

**CONTENT ANALYSIS OF NATIONAL HIGH SCHOOL PHYSICS
CURRICULUM OF TURKEY AND PHYSICS COURSE TEXTBOOKS IN
TERMS OF EDUCATION FOR SUSTAINABLE DEVELOPMENT**

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

EKİN SU KAPLAN

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
SCIENCE EDUCATION IN MATHEMATICS AND SCIENCE EDUCATION

SEPTEMBER 2023

Approval of the thesis:

**CONTENT ANALYSIS OF NATIONAL HIGH SCHOOL PHYSICS
CURRICULUM OF TURKEY AND PHYSICS COURSE TEXTBOOKS IN
TERMS OF EDUCATION FOR SUSTAINABLE DEVELOPMENT**

submitted by **EKİN SU KAPLAN** in partial fulfillment of the requirements for the degree of **Master of Science in Science Education in Mathematics and Science Education Department, Middle East Technical University** by,

Prof. Dr. Halil Kalıpçılar
Dean, Graduate School of **Natural and Applied Sciences**

Prof. Dr. Mine Işıksal Bostan
Head of Department, **Mathematics and Science Education**

Assoc. Prof. Dr. Ömer Faruk Özdemir
Supervisor, **Mathematics and Science Education, METU**

Examining Committee Members:

Prof. Dr. Ahmet İlhan Şen
Mathematics and Science Education, Hacettepe Üni.

Assoc. Prof. Dr. Ömer Faruk Özdemir
Mathematics and Science Education, METU

Prof. Dr. Gaye Teksöz
Mathematics and Science Education, METU

Date: 07.09.2023

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Surname : Ekin Su Kaplan

Signature :

ABSTRACT

CONTENT ANALYSIS OF NATIONAL HIGH SCHOOL PHYSICS CURRICULUM OF TURKEY AND PHYSICS COURSE TEXTBOOKS IN TERMS OF EDUCATION FOR SUSTAINABLE DEVELOPMENT

Kaplan, Ekin Su

Master of Science, Science Education in Mathematics and Science Education
Supervisor: Assoc. Prof. Dr. Ömer Faruk Özdemir

September 2023, 80 pages

Sustainable development (SD) is one of the main issues on the agenda of the United Nations due to the environmental, economic and social challenges the world is facing. For a more livable future and planet, the concept of sustainable development is tried to be integrated into every step of education in order to solve the environmental, economic and social problems from the past to the present. There is a need for research on how these concepts, with their environmental, economic and social dimensions, are integrated and should be integrated into curricula. The aim of this study is to investigate the extent to which the Turkish national high school physics curriculum, which has been implemented since 2018, includes the dimensions of SD and to evaluate how compatible the Ministry of National Education physics textbooks are with the educational goals for SD. For this purpose, content analysis method was used. The dimensions of SD were determined as the conceptual framework of the study and the curriculum objectives were coded according to these dimensions. Quotations from the textbooks for the relevant objectives are exemplified according to the sub-categories of these dimensions specified in the Agenda 21 text.

Keywords: Sustainable Development, Education for Sustainable Development, Curriculum Studies for Education for Sustainable Development, High School Physics Curriculum.

ÖZ

TÜRKİYE ULUSAL LİSE FİZİK DERSİ MÜFREDATININ VE FİZİK DERSİ KİTAPLARININ SÜRDÜRÜLEBİLİR KALKINMA İÇİN EĞİTİM AÇISINDAN İÇERİK ANALİZİ

Kaplan, Ekin Su
Yüksek Lisans, Fen Bilimleri Eğitimi, Matematik ve Fen Bilimleri Eğitimi
Tez Yöneticisi: Doç. Dr. Ömer Faruk Özdemir

September 2023, 80 sayfa

Sürdürülebilir kalkınma (SK), dünyanın içinde bulunduğu çevresel, ekonomik ve sosyal zorluklardan dolayı Birleşmiş Milletlerin gündeminde olan temel konulardan biridir. Daha yaşanılabilir bir gelecek ve gezegen için geçmişten günümüze süregelen çevresel, ekonomik ve sosyal problemleri çözmek için eğitimin her basamağına SK kavramı entegre edilmeye çalışılmaktadır. Bu kavramların çevresel, ekonomik ve sosyal boyutlarıyla öğretim programlarına nasıl entegre edildiği ve edilmesi gerektiği ile ilgili araştırmalara ihtiyaç vardır. Bu çalışmanın amacı 2018 yılından itibaren uygulanmakta olan Türkiye ulusal lise fizik dersi öğretim programının SK'nın boyutlarını ne ölçüde içerdiğini araştırmak ve Millî Eğitim Bakanlığı fizik dersi kitaplarının sürdürülebilir kalkınma için eğitim hedefleri ile uyumunu değerlendirmektir. Bu amaç için içerik analizi yöntemi kullanılmıştır. SK'nın boyutları çalışmanın kavramsal çerçevesi olarak belirlenmiş ve kazanımlar bu boyutlara göre kodlanmıştır. Ders kitaplarından ilgili kazanımlar için yapılan alıntılar ise bu boyutların Gündem 21 metninde belirtilen alt kategorilerine göre örneklendirilmiştir.

Anahtar Kelimeler: Sürdürülebilir Kalkınma, Sürdürülebilir Kalkınma için Eğitim, Sürdürülebilir Kalkınma için Eğitim için Müfredat Çalışmaları, Lise Fizik Müfredatı

To my mother, my friends and to all forward-thinking teachers in the world.

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my supervisor, Assoc. Prof. Dr. Ömer Faruk Özdemir for his comments, feedbacks, positive reinforcement, suggestions, support, and encouragement throughout not only this research but also my entire university studies.

I would also like to thank my examining committee members, Prof. Dr. Ahmet İlhan Şen and Prof. Dr. Gaye Teksöz, for their feedback, suggestions, and comments. I have decided to study Education for Sustainable Development after taking Prof. Dr. Gaye Teksöz's "A New Trend in Education: Education for Sustainable Development" course. I feel lucky to have such opportunity by taking her course.

The different perspectives on education and the less than ideal attitudes towards teachers that I've encountered in the school administrations I've worked with so far have encouraged me to seek a different path within the education system. Some of these administrations seemed to view education primarily as a profit-driven enterprise, and I found it challenging to thrive within such frameworks. I appreciate the motivation they inadvertently provided, and I sincerely hope that they consider reevaluating their attitudes in the near future.

I would like to thank my friends, İrem Kül, Esen Sargut Sönmez, Bilge Gizem Görgülü, Aylin Taner, Elif Yavuz, Burak Şahin, Okan Yılmaz and Dilan Köse who always encouraged and helped me to complete this work. Also, a very special thanks go to Emine & Bilhan Görgülü for their support as my second family.

I would like to express my deepest gratitude to my extended family who made me who I am. Especially, without my mother's support and understanding I could not have completed this work.

