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Comparison of Secondary School Mathematics Curriculums in Türkiye According to the Top-down and Bottom-up Approach*

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ABSTRACT

This study aims to examine the mathematics curriculum of vocational education centers, secondary education, and science high schools, currently implemented at the secondary education level, in terms of various variables based on the top-down and bottom-up approach. The document review method, a qualitative research method, was employed, and criterion sampling was adopted as the sampling method. Data were obtained through comparisons made by evaluating the purposes, perspective, basic philosophy, general aims, number of acquisitions, and learning domains of the curricula. The ratios of the acquisitions in the curriculums related to real-life situations, "scientists and their studies" emphasized in the general aims of the curriculum and information and communication technologies to all acquisitions were also analyzed. Descriptive statistical methods, such as percentage and frequency, were used to reveal differences between the curricula. As a result of the research, it has been observed that there are similarities in the purposes, competencies, and general aims of the mathematics curriculum of all three curriculums within the framework of the curriculum in which the top-down bottom-up approach is aimed. Within the framework of the applied curriculum, it was concluded that the least association was in the mathematics curriculum of vocational education centers in the examination of the associations made with scientists and their studies, real-life, and information and communication technologies in all three curriculums. In this direction, suggestions have been made for the points that need to be developed in line with the purposes, perspectives, and associations with acquisitions of the curriculums.

Keywords: Secondary education mathematics curriculum, top-down and bottom-up approach, curriculum evaluation

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1. INTRODUCTION

In our constantly developing and changing world, preparing societies for the future, and preparing individuals to meet the demands of the age, are among the main aims of education (Abdioğlu & Çevik, 2018). In this regard, education is the most important requirement to create a prosperous and developed society (Tekalmaz, 2019). Along with the desired behavioral change in individuals, the standard of living of societies also increases with the education process (Sönmez, 2019). One of the most important concepts in this process is curricula (İlhan & Aslaner, 2019; Özdemir 2012). Educators from around the world have been called upon in recent years to prepare students for a globalized 21st-century world (Ananiadou & Claro, 2009; National Research Council, 2011; Organization for Economic Cooperation and Development (OECD), 2018; Partnership for 21st Century Skills (P21), 2006; Wallis & Steptoe, 2006). It is possible for educational programs prepared under today's conditions to provide individuals with the knowledge and skills they need to succeed in the 21st century (Duru & Korkmaz, 2010). Education-training program is expressed as the body of information about the plans that are put forward to convey the values and orientations of a society and to reach the aims of the planned education (Legendre, 1988). In other words, education and training programs answer the question of how to raise a human being (Yüksel, 2003). The curriculum is the planned arrangement of the behaviors, attitudes, knowledge, and skills that are wanted to be acquired by individuals for the purposes of the education program by being included in the education program (Demirel, 2017). Oliva and Gordon (2012), on the other

* This article was conducted on document analysis and does not contain any studies with human or animal subjects. All data have been obtained and reported by ethical concerns, principles, and rules.

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hand, state that the curriculum includes functional suggestions on what to teach and how the lessons will be carried out as a detailed plan of a lesson.

When viewed as a framework for addressing teaching and learning needs related to content and proficiency, curricula are implemented to shape students' learning experiences in school education (Schmidt et al., 1997). The goals of education in schools vary and should be redefined to align with evolving expectations and needs, or interpreted in the context of these changes. (Oral & Yazar, 2017). Demirel (2020) also states that curricula should be reviewed in different periods to meet the expectations of the age, together with the education and training approach that develops in line with the changing needs of individuals, societies, nations, and the world.

Curriculum reform movements in many education systems have been the focus of educational research and changes in mathematics curricula and curriculum have often been the main focus of major educational reform movements in the history of mathematics education. (Li & Lappan, 2014). Especially with the publication of the principles and standards by the National Council of Teachers of Mathematics (NCTM), efforts to develop and evaluate curriculum materials have begun to attract more and more attention (Reys, 2014; Schoenfeld, 2014; Senk & Thompson, 2003; Umay et al., 2006; Üredi & Ulum, 2019). In this context, the mathematics curriculum and its effect on learning and teaching have also become the main point of many research studies. International assessment studies such as TIMSS (Trends in International Mathematics and Science Study) and PISA (Programme for International Student Assessment) have also enabled the updating and evaluation of the programs as a guide for the participating countries to analyze the students' learning and evaluate the curriculum (Kadijevich, 2019; Kılıç et al., 2014). Although the curricula of the countries differ from each other, the curricula, education systems, and practices of the countries that are successful in international exams such as TIMSS and PISA serve as a guide for countries with a low level of success (Bozkurt et al., 2020; Hook et al., 2007). To rank high in these exams, countries have to keep their curricula updated in line with the developments in the world and the needs of the societies (Üredi & Ulum, 2019). It can be said that the mathematics curriculum should be constantly analyzed and evaluated both according to the evaluations made in line with international practices such as PISA and TIMSS and according to the standards set by NCTM (İlhan & Aslaner, 2019). In other words, if a country is going to carry out a study to improve mathematics education and training, the development of the mathematics curriculum is an integral part of this study (Erbilgin, 2014). In this context, countries sometimes revise and update their mathematics curriculum (Baki, 2008). In Türkiye, the latest updates were made in 2018 in primary, secondary, and secondary education mathematics curricula. This study focuses on the secondary school mathematics curriculum in Türkiye.

Reviewing the change processes of institutions providing secondary education is considered beneficial for evaluating the secondary education mathematics curriculum in Türkiye. In this context, while there were 79 different types of schools providing secondary education in Türkiye in the 2000s, with the reforms carried out in the following eight years, it has been reduced to eight high school, including Multi-Program Anatolian High School, Vocational and Technical Anatolian High School, Social Sciences High School, Fine Arts High School, Sports High School, Anatolian High School, Imam Hatip High School and Science High School (Çelik, 2015). In addition to the types of schools that carry out educational activities at the secondary level, Vocational Education Centers (VEC) were also included in the scope of compulsory secondary education with the amendment published in the Official Gazette dated 9/12/2016 and numbered 29913. In other words, individuals who have completed secondary school will be able to complete their secondary education at VEC. When the secondary school mathematics curriculum is examined, apart from VEC, there are two different secondary education mathematics curriculums for Science High School and other high school types (Biçer & Ada, 2020). Currently, three different teaching curriculums are applied for mathematics at the secondary school level, together with the mathematics curriculum applied for VEC. It is considered important for secondary school mathematics teachers to know about these three different curriculums for the realization of effective mathematics education because mathematics curriculum influences being successful in mathematics (Berkant & Gençoğlu, 2015). In this respect, it is thought that revealing the similar and different aspects of the secondary education curriculum by comparing them with each other will be beneficial in terms of realizing effective learning, providing teachers with information about the curriculums, and providing a resource for the updates to be made in the coming years.

According to Inprasitha (2019, p. 59), a traditional mathematics curriculum model includes the intended curriculum, implemented curriculum, and attained curriculum and the most emphasis is on the intended part. The intended curriculum includes the plans and objectives that students are asked to experience and learn. Classroom activities planned to be carried out within the framework of these plans and purposes characterize the implemented curriculum. Finding the reflections of the applied curriculum in the teaching books, its implementation by the teachers, and the evaluation of the students within the framework of the achievements are within the scope of the attained curriculum (Lin & Chang, 2019). In the teaching model of the TIMSS, which aims to evaluate the knowledge and skills of fourth and eighth-grade students in the fields of mathematics and science and carried out at the international level, there are curriculums as intended curriculum, implemented curriculum and attained curriculum (Mullis & Martin, 2017). In TIMSS, the intended curriculum is associated with the aims of education systems and the structures established for these purposes, while the implemented curriculum refers to the practices and activities designed in the school and classroom for these purposes and targets (Schmidt & Cogan, 1996). The attained curriculum is associated with what students gain from their educational experiences (Schmidt & Cogan, 1996). The traditional model is a kind of top-down approach that does not receive any feedback from the classroom and ignores the revision process for improvement and continuous improvement (Figure 1). In this model, the main emphasis is on “what” is to be taught, “how” will be taught, and “to what extent” students learn is considered.

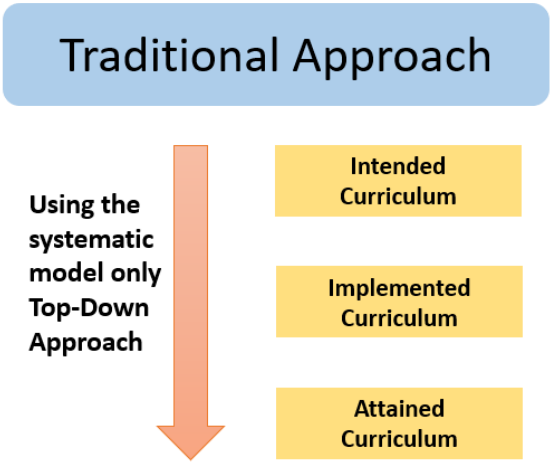

Figure 1. A top-down approach model of the mathematics curriculum (Inprasitha, 2019, p. 60)

Inprasitha (2019, p. 59) emphasizes the need to pay sufficient attention to what is intended, implemented, and attained for mathematics curriculum models, and states that a bottom-up approach should be included in the top-down approach (Figure 2). The top-down approach focuses only on students' test scores, ignoring the abilities and influence of teachers, who are one of the country's greatest resources for mathematics education. In this direction, a top-down and bottom-up approach should be considered in which the interaction of all components with each other is taken into account within the framework of a holistic perspective, the opinions and evaluations of the teachers, the school, and the students who are the implementers of the curriculums contribute to the creation of the intended curriculum design, the intended curriculum is implemented in the classrooms, and the student success and behaviors affect the intended curriculum.

