of 1926, 1936 and 1948. In later programs, there were no regulations for the use of homework with regard to this principle. There are studies that emphasize the use of homework for the purposes of practice and consolidation and that reported positive effects on mathematical attainment of especially low-achieving students (Trautwein et al., 2002). However, research on homework point out two important findings: (1) homework contributes more to the academic achievement of secondary and high school students; (2) there is a negative correlation between academic attainment and homework completion time (Mullis et al., 2008). In the curricula of some European countries, such as Ireland, the UK and Belgium, there are regulations for the use of homework for consolidation purposes. When the results considered holistically, it can be concluded that assigning homework for the purpose of consolidation, with the appropriate length of completion time and suitability to the student level, contributes positively to mathematical attainment. Therefore, it can be said that, in future curriculum development efforts, it will be useful to consider homework with guidelines for its use.

Individual Differences

This principle is based on the assumption that learners differ in their social, cultural, physical, psychological, aesthetic and moral development levels and an effective teaching requires taking into consideration of these diversities (Acero et al., 2000). Studies have shown that students' home background, cultural environment and socio-economic levels are important factors in determining school success (Breen & Jonsson, 2005; Mullis et al., 2008). In age-grading classrooms, students from different socio-economic and cultural layers of the society are placed together in the same learning environment.

Effective teaching hence has to take into account the individual differences among the students in such a way that responds to their needs. The analysis of mathematics curricula shows that there is a tendency to consider individual differences on the basis of learning speed: slow, moderate and fast learners. The emphases put on the necessity of teaching students at their learning level in all the programs since 1936 confirm this observation. It is interesting to see that consideration of students' cultural differences is only mentioned in 2015 program. Therefore, the individual differences principle is addressed in a narrow framework in the programs and this principle is mostly dealt with attainment-oriented regulations.

Active Participation

Studies in mathematics instruction have provided considerable evidence that the achievement in mathematics is a direct result of the students' active participation in the learning process (eg, Hambrick, 2005). For this reason, it is suggested that teachers should have high expectations for their students and get students' active involvement in the teaching-learning process (eg, Hambrick et al., 2010). All curricula documents of the Republican period are consistent in their emphasis on and suggestions for students' active participation to teaching-learning activities. Further to this, students' construction of mathematical knowledge through their own experiences has been a concern for the programs since 1936. This concern, however, is not always reflected in teaching-learning arrangements but just stated as an aim (see, for example, 1983, 1990 & 1998 programs). Nonetheless we can safely conclude that curriculum developers in Turkish Republic history realize the importance of this principle for student learning.

Collaboration

This principle, in its simplest form, refers to a group students working together by taking responsibilities (and being held accountable) for each other's learning (Aggarwal, 2009). Therefore, collaboration is more than just an ensemble of students put together in a group. Collaboration is important for students' social, cognitive, academic and adaptive thinking developments (Plass et al., 2013). The analysis of curricula documents shows that this principle has unfortunately been largely neglected. This principle found a place only in 1948, 1968 and 2005 programs.

There are also important differences in the teaching-learning regulations of the programs in terms of this principle. For example, in the 1948 curriculum, collaboration was prescribed for students from different level groups (often with successful students teaching less successful ones). In the 1968 program, it was suggested that the level groups be formed by taking into consideration students' individual differences in terms of academic achievements. The 2005 program is arguably the most advanced one regarding this principle in terms of details of collaborative work and the suggestions to the teachers.

Making Connections

This principle is based on the assumption that the units that make up the knowledge structures are parts of the same whole and for a teaching to be effective there should be structural links established in and between the ideas, actions and concepts (Aggarwal, 2009). Studies in the field of mathematics education treat connections as an indispensable principle for mathematics teaching-learning and accept this as an indicator of the meaningful teaching-learning of mathematics (e.g. Star & Stylianides, 2013). The permanence, richness, depth and practicality of the mathematical learning are claimed to depend on the establishment of links in and among mathematical structures, concepts, processes and representations (Hiebert & Carpenter, 1992; Kilpatrick et al., 2001).