TABLE OF CONTENTS

ABSTRACT.....	v
ÖZ	vi
ACKNOWLEDGEMENTS	viii
TABLE OF CONTENTS	ix
LIST OF TABLES	xi
LIST OF FIGURES.....	xii
CHAPTER 1.....	1
1 INTRODUCTION	1
1.1 Purpose of The Study.....	3
1.2 The Significance	4
CHAPTER 2.....	7
2 LITERATURE REVIEW.....	7
2.1 History of Sustainable Development	7
2.2 Formation of The Concept of Education for Sustainable Development..	11
2.3 Conceptual Framework for Sustainable Development	13
2.3.1 Environmental Dimesnion of Sustainable Development	14
2.3.2 Economonic Dimension of Sustainable Development.....	16
2.3.3 Social Dimension of Sustainable Development.....	18
2.3.4 Different and Common Areas of Dimensions of Sustainable Development	19
2.4 The Integration of The Concept of Education for Sustainable Development into Education Programs and Its Importance.....	20
2.5 Research Conducted on The Integration of Education for Sustainable Development and The Result of These Studies	23

3	METHODOLOGY	27
3.1	Content Analysis	28
3.1.1	Analysis of National High School Physics Curriculum of Turkey .	31
3.1.2	Analysis of Physics Textbooks	31
3.1.2.1	9 th Grade Physics Textbook	31
3.1.2.2	10 th Grade Physics Textbook	32
3.1.2.3	11 th Grade Physics Textbook	32
3.1.2.4	12 th Grade Physics Textbook	32
3.2	Trustworthiness.....	32
3.2.1	Credibility.....	32
3.2.2	Transferability	33
3.2.3	Dependability and Confirmability.....	34
3.3	Limitations of The Study	34
4	FINDINGS	37
4.1	Environmental Dimension	41
4.2	Economic Dimension.....	50
4.3	Social Dimension	55
5	DISCUSSION, IMPLICATION AND RECOMMENDATION FOR FURTHER STUDIES, AND CONCLUSION	65
5.1	Discussion.....	65
5.2	Implication and Recommendation for Further Study	69
5.3	Conclusion	70
	REFERENCES	73
	APPENDICES	79
6	A. BOARD DECISION ON PHYSICS CURRICULUM IN ENGLISH	79
7	B. BOARD'S DECISION ON PHYSICS CURRICULUM IN TURKISH..	80

LIST OF TABLES

TABLES

Table 1 Environmental Dimension of SD	14
Table 2 Economic Dimension of SD	17
Table 3 Social dimension of SD.....	18
Table 4 Conceptual framework of the study	29
Table 5 Number of ESD related objectives of each grade	38
Table 6 Number of ESD related objectives of each grade based on each dimension of SD	38
Table 7 ESD related units and objectives with codes as written in the curriculum	39
Table 8 Comparion of energy resources	44

LIST OF FIGURES

FIGURES

Figure 1 Venn diagram of dimensions of SD.....	20
Figure 2 Distribution of ESD related objectives of each grade.	66

CHAPTER 1

INTRODUCTION

The existence of modern humanity on Earth, which is about 4.5 billion years old, dates back to two hundred thousand years ago. Unfortunately, in these two hundred thousand years, which is an exceedingly small period of time compared to the age of the Earth, the World has received and still continues to receive the greatest artificial touches and damage, especially with the growing population and the steps taken to meet the needs of this population. Ozone depletion, global climate crisis, air-water and soil pollution, and water scarcity are only examples of the environmental dimensions of this damage to the planet. In addition, social and economic problems such as migration, wars, inequality between men and women, income inequality, and economic injustice have also manifested themselves even more, especially in the recent past, and continue to increase rapidly. Taking all this into account, the current understanding of development and our interaction with the environment should ensure both natural balance and economic and social development and require a new strategy that will provide equal opportunity and prosperity for everyone. (UNCED,1993)

With the increasing threat levels of these environmental, economic, and social problems facing the planet and humanity, the countries of the world have started to take steps towards creating action plans and increasing global awareness since the 1970s. In the light of global conferences held in different years under the leadership of the United Nations (UN), concepts such as Sustainable Development (SD), Environmental Education (EE), and Education for Sustainable Development (ESD) have emerged, been defined, and placed in action plans. At the Brundtland Report, or known as Our Common Future, the concept of SD was finalized as meeting the needs

of today without compromising the ability of future generations to meet their own needs (WCED,1987)

Undoubtedly, one of the biggest stakeholders in increasing the applicability of the action plans mentioned above and social awareness at the global level throughout the conferences and meetings is education. The UN General Assembly has designated the years 2005-2014 as the Decade of Education for Sustainable Development in the light of the experiences and lessons learned between 1992 and 2002 and with the idea that the meaning of SD is to have a different perspective on the world and that education is the engine of this change. (Teksöz, 2016)

Promoting sustainable development and enhancing people's ability to address environmental and development concerns require education (Tiburry,1995) Therefore, existing education and educational curricula should be enriched in line with all these actions. Education needs to be reoriented, and many countries are taking steps to shape their education systems by including ESD in their curricula. (McKeown et al.,2006)

David Orr said in his book *Earth in Mind* "The solution of the big environmental, economic and social problems of the next century requires us to reconsider the content, process and purpose of education." (Orr, 1994, p.27)

There are many issues where all these problems, the action plans put forward for the problems and the global awareness that needs to be increased are combined with education. Some of these can be listed as the global warming crisis and climate change, technological waste, reducing the use of non-renewable energy sources, spreading a greener transportation system, preventing industrial growth and waste, population management, and more. In addition, considering the dimensions of sustainable development, the conscious processing of these issues in education and their inclusion in national curricula is vital for the future of humanity, the solution of problems, and global awareness. These issues are not only among the topics that can

be integrated into education, but also are at the heart of ESD. ESD is also included in the Rio+10 Johannesburg Declaration, which was implemented in 1992 and 10 years later. (Teksöz,2016)

Considering the number of people that education can reach around the world, it is important for the countries that have signed conferences, published declarations, and many other action plans to indicate their goals and methods in the trainings they implement to make rapid progress. Turkey is also located in these countries. The main philosophy and objectives of the National High School Physics Curriculum of Turkey include the articles emphasizing the importance of physical science in understanding events in the universe, problem-solving, using scientific process skills, the impact of physical science on social life, economics, and technology, and the ability to draw inferences about sociological events related to the use of different energy sources. (MoNE Commission, 2018)

1.1 Purpose of The Study

The aim of this qualitative study is to reveal the status of inclusion of curriculum achievements reflecting ESD in the National High School Physics Curriculum, which has been implemented since 2018. The conceptual framework foundation of this study is constructed from the environmental, economic, and social dimensions of SD as articulated in Agenda 21. These dimensions are separated into chapters and issues “based on Agenda 21 text by Canan Turkmen in 2018 to use them a conceptual framework in her study. In this framework, there are chapters related to environmental, economic, and social dimensions of SD and issues represents these chapters as subtitles. There are 11 chapters and 39 issues for environmental dimension, 6 chapters and 22 issues for economic dimension, and 6 chapter and 21 issues for social dimension. This conceptual framework and its chapters with issues are explained in the literature review part in detail.

The specific research questions generated for this aim are as follows:

1) To what extent does the National High School Physics Curriculum of Turkey (2018-present) incorporate sustainable development (SD) dimensions outlined by the United Nations' Agenda21 text?

2) How are the physics course textbooks approved by the Ministry of National Education (MoNE) of Turkey aligned with the education for sustainable development (ESD) principles and concepts outlined in the National High School Physics Curriculum?