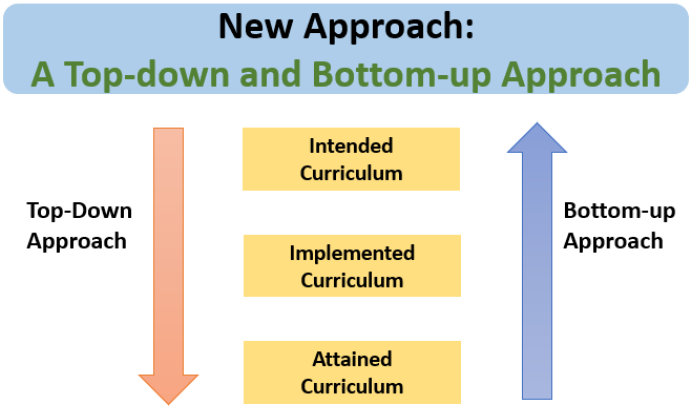

Figure 2. Top-down and bottom-up approach model of the mathematics curriculum (Inprasitha, 2019, p. 60)

Top-down and bottom-up approaches are mentioned in many areas of mathematics education. Tiong (2005) recommends the top-down approach for training in problem-solving strategies. As a general case, it is recommended to move from the top-down to a more specific strategy, from teaching concepts and ideas about representational forms to drawing diagrams and histograms in particular. Cellucci (2013), on the other hand, refers to the top-down approach as an approach that tries to explain nature in the philosophy of mathematics, and the bottom-up approach, which is an alternative to this approach, is explained in terms of the activity and interactions of individuals. Johnson (2004) deals with the top-down and bottom-up approaches in terms of teaching. Gür (2006) compared British and Turkish curricula within the framework of top-down and bottom-up approaches.

This approach can also be considered in the evaluations to be carried out within the framework of the top-down and bottom-up approach to the mathematics curriculum. In this context, within the framework of the intended curriculum, the purposes, objectives, and perspectives of the curriculum, the scientists who contribute to mathematics and their studies, real-life, and information and communication technologies can be associated with the curriculums at the implemented curriculum stage, and the acquisitions can be evaluated within the framework of the attained curriculum. Considering that the intended curriculum in the top-down and bottom-up approach includes learning expectations and ways of guiding learning (Hino & Ginshima, 2019), in this study, the aims, perspective, values, and competencies of the curriculum, as well as the stages of preparation, were considered in the intended curriculum stage. The implemented curriculum includes classroom-oriented application models of planned and intended acquisitions (Lin & Chang, 2019). In the Implemented stage, the focus is on scientists and their studies who contribute to mathematics in the curriculum, associating with real-life and associating with information and communication technologies, and mathematics lesson hours. Considering that the purposes intended to be achieved by students within through classroom activities are outlined in the curriculum (Çil & Çepni, 2014; Lin & Chang, 2019), the focus is on learning domains, sub-learning domains, and acquisitions in the curriculum within the framework of the attained stage. When the studies

on secondary school mathematics curriculum are examined, there are studies in which the opinions of teachers (Aydın et al., 2018; Berkant & Gençoğlu, 2015; Biçer & Ada, 2020; Çiftçi et al., 2013; Çiftçi & Tatar, 2015; Sakallı et al., 2016; Tekalmaz, 2019; Yalçınkaya, 2018) and administrators (Abdioğlu & Çevik, 2018) are taken. Biçer and Ada (2020), Çiftçi et al. (2013), and Yalçınkaya (2018) focused on the evaluation of the ninth-grade mathematics curriculum as a result of their interviews with mathematics teachers. As a result of semi-structured interviews with mathematics teachers working at Vocational and Technical Anatolian High School, Biçer and Ada (2020) emphasized that students had problems due to their lack of knowledge during the implementation phase of the curriculum, students had negative attitudes towards mathematics, and their mathematics achievement was below the expected level. Similarly, Çiftçi et al. (2013) stated that the achievements in the ninth-grade mathematics curriculum, which started to be implemented in the 2005-2006 academic year, are not suitable for every student's level and that the same achievements at every school level pose a problem. Another problem encountered in the study is that the textbook cannot be used, and the activities are not implemented. It has been mentioned that mentioning the lives of scientists in the lessons about this problem can be an important step in eliminating the problem. Both Biçer and Ada (2020) and Çiftçi et al. (2013) suggested that the curriculum should be created according to school types to eliminate the problems experienced. Yalçınkaya (2018), on the contrary, aimed to determine the difficulties experienced by teachers and solution suggestions for the ninth-grade mathematics curriculum, which started to be implemented in the 2017-2018 academic year. In line with the opinions of the teachers, it is expressed that the units and subjects in the new curriculum are more understandable, the integrity of the subject and the appeal to all students are considered as the positive aspects of the curriculum, while the curriculum is not sufficient in terms of number and basic concepts, the number of subjects and the lack of appropriate resources for the curriculum is the negative aspects of the curriculum.

Aydın et al. (2018), Berkant and Gençoğlu (2015), Çiftçi and Tatar (2015), Hahler and Corbett (2014), Sakallı et al. (2016) and Tekalmaz (2019) carried out their studies within the framework of teachers' views on mathematics curriculum. Berkant and Gençoğlu (2015) stated that almost all the teachers participating in the research indicated that the mathematics curriculum affected the success of the mathematics course. The opinions of the teachers in that the curriculum is intense and a different curriculum should be applied in vocational high schools are included. Similarly, Çiftçi and Tatar (2015) emphasized that the curriculum is intense in line with the thoughts of mathematics teachers about the secondary school mathematics curriculum that started to be implemented in 2013 and stated that it would be beneficial to reduce the subject density, use information and communication technologies, and introduce the curriculum to teachers in detail. Aydın et al. (2018) concluded that there are difficulties in the implementation of the curriculum in terms of various variables such as students, teachers, school type, program, and teaching material for the secondary education mathematics curriculum updated in 2013. It has been suggested that separate curriculum should be created according to school types to overcome the difficulties experienced, the content in the curriculum should be simplified and the content should be more associated with real life. Hahler and Corbett (2014) evaluated the National Integrated Cyber Education Research Center's Advanced Math for Engineering and Science (AMES) high school curriculum in line with teacher opinions. In the study, it was emphasized that the content of the curriculum was too much, it was time-consuming, and the activities and projects in the curriculum were an important plus for the curriculum. It has been stated that considering the advice and perspectives of teachers before the implementation of the curriculum will increase not only the implementation of the curriculum but also student success and teachers' ownership of the curriculum. Another study that highlighted the intensity of the mathematics curriculum was conducted by Sakallı et al. (2016). In the study, it was emphasized that the mathematics curriculum should be prepared separately according to the school types, by including the opinions that the mathematics curriculum was not effective enough and the time for implementation was limited. Tekalmaz (2019), meanwhile, aimed to explore teachers' opinions on the 2017 update and revision of the secondary school mathematics curriculum. In the study, teachers stated that reducing the subject density in the updated secondary school mathematics curriculum, reorganizing the acquisitions and the use of information and communication technologies in the curriculum were positive. In addition, the fact that some teachers feel inadequate in terms of information and communication technologies and that there are teachers who do not use information and communication technologies are among the important findings of the study. It is important for teachers to have detailed knowledge of the curriculum and to receive in-service training on the use of information and communication technologies.

Apart from the opinions of teachers, Abdioğlu and Çevik (2018) examined the opinions of high school administrators about the secondary school mathematics curriculum that started to be implemented in the 2013-2014 academic year. In general, it was stated that the administrators did not have sufficient knowledge about the mathematics curriculum, that the curriculum should be reconstructed according to high school types, and that the curriculum should be more related to real life. The high school administrators who participated in the study also stated that teachers' opinions were not taken when creating the curriculum and that it was not suitable for the levels of the students, since the curriculum was generally intense. In the literature, there are also studies examining the effect of curriculums. Kramer and Keller (2008) compared the effectiveness of a traditional mathematics curriculum and NCTM's Standards-based curriculum in a high school in the United States. In the study, it was emphasized that the mathematics achievement of most students who were educated according to the standards-based curriculum was better than the students who were educated according to the traditional curriculum. Examining the effect of the high school mathematics curriculum on student achievement, Krupa and Confrey (2017) compared the effects of subject-specific curriculum and integrated reform-based curriculum. It was found that students enrolled in the integrated mathematics curriculum performed better in algebra compared to those in the subject-specific curriculum. Görlitz and Graver (2018) analyzed the impact of a high school curriculum reform on students' likelihood of entering university and pursuing science,

technology, engineering, and mathematics (STEM) fields. The reform was shown to increase university placement rates and positively influence men in choosing STEM disciplines.

1.1. Statement of the Problem

Abdioğlu and Çevik (2018) stated that although there are many studies on the primary school mathematics curriculum, a limited number of studies are carried out at the secondary education level and pointed out that the studies on the secondary education mathematics curriculum are not sufficient. Based on the evaluations conducted, a limited number of studies have been found in the literature regarding the evaluation of the current mathematics curriculum applied at the secondary school level (Biçer & Ada, 2020; Tekalmaz, 2019; Yalçınkaya, 2018). In this context, the comparison of the mathematics curriculum applied at the secondary school level will contribute to the literature. On the other hand, since evaluations will be made regarding the purposes, objectives, perspectives, general aims, learning domains, acquisitions, and associations made in the acquisitions of the curriculum, it will be a source for teachers and school administrators to get to know and have information about the curriculum by providing information about it.