Analysis of the curricula documents shows that making connections was historically given a prominent role in shaping instruction. Relating mathematics to other subjects such as life-sciences or painting-work has been a common feature of all programs. Comprehension of the relations among numbers and the relations among calculations (e.g. between addition and multiplication) has been adopted as teaching principles since the 1948 program was issued. Establishment of links among multiple representations of mathematical concepts as a teaching principle found a place as early as 1968 and since then it has been invariably stressed in the curricula documents. The main weakness of the curricula is, I believe, the ignorance of connections between computational and conceptual knowledge; this was stressed only in 1968, 1998 and 2005 programs.

Research in mathematics education provides compelling evidence that making connections is often ignored by teachers and does not always become an explicit focus of instruction (Özmantar et al., 2010). When left to the students, however, connections are not often established (Özmantar et al, *ibid*.) as this brings a heavy cognitive load on the part students who hence avoid or even do not feel the need for this (Berthold et al., 2009). These studies indicate that if making connection is not adopted as a teaching principle, students will not reach the level of comprehension expected from them. These findings demonstrate the importance of connection principle. The curricula developers of the Republican period appear to well realize this importance and hence have included this as a principle since 1948.

Meaning-making

Learning mathematics is more than just reaching the right results by applying certain operations error-free. Mathematics learning also includes an understanding of how and why certain procedures are applied (to solve problems), how and why certain operations are performed as well as involves conceptual understanding of mathematical structures. Analysis of the curricula shows that there are ups and downs in terms of this principle. For instance, especially in the periods of 1948-1983 and after 2005, there has been a real concern for teaching mathematics meaningfully. However, curricula put into practice until 1948 and between the period of 1983-2005, meaning-making, as interpreted in this study, seemed to be ignored.

Among the circles of Turkish educators and researchers there is a widespread belief that curricula before 2005 have promoted rote-learning (e.g., Fer, 2005). Certain programs (such as the 1983, 1990 curricula) could provide examples to justify such a belief. However, I believe that extending this argument to include all the curricula of the Republican period would be an overgeneralization and in fact 1968 curriculum, for instance, took a firm position against rote-learning.

Transfer

The notion of transfer is a complicated one; but it could be defined simply as the ability to use acquired knowledge while solving new problems, to answer new questions and to learn new topics (Mayer, 2002). Transfer of knowledge, hence, depends on depth and breadth of one's understanding of mathematical structures. Transfer principle in the Republican curricula seemed to be a concern with two aspects: the use of knowledge in everyday life and in different subjects. The students' use of mathematical knowledge and skills in everyday life were emphasized in all the curricula documents other than 1936. Emphasis on the use of knowledge and skills in other subjects emerged after 1990, but this principle was not somehow referred to in the 2015 curriculum.

Final Remarks

The discussion hitherto focused on the examination of teaching principles observed in the curricula documents separately. This examination provides important information on approaches of teaching mathematics to students of early ages during the Republican period, at least on the philosophical and political levels. It also informs us about the historical evolution of these approaches. When considered holistically, teaching principles observed in the official documents have important commonalities with current research findings for an effective mathematics instruction. It is a widely accepted fact that mathematical competence in the knowledge society is one of the key skills for personal fulfillment, participatory citizenship, social inclusion and employment. The importance of teaching principles for the development of this competence is all too apparent. However, teaching principles in the official documents do not necessarily come into life in real classrooms. With individual choices and approaches, the teachers play an important role in organizing the teaching-learning environment and make decisions as to which principles to employ or not. It would be a useful research agenda to study real classroom environments to gain insights into teachers' adoption of principles to make instruction effective. It would also be fruitful to study on what bases teachers prefer to use certain principles while ignoring the others and the rationales behind their choices. I also believe that future program development efforts need to make clear statements as to the prescription of teaching principles but these prescriptions need to be informed by relevant research findings.

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