1.2 Significance of the Study

Former United Nations secretary- general Ki-Moon said “It was decided to support ESD and realize the integration of the concept of SD into education in a more active way during the continuation of the 10th year of the UN training for SD. In 2015, the previously set 8 Millenium Development Goals were replaced by 17 Sustainable Development Goals. These goals should be well understood and integrated into the teaching programs.” (Teksöz,2016, p.13) The physics program of secondary education in Turkey was updated in 2018 and this program is still valid today. The research of education for sustainable development in this updated educational program is necessary in order to make a generalization about the contents of Turkish educational programs in this direction in general. The literature review on the subject has clearly shown the research gap in the field of curriculum analysis of physics education in terms of education for sustainable development. Although content analysis of secondary school science, computer technologies, high school chemistry courses in Turkey have been analyzed in the recent past, no physics course curriculum research has been found in the field of education for sustainable development. When the role of ESD is examined, it is aimed to accelerate global action plans and global awareness, to identify good examples and shortcomings, if any, in existing programs in order to achieve the goals set in this direction faster. Therefore, it is important to analyze the current state of the curriculum in force. A detailed study of the achievement of the secondary education physics curriculum, which has been

implemented in Turkey since 2018, in terms of ESD contributes to the inclusion of Turkey in the global goals and action plans set in the light of the declarations of international meeting, conferences and publications supported by many developed countries around the world.

In addition, this study provides an important basis for the physics education within the Turkish Education System and the analysis of the field of education for sustainable development, which is one of the biggest topics in the world.

This study holds significant educational relevance as it focuses on the integration of educational principles for sustainable development into the Turkish National High School Physics Curriculum. With this study, it can be understood how and how much the sustainable development dimensions specified in the Agenda 21 text are incorporated in the high school physics curriculum objectives. Valuable insights can be gained into the educational strategies and approaches used to promote sustainable development among high school students.

In addition, the findings of this study may have a substantial impact on education policy makers and curriculum developers. As a result of the study, it will be evaluated to what extent the dimensions of sustainable development are included in the physics curriculum and physics textbooks. Thus, this assessment can identify gaps and areas for improvement that could potentially lead to revisions or improvements in the content of curriculum guidelines and textbooks.

The United Nations has seventeen sustainable development goals. Of these goals, Goal 4 is about Quality Education and Goal 12 is about Responsible Consumption and Production. While this study is specifically compatible with these two sustainable development goals, it is aligning a total of thirteen goals and encourages sustainable practices. It also contributes to the topic of sustainability in education which is a global issue of 21st century.

Undoubtedly, instilling sustainable development to future generations through education systems is possible with teachers' development and being progressive in this field. Therefore, the results of this research can inform teacher training programs and professional development initiatives. Understanding how sustainable development concepts are represented in the curriculum and textbooks can help educators effectively incorporate these principles into their teaching practices and foster responsible behavior among students.

This study can facilitate comparative analysis with other countries' physics curricula and textbooks regarding education for sustainable development. Such comparisons can offer valuable insights into best practices and lessons learned, promote knowledge exchange and potential improvements in education policies and practices.

Among the common goals of the curricular studies with the title of education for sustainable development and the potential curative and progressive evaluations made as a result of these studies, there is an opportunity to meet the expectations for a better future. This study contributes to this common purpose by examining the Turkish National High School Physics Curriculum in terms of SD and ESD.

Ultimately, this study addresses an important gap in the existing literature and has the potential to contribute to the education policy, practice and promotion of sustainable development in the Turkish education system. By investigating the inclusion of education for sustainable development in the National High School Physics Curriculum of Turkey and its representation in physics course textbooks, it lays the foundation for further research on integrating sustainable development principles into other subject areas or levels of education, inspiring scholars and researchers to explore additional strategies, resources, and innovative pedagogical approaches that enhance sustainability education.

CHAPTER 2

LITERATURE REVIEW

In this section, history of SD, formation of the concept of ESD, conceptual frameworks for SD, integration of the concept of ESD into education programs and its importance, and research conducted on the integration of ESD and results of these studies are presented. In the first part, the history of sustainable development is given. In the second part, the emergence of the concept of education for sustainable development is explained. In the third part, the dimensions of sustainable development are included and explained in detail. In the fourth chapter, the integration of education for sustainable development into today's educational programs and the importance of this are expressed. In the last section, the research conducted on the integration of education for sustainable development and the results of these studies are included.

2.1 History of Sustainable Development

The concept of SD has its place in the literature concretely in the 20th century. Although it took a century, the concept of sustainability dates back to the Middle Ages and even ancient Greek mythology (Campbell,1996). When the civilizations of the period are examined in general, it is seen that the concept of sustainability is shaped according to the people's lifestyles and livelihoods. It is known that while carrying out activities such as forestry, fishing, agriculture, traditional culture supports use as much as need, and it is considered an important factor in ensuring that what exists also serves future generations. This culture has allowed the idea of sustainability to be shaped (Bozdoğan, 2005).

In the recent past, it is seen that the concept of sustainability has started to take place on the world agenda as environmental problems that are large and destructive enough to affect human life arise. The biggest reason for these problems is the rapidly increasing world population.

In the 2002 World Population Prospects Revision report prepared by the Department of Economic and Social Affairs of the United Nations, it was stated that the fastest deceleration rate from the past to the present was between 1955 and 1975 with increases of over 1.8% per year. In particular, it was recorded that this rate reached a record rate of 2.1% between 1965 and 1975 (UNDESA, 2021).

The emergence of the concept of environmental problems dates back to the 1960s when these statistics were realized. The rapid increase in the population has also greatly increased the need for food. So much so that new agricultural practices and inventions have emerged to meet the increasing need for food. For example, these applications and inventions to meet the need for food started with the Green Revolution. With Green Revolution, millions of people were saved from starving to death in 1970, especially in India, Mexico, and the Middle East (Teksöz, 2016). However, the basis of the application is the use of excess chemical fertilizers to increase production in agriculture and toxic drugs such as DDT and pesticides to eliminate agricultural pests (Tilman, 1998). In addition, forests have been cut down and wetlands dried for more fields in order to meet the needs of the population. These practices have been the biggest causes of the major environmental disasters experienced in the 1980s (Pingali,2002).

However, in 1962, when these practices were experienced, a study called Silent Spring was published by Rachel Louise Carson, an American marine biologist. In the study, Carson addressed the damage caused to the environment by chemicals used, especially DDT, and agricultural practices. The study made a huge noise in the Western world and also played a major role in banning the use of DDT in America

in 1972. The study was also one of the first publications in the literature that led to the awareness of sustainability and environmental protection (Teksöz, 2016).

As environmental protection awareness increased, environmental movements turned into a holistic approach in a short time in the 1970s and contributed to the development of the concept of sustainability (Bozdoğan, 2005). In 1972, the UN Conference on the Humanitarian Environment was held in Stockholm, the capital of Sweden. As a result of the conference, the UN Declaration on the Human Environment was published. The principles in the declaration have become the basic foundations of the concept of sustainability (IULA-EMME,1997).

However, although conferences have been organized on a global scale, decisions have been made and declarations have been used, major environmental problems that threaten the life of living things have continued to occur. For example, a chemical substance leaked from a pesticide factory established by an American company called Union Carbide in the Indian town of Bhopal led to the death of 18,000 people and poisoning of 150,000 people. The effects of this disaster experienced in 1984 have continued their traces in subsequent generations (Eckerman,2005).