There is almost no study in the literature on the comparison of secondary school mathematics curriculum and the examination of vocational education center mathematics curriculum. In this context, with the contribution of the study to the literature, the comparison of the currently applied vocational education centers mathematics curriculum (VECMC), secondary education mathematics curriculum (SMC) and science high school mathematics curriculum (SHMC) will be a start for further studies and it will also be a basis for studies where comparisons can be made in terms of activities and materials developed for three different curriculums. Science high schools are secondary education institutions that are preferred by students with high scores, which are mainly trained in science and mathematics and are the source of training qualified "scientists" needed in science and mathematics (Günbayı et al., 2015). In this context, considering the foundational goals of science high schools and the strong focus on science and mathematics education, it is expected that the mathematics curriculum and course hours in science high schools will differ from those of other secondary education institutions. It is also thought that the comparison of secondary education mathematics curriculum will provide information on how the science high school mathematics curriculum is different from other mathematics curricula and an idea will be put forward as to the extent to which science high schools serve the foundation purposes.

Schools should not be a field that prepares students for life, but life itself (İnan, 2006). Therefore, curricula should be associated with real-life (Altun & Akkaya, 2014). It is thought that the more inclusion of acquisitions associated with real life in the curriculum will enable schools to get closer to the real-life environment. In this context, the acquisitions in the secondary school mathematics curriculum should also be evaluated according to their relations with real life.

1.2. Purpose of the Study

In this study, the science high school mathematics curriculum (**SHMC**), which has been implemented since 2018, the secondary education mathematics curriculum (**SMC**) which has been applied in secondary education institutions such as multi-program Anatolian high school, vocational and technical Anatolian high school, social sciences high school, fine arts high school, sports high school, Anatolian high school, Anatolian imam hatip high school, and the vocational education center mathematics curriculum (**VECMC**) implemented in the 2020-2021 academic year, is aimed to be examined based on some variables, considering the top-down and bottom-up approach.

1.3. Problem of the Study

Is there a difference between the curricula applied in the secondary school mathematics course in Türkiye According to Top-down and Bottom-up Approach?

1.3.1. Sub-problems of the study

The sub-problems of the study within the framework of the top-down bottom-up approach are presented in Table 1.

Table 1.
The sub-problems of the study within the framework of the top-down bottom-up approach

Top-down and button-up approach	Sub-problems
Intended Curriculum	1. Is there a difference between VECMC, SMC, and SHMC according to their purposes? 2. Is there a difference between VECMC, SMC, and SHMC according to their perspectives? 3. Is there a difference between VECMC, SMC, and SHMC according to values and competencies? 4. Is there a difference between VECMC, SMC, and SHMC according to their general aims?
Implemented Curriculum	5. Is there a difference between VECMC, SMC, and SHMC in terms of the acquisitions of scientists who contribute to mathematics and their studies? 6. Is there a difference between VECMC, SMC, and SHMC according to their real-life relationships?

	7. Is there a difference between VECMC, SMC, and SHMC according to the acquisitions associated with information and communication technologies?
Attained Curriculum	8. Is there a difference between VECMC, SMC, and SHMC according to learning domains? 9. Is there a difference between VECMC, SMC, and SHMC according to learning outcomes and course hours? 10. Is there a difference between VECMC, SMC, and SHMC according to their acquisitions in sub-learning domains?

2. METHODOLOGY

Qualitative research approach was adopted in this study, which aims to perform comparative analysis of the mathematics curriculums of secondary education institutions such as secondary education vocational education centers, vocational-technical, fine arts, sports, and Anatolian high schools and science high schools in terms of some variables. Qualitative research is described as "an approach that prioritizes researching and understanding social phenomena within their natural environment, using a perspective based on theory building" (Yıldırım & Şimşek 2018, p.41). In studies employing a qualitative research approach, efforts are made to gain a deep understanding of the subject being examined (Karataş, 2017).

The study is a descriptive case study of qualitative research methods. In this direction, the current situation has been tried to be revealed by document analysis. Descriptive research aims to define a situation as fully and carefully as possible (Büyüköztürk et al., 2015) and enables it to be described comprehensively (Bloor & Wood, 2006). A comprehensive comparative description of the secondary education mathematics curriculum was made in the study carried out in this direction.

2.1. Sampling

Criterion sampling, one of the purposive sampling methods, was chosen as the sampling method for determining the study group. Purposive sampling allows for an in-depth examination of situations that provide rich information, helping to discover and explain facts and events (Patton, 1997). Criterion sampling, classified under purposive sampling methods, is expressed as "studying all situations that meet a predetermined set of criteria" (Yıldırım & Şimsek, 2018, p.122). In this study, the sample criterion for document analysis was set as analyzing the secondary education component of the mathematics curriculum applied during the 2020-2021 academic year.

2.2. Obtaining Data

In qualitative research, techniques such as interview, observation, or document review are mostly used in the process of obtaining data (Yıldırım & Şimşek, 2018). To examine the mathematics curriculum applied at the secondary school level in terms of various variables, the data for the study consisted of the secondary education mathematics curriculum published on the Ministry of National Education (MoNE)'s website in 2018, the secondary education science high school mathematics curriculum, and the Vocational Education Centers (VEC) mathematics course curriculum published in 2020. In this context, the document analysis method was adopted as the data collection method in the study. Document analysis is a systematic procedure for examining or evaluating materials, including both printed and electronic documents transmitted via computer or internet, and like other analytical methods in qualitative research, it involves analyzing and interpreting data to reveal meaning, develop empirical knowledge, and gain understanding (Bowen, 2009). When conducting a document review, the process consists of five steps: "reaching the documents, checking the originality, understanding the documents, analyzing the data and using the data" (Forster, 1995; cited in Yıldırım & Şimşek, 2018 p.194).

In this study, the steps outlined in Figure 3 were followed. In the ***first stage***, secondary school mathematics curricula were accessed from the official web pages of the Board of Education and the General Directorate of Vocational and Technical Education (GDVTE). In the ***second stage***, the originality of the curricula obtained electronically was verified. To confirm the authenticity of the VEC mathematics course curriculum, a confirmation email was sent to MoNE communication center via the link from which the curriculum was accessed. Additionally, the originality of the documents obtained in the second stage was verified by ensuring that they were related to MoNE, accessed from primary sources, identical to the originals, and officially published by MoNE.

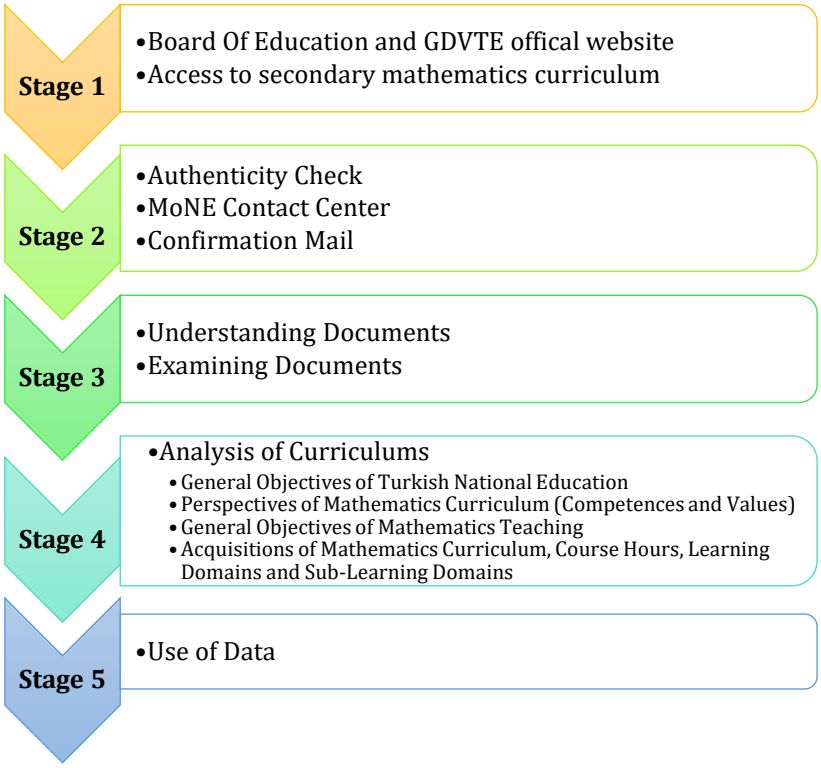

Figure 3. Stages of document review carried out in the study

In the ***third stage***, the obtained documents were understood and in the ***fourth stage***, they were analyzed. In case the research is based on documents, the obtained documents should be analyzed comparatively within a structured system (Yıldırım & Şimşek, 2018). When the curricula are examined; First, the general aims of the curriculums prepared by considering the ***General Aims of Turkish National Education*** are included (MoNE, 2018a; MoNE, 2018b; MoNE, 2020). Afterward, the perspectives of the curricula that include the competencies and values that provide the connection and integrity between these concepts for the acquisition of knowledge, skills, and behaviors are explained (MoNE, 2018a; MoNE, 2018b; MoNE, 2020). In other words, ***perspectives*** are shaped around competencies and values. ***Competencies*** are clarified within the framework of knowledge, attitudes, skills, and values. Information on the processes and stages passed in the process of updating the curriculum is also included.

In the other phase of the curriculum, the ***general aims*** of the mathematics curriculum were expressed and the ***acquisitions***, timetables, ***learning domains, sub-learning domains***, and acquisition explanations were included. In this direction, to analyze the mathematics curriculum applied in secondary education in the 2020-2021 academic year comparatively with a holistic approach, the comparison of the curriculums according to the general aims, perspectives, general aims of the mathematics curriculum, acquisitions, course hours, number of acquisitions in sub-learning domains were carried out. The data obtained in line with the examinations were used in the last stage and included in the findings section.

