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SCIENCE EDUCATION IN TOP FIVE 2018 PISA COUNTRIES AND TURKEY[1]

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ABSTRACT

In this research, aim was to examine science education in China, Singapore, Macau, Estonia, and Japan which are among the top five countries in the field of science literacy, and Turkey according to the results of the Program for International Student Assessment (PISA) 2018, under some subtopics. Research has been done on how countries follow in subtopics such as the aims of the science education program, the measurement and evaluation approach, and the methods and strategies adopted in the science curriculum. The study was carried out with document analysis technique within the scope of qualitative research methods. It has been shown that there are similar concepts such as access to scientific knowledge and nature education in the science teaching programs that were examined, as well as certain concepts that each country emphasizes. However, we can see that all countries gather around the goal of raising scientifically literate individuals, but the processes they follow to achieve this goal differ from each other.

Key Words: Scientific literacy, science education, science teaching program

2018 YILINDAKİ İLK BEŞ PISA ÜLKESİNDE VE TÜRKİYE'DE FEN EĞİTİMİNİN İNCELENMESİ

ÖZET

Bu araştırmada, Uluslararası Öğrenci Değerlendirme Programı (PISA) 2018 sonuçlarına göre fen okuryazarlığı konu alanında ülke sıralamasında ilk beşte yer alan Çin, Singapur, Makao, Estonya ve Japonya ile Türkiye fen eğitiminin bazı alt başlıklar halinde incelenmesi amaçlanmaktadır. Fen Öğretimi programının amaçları, ölçme ve değerlendirme yaklaşımı ve fen öğretim programında benimsenen yöntem ve stratejiler gibi alt başlıklarda ülkelerin nasıl bir yol izlediği araştırılmıştır. Çalışma nitel araştırma yöntemleri kapsamında doküman analizi tekniğiyle yapılmıştır. Ele alınan fen öğretim programlarında bilimsel bilgiye ulaşma ve doğa eğitimi gibi benzer kavramlar olduğu gibi her ülkenin vurgu yaptığı belirli kavramların olduğu da belirlenmiştir. Ancak, tüm ülkelerin fen okuryazarı bireylerin yetiştirtilmesi amacı etrafında toplandığı fakat bu amaca ulaşmada takip ettikleri süreçlerinin farklılaştığı tespit edilmiştir.

Anahtar Kelimeler: Fen Okuryazarlığı, Fen Eğitimi, Fen Öğretim Programı

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INTRODUCTION

Countries can change their education programs over time according to the requirements of the period and make various changes. It is very important to structure and apply education programs in unison with their purpose in gaining the needed individual characteristics. In particular, it is planned in line with the aims of the education programs in recent years, the strategies and methods they have adopted, the measurement and evaluation approaches, the number of courses and their achievements, innovation, knowledge, media and technology, life and career skills defined under three main headings (Yalçın, 2018) as 21st century skills.

In addition, in international scale exams (PISA, TIMMS), each country tries to prepare its education programs in a competitive form in order to have a successful ranking among other countries participating in the exam. In this context, countries compare their own education programs with other countries' programs based on the findings of international examinations and make some adjustments as a result of detailed examinations and analyses. In this context, especially recently, countries such as China, Singapore and Macau, as well as Estonia and Japan, have achieved much more successful results in the field of science literacy than most other countries, and these countries' science education programs should be examined and discussed together with the 2018 current science program implemented in Turkey which formed the aim of this study. In addition, another factor in the inclusion of these countries, which are among the top five in the PISA 2018 results in the field of science literacy, is that they have similar (China and Japan) and different (Singapore, Macau and Estonia) structures with Turkey in terms of population characteristics (Özcan and Güçlüm, 2020). Aim was to investigate what the main factors might be in the countries with a very high population to have a successful ranking in science literacy, just as those with a low population.