Due to the continuation of such problems and the occurrence of disasters, the World Environment and Development Commission has been convened to search for a solution to them (WCED,1987). The commission, chaired by Norwegian Prime Minister Gro Harlem Brundtland, consisting of participants from twenty different countries, prepared the document, also known as the Brundtland Report or Our Common Future, in 1987 (Bozdoğan, 2005). Our Common Future is one of the milestones that change the perspective of environmental problems (Teksöz, 2016). With this document, the concept of sustainable development has entered our lives and its definition has been made. Sustainable development is the satisfaction of today's needs without eliminating the potential of future generations to meet their own needs (WCED,1987)

5 years after the publication of the Brundtland Report, the UN Environment and Development Conference was held in Rio, Brazil in 1992. In addition to official organizations, and political representatives, groups such as students, teachers, non-governmental organizations, scientists, and business world representatives also participated in this conference. This situation indicates that the contribution of society is important in the development of SD (Teksöz, 2016). In addition, as a result of the Rio conference, the final document entitled Agenda 21 was published. The document elaborates on the concept of sustainable development in detail, as well as the economic, social, and other aspects of SD. The dimensions are also taken into account (Bozdoğan, 2005).

The concept of sustainable development is not limited to these declarations and conferences. In the following years, the steps given chronologically below have been taken to expand the concept, increase global awareness, and create action plans.

- In 1992, the 5th European Union Action Plan has been adopted under the name of Towards Sustainability.
- In 1993, the Commission for SD was established within the UN. The aim of the Commission is to examine the developments towards the implementation of Agenda 21 at the national and international levels (UN, 1992 b).
- In 1995, the UN Population and Development Conference was held in Cairo and the concept of SD was associated with the concept of population (UN, 1995).
- In 1996, the UN Human Settlements Conference was held in Istanbul, and SD and human settlements were related (Bozdoğan, 2005).
- In 1997, the Rio+5 Forum was organized. The aim of the Forum is to transfer the concept of SD from the agenda to implementation (Asia-Pacific Council, 1997).
- In 2002, the SD conference for general evaluation purposes was organized in Rio+10 Johannesburg. At the conference, the latest situations of the countries

in preparing their national sustainable development strategies were evaluated. In addition, the problems encountered during the implementation of Agenda 21 were discussed (Bozdoğan, 2005).

- In 2012, the UN SD Conference, also known as Rio+20 or Earth Summit 2012, was held for the third time (Teksöz, 2016).

But despite all the studies conducted on a global scale, unfortunately, there have still been large-scale environmental disasters and they still continue to happen. In 2015, 17 sustainable development goals were published by the UN, and these 17 goals were set to be achieved by 2030 for the peace and prosperity of people living on the Earth (Teksöz,2016).

The concept of SD has emerged as a result of the large-scale damage caused to the ecosystem by economic and social developments in the recent past. The fact that the ontological continuity of the global society faces the threat of extinction as a result of this damage has caused the content of the concept to expand until today; the concept remains at the top of the world agenda and also exist in the near future plans for nations.

2.2 Formation of The Concept of Education for Sustainable Development

As a result of the studies and research carried out during the emergence of the concept of sustainable development and the global conferences, the opinion that education will be a mass tool for SD has emerged. Within the historical development of SD, environmental education has come to the agenda and environmental education has evolved into the concept of education for sustainable development over time (Teksöz,2016). Below, the ways followed during this information, the studies carried out, the conferences held, and the decisions taken as a result of all these were shared and the formation of the concept of education for SD was explained.

The idea of developing an educational program for environmental problems first emerged as a result of the Stockholm Conference by the UN in 1972. This idea is

stated in the UN Declaration on the Human Environment published as a result of the conference. In addition, in light of this emerging idea, UNESCO conducted a survey on the evaluation of environmental education resources in 136 countries in 1975. The purpose of the application is to collect information that will form the basis of EE. In accordance with the results of the survey, the International Environmental Education Program (IEEP) was established in cooperation with UNESCO and the UN Environment Program (UNEP) (Teksöz,2016).

By 1977, an International Environmental Education Conference was held, the first for EE. In the declaration, published as a result of the conference (Tbilisi Declaration), EE has become a global agenda and the main lines, objectives, and pedagogical principles of this education have been determined (UNEP, 1977).

In 1992, as a result of the Rio Conference, which was the pioneer of a transition from environmental education to the concept of education for SD, the next of Agenda 21 was published. 36th section of the text links the concept of SD with education (Teksöz, 2016). In this section, a global education aimed at strengthening attitudes, values and behaviors for sustainable development is mentioned. The items included among the decrees of this global education are: (UN, 1992)

- Ensuring basic education and environmental literacy
- Ensuring that environmental and development education reaches people of all age groups.
- Integration of the concepts of environment and development into all educational programs in detail
- Ensuring the participation of primary school students in environmental health studies.

In the rio+10 Johannesburg Declaration in 2002, the scope of the concept of sustainable education for SD, the goals of which were previously outlined, were determined. Biodiversity, climate change, cultural diversity, local knowledge,

disaster and risk management, poverty alleviation, gender equality, health sustainable lifestyles, peace and security, water and sustainable urbanization have been identified as the topics of these scopes. (Rio+10,2002). Also, in December 2002, a first for the concept of ESD was signed and the Decennial of ESD between 2005 and 2014 was declared by the UN. The aim here is for everyone to have the opportunity to study and to give people awareness of life for a sustainable future (UNESCO,2005). Another step taken to support this decade is the International Implementation Guide published by UNESCO. The guide is intended to be a guide for all countries on behalf of the concept of ESD. In it, there are many substances such as the content, goals, application principles of education for SD, etc. (IIS, 2005)

In 2012, 20 years after the Rio Conference (Rio+20), the role of education for SD was brought back to the agenda. As a result of the conference, it was evaluated that the ESD Decade will continue after 2014. In fact, as a result of the conference, the former UN Secretary-General Ki-Moon expressed the following words. “It has been decided to support ESD and realize the integration of the concept of SD into education in a more active way to continue the education decade (Teksöz, 2016).

Human-caused disasters on the planet have caused global turmoil and the emergence of complex problems. The role of education in solving these problems and learning from problems is undoubtedly very great. It is very important to increase global awareness for a more sustainable future and a livable world. The concept of education for sustainable development has emerged with these goals and thoughts and has taken its place in literature.

2.3 Conceptual Framework for Sustainable Development

There are many studies, research, and meetings about SD from the past to the present. As a result of each of these, the papers and texts of the studies carried out have been published. Agenda 21, as mentioned in the previous sections of the study, is an international text prepared after the Rio Conference held in 1992. Three dimensions

of SD are mentioned in the text. These are environmental, economic, and social dimensions. In addition, each dimension is discussed in detail in the text with the areas and subheadings it covers. Based on these, the importance of considering SD not environmentally but also economically and socially together with the environment is understood.

2.3.1 Environmental Dimension of Sustainable Development

The Earth, which is the only planet in the known universe where life activities can take place, is an environment for all organisms (Montmerle et al., 2006). It serves as a place where all the basic needs necessary for the continuation of the life activities of living beings are met. However, out of millions of living species it contains, only man has been and continues to be the cause of these environmental disasters faced by the Earth. As a result of environmental disasters, this planet has faced many negative situations, such as water and air pollution, global warming, and climate change, the decline or extinction of living species, ozone layer damage, and the destruction of natural resources. Table 1, created according to the Agenda 21 text, lists the titles and scopes of the environmental dimension (Türkmen, 2018).