2.3 Analysis of Data

Mathematics curricula applied at the secondary education level were analyzed using the document analysis method. One-to-one comparisons were made by tabulating the explanations for the purposes and perspectives of the curriculum. The explanations given in the curriculums regarding the aims and perspectives of the curricula were taken one by one and focused on the difference in their sentences. Values and competencies in the curriculum were tabulated and comparisons were made. Comparisons were also made in line with the tables created by taking the explanations for the general aims of the curricula.

The information about the learning domains, sub-learning domains, the number of acquisitions, and course hours in these areas in VECMC, SMC, and SHMC were examined by considering the grade levels, and the obtained data were analyzed using descriptive statistical methods such as frequency and percentage, and similarities and differences between the curriculums were revealed. In the examination of the acquisitions related to "scientists and their studies", "real life" and "information and communication technologies", which are emphasized in the general aims of the curriculums, were analyzed by three different researchers via content analysis method. The reliability of the codes that emerged as a result of the content analysis was determined according to the security level formula (reliability= number of agreements/(total number of agreements+disagreements) developed by Miles and Huberman (1994, p. 64). The reliability of the coding was calculated as 95.45% for the acquisitions related to scientists and their studies, 97.56% for the real-life-related acquisitions, and 98.75% for the ICT-related acquisitions. Scientists and their studies, real life, and the ratios of ICT-related acquisitions to all acquisitions were also examined, and whether there was a difference between curriculums was determined by using descriptive statistical methods such as percentage and frequency.

3. FINDINGS

The findings obtained as a result of the analyzes carried out for the comparison of secondary education mathematics curriculum applied to vocational education centers (VECMC), multi-program Anatolian High School, Vocational and Technical Anatolian High School, Social Sciences High School, Fine Arts High School, Sports High School, Anatolian High School, Anatolian Imam Hatip High Schools (SMC) and Science High Schools (SHMC) are presented within the framework of research problems.

3.1. Findings for the First Sub-problem

The first sub-problem of the research focuses on comparing secondary education mathematics curricula in terms of their purposes. When the purposes of the secondary curriculums are examined within the framework of the top-down and bottom-up approach, it can be said that the top-down approach is applied when it is considered that the MoNE is formed by a committee of experts in determining the purposes for the curriculum. In this framework, the purposes of the mathematics curriculum applied at the secondary education level were examined and the results are presented in Table 2.

Table 2.
Purposes of Secondary Education Curriculum

VECMC (MoNE, 2020, p. 2-3)	**SMC** (MoNE, 2018a, p. 4-5)	**SHMC** (MoNE, 2018b, p. 4-5)
1. Supporting the healthy development of students who have completed pre-school education in physical, mental, and emotional areas, taking into account their individual development processes.	1. Supporting the healthy development of students who have completed pre-school education in physical, mental, and emotional areas, taking into account their individual development processes.	1- Supporting the healthy development of students who have completed pre-school education in physical, mental, and emotional areas, taking into account their individual development processes.
2. In accordance with the development level and individuality of the students who have completed primary school, they have acquired the basic level of verbal, numerical and scientific reasoning, social skills, and aesthetic sensitivity that they will need in daily life, within the framework of moral integrity and self-awareness, using them effectively to ensure that they become individuals with a healthy life orientation.	2. In accordance with the development level and individuality of the students who have completed primary school, they have acquired the basic level of verbal, numerical and scientific reasoning, social skills, and aesthetic sensitivity that they will need in daily life, within the framework of moral integrity and self-awareness, using them effectively to ensure that they become individuals with a healthy life orientation.	2. In accordance with the development level and individuality of the students who have completed primary school, they have acquired the basic level of verbal, numerical and scientific reasoning, social skills, and aesthetic sensitivity that they will need in daily life, within the framework of moral integrity and self-awareness, using them effectively to ensure that they become individuals with a healthy life orientation.
3. To ensure that students who have completed secondary school become individuals who have adopted national and moral values, exercised their rights and fulfilled their responsibilities by developing the competencies they gained in primary school, and gained basic level skills and competencies that are expressed in the "Turkish Qualifications Framework" and also in discipline-specific areas.	3. To ensure that students who have completed secondary school become individuals who have adopted national and moral values, exercised their rights and fulfilled their responsibilities by developing the competencies they gained in primary school, and gained basic level skills and competencies that are expressed in the "Turkish Qualifications Framework" and also in discipline-specific areas.	3. To ensure that students who have completed secondary school become individuals who have adopted national and moral values, exercised their rights and fulfilled their responsibilities by developing the competencies they gained in primary school, and gained basic level skills and competencies that are expressed in the "Turkish Qualifications Framework" and also in discipline-specific areas.

4. To ensure that students who graduate from vocational education centers adopt the national and spiritual values and transform them into a lifestyle by developing the competencies they acquire in primary and secondary school, contributing to the economic, social, and cultural development of our country as productive and active citizens, in the "Turkish Qualifications Framework" and also in discipline-specific areas, and they are individuals who have gained basic level skills and competencies and are ready for a profession and life in line with their interests and abilities.	4. To ensure that by developing the competencies that students who complete high school acquire in primary and secondary school, adopting national and spiritual values and transforming them into a lifestyle, contributing to the economic, social and cultural development of our country as productive and active citizens, which are expressed in the "Turkish Qualifications Framework" and also in discipline-specific areas and they are individuals who have gained high-level skills and competencies and are ready for a profession, ***higher education*** and life in line with their interests and abilities.	4. To ensure that by developing the competencies that students who complete high school acquire in primary and secondary school, adopting national and spiritual values and transforming them into a lifestyle, contributing to the economic, social and cultural development of our country as productive and active citizens, which are expressed in the "Turkish Qualifications Framework" and also in discipline-specific areas and they are individuals who have gained high-level skills and competencies and are ready for a profession, ***higher education*** and life in line with their interests and abilities.

When Table 2 is examined, it is seen that the purposes of SCM and SHMC are the same, and the first 3 purposes are exactly the same as in other area curriculums. However, the fourth aim is expressed as "to ensure that the students who graduate from VECMC are ready for a career and life in line with their interests and abilities", it is seen that in other education curriculums, in addition to this purpose, it ensures that the graduates are individuals who are ready for "higher education".

3.2. Findings for the Second Sub-problem

The second sub-problem of the research focuses on comparing secondary education mathematics curricula in terms of their perspectives. The perspectives of the mathematics curriculum applied at the secondary education level are examined and presented in Table 3:

Table 3.
The Perspective of Secondary Education Mathematics Curriculum

VECMC (MoNE, 2020, p. 3)	**SMC** (MoNE, 2018a, p. 5)	**SHMC** (MoNE, 2018b, p. 5)
The main purpose of the education system is to raise individuals ***with high efficiency*** with knowledge, skills, behavior and *work habits* integrated with our values and competencies. Our values, distilled from our society's national and spiritual resources, have reached today and are our heritage that we will pass on to our future. Competencies are our operational integrity that enables this heritage to participate and contribute to life and the human family. In this respect, our values and competencies inseparably form our essential part in the unity of theory and practice. A program approach aimed at raising individuals who have at least a common general culture, are sensitive to social problems, and have the awareness and competence to contribute to economic, social and cultural development has been adopted.	The main purpose of the education system is to raise individuals with knowledge, skills and behaviors integrated with our values and competencies. Our values, distilled from our society's national and spiritual resources, have reached today and are our heritage that we will pass on to our future. Competencies are our operational integrity that enables this heritage to participate and contribute to life and the human family. In this respect, our values and competencies inseparably form our essential part in the unity of theory and practice. The knowledge, skills and behaviors we try to gain through learning and teaching processes are the tools and platforms to gain visibility into our values and competencies that make us who we are; it can change under the conditions of the day, it is accidental with its structure and therefore it is updated and renewed with constant reviews.	The main purpose of the education system is to raise individuals with knowledge, skills and behaviors integrated with our values and competencies. Our values, distilled from our society's national and spiritual resources, have reached today and are our heritage that we will pass on to our future. Competencies are our operational integrity that enables this heritage to participate and contribute to life and the human family. In this respect, our values and competencies inseparably form our essential part in the unity of theory and practice. The knowledge, skills and behaviors we try to gain through learning and teaching processes are the tools and platforms to gain visibility into our values and competencies that make us who we are; it can change under the conditions of the day, it is accidental with its structure and therefore it is updated and renewed with constant reviews.

When the perspectives of the curricula are examined, it is seen that in VECMC, the understanding of raising qualified individuals in terms of "work habits and high efficiency" has been adopted. In other words, VECMC's understanding of raising conscious and competent individuals in terms of economic, social, and cultural aspects constitutes the perspective of the curriculum. In

this context, there is a difference between VECMC and SMC-SHMC. SMC and SHMC are exactly the same in terms of perspective as they are in purposes. When the perspectives towards the curriculums are expressed according to the top-down and bottom-up approach, it is seen that how the teachers, who are the implementers of the curriculums, will teach or their views are not included. Again, it can be stated that there is not enough correlation between the acquisition for students and perspectives. Considering these situations, it can be said that the perspectives of the curricula are also within the framework of the Top-down approach.

3.3. Findings for the Third Sub-problem

The third sub-research problem focuses on examining the mathematics-specific values and competencies included in the secondary mathematics curriculum. When the curricula are examined in terms of values and competencies, it is seen that the values and competencies in all three curricula are the same. Unlike other curricula, in VECMC, emphasis is placed on the "Ahi-Order Culture", which includes these values together with the root values. However, the fact that information on how to gain values and competencies is not included in the curriculum is thought to create a gap in terms of teachers who are the implementers of the curriculum and students who are aimed to gain these values and competencies. In this context, it can be said that values and competencies are included in the curriculums within the framework of the top-down approach. Values and competencies in curricula are presented in Table 4.