In science teaching, scientists such as John Dewey and Percy Nunn in the 1920s and 1930s stated that different perspectives should be developed and their impact on society should be emphasized (Büyükşahin, 2019). In the 1940s, scientists such as Schwab and Conant were pioneers in the formation of important changes in science education and they emphasized that not only laboratory practices but also all practices with historical, cultural and philosophical dimensions are important in science teaching. In parallel with the reforms in science education in many countries such as England and the United States, some steps have been taken to make some arrangements in Turkey. In 1924, John Dewey conducted studies in Turkey for two months and prepared a report emphasizing the creation of a training program within the scope of national needs. The effects of this report were seen in the curriculum published in 1926, and the special aims of the courses were mentioned in the program, taking into account the interdisciplinary relations. Science lessons were handled with an emphasis on nature and the environment, and a science curriculum was created based on experience. Learning by doing and experiencing came to the fore in the 1936 and 1948 curricula. In 1960s Ankara Science High School and the Scientific and Technological Research Council of Turkey (TÜBİTAK) were opened in Turkey and to this day they have an important place in science education in Turkey.

In the program published in 1968, science teaching was given under the name of "Science and Natural Science" and a problem-based learning approach was adopted in this program. Science and Nature course consists of units and until 1994 science teaching could not be handled holistically. However, since this date, important subjects such as educational status and evaluation stages have been included in the curriculum. Turkey participated in an international exam for the first time in 1999, in which 38 countries participated, and became the 33rd country in science achievement ranking. These exam results made it apparent that some changes had to be made in the science curriculum and in 2000, a skill-oriented philosophy approach was accepted, in this program aim was to raise scientifically literate people.

In 2004, subject areas such as skills, understanding, attitudes and values were included in the new program based on the constructivist approach. A spiral curriculum content, which is also seen in today's curriculum, has been adopted. A radical change was made in the Turkish education system in 2012 and compulsory education was increased to 12 years (4 years primary school, 4 years secondary school and 4 years high school). This change also necessitated the reorganization of all curricula. In 2013, the science curriculum under the name of "Science" started to be implemented from the 3rd grade of primary school and an inquiry-based teaching model was adopted. In the current 2018 curriculum, an inquiry-based teaching strategy is still adopted. The general and specific objectives of the program, competencies, field-specific skills, and science, engineering and entrepreneurship practices were included in the latest science program.

After all these processes related to science education programs in Turkey, it is thought that it would be beneficial to evaluate the science education of Turkey and the science education of the countries that are at the top in success order, in order to analyze the point reached in raising individuals as science literate and the level of this subject area in international exams. In the literature review conducted in this context, it has been seen that the programs of countries such as the UK, the USA, Germany, Finland, Singapore, Kazakhstan, Canada, Hong Kong, Korea, China and Japan have been examined in various years and compared with the education programs of Turkey (Özcan and Güçlüm, 2020; Yazıcıoğlu and Pektaş, 2019; Püsküllüoğlu and Hoşgörur, 2017; Berber and Güzel, 2017; Bal and Başar, 2014). In these studies, although there are some similarities in terms of aims and objectives, it has also been determined that there are differences in terms of course content, learning area along with measurement and evaluation. Özcan and Güçlüm (2020) studied science curricula in China, Finland, Japan, Canada, Singapore, and Turkey and evaluated the 8th grade science curricula of Canada and Turkey in particular. They stated that the countries they examined had common goals of raising scientifically literate individuals, but there were differences in their curriculum practices. In the comparison of the 8th grade science program in Canada and Turkey, they emphasized that they had different determinations in terms of learning outcomes, topics covered and course hours.

Unlike the studies that were carried out recently, the current study is aimed to examine the science curriculum of countries such as Macau and Estonia, which left countries such as Finland that was especially frequently examined behind in the field of science literacy.

According to the results of PISA 2018, China, Singapore, Macau, Estonia and Japan achieved great success and left behind countries such as Canada, England, America, Germany and Finland. In this study, aim was to present some suggestions especially for the implementation of Turkey's science curriculum by considering the subtopics of China, Singapore, Macau, Estonia, Japan and Turkey science curricula such as objectives, measurement and evaluation approaches, adopted methods and strategies.