Table 1 Environmental Dimension of SD

The Chapter in Agenda 21	Environmental Issues
Protection of Atmosphere	Ozone Layer Deplation
	Greenhouse Gases
	Climate Change
	Transboundary Atmosphere Pollution
	Renewable Energy Sources
	Alternative Energy Sources
Integrated Approach to the Planning and Management of Land Resoruces	Land Resources
	Ecology

Table 1 (Cont'd): Environmental Dimension of SD

Combating Deforestation	Deforestation Forest Rehabilitation Afforestation
Managing Fragile Ecosystems: Combating Desertification and Drought	Desertification Drought
Managing Fragile Ecosystems: Sustainable Mountain Development	Soil Erosion Loss of Habitat Genetic Diversity Mountain Ecosystems
Promoting Sustainable Agriculture and Rural Development	Pest Management Land Conservation and Rehabilitation Soil Fertility Food Security
Conservation of Biological Diversity	Biodiversity Protection of Ecosystems
Protection of Oceans, All Kinds of Seas, Including Enclosed & Semi- enclosed Seas, Coastal Areas and the Protection, Rational Use and Development of Their Living Resources	Marine Ecosystem Climate Change Small Islands Marine Pollution Bioaccumulation
Protection of The Quality and Supply of Freshwater Resources: Application of Integrated Approaches to the Development, Management and Use of Water Resources	Hydrological Cycle Climate Change Atmospheric Pollution Freshwater Scarcity Flood Prevention
Environmentally Sound Management of Toxic Chemicals, Including Prevention of Illegal	Chemical Contamination

Table 1 (Cont'd): Environmental Dimension of SD

International Traffic in Toxic and Dangerous Products	
Environmentally Sound Management of Hazardous Wastes, in Hazardous Wastes	Hazardous Wastes
	Rehabilitation of Contaminated Sites
Environmentally Sound Management of Solid Wastes and Sewage Related Issues	Solid Wastes
	Life Cycle Management
	Waste Reuse and Recycling
	Waste Disposal and Treatment
	Sewage Disposal
Safe and Environmentally Sound Management of Radioactive Wastes	Radioactive Wastes

2.3.2 Economic Dimension of Sustainable Development

Throughout history, improper activities carried out to meet the needs of an increasing population have caused damage not only in the environmental dimension but also in the economic dimension. And still continues to happen. Undoubtedly, one of the first words that comes to mind when we say economy is capital. For example, all the natural resources that the planet has are the capital of this environment in which we live. The generally accepted definition of the economic dimension of sustainability is the protection of capital and the prevention of its deterioration (Bilgili, 2017). Each generation must decide how much capital it will consume now and how much capital it will accumulate and preserve for future generations (Markulev et al., 2013). Therefore, no matter what area it is in, consumption without production is one of the biggest things that will harm this planet economically. Table 2 contains the subheadings and the scope of the economic dimension of SD in accordance with the text of Agenda 21 (Türkmen, 2018).

Table 2 Economic Dimension of SD

The Chapter in Agenda 21	Economic Issues
International Cooperation to Accelerate Sustainable Development in Developing Countries and Related Domestic Policies	National Economic Policies International Economic Relations Multilateral Trading System Market Access for Developing Countries
Combating Poverty	Equity in Income Distribution Human Resource Development Strengthening Employment Poverty Eradication Food Security
Changing Consumption Patterns	Economic Growth Patterns of Consumption and Production Minimizing Waste Rules and Regulations for Industry
Demographic Dynamics and Sustainability	Population Growth Capacity of Planet
Promoting Sustainable Human Settlement Development	City Planning Transportation Renewable Energy Life Cycle Coast Sustainable Construction Industry
Integrating Environment and Development in Decision Making	Research and Development Science and Technology

2.3.3 Social Dimension of Sustainable Development

The social dimension of SD emphasizes on meeting the basic needs of the members living in society (Bilgili, 2017). A socially sustainable society should have the flexibility to protect, develop its own resources, and prevent and solve problems in the future (City of Vancouver, 2015). In general, the social dimension of SD sets out various principles and ideas for individuals and societies to achieve a better quality of life, brings up in-depth analyses to solve the social crises encountered, and aims to ensure that future generations can benefit from social opportunities at least as much as today's generations (Bilgili, 2017). Table 3 contains the headings and the scope of the social dimension of SD contained in the Agenda 21 text (Türkmen, 2018).

Table 3 Social dimension of SD

Chapters in Agenda 21	Social Issues
Combating Poverty	Empowering Communities Disadvantaged Groups (Women, Children and Youth, Refugees) Food Security
Changing Consumption Pattern	Sustainable Consumption Patterns Promotion of Energy Efficiency Minimizing Waste Awareness & Responsibility
Demographic Dynamics and Sustainability	Protecting Vulnerable Groups (Rural Landless Workers, Ethnic Minorities, Refugees, Migrants, Women Heads of Household, Indigenous People)
Protecting and Promoting Human Health Conditions	Human Health Quality of Life Protecting Vulnerable Groups

Table 3 (Cont'd): Social Dimensions of SD

Promoting Sustainable Human Settlement Development	Human Health
	Quality of Life
	Protecting Vulnerable Groups
	Shelter for All
	Urbanization
	Living and Working Environment
	Sustainable Transportation
	Raisin Awareness
Integrating Environment and Development in Decision Making	Policy & Planning & Management
	Legal & Regulatory Framework
	Education
	Public Awareness
	Legal & Regulatory Instruments

2.3.4 Different and Common Areas of Dimensions of Sustainable Development

In Table 1, Table 2, and Table 3, prepared on the basis of Agenda 21 by Canan Türkmen in 2018, it is seen that some issues concern all dimensions, while others fall into the field of only or at least one of environmental, economic, and social dimensions. The subheadings and related dimensions of SD are shown in Figure 1 as a Venn Diagram to create an overview of Table1, Table 2, and Table 3 (Türkmen,2018).

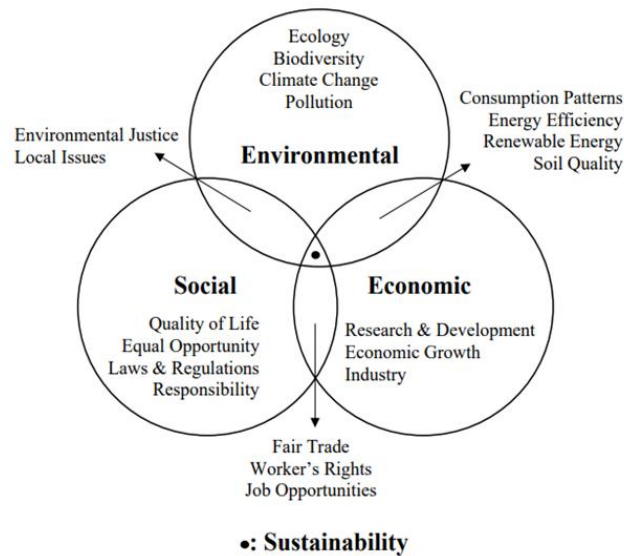


Figure 1 Venn diagram of dimensions of SD

2.4 The Integration of The Concept of Education for Sustainable Development into Education Programs and Its Importance

Education is defined in the dictionary as helping new generations to acquire the necessary knowledge, skills, and understanding to take their place in public life, to develop their personalities (TDK). Individuals who are sufficiently strengthened with knowledge, skills, values, and attitudes should be raised for the continuity of decisions taken as a result of studies conducted for SD and for the realization of planned actions. Thus, continuity for SD will be ensured in societies and for the future of societies. Education can be seen as the greatest resource available to all, regardless of economic conditions and impasses, in helping nations achieve a vision of a just and sustainable society (Schumacher, 1973). Therefore, education has an important role for SD and its continuity. The UN General Assembly, with its resolution 57/254 of 20 December 2002, established that ESD is a fundamental tool for achieving environmental development goals by developing knowledge, values, competencies, and skills that contribute to a just, economically viable and ecologically sustainable human future and encourages education (Borreguero et al., 2019). For this reason, in