Table 4.
Values and Competencies in Secondary Mathematics Curriculum

Values	**VECMC**	**SMC**	**SHMC**
Justice	x	x	x
Friendship	x	x	x
Honesty	x	x	x
Self-Control	x	x	x
Patience	x	x	x
Respect	x	x	x
Love	x	x	x
Responsibility	x	x	x
Patriotism	x	x	x
Helpfulness	x	x	x
Competencies	**VECMC**	**SMC**	**SHMC**
Communication in mother tongue	x	x	x
Communication in foreign languages	x	x	x
Mathematical competence and core competences in science/technology	x	x	x
Digital competence	x	x	x
Learning to learn	x	x	x
Social and civic competencies	x	x	x
Initiative and entrepreneurship	x	x	x
Cultural awareness and expression	x	x	x

3.4. Findings for the Fourth Sub-problem

The fourth sub-problem of the research is related to the general aims of the curriculums. After examining the purposes, perspectives, values, and competencies of VECMC, SMC, and SHMC the general aims of the curriculums are compared and presented in Table 5 (MoNE, 2018a, p. 11; MoNE, 2018b, p. 11; MoNE, 2020, p. 11):

Table 5.
General Aims of Secondary Education Mathematics Curriculum

General Aims	**VECMC**	**SMC**	**SHMC**
1- Developing problem-solving skills by looking at problems from different perspectives.	x	x	x
2- Gaining mathematical thinking and application skills	x	x	x
3- To use mathematics correctly, effectively, and beneficially.	x	x	x
4- Valuing mathematics and mathematics learning	x	x	x
5- Recognize the historical development process of mathematics, scientists who contributed to the development of mathematics and their studies	x	x	x
6- Developing a perspective on whether a problem they encounter in life is a problem for them and reaching a certain level of knowledge	x	x	x

When Table 5 is examined, it is seen that the general aims of all three curriculums for teaching mathematics are to provide students with problem-solving, mathematical thinking, and application skills, to use mathematics effectively, to value mathematics, to recognize scientists and their work, and to reach the level of knowledge that can overcome the problems they encounter in real life. In this regard, the mathematics curriculum applied at the secondary education level aim at achieving the

same goals of students. In addition, while expressing the general aims of the curriculum, it can be stated that the general aims of the secondary education mathematics curriculum are formed within the framework of the top-down approach since the acquisition is not associated with the stated purposes and an approach is not presented within the framework of the applied curriculum.

3.5. Findings for the Fifth Sub-problem

The fifth sub-problem of the research focuses on comparing the acquisitions of scientists who contributed to mathematics as presented in the curriculums, along with their works. The acquisitions of "historical development process of mathematics, the scientists who contributed to the development of mathematics and their studies", which are also included in the purposes of the mathematics curriculum in practice at the secondary education level, were examined within the framework of the curriculum. For example, when examining the curriculums; There is a description of "Boole and Leibniz's works are included" for the outcome of "Explains the proposition, the truth value of the proposition, the equivalence of two propositions and the non-proposition" in the 9th grade level in SMC and SHMC (MoNE, 2018a, p.18; MoNE, 2018b, p.17). Similarly, in the acquisition of "Explains the concepts related to proposition with examples" in VECMC, there is an explanation of "... the studies of scientists taking part in the process are included" (MoNE, 2020, p. 16). The acquisitions in this direction in the curriculum were evaluated as the acquisitions related to the "historical development process of mathematics, the scientists who contributed to the development of mathematics and their studies". The findings obtained as a result of the analysis are presented in Table 6:

Table 6.
Historical Development Process of Mathematics, Scientists Contributing to the Development of Mathematics and Acquisitions Related to Their Studies

Grade	Topics	VECMC Acquisitions	Topics	SMC Acquisitions	Topics	SHMC Acquisitions
9th Grade	Logic	9.1.1.1	Logic	9.1.1.1	Logic	9.1.1.1
			Clusters	9.2.1.1	Clusters	9.2.1.1
			Equations and Inequalities	9.3.3.2	Equations and Inequalities	9.3.3.2
			Triangles	9.4.1.1	Triangles	9.4.1.1
				9.4.2.3		9.4.2.3
				9.4.4.1		9.4.4.1
				9.4.4.2		9.4.4.2
				9.4.4.4		9.4.4.4
	Total	1		8		8
10th Grade	Triangles	10.2.1.1	Sorting and Selecting	10.1.1.1	Sorting and Selecting	10.1.1.1
		10.2.2.3		10.1.1.5.		10.1.1.6
			Probabilities of Simple Events	10.1.2.1	Probabilities of Simple Events	10.1.2.1
			Quadratic Equations	10.4.1.1	Quadratic Equations	10.4.1.1
	Total	2		4		4
11th Grade	Sorting and Selecting Functions	11.2.1.1	Circle and Circular Region	11.5.4.1.	Circle and Circular Region	11.5.4.1.
		11.1.1.1	Possibility	11.7.1.1	Possibility	11.7.1.1
	Total	2		2		2
12th Grade	Quadratic equations with one unknown	12.2.1.1	Logarithm	12.1.2.1	Logarithm	12.1.2.1
			Trigonometry	12.3.2.1	Trigonometry	12.3.2.1
			Derivative	12.5.1.1	Derivative	12.5.1.1
				12.5.1.3		12.5.1.5
				12.5.2.1		12.5.2.1
	Total	1		5		5
	Grand Total	6		19		19

As a result of the examination of the acquisitions in the secondary education mathematics curriculum on "the historical development process of mathematics, the scientists who contributed to the development of mathematics and their studies", it was concluded that six acquisitions in VECMC and 19 acquisitions in SMC and SHMC were associated with scientists and their

work. When the average of the acquisitions related to the scientists who contribute to mathematics and their studies is examined for all the acquisitions in the curriculums, it is seen in Table 6 that the highest rate (14.6%) is in SMC, followed by HSMC (13.7%) and the lowest rate (9.4%) in VECMC. Considering the lowest association rates in terms of grade level, it is seen that it is at the 9th grade level in VECMC and the 11th grade level in SMC and SHMC. Table 6 shows that the highest level of association at grade level is at the 10th grade in VECMC, and the 9th grade in SMC and SHMC. In all three curricula, it has been determined that the most common linking of scientists and their studies or historical development is triangles. It is seen in Table 6 that the number of associations made with the acquisitions of the history of mathematics, scientists, and their studies are equal and on the same subjects in SMC and SHMC.

The acquisitions related to the history of mathematics and the studies of scientists were evaluated within the scope of the implemented curriculum within the framework of the top-down and bottom-up approach. Finding explanations about the need to include the work of scientists in the acquisitions aimed to be gained by the students, presenting explanations to the teachers about these acquisitions for practice, and the general aims of the mathematics curriculums within the framework of the intended curriculum, including the "recognition of the historical development process of mathematics, the scientists who contributed to the development of mathematics and their studies", it can be said that this association was created within the framework of the top-down and bottom-up approach.

3.6 Findings for the Sixth Sub-problem

Within the framework of the sixth sub-problem, investigations were also carried out in terms of real-life situations of acquisitions in secondary education mathematics curriculum. For example, while determining real-life acquisitions in the curriculums; There is an explanation of "Real-life problems are included" in the explanations of the 9th-grade level "Makes applications related to GCD and LCM in whole numbers" (MoNE, 2018a, p. 20; MoNE, 2018b, p. 20). Similarly, "Real-life problems are included" is also involved in the explanation of the outcome "Solves problems related to GCD and LCM in natural numbers" in VECMC (MoNE, 2020, p. 18). These acquisitions were evaluated as acquisitions associated with real-life while performing the analyses. The findings obtained in line with the analyzes are presented in Table 7:

Table 7.
Distribution of Acquisitions Related to Real Life by Grade Level, Learning Domains and Topics

Grade	Learning Domains	Topics	VECMC Acquisitions	SMC Acquisitions	SHMC Acquisitions
9th Grade	Numbers and Algebra	Basic Concepts in Clusters		2	2
		Operations in Clusters	1	1	1
		Divisibility Rules	1	2	2
		First-order equations and inequalities	2	2	3
	Geometry	Triangles		4	4
	Data Counting and Probability	Data		2	2
		Total	4	13	14
10th Grade	Numbers and Algebra	Equations and Inequalities	1		
		Functions		2	2
		Quadratic Equations		1	1
	Geometry	Triangles	3		
		Quadrilaterals		1	2
		Solids		1	1
	Data Counting and Probability	Sorting and Selecting		1	1
		Probabilities of Simple Events		1	1
		Total	4	7	8
11th Grade	Geometry	Trigonometry		2	3
		Circle and Circular Region		1	1
		Solids		1	1
	Data Counting and Probability	Data	1		
		Sorting and Selecting	1		
		Probabilities of Simple Events	1		
		Possibility		3	3
		Total	3	7	8

12th Grade	Numbers and Algebra	Logarithm		1	1
		Series		1	1
		Derivative		1	1
		Integral		1	1
	Geometry	Circle and Circular Region	1		
		Solids	1		
		Trigonometry		1	1
		Fundamental Transformations in the Analytical Plane		1	1
		Total	2	6	6
		Grand Total	13	33	36

When Table 7 is examined, it is seen that the acquisitions that are most associated with real-life are in SHMC and the acquisitions that are associated with real-life the least are in VECMC. The ratio of the acquisitions related to real life in the curriculums to all the acquisitions was calculated as 19% in VECMC, 25% in SMC, and 26% in SHMC. At the 12th grade level, the number of acquisitions related to real-life is equal in SMC and SHMC, while the acquisitions that are most associated with real-life are included in SHMC. Although there are acquisitions for all three learning domains in the 11th grade curriculum, it has been found that there are no acquisitions associated with real life in the areas of learning numbers and algebra.