In this study, instead of studying countries such as Finland and Japan, we studied countries such as Macau and Estonia, which are not frequently discussed or where less data on science education are presented in the relevant literature, and it is thought that a broader perspective will be presented in this respect. It is considered that this study will be a useful resource for other researchers who will conduct similar studies. It is thought that presenting information about science education in these countries, which have very different socio-economic characteristics than Turkey, and making evaluations within the scope of some sub-headings, will lead to the emergence of some innovative ideas about science education. In this context, it has been seen as a study that will contribute to the related literature. In this study, 2018 PISA results aimed to examine the top five countries in science education and Turkey in terms of science education in terms of science education. We sought answer to the question of "What are the characteristics of science education in terms of the Assessment and Evaluation Approach of the Science Curriculum?" in this research.

1. METHOD

In this study, document analysis, which is a data collection procedure, was used to ensure that the contents of the written documents for science teaching of the specified countries are handled purposefully and meticulously (Yıldırım and Şimşek, 2006). Document analysis is a process that includes the examination and evaluation of all articles published in print or electronic media (Kıral, 2020). It is possible to reach a conclusion from these contents, which are interpreted by document analysis. In document analysis, archival documents such as texts, pictures and sound recordings, reports can be used as well as many other documents such as books, articles, statistics, newspaper articles and legal documents related to the research topic (Bowen, 2009). In this study, articles that provide information about the science curriculum of the five examined countries, scientific reports, and articles on the official websites of the ministries of education of the countries and published curriculum were used. Although the stages of document analysis are expressed in different ways by researchers, it is generally carried out within the scope of a plan (Merriam, 2009). In this study, the stages specified by Merriam (2009) were preferred and the process was operated in four stages: finding the appropriate documents, checking the originality of the documents, creating a systematic about coding and cataloging, and performing data analysis (Sak et al., 2021). The main purpose of this study is to obtain information about the science education programs of the countries that are in the top five in the field of science literacy in the 2018 PISA results, and to evaluate the science programs of our country, which did not achieve a desired level of success by getting a score below the OECD average in the same exam, within the framework of the same subtopics.

In this context, science curricula of China, Singapore, Macau, Estonia, Japan and Turkey were examined in terms of objectives, assessment and evaluation approaches, adopted methods and strategies.

2. RESULTS

In this section, science curricula of China, Singapore, Macau, Estonia, Japan and Turkey will be examined in terms of objectives, assessment and evaluation approaches, adopted methods and strategies. However, first of all, some information about the geographical locations and population information of these countries will be shared. According to the latest figures, the world population has been determined as 7,510,705,517 and 1,406.676.560 of this population is in China. Singapore has 5,703,600, Macau has 6.58,000, Estonia has 1,329,000, Japan has 126,265,000 and Turkey has 84,680,273 population. Among these countries, we see that China and Japan have a very high population compared to other the countries, and Turkey has bigger population compared to Singapore, Estonia and Macau. However, it is also obvious that very crowded countries can have a better ranking in the field of science literacy like other countries. Based on this, we should also evaluate these typical examples while discussing the impact of country populations on education systems.

In this study, the information about the examination of the science education programs of the above-mentioned countries in terms of objectives, measurement and evaluation approaches, adopted methods and strategies is given below.

2.1. Aim of the Science Teaching Programs

When we examine the aims of the science education programs of the countries discussed in the study, it is seen that especially attention is paid to the training of scientifically literate individuals and to the emphasis on understanding science and nature. China started to implement a new curriculum in science teaching in 2017 and adopted four important strategies in this curriculum to increase students' science literacy and enable them to become competent citizens. These strategies are stated as prolonging the learning period of science education, adding engineering and technology-related content to the science lesson, creating a progressive learning design that will enable progress in learning, and using the main concepts to guide the teaching content.