2002, the UN declared the years between 2005 and 2014 the World Education Decade for SD. The aims in the text published with this announcement were determined as promoting and developing quality education, reorienting education programs, and providing practical training (Teksöz, 2011). Learning about SD through education programs can benefit the development of both students and societies.

In his book, David Orr criticized the existing programs and stated that education curricula should be renewed within the framework of the concept of education for SD. For the most part, we continue to educate young people as if there is no planetary emergency. When we take out computers and interspersed courses and programs in the catalog, the curricula of the 90s look a lot like those of the 50s. The crisis we are facing is, first and foremost, a challenge. This is an educational problem. The continuation of the same type of education will make things worse. The solution to the big ecological problems of the real century requires us to review the content, process, and purpose of education. (Orr, 1994)

For this future which David Orr refers to in his book, many countries envision policies to integrate the concept of ESD into their school curricula and devote a great time and effort to developing curricula appropriate to local conditions. Fully integrating the concept of sustainability into curricula is the most important tool for facilitating changes in students' future behavior and decisions regarding sustainability and raising their awareness (Dietz et al., 2005). Societies will act under the influence of economic and cultural pressures and will not be able to make sustainable choices without having knowledge, positive attitudes, responsibilities, and skills for a sustainable future in every field. Responsibility comes with education. At the core of the concept of ESD is the aim of integrating SD principles, values, and practices into all aspects of education to address the social, economic, cultural, and environmental problems we face, especially in the 21st century. Therefore, the ESD should be included in more disciplines and at all levels of education (UNESCO,1992). Thus, individuals with the necessary responsibility in the future will have a place in society.

For example, the Southeast Asian Education Ministers Organization has succeeded in embedding education in social studies, arts, and science courses for SD and creating good practices according to the courses. They also initiated capacity-building training for teachers, curriculum developers, school leaders, and policymakers. In Australia, in 2011, it was reported that education for environmental sustainability and sustainability became widespread in the society together with the school (Lee et al., 2016).

The importance of integrating the concept of ESD is stated in the text of the World Commission Strategy 1991, *Caring for the Earth* as follows, sustainable living should be a new model for all levels. Individuals, societies, and the world. Many people will need to make a significant change in their attitudes and practices to adopt this new model. We will need to ensure education programs are integrated into the concept of ESD and the importance of sustainable living ethics. (IUCN, UNEP, WWF, 1991)

Chapter 46 of Agenda 21 states that promoting ESD is critical to improving people's capacity to address environmental and developmental issues (UN, 1992). One of the most important aspects of this development is the inclusion of education in the curriculum for SD. Because curriculum integration is essential and effective in providing students with the skills and insights that will help society become more sustainable (Jauhariyah et al., 2021).

Education is a global tool that exists worldwide and in societies, especially among the young generations in the masses. Including the goals, objectives, and actions of the concept of education for SD in educational programs, and associating them with related issues will help to create a mass behavior. Curricula organized in the light of the concept of ESD will allow high-awareness, problem-solving, sensitive and responsible individuals to grow up in a society in the face of this big problem facing the world (Perez et al., 2019).

2.5 Research Conducted on The Integration of Education for Sustainable Development and The Result of These Studies

Curricula integrated with the concept of ESD can provide opportunities for school students to develop action competence. (Gooch,2008). Especially after the publication of the Agenda 21 text and declaration of the UN Decade of ESD, many countries have begun to revise their existing curricula in line with the objectives of the concept and the decisions taken. Existing achievements are particularly associated with relevant dimensions of SD.

A review of studies examining the incorporation of Sustainable Development (SD) in educational curricula reveals valuable insights into the extent of integration and potential areas for improvement. Various studies have assessed the compatibility of curricula with SD objectives in different countries, provided examples for others, and highlighted the need for balance and integration across dimensions.

For example, Türkmen (2018) conducted a study evaluating the Secondary Education Chemistry Curriculum in Turkey (2013-2018) with respect to education for sustainable development. The findings revealed that while the integration of education for sustainable development was successful at the 9th and 10th grade levels, it was insufficient at the 11th and 12th grade levels.

Similarly, Tatlılıoğlu (2019) analyzed the 2018 Secondary School Science Curriculum and Science Textbooks to address sustainable development goals. The study found that most achievements related to sustainable development goals were concentrated at the 8th grade level, with at least six out of the 17 goals addressed in each grade. It was also observed that the environmental dimension of sustainable development was the most integrated among the three dimensions.

Lee et al. (2016) explored the efforts of the UNESCO Hong Kong Association to integrate education for sustainable development into school lessons and curricula. The study revealed an imbalance in the integration of sustainable development

dimensions within the curricula, with 62% of learning activities related to the environmental dimension, while the economic dimension constituted only 8%. This indicated a need to strengthen the integration of the curriculum in light of successful examples.

Jauhariyah et al. (2020) investigated the infusion of education for sustainable development into physics curricula through creative problem-solving and behavioral assessment. The study demonstrated the potential for students to develop an education-based physics curriculum for sustainable development using these approaches.

Barak et al. (2022) conducted a comparative analysis of secondary education curricula in Turkey and Germany (Bavaria) in terms of education for sustainable development. The study highlighted the relationship between the curricula and sustainable development principles, with Turkey's social sciences program focusing more on the social dimension, while Germany's geography, nature, and technology curricula emphasized the environmental dimension. Both curricula had limited emphasis on the economic dimension.

Erten et al. (2022) compared the science curricula of Turkey, Canada, and the United States in terms of environmental education. The study found that Canada had a comprehensive program for raising environmentally conscious individuals, while Nebraska lacked an adequate program. The Turkish Science Curriculum was considered to be intermediate, requiring further development in terms of environmental education.

In another study, Tanrıverdi (2009) assessed the extent to which student achievements in primary education programs in Turkey aligned with the requirements of sustainable environmental education. The findings indicated that the programs predominantly focused on knowledge and attitude development while lacking skill-

building, understanding, and values. The programs primarily emphasized environmental protection rather than sustainable environmental education.

These studies collectively underscore the importance of evaluating curricula in terms of education for sustainable development and highlight the need for further integration across dimensions and grade levels. They provide insights, recommendations, and examples to guide curriculum development efforts and promote sustainable education practices.