When the acquisitions associated with real-life are evaluated within the framework of the top-down and bottom-up approach, it is emphasized that the situations encountered in life are emphasized in the aims of the curriculum and it is emphasized that real-life examples should be given to the teachers, who are the implementers of the curriculums, in the explanations of the acquisitions. In this context, it can be stated that the explanations within the framework of the attained curriculum and the implemented curriculum, and the fact that the purpose of real-life is included in the general aims of the curriculum for the intended curriculum, the associations made with real-life are formed within the framework of the top-down and bottom-up approach.

3.7. Findings for the Seventh Sub-problem

The seventh sub-problem focuses on examining the association made with ICT in the acquisitions of VECMC, SMC, and SHMC. When examining the association of acquisitions with ICT, for example; "Information and communication technologies are used" are included in the explanations of the outcome "Get the properties of the inner and outer bisectors of the triangle" in SMC and SHMC (MoNE, 2018a, p. 23; MoNE, 2018b, p. 23). In this context, it is seen that the relevant acquisitions are associated with ICT. The level of association of the acquisitions in the curriculum with ICT has been examined in this context. The findings obtained from the analyzes performed are presented in Table 8.

Table 8.
Distribution of ICT-related acquisitions by grade level, learning domains, and topics

Grade	Learning Domains	Topics	VECMC Acquisitions	SMC Acquisitions	SHMC Acquisitions
9th Grade	Numbers and Algebra	GCD and LCM	1		
	Geometry	Triangles		9	10
	Data Counting and Probability	Data		1	1
		Total	1	10	11
10th Grade	Numbers and Algebra	Functions		2	3
	Geometry	Special quadrilaterals		1	1
		Solids		1	1
		Total	0	4	5
11th Grade	Numbers and Algebra	Functions	1	3	3
		Equations and Inequalities		2	2
		Trigonometry		1	2
	Geometry	Analytical Examination of Truth		1	1
		Circle and Circular Region		2	2
		Solids		1	1
	Data Counting and Probability	Experimental and Theoretical Probability		1	1
		Total	1	11	12

12th Grade	Numbers and Algebra	Exponential Functions		1	1
		Logarithm		2	2
		Derivative		4	4
		Integral		2	2
		Solids	1		
	Geometry	Analytical Study of the Circle		2	2
		Fundamental Transformations in the Analytical Plane		1	1
	Total		1	12	12
Grand Total			3	37	40

When Table 8 is examined, it is seen that the curriculum in which the association made for ICT is made at least is VECMC, and the acquisitions with the most associations are in SHMC. The ratio of the acquisitions for the use of ICT to all the acquisitions in the curriculums was calculated as 4.7% in VECMC, 28.5% in SMC, and 28.8% in SHMC. In VECMC, there are explanations regarding the use of ICT in an acquisition at the 9th, 11th, and 12th grade levels, while in SMC and SHMC, the most associated acquisitions with ICT are in the "Geometry" learning domain, the least associated learning domain. It has been found that the field is in the learning domain of "Data, counting and probability". Table 8 shows that the acquisitions regarding the use of ICT in SMC and SHMC differ in the 9th grade "Triangles", 10th grade "Triangles" and 11th grade "Trigonometry" subjects, with equal correlations in both curriculums.

When the associations regarding ICT are examined, expressions such as "utilizing information and communication technologies" or "with the help of information and communication technologies..." are included in the explanations of the acquisitions. In this context, when the correlation made with ICT in terms of top-down and bottom-up approaches is examined, there is a relationship within the framework of acquisitions. In line with the implemented curriculum, teachers are advised to use information and communication technologies while teaching acquisitions, and it is seen that there is no expression about ICT in the aims of the curriculum. In this context, it can be said that the emphasis is on the implemented curriculum and attained curriculum. Therefore, the association with ICT is evaluated within the framework of the bottom-up approach.

3.8. Findings for the Eighth Sub-problem

The eighth sub-problem focuses on the learning domains and sub-learning domains in the secondary school mathematics curriculum. It was observed that the acquisitions in all three curriculums were in the learning domains of "Numbers and Algebra", "Geometry" and "Data, Counting and Probability". In line with the examination carried out, the learning domains, sub-learning domains, and number of acquisitions in the curriculums according to the grade levels are presented in Table 9:

Table 9.
Learning and Sub-Learning Domains in Secondary Education Mathematics Curriculums

	Learning Domains	**Sub- Learning Domains**	**VECMC**	**SMC**	**SHMC**	**SMC-EM**
9th Grade	Numbers and Algebra	Logic	4	5	8	
		clusters	4	5	6	
		Equations and Inequalities	7	12	13	
	Geometry	triangles		16	15	
	Data, Counting and Probability	Data		3	3	
10th Grade	Numbers and Algebra	Equations and Inequalities	4	0	0	
		Functions		7	7	
		Polynomials		4	4	
		Quadratic Equations		4	3	
	Geometry	triangles	12	0	0	
		Quadrilaterals and Polygons		3	3	
		Stereometry		1	1	
	Data, Counting and Probability	Counting and Probability		8	9	
11th Grade	Numbers and Algebra	Numbers				5
		Equations and Inequalities				4
		Functions**	3	0	0	

		Applications in functions		4	4	
		Systems of Equations and Inequalities		3	3	
		Triangles				3
		Circle and Circular Region		5	5	3
	Geometry	Quadrilaterals and Polygons**	11	0	0	
		Trigonometry		7	8	
		Analytical geometry		4	4	
		Stereometry		1	1	
	Data, Counting and Probability	Data*	2	0	0	
		Counting and Probability*	6	0	0	
		Probability		4	4	
12th Grade		Equations and Inequalities				2
		Polynomials**	4			
		Quadratic Equations**	3			
	Numbers and Algebra	Exponential and Logarithmic Functions		6	6	
		Series		4	4	
		Derivative		11	15	
		Integral		6	6	
		Measuring				1
		Solids				1
		Circle and Circular Region **	3			
	Geometry	Stereometry**	1			
		Trigonometry		3	3	
		Conversions		2	2	
		Analytical geometry		2	2	
	Data, Counting and Probability	Data Analysis				1

[Note 1: While SMC has a single content for 9th and 10th grades, it offers two different options for 11th and 12th grade students, taking into account the needs, goals, and career plans of the students. Elective Mathematics in 11th and 12th grades is the course chosen in Anatolian High Schools in line with the student's interests and wishes and the higher education programs they target. Elective Basic Mathematics can be chosen by students (verbal-language) who do not prefer a mathematics-based program in Vocational and Technical, Fine Arts and Sports High Schools and Anatolian High Schools. These courses cannot be taught together in 11th and 12th grades due to the nature of the curriculum." (MoNE, 2018a, p17).

Note 2: While VECMC has a single content for 9th and 10th grades, two different options are offered for 11th and 12th grades as master's and diploma programs. While students who continue their master's education receive education only in line with the acquisitions in the field of "Data counting and probability" in the 11th grade, there is no mathematics course in the 12th grade.
*Mathematics course taken as a basis by those who continue their VECMC mastership and diploma education
**Mathematics course is additionally taken by those who attend the VECMC diploma program]

According to Table 9, there are three learning domains in 9th, 10th, and 11th grade levels of SMC and SHMC, and there are "Numbers and Algebra" and "Geometry" learning domains at 11th grade in SMC elective mathematics courses. It is seen that the "Data Counting and Probability" learning area is not included in the 11th grade. On the other hand, in VECMC, there is only "Numbers and Algebra" learning domain, unlike SMC and SHMC at the 9th grade level. At the 10th grade level, while all learning domains are included in the other two curricula, there is no "Data counting and Probability" learning domain in VECMC. In other words, while in VECMC, students encounter the "Data Counting and Probability" learning area in the 11th grade, they encounter it in the 9th and 10th grades in other curriculums. At the 12th grade, students who attend the VECMC diploma program do not encounter the "Data counting and Probability" learning domain, as in SMC and SHMC, while the students who take the elective mathematics course at the 12th grade encounter all learning domains.

3.9. Findings for the Ninth Sub-problem

The ninth sub-problem is about whether there are differences in secondary school mathematics curriculum in terms of acquisitions and course hours. The findings obtained by examining the number of acquisitions, course hours, and the ratio of course hours to the number of acquisitions in line with the learning domains of VECMC, SMC, and SHMC are presented in Table 10.