The Ministry of Education of China prioritizes inquiry teaching in the science lessons of primary schools, ensuring that students are curious about science, and raising scientifically literate individuals in general (Pei, 2019). Although the science curriculum implemented by Singapore has similar objectives, in the 'Science Syllabus Primary' published by the Singapore Ministry of Education in 2013, the objectives of science teaching are to teach students basic scientific terms and concepts, to gain experiences based on their interests, and to develop their skills and habits.

It is explained as providing opportunities, increasing their curiosity about science and the environment, helping people to use scientific knowledge, and making personal decisions, and explaining how science affects people, our lives and the environment (MOE, 2014). In Singapore, the importance of science is tried to be taught to students through science teaching.

According to the 2018 PISA results, Macau, which follows China and Singapore and has left many countries behind in the field of science literacy and has achieved a successful ranking, does not have an education system with its own central features. In Macau, which is the special administrative region of China, fifteen years of free education are provided, including three years of pre-school, six years of primary education and six years of secondary education (Erparun, 2017). Out-of-school activities have an important place in Macau, where bilingual education is provided. As in all their curricula, they have adopted a professional development-oriented education in science teaching.

Estonia, which comes after Macau and ranks fourth in the country ranking according to the PISA 2018 results in the field of science literacy, aims to teach students that mutual interaction between human and environment is important and that human activities are effective on the environment by prioritizing the teaching of natural sciences in science education. It has been adopted those natural sciences should be taught in order to reach goals in the curriculum (Pevkur, 2011). The most general purpose of this education is to teach nature to students and encourage them to study nature. It was also emphasized that necessary skills should be acquired in order to study nature and acquire knowledge. How to access scientific information and how to report this information is another important issue in science education in Estonia. With science education, it is aimed that students acquire information about natural sciences, know how to access this information and write scientific articles.

Finally, another country that has been successful in the field of science literacy among OECD countries is Japan. In particular, observing nature and adopting respect for nature was accepted as the most basic goal for students from the third to the sixth grade. In the science course curriculum, it is aimed that students gain scientific perspectives, improve their problem-solving skills, and most importantly, gain a scientific perspective (URL 1).

Besides these countries, when the science curriculum in the Turkish Education System is examined, it is seen that the main aim is to raise scientifically literate individuals. In order to achieve this goal, gaining basic knowledge about science and engineering practices, exploring nature, adopting to scientific process skills and scientific research approach, finding solutions to the problems encountered in these fields, realizing the relationship between the individual-environment-society and ensuring sustainable development, developing life skills and reasoning, and decision-making skills with socio scientific issues were aimed.

Above, the most general characteristics of six countries (Turkey, China, Singapore, Macau, Estonia, and Japan) and the objectives of the science curriculum are given. Based on these purposes, it is seen that there are some prominent goals such as students' examining and discovering nature, adopting the relationship between human and nature, understanding the ways of obtaining scientific knowledge, and adopting scientific process skills. Although the objectives adopted by the countries in science teaching are similar, the issues emphasized in their own implementation programs may differ.

2.2. Strategies and Approaches Adopted in Teaching Science

It is seen that similar aims are adopted in science education programs, and they are organized within the scope of raising science literate individuals. However, the ways countries follow to achieve this general goal may differ. The Chinese education system provides six years of compulsory primary education. In this six-year educational process, the science course also has an important place. In the science course, particular attention is paid to the application of methods and techniques that prioritize students' gaining experience and access to information. In addition, it is considered important to create learning environments that will enable students to use the language of science, to understand the ways of producing science and to realize their individual development in this way. In this context, science teaching is carried out within the scope of students gaining knowledge through science applications (Pei, 2019).

Although a similar approach is adopted in Singapore, learning environments are created that enable students to become active citizens and contribute to the very good use and production of technology. Students are encouraged to use scientific knowledge in their daily and social lives and to experience natural knowledge. Three basic strategies, namely knowledge, understanding and application, skills and processes, ethics and attitudes, were adopted in the science curriculum. A teaching activity is carried out in which science is a research and the understanding and application of the knowledge produced through science is provided (URL 2).