CHAPTER 3

METHODOLOGY

The aim of this study is to analyze and evaluate the objectives of the National High School Physics Curriculum of Turkey, which has been implemented since 2018, in terms of its environmental, economic, and social dimensions of sustainable development (SD). Additionally, the study aims to examine the inclusion of education for sustainable development (ESD) within the curriculum and textbooks. To accomplish these objectives, the research questions guiding this study are presented below.

1) To what extent does the National High School Physics Curriculum of Turkey (2018-present) incorporate sustainable development (SD) dimensions outlined by the United Nations' Agenda21 text?

2) How are physics course textbooks approved by the Ministry of National Education (MoNE) of Turkey aligned with the education for sustainable development (ESD) principles and concepts outlined in the National High School Physics Curriculum?

To answer these questions and reach a conclusion in this study, content analysis is chosen to examine the National High School Physics Curriculum of Turkey and physics textbooks approved by Board of Education of MoNE.

This chapter of the study comprises three sections that provide a detailed explanation of the methodology employed. The first section elucidates the content analysis method, including the data sources and the conceptual framework employed. The second section addresses the trustworthiness of the study. Finally, the last section delves into the limitations of the research.

3.1 Content Analysis

Content analysis is a valuable method that allows researchers to indirectly study human behavior by analyzing various forms of communication. As the name suggests, content analysis involves examining the typical, though not exclusive, written contents of communication (Fraenkel et al., 2011). By employing content analysis as a research method, one can draw reliable and valid conclusions that demonstrate the relationship between documents, signs, visuals, and sounds within their respective contexts (Krippendorff, 2004).

In this study, two primary data sources are examined using content analysis: the National Physics Curriculum of Turkey, which has been in use since 2018, and physics textbooks from grades 9 to 12. The content analysis approach is applied to these sources to investigate the inclusion of sustainable development (SD) dimensions, namely the environmental, economic, and social dimensions. These dimensions serve as categories for coding in the content analysis process and are presented as a unified conceptual framework in Table 4 (Türkmen, 2018). Furthermore, the study examines the relevance of the content in physics textbooks to the dimensions of sustainable development.

Table 4 Conceptual framework of the study

ENVIRONMENTAL	<ul style="list-style-type: none"> • Protection of Atmosphere • Integrated Approach to the Planning & Management of Land Resources • Combating Deforestation • Managing Fragile Ecosystems: Sustainable Mountain Development • Promoting Sustainable Agriculture and Rural Development • Conservation of Biological Diversity • Protection of Oceans, All Kinds of Seas, Including Enclosed & Semi-enclosed Seas, Coastal Areas and the Protection, Rational Use and Development of Their Living Resources • Protection of The Quality and Supply of Freshwater Resources: Application of Integrated Approaches to the Development, Management and Use of Water Resources • Environmentally Sound Management of Toxic Chemicals, Including Prevention of Illegal International Traffic in Toxic and Dangerous Products • Environmentally Sound Management of Hazardous Wastes, in Hazardous Wastes • Environmentally Sound Management of Solid Wastes and Sewage Related Issues 	<ul style="list-style-type: none"> • Ozone Layer Depletion • Greenhouse Gases • Climate Change • Transboundary Atmosphere Pollution • Renewable Energy Sources • Alternative Energy Sources • Land Resources • Ecology • Deforestation • Drought • Soil Erosion • Loss of Habitat • Genetic Diversity • Mountain Ecosystems • Pest Management • Land Conservation and Rehabilitation • Soil Fertility • Food Security • Biodiversity • Protection of Ecosystems • Marine Ecosystem • Climate Change • Small Islands • Marine Pollution • Bioaccumulation • Hydrological Cycle • Climate Change • Atmospheric Pollution • Freshwater Scarcity • Flood Prevention • Chemical Contamination • Hazardous Wastes • Rehabilitation of Contaminated Sites • Solid Wastes • Life Cycle Management • Waste Reuse and Recycling • Waste Disposal and Treatment • Sewage Disposal • Radioactive Wastes
----------------------	--	--

Table 4 (Cont'd): Conceptual framework of the study

ECONOMIC	<ul style="list-style-type: none"> • International Cooperation to Accelerate Sustainable Development in Developing Countries and Related Domestic Policies • Combating Poverty • Changing Consumption Patterns • Demographic Dynamics and Sustainability • Promoting Sustainable Human Settlement Development • Integrating Environment and Development in Decision Making 	<ul style="list-style-type: none"> • National Economic Policies • International Economic Relations • Multilateral Trading System • Market Access for Developing Countries • Equity in Income Distribution • Human Resource Development • Strengthening Employment • Poverty Eradication • Food Security • Economic Growth • Patterns of Consumption and Production • Minimizing Waste • Rules and Regulations for Industry • Population Growth • Capacity of Planet • City Planning • Transportation • Renewable Energy • Life Cycle Cost • Sustainable Construction Industry • Research and Development • Science and Technology
	SOCIAL	<ul style="list-style-type: none"> • Combating Poverty • Changing Consumption Patterns • Demographic Dynamics and Sustainability • Protecting and Promoting Human Health Conditions • Promoting Sustainable Human Settlement Development • Integrating Environment and Development in Decision Making

3.1.1 Analysis of National High School Physics Curriculum of Turkey

This research utilizes the National High School Physics Curriculum as the primary content for the content analysis. The curriculum was renewed in 2017 with approval from the Head Council of Education and Board of Education. It was first implemented in 2018, starting with 9th grade, and has been in use ever since. The curriculum consists of three parts: the first part provides general information about the curriculum, including its vision and mission; the second part focuses on the implementation of the curriculum, and the final part comprises objectives and their explanations for 9th, 10th, 11th, and 12th grades.

In the content analysis, the objectives of all units within the curriculum are coded according to the dimensions of sustainable development. Objectives related to these dimensions and education for sustainable development are marked, thus creating the initial draft of the curriculum data. To finalize the related objectives, online meetings were conducted with the study advisor and two different experts. After reaching an agreement with the advisor and experts, the final version of the education for sustainable development objectives was determined for research question 1.

3.1.2 Analysis of Physics Textbooks

In this research, physics course textbooks of 9th, 10th, 11th, and 12th grade of high school which are approved by the Board of Ministry of National Education are used for content analysis.

3.1.2.1 9th Grade Physics Textbook

It is written by Canan Sever, Demet Türeci, Nadire Artar and Orhan Dağ and published by Özgün Publication in 2022. It has been approved in June 2019 as a physics course book.

3.1.2.2 10th Grade Physics Textbook

It is written by Adnan Kaderođlu, Necdet Kaya, Veysel Emrah Karaaslan and Yusuf Serhat Koç and published by Ada Publication in 2022. It has been approved in April 2019 as a physics course book.

3.1.2.3 11th Grade Physics Textbook

It is written by Aslı Gülsüm Döyen, Aynur Çetinol, Ertan Erbek, Mehmet Turan, Nermin Esra Alagöz and Ufuk Özübek and published by Ada Publication in 2022. It has been approved in April 2019 as a physics course book.

3.1.2.4 12th Grade Physics Textbook

It is published by Adnan Kaderođlu, Necdet Kaya, Veysel Emrah Karaaslan and Yusuf Serhat Koç and published by Özgün Publication in 2022. It has been approved in May 2018 as a physics course book.