Table 10.
Number of Acquisitions and Course Hours by Grade Levels and Learning Domains

		VECMC			SMC			SMC EM*			SHMC		
	Learning Domains	**Acq.**	**Hour**	**A/H**	**Acq.**	**Hour**	**A/H**	**Acq.**	**Hour**	**A/H**	**Acq.**	**Hour**	**A/H**
9th Grade	Numbers and Algebra	15	72	4,8	22	130	5,9				27	130	4,8
	Geometry				16	70	4,4				15	70	4,7
	Data, Counting and Probability				3	16	5,3				3	16	5,3
	Total	15	72	4,8	41	216	5,3				45	216	4,8
10th Grade	Numbers and Algebra	4	20	5,0	15	108	7,2				14	108	7,7
	Geometry	12	52	4,3	4	70	17,5				4	70	17,5
	Data, Counting and Probability				8	38	4,8				9	38	4,2
	Total	16	72	4,5	27	216	8,0				27	216	8,0
11th Grade	Numbers and Algebra	3**	39**	13,0**	7	76	10,9	9	42	4,7	7	76	10,9
	Geometry	11**	69**	6,3**	17	122	7,2	6	30	5,0	18	122	6,8
	Data, Counting and Probability	8	36	4,5	4	18	4,5				4	18	4,5
	Total	22	144	6,5	28	216	7,7	15	72	4,8	29	216	7,4
12th Grade	Numbers and Algebra	7**	72**	10,3**	27	142	5,3	2	36	18,0	31	142	4,6
	Geometry	4**	36**	9,0**	7	74	10,6	2	26	13,0	7	74	10,6
	Data, Counting and Probability							1	10	10,0			
	Total	11	108	9,8	34	216	6,4	5	72	14,4	38	216	5,7
Grand Total		64	396	6,2	130	864	6,6	20	144	7,2	139	864	6,2

(* Elective mathematics course at 11th and 12th grade level in SMC, ** Mathematics course taken by students who continue their diploma program in VECMC)

When Table 10 is examined, it is seen that the most acquisition is in SHMC (n_{SHMC}=139), followed by SMC (n_{SMC}=130), and the least acquisition is in VECMC (n_{VECMC}=64). While there are only 15 acquisitions in numbers and algebra in the 9th grade level in VECMC, there are 41 acquisitions in three learning domains in SMC, and similarly, a total of 45 acquisitions in SHMC. While the total number of acquisitions covering all three learning domains is equal (n=27) at the 10th grade level in SMC and SHMC, as the acquisitions are examined in detail in terms of learning domains, there is a difference between the two curriculums in the learning domains of "Numbers and Algebra" and "Data, Counting and Probability". VECMC has the least acquisitions among the mathematics curriculums applied in secondary education at the 10th grade level. At the 11th grade level, the acquisitions in SHMC are higher than in other curriculums. It can be said that the least acquisitions at the 11th grade level are for the students who continue their master's education in VECMC, and then for the students who take the mathematics course as an elective according to SMC. At the 12th grade level, with 38 acquisitions, SHMC has the highest number of acquisitions, while at the 12th grade level, there are 34 acquisitions in SMC and 11 acquisitions in VECMC. In addition, at the 12th grade level, there are no acquisitions for the learning field of "Data, Counting and Probability" in all three curriculums, except for students who take elective mathematics courses in SMC EM. It can be said that the biggest difference between SMC and SHMC with VECMC in terms of learning outcomes is at the 9th and 12th grade levels.

When the curriculums are examined in terms of course hours it is seen that the lesson hours in SMC and SHMC at the 9th and 10th grade levels are the same and it is more than VECMC. In line with the examinations, the weekly mathematics course at the 9th and 10th grades is two hours in VECMC, it is six hours per week in SMC and SHMC. While students who continue their mastership education in VECMC at the 11th grade level take a total of 36 hours of mathematics, students who continue to the diploma program take a total of 144 hours of mathematics. On the other hand, in SMC, students at the 11th grade take a total of 216 hours of mathematics lessons during the one-year education period, as in SHMC. It can be said that mathematics lesson hours are the same at all grade levels in SMC and SHMC and students receive six hours of mathematics lessons per week. On the other hand, students who take the elective mathematics course in SMC at the 11th grade attend a total of 72 hours of mathematics, two hours per week. Students who take at least mathematics courses at the 12th grade level are the students who take the mathematics course as an elective according to SMC. Students who attend the 12th grade VECMC diploma program take more mathematics courses than the students who take the elective mathematics course according to SMC. As in other grade levels, Table 10 reveals that the highest number of course hours at the 12th grade level is in SMC and SHMC.

The attained curriculum within the framework of the top-down and bottom-up approach refers to the acquisitions that are aimed to be gained by the students within the framework of the classroom activities in the curriculum. In this context, within the framework of the attained curriculum, the learning domains, sub-learning domains, and acquisitions in the curriculum are focused. Within the framework of the examinations carried out, it was observed that the association of the acquisitions with the purposes of the curriculum was not carried out, and explanations and warnings were made for the teachers who were the implementers of the curriculum. Therefore, it is thought that the acquisitions in the secondary education mathematics curriculum are included in the curriculums within the framework of the bottom-up approach. Considering that the lesson hours are determined centrally in the determination of the mathematics lesson hours, it can be said that the lesson hours are determined within the framework of the top-down approach.

4. RESULTS, DISCUSSION AND RECOMMENDATIONS

One of the basic building blocks of the education system is the qualified education curriculum. In this respect, it can be said that the quality of education to be offered to students is closely related to the curriculum. As a matter of fact, studies show that the curriculum has a great impact on students' success (Berkant & Gençoğlu, 2015; Görlitz & Graver, 2018; Kramer & Keller, 2008; Krupa & Confrey, 2017). The curriculum, which has an important share in students' success, may have some deficiencies in terms of some points (Sakallı et al., 2016). The examination and evaluation studies carried out for the curricula can be an important step in terms of shedding light on the deficiencies or non-functioning aspects of the curricula (Saylan, 2001; Berkant & İncecik, 2018). In this respect, it is thought that the comparison of the mathematics curriculums applied at the secondary education level will contribute to the development and improvement studies to be made in the curriculums in terms of providing resources.

As a result of the examination carried out within the framework of the top-down and bottom-up approach, it was concluded that the purposes of the secondary education mathematics curriculum were almost exactly the same at the intended curriculum stage and that the goals for the top-down approach were determined. In this context, when Table 2 is examined, while there is a purpose of preparing students for a profession in line with their interests and abilities, it is emphasized that students are prepared for higher education in addition to this purpose in SMC and SHMC. VECMC differs from other curriculums in that it does not have the purpose of preparing students for higher education. Therefore, in terms of the aims of the curriculum, it can be said that vocational education centers are institutions that directly prepare students for the profession. Sönmez (1988) also stated that education takes place in three ways after primary education; emphasizes that these are the institutions that prepare students for higher education, profession, and both higher education and profession, and vocational education centers are one of the institutions that directly prepare them for the profession. All three education curriculums aim to support the physical, mental, and emotional development of students, to prepare individuals for real life in every aspect, and to ensure that they gain basic skills and competencies within the framework of Turkish competencies. Within the framework of these purposes, it is seen that the education curriculum aims to prepare students for the profession they will acquire in society and to support their development to be able to produce solutions to the problems they may encounter in real life. This situation supports the result of Güzel et al. (2010) in their studies in terms of Türkiye's secondary education mathematics curriculum.

When the curriculums are evaluated in terms of perspectives that cover the competencies and values that provide the connection and integrity between the concepts for the acquisition of knowledge, skills, and behaviors, it is stated that the main purpose of education system in SMC and SHMC is to "raise individuals with knowledge, skills, and behaviors integrated with our values and competencies", in addition to this purpose in VECMC, "raising individuals with high productivity with their work habits" is among the main purposes (See Table 3). While the same values and competencies are included in all three curriculums in terms of values and competencies, VECMC also emphasizes the culture of Akhism (See Table 4). It can be said that values are not included as a separate learning domain or subject in curricula, on the contrary, they are seen as the spirit and ultimate purpose of curricula in general terms (MoNE, 2018a; MoNE, 2018b). In line with the examination, it is revealed that the values and competencies in the curriculum are not associated with the acquisition and that adequate associations and information about practices are not included in the curriculum. It is seen that Deniz's (2018) study also included a similar result. In this context, it can be said that the values and competencies in the curriculum are created within the framework of the top-down approach. The reason why competencies and values cannot be associated with achievements may be due to the fact that competencies and values are the ultimate goal of the education process. While teachers, who are the most important element and implementer of the curriculum, have positive thoughts about values education, they have problems in terms of implementation, or they see themselves as inadequate (Bayırlı et al., 2020; Deniz, 2018), therefore, it is considered that the values and competencies in the curriculum are needed to be more clearly associated with the acquisitions. It is thought that it will be beneficial in terms of values education. The opinion of Asıcı and Dede (2019) on making values education curricula more evident in their studies supports this idea. In addition, the top-down approach is based on the fact that the teachers who are the implementers of the curriculums and the students whose aim is to provide meaningful and permanent learning with the curriculums they implement within the framework of their professional, pedagogical, and field knowledge, are aware of the values and competencies in the curriculum and their opinions are taken into account in the development and application phase of the values and competencies. Values and competencies created within the framework of the project should be supported by the bottom-up approach.

The general framework of the VECMC perspective can be seen as raising qualified individuals and preparing them for the profession, together with their work habits in line with values and competencies. Putting this perspective on solid foundations can be achieved by blending the values and competencies of the Ahi culture. As a matter of fact, the education model put forward by the Akhism culture, which has an important place in history, is "one of the strongest structures that can be presented as an alternative to Western-based methods in terms of values education" (Yeşil & Kart, 2018, p.163). Despite the emphasis on ahi culture in VECMC, how values and competencies will be transferred to students within the framework of ahi culture and which subjects, concepts, or acquisitions in mathematics are not clearly included in the curriculum. In this context, it is recommended to make associations with the Ahi-Order culture at the achievements in VECMC, to clearly reveal the associations for values education in all three curriculums, and to inform the teachers, who are the implementers of the curriculum, about these connections through in-service trainings.