Macau has no centralized education system and educational strategies vary depending on who runs the schools. Each school has its own unique features, and these features make great differences. For example, the language of instruction may be English, Chinese or Portuguese, as there is no centralized education in schools opened by churches, businesses or individuals. However, we can say that there is a system similar to China due to its proximity, at least one that is heavily influenced by China (Chan Chi-Hou, 2007).

In Estonia, which we examined as the fourth country, basic education is nine years, three years of primary school and six years of secondary school. Science is taught under the name of Natural Sciences. In the natural sciences curriculum, it has been adopted that it is important to acquire basic information about the events in the natural, technological and social environment, to use scientific knowledge in the explanation of environmental phenomena, and to apply scientific research methods in the process of obtaining this scientific knowledge (URL 3).

The necessity of creating scientific and technological learning environments that will enable students to make observations, analyzes and explanations in reaching this competency has been emphasized. In this context, learning by doing and experiencing has been adopted based on the constructivist approach (Pevkur, 2011).

In Japan, which ranks fifth in the 2018 PISA ranking, primary school is compulsory for six years. The subject of science is given from the third grade of primary school, but in the first two years, students take a course under the name of life and environment. It comes to the fore that school and environmental conditions are important in the implementation of the curriculum and that appropriate application processes should be adopted within the scope of possibilities. Methods and strategies such as individual and group-specific learning, repetitive learning, and learning according to students' competencies have been adopted in science teaching (Erdoğan, 2019). In addition, individual-targeted teaching is applied by assigning tasks to students according to their competencies. In this way, while group learning takes place, individual learning and progress are also provided.

In the 2018 science curriculum currently implemented in Turkey students reach scientific knowledge and acquire knowledge by researching and questioning. The inquiry-based learning strategy is based on the science curriculum. There is a science teaching approach in which students are responsible for their own learning with an interdisciplinary approach and are active in the learning process. It is stated that it should be carried out in student-centered learning environments where methods and techniques such as argumentation, cooperative learning and problem-based learning will be applied in science lessons.

Above, the strategies and methods adopted by the countries covered in this study in science teaching are mentioned in general. It is seen that countries especially adopt student-centered learning strategies. However, while some countries emphasize the teaching of scientific knowledge by considering science and environmental phenomena together, associating conceptual learning with daily and social life as a part of life, it comes out that science teaching should be done within the scope of students' competencies by emphasizing individual learning and differences in some countries.

2.3.Assessment and Evaluation Approach of Science Teaching Program

China is a very crowded country with a large number of students. It is a country where there is a competitive assessment and evaluation system for students who want to enter the limited number of quotas of qualified schools. High-stakes testing is considered important for both parents and students (Yin and Buck, 2015). In addition to this, homework is also a frequently used method.

It is important to measure the knowledge, skills and attitudes that students expect to gain in science teaching in Singapore. Based on these measurements, it is much more important to inform students, teachers, parents and school administrators and to provide feedback on students' levels. The measurements here are effective for students to see their strengths and weaknesses, as well as for teachers to see their students' strengths and weaknesses.

Although it is known that concept-based knowledge teaching is important in Macau, where very detailed information cannot be accessed as a third country, it is thought that there are various assessment approaches due to the application of different systems or the absence of a central system.

In Estonia, general learning outcomes and subject-related learning outcomes are measured. Students are assessed both orally and in writing. In addition, the activities carried out by the students are included in the scope of evaluation.

The main purpose of all these assessments is to follow the progress of the students and to encourage them to study. In particular, written measurement tools are used to determine whether content-related learning outcomes have been achieved. In these written answers, it is aimed to correct grammatical rules if there are errors. In addition, different measurement processes can be performed according to the variety of gains.