In the evaluation of secondary education mathematics curriculum within the framework of the top-down and bottom-up approach, the scientists who steered the mathematics at the stage of the curriculum and their studies, there is a difference between VECMC with SMC and SHMC in terms of associating with real-life and ICT. It was concluded that there are similar associations. The historical development of mathematics, which is examined within the framework of the application phase, and the association made with the scientists who direct mathematics and their studies appear as an important concept among the general aims of all three curricula. Having students' knowledge about the historical development of mathematics can increase their motivation towards mathematics and mathematics learning and develop positive attitudes (MoNE, 2013). As a matter of fact, studies also reveal findings that the history of mathematics increases the motivation of students (Ersoy, 2015; Mersin & Durmuş, 2020; Tzanakis & Arcavi, 2000). Although the rate of acquisitions associated with scientists and their studies in SMC and SHMC is higher than in VECMC, it can be said that approximately 15% of the acquisitions are related to this association (See Table 6). It is seen that this rate does not even reach 10% in VECMC. The reason why this rate in SMC and SHMC is higher than VECMC may be due to the fact that these two curriculums are more comprehensive than VECMC. In addition, considering the establishment aims of science high schools to train scientists, it can be said that this rate is not at a sufficient level in terms of SHMC. Therefore, it is thought that increasing the number of acquisitions related to the historical development of mathematics and the studies of scientists who direct mathematics will contribute to the purpose of the curriculum, functionality, and providing meaningful learning. Sharing information about historical personalities, their contributions to mathematics, and their works in mathematics lessons will increase meaningful learning (MoNE, 2013).

One of the important goals of the secondary education mathematics curriculum is to associate mathematics with daily life and to equip students with the knowledge and skills to overcome the problems they may encounter in real life. In this context, when the levels of associating the acquisitions in the curriculum with real-life were examined, it was concluded that the highest association was 25% in SHMC, and the least association was 19% in VECMC (See Table 7). Ada and Biçer (2020) emphasize that a simpler, flexible curriculum that can be applied in real life and for professions should be prepared for vocational high schools. They state that activities and examples should be included to reveal the importance of mathematics and the need for mathematics in students' daily life, in their own fields, and in their professional lives. Similarly, Berkant and Gençoğlu (2015) suggest that students can use case studies about interesting and remarkable real-life situations to show that mathematics is in life and show the importance of associating it with real life. The presence of real-life examples in new curricula will replace learning by rote with meaningful learning, increasing students' interest in mathematics and providing meaningful learning (Yalçınkaya, 2018). Considering that one of the aims of vocational education centers is to prepare students for professional life, in other words, for real life, it is thought that the correlations between real and business-related acquisition should be made in the curricula for vocational education centers. In this respect, it will be important to make more associating the acquisitions in VECMC with real life, at least to draw the connection made with real life to the level of other curricula, in order to realize meaningful learning and the function of mathematics in real life. Associating mathematics with real life significantly ensures meaningful learning and increases interest, attitude, and motivation toward mathematics (Gainsburg, 2008). The need for individuals who can use and understand mathematics in daily life is increasing day by day (Yenilmez & Sölpük, 2014). In this respect, although the associations with real life are perceived to be sufficient in SMC and SHMC, it can be said that the associations with real life should be increased to realize meaningful learning for the acquisitions.

Another concept examined within the framework of the implemented curriculum is information and communication technologies, which are expressed as a part of school curriculums (Aşkar & Olkun, 2005). In this context, Çiftçi and Tatar (2015) and Tekalmaz (2019) stated in their studies that teachers found the inclusion of information and communication technologies in the curriculum positive, and they expressed an opinion that information and communication technologies would support the development of students. As a result of the examination of the associations made with information and communication technologies in the mathematics curriculum applied at the secondary education level, it was revealed that only three acquisitions were associated with ICT in VECMC, and the highest number of associations was in SHMC with 40 acquisitions (See Table 10). With the use of technology in education, the quality of learning will increase, and meaningful learning will be possible (Kuzgun & Özdinç, 2017). It is seen that the most acquisitions associated with ICT in the curriculum are in the geometry learning domain. In this context, since the geometry learning domain includes many concepts in terms of abstract concepts and relationships (Delice & Sevimli, 2010), geometric concepts that contain abstract concepts can be concretized by using information and communication technology (Yazlık, 2019). Considering that the acquisition rate made about ICT in curricula is around 28.5% in SMC and SHMC, it has been determined that the associations made are at a sufficient level, while this rate does not exceed 5% in VECMC. In this context, it is recommended to increase the applications and acquisitions related to ICT in

VECMC in order for the students of VEC to make sense of abstract concepts, to visualize the concepts, and to provide meaningful learning.

When the literature on curriculum is examined, it is seen that teachers (Ada & Biçer, 2020; Aydın et al., 2018; Çiftçi & Akgün, 2013; Berkant & Gençoğlu, 2015; Sakallı et al., 2016; Dikbayır & Bümen, 2016) and school administrators (Abdioğlu & Çevik, 2018) state that different mathematics curriculums should be applied according to school types. However, in terms of secondary education level, there are currently 3 different mathematics curricula: VECMC applied in VEC, SHMC applied in science high schools and SMC applied in other high schools. As a result of the examinations carried out for the acquisitions in the curriculum within the framework of the curriculum reached for the top-down and bottom-up approach, it has been concluded that the learning domains, acquisitions, and acquisition explanations of SMC and SHMC are almost identical to each other. However, in line with the examinations, it has been seen that some of the acquisitions in SHMC are explained in more detail than in SMC. In this context, different from SHMC, there are warnings not to go into details in some of the acquisitions in SMC. Although it is thought that some of the acquisitions in SHMC will be handled more comprehensively than SMC, one of the founding goals of science high schools, "to be a resource for the training of highly qualified scientists in the fields of mathematics and science", to some extent, it is thought that SHMC and SMC are similar in general. It is thought that SHMC should be revised considering this purpose. In addition, the reason why both curricula are in a similar framework may be that the same two curricula were created by similar committees. It can be said that the fact that the highest number of achievements in terms of all three curriculums is in SHMC is another result of this situation.

In line with the findings, it is seen that the most detailed curriculum is SHMC, and the curriculum that is shallower than the others is VECMC. The 9th, 10th, 11th, and 12th-grade acquisitions in VECMC are included in the 9th and 10th grades in SMC and SHMC, only the acquisitions for the 11th-grade circle and circular region sub-learning domains of SMC and SHMC are included in the VECMC. Apart from these acquisitions, it has been concluded that the 11th and 12th-grade acquisitions in SMC and SHMC are not found in VECMC. Within the framework of these findings, it can be said that VECMC is superficial compared to other curriculums. As a result of the examinations on the acquisitions of the 11th and 12th grade mathematics courses in the curriculum as an elective at the SMC basic level, these acquisitions can be described as the repetition of the 9th and 10th grade mathematics course contents. In this context, there is a similar view in the study of Ada and Biçer (2020).

In this study, the focus is on examining the current mathematics curriculums at the secondary education level according to top-down and bottom-up approach. In line with the examination, it was seen that the comparison of the curriculums and the studies on VECMC were not sufficiently included in the literature. In this context, historical comparison of curricula, comparison of textbooks for curricula, and further studies on VECMC will contribute to the field and teachers to have more information about the curricula. In addition, within the framework of the top-down and bottom-up approach, textbooks and teaching materials for secondary curriculums can be evaluated. It is thought that making comparisons by evaluating curricula within the framework of teacher and student views will also contribute to the field. In many studies, it is revealed that the curricula are not fully understood by the teachers (Ada & Biçer, 2020; Çiftçi & Tatar, 2015; Duru & Korkmaz, 2010; Tekalmaz, 2019). Similarly, it is stated that school administrators do not have enough knowledge about the mathematics curriculum (Abdioğlu & Çevik, 2018). However, each teacher should strive to develop the curriculum and know as much as possible to structure it, no matter what kind of curriculum he or she applies (Kilpatrick, 2009). In this context, changes made in curriculums for various reasons also require some adaptation processes for teachers (Toker, 2021). Teachers should also be encouraged to participate in in-service activities that will increase their proficiency levels in the curriculum.

Limitations

This study is limited to examining the Vocational Education Centers mathematics curriculum (VECMC), secondary education mathematics curriculum (SMC), and Science High School mathematics curriculum (SHMC) within the framework of top-down and bottom-up approach in Türkiye. Different perspectives can be put forward by using different approaches to the comparison of curriculums. It is aimed to reveal the differences by examining the comparisons made by the document analysis method of the curriculums. Since the study was carried out during the COVID-19 pandemic period, the opinions of the teachers and administrators who are the implementers of the curriculums could not be sought. This situation can be expressed as another limitation of the study. In future studies, this limitation can be overcome by revealing the similarities and differences of the curriculums by referring to the opinions of teachers and administrators for each curriculum. In order not to ensure the integrity of the subject and to prevent the reader from staying in the details in the comparison of the curriculums, a detailed comparison of the acquisitions was not made. Another limitation of this study is the comparison of curricula with their aims, perspectives, values and competencies, general aims, learning domains, sub-learning domains, and number of acquisitions. The study was limited within the framework of comparing the curriculums for associating the acquisitions within the framework of the implemented curriculum in the top-down and bottom-up approach, examining the acquisitions related to the scientists and their studies, real-life situations, and ICT. Comparison of the curriculum can also be made within the framework of the acquisitions related to NCTM's mathematical process skills such as problem-solving, reasoning, communications, connections, and representations or PISA process skills such as formulating, employing, and interpreting.

Research and Publication Ethics Statement

This article was conducted on document analysis and does not contain any studies with human or animal subjects. All data have been obtained and reported by ethical concerns, principles, and rules.

Contribution Rates of Authors to the Article

First author; determination of problem situation, literature review, research problem, methodology, determination of study group, selection and application of data collection tools, analysis, writing-original draft, and resources. Second author; planning and implementation of activities, methodology, analysis, validation, arrangement, reviewing and inspection, editing, visualization, and supervision.

Statement of Interest

The authors declare that there is no conflict of interest regarding this study. This study does not have any financial, commercial, legal, or professional relationship with other organizations.

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