Although there is no detailed information about measurement and evaluation approaches in the Japanese science curriculum, it is seen that an assessment-evaluation approach is adopted that will motivate students to learn science, determine their teaching processes and support positive developments (Erdoğan, 2019). In particular, it is emphasized that individual differences are at the forefront, individual development is given importance, and that measurement and evaluation should be not only result-oriented but also process-oriented.

Similarly, process evaluation is important in the measurement and evaluation approach in the science curriculum in Turkey, and individual differences should be paid attention to. It is also recommended to use different and appropriate alternative measurement and evaluation tools. However, the techniques to be used by science teachers are not clearly stated. In addition, it is emphasized that the evaluation of cognitive skills alone will not be sufficient.

CONCLUSION AND DISCUSSION

In this study, aim was to examine the science education of China, Singapore, Macau, Estonia and Japan, which are among the top five countries in the field of science literacy according to the results of PISA 2018, and Turkey, under some subtopics. It is aimed to present some information in terms of the aims of science education programs, the methods and strategies adopted in science teaching, and measurement and evaluation approaches. In the study, the information obtained from the relevant sources was presented and some interpretations were made in line with this information. When we look at the aims of the science education programs of the countries where knowledge is obtained, it is seen that the emphasis is generally on teaching natural sciences and adopting the relationship between human and nature. In addition, students' perception of the processes in acquiring scientific knowledge and teaching the ways of acquiring knowledge come to the fore. It is seen that there are similar features in Turkey 2018 Science Curriculum and emphasis is placed on science and engineering practices, the interaction between the individual, the environment and society, and the adoption of scientific process skills and scientific research approaches.

In addition, it is aimed to develop career awareness and entrepreneurship skills related to science. It is seen that the above-mentioned countries have basically similar science teaching purposes, but they also have special purposes that the countries emphasize according to their own needs and perspectives.

When evaluated in terms of the methods and strategies adopted in science education programs, it is seen that importance is given to the creation of learning environments that will allow practice and the acquisition of scientific knowledge. It is noteworthy that the methods and techniques that students will learn by experiencing science and science are preferred. In addition, learning environments are created that will allow the use and production of technology in science teaching. An inquiry-based learning strategy has been adopted in science teaching in Turkey. As in other countries, the use of methods and techniques for the production of scientific knowledge and the process of obtaining scientific knowledge comes to the fore. In particular, argumentation-based science learning and cooperative learning are adopted. In the PISA 2018 results, it is seen that the countries that have a successful ranking in the field of science literacy have similarities in terms of science curricula and adopted strategies, including Turkey. However, it is thought that there may be differences in the transfer of these goals and strategies to the learning environment and in the execution of practical teaching activities.

Finally, when the assessment and evaluation approaches adopted in science teaching are evaluated, it is seen that there is a ranking-based practice that will ensure the existence of a competitive environment in some countries with a large number of students. However, in some countries, the presence of process-oriented assessments, which emphasize the importance of feedback and prioritize student development, draws attention. It is seen that importance is given to measurement and evaluation approaches to be made by paying attention to individual differences in Turkey. In all these applications, it is clear that measuring the achievements of the students will not be sufficient, and it is necessary to complete the deficiencies and ensure development through careful evaluations based on the measurement results.

We summarized the aims of some countries in science education, the strategies, the methods they adopted and the assessment and evaluation approaches in this study. When we take all of these findings to the account, it is seen that in these five countries, which are considered successful, science education is mostly emphasized on the concretization of concepts and teaching by practice. It is noteworthy that nature education begins at a very early age and that students have learning environments intertwined with nature. In this context, it is seen as an important issue for a successful science education to create and maintain learning environments that will make students active and enable permanent learning in Turkey or in countries providing education under similar conditions. In similar studies to be carried out in the future, the curricula of the countries covered in this study can be discussed under different subtopics. In addition, science curricula of different countries can be examined. It is also possible to compare countries' curricula such as science and mathematics.

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