3.2 Trustworthiness

In this study, qualitative research in the form of content analysis is conducted. Due to the nature of the study design, there are variations in validity and reliability issues and methods compared to quantitative research (Fraenkel et al., 2011). In terms of trustworthiness, Lincoln and Guba (1986) examined credibility, transferability, dependability, and confirmability. Credibility pertains to internal validity, transferability relates to external validity, dependability addresses reliability, and confirmability focuses on objectivity. Throughout the research process, from data collection to data analysis, the trustworthiness factor was given careful consideration, and it will be further explained in the following sections.

3.2.1 Credibility

There are various methods to ensure that the study's conclusions align with the actual circumstances. According to Lincoln and Guba (1986), both the research

methodology and the credibility of the findings should be considered adequate to enhance the credibility of a study. To strengthen the credibility of qualitative research, several strategies are suggested, including prolonged engagement, persistent observation, negative case analysis, triangulation, peer debriefing, and member checks. Triangulation, as described by Lincoln and Guba (1986) and Onwuegbuzie and Leech (2007), involves cross-checking data using multiple sources, research techniques, and investigators.

In this study, data triangulation and investigator triangulation were employed to enhance credibility. The research aimed to examine how the objectives of the physics curriculum addressed the inclusion of Education for Sustainable Development (ESD). To ensure the chosen objectives accurately reflected ESD, the physics course textbooks were also included as data sources. This process involved analyzing the outcomes using both the curriculum and textbooks, known as data triangulation.

Furthermore, investigator triangulation was utilized by seeking expert opinions from various fields of expertise throughout the investigation, further strengthening the credibility of the study.

One of the experts is a private school physics teacher with a master's degree in physics (Alternative Energy Systems, Solar Cells). She leads STEAM in European Union projects and gives lectures to secondary school students on sustainability at her school. The other is the head of the physics department of a large private school group in Turkey. Throughout the study, he prepared sustainability course outcomes as an example of course contents and curriculum studies on sustainability at his school.

3.2.2 Transferability

According to Lincoln and Guba (1986), providing an explanatory interpretation along with the findings allows individuals who wish to apply those findings to assess the degree of similarity or applicability. To enhance the transferability of the study,

detailed information and a comprehensive database were utilized (Geertz, 1973). The examination of the curriculum and textbook resulted in the creation of an extensive and in-depth list of objectives and textbook excerpts. Translations of these objectives and excerpts are presented in the findings section to enable readers to access the information derived from the research.

3.2.3 Dependability and Confirmability

Dependability refers to the consistency and stability of the research outcomes, while confirmability relates to the objectivity of those outcomes (Lincoln & Guba, 1986). Dependability ensures that there is coherence between the data collected and the resulting outcomes in relation to the research's objectives. Conversely, confirmability demonstrates that the outcomes are supported by the data rather than influenced by the researcher's bias.

To ensure dependability and confirmability, this study provided detailed explanations of the data gathering, analysis, and results. The analysis procedure was reviewed by the advisor to validate the consistency of the data and outcomes in this investigation. Additionally, investigator triangulation was employed in this study, obtaining the professional viewpoints of two scholars. One of them is a PhD candidate in the Department of Science Education (Physics) at Middle East Technical University (METU). During her studies, she completed her master's study and has worked as a research assistant. The other researcher is from University of Nevada Las Vegas (UNLV). The researcher took Education for Sustainable Development courses during the research, and he has worked as a research assistant at UNLV in Science Education. This approach further strengthened the dependability and confirmability of the study by considering multiple perspectives and reducing potential bias.

3.3 Limitations of The Study

One limitation of this study is that it focuses solely on the National High School Physics Curriculum of Turkey and physics textbooks approved by the Ministry of

National Education. While these sources provide valuable insights into the inclusion of education for sustainable development (SD), the study does not encompass other potential sources of educational materials or perspectives. Therefore, the findings may not fully capture the breadth of education for sustainable development practices in other educational contexts or alternative physics curricula that may exist within the country.

This study explores the educational integration for sustainable development of the National High School Physics Curriculum, which has only been in effect since 2018. However, examining the 2018 curriculum alone may not be enough to gain information about the potential development and revision of the integration of sustainable development into the curriculum from past to present.

In Turkey, high school science education is given as separate courses with the titles of Physics, Chemistry and Biology. Therefore, all science courses should be considered in the full evaluation of the integration of sustainable development into education. Since this study only examines the physics course curriculum, definite results may not be revealed under the concept of science.

CHAPTER 4

FINDINGS

In this chapter of the study, data gathered from the National Highschool Physics Curriculum approved by MoNE and from the physics course textbooks approved by Board of Education of MoNE are presented based on dimensions of sustainable development and integration of education for sustainable development by conducting content analysis. The objectives of curriculum which are related to the dimensions of sustainable development are separated to levels as 9th grades, 10th grades, 11th grades and 12th grades. All numerical values, names of objectives marked from each level are presented with different tables. Furthermore, each objective related to the dimensions of sustainable development are investigated specifically to reveal how they are connected with goals of education for sustainable development with the related content from physics course textbooks.

The National High School Physics Curriculum has been prepared in a structure that will serve to raise individuals who can produce knowledge, solve problems, think critically and who have qualifications that contribute to society and culture. In addition, to understand the key role of physics to get information about universe, to produce scientific knowledge and to share it, to be aware of how physics contributes to economy, social life, and technology and to make inferences about socio-scientific events related to the use of different energy sources are main goals of National High School Physics Curriculum of Turkey. (MoNE Commission, 2018)

To reach these goals, there are 213 objectives as total from 9th to 12th grades in The National High School Physics Curriculum of Turkey. 27 objectives from the curriculum are related to the dimensions of sustainable development. At least one of these objectives represents all three dimensions of sustainable development. Related objectives are shown according to the grade level in Table 5.

Table 5 Number of ESD related objectives of each grade

Grades in Curriculum	Number of Objectives	Number of ESD Related Objectives
9th Grade	44	7
10th Grade	39	6
11th Grade	62	1
12th Grade	68	10
TOTAL	213	24

According to Table 5, there are 213 objectives for physics course in the National Turkish High School Physics Curriculum. While the maximum number of objectives is at the 12th grade level, the least achievement is at the 10th grade level. While the objectives related to education for sustainable development were at the 12th grade with a maximum of 10 objectives, the least number of objectives was found at the 11th grade level. The number of related objectives from 9th grade to 12th grade are shown in Table 6 with respect to type of dimensions of SD.

Table 6 Number of ESD related objectives of each grade based on each dimension of SD

Grades in Curriculum	Number of objectives related with dimensions of SD		
	ENV.	ECO.	SOC.
9th Grade	3	5	6
10th Grade	3	1	5
11th Grade	1	1	1
12th Grade	6	7	5
TOTAL	13	14	17

According to Table 6, in the National High School Physics Curriculum of Turkey, there are 13 objectives which represent the environmental dimension of SD. Among these objectives, 3 of them are from 9th grade, 3 of them are from 10th grade, 1 of them is from 11th grade and 6 of them are from 12th grade level of the curriculum. Also, there are 14 objectives under the economic dimension of SD from the curriculum. 5 of them are from 9th grade, 1 of them is from 10th grade and 11th grade, and 7 of them are from 12th grade. Lastly, there are 17 objectives which have connections with the social dimension of SD. 6 of them are from 9th grade, 5 of them are from 10th grade, 1 of them is from 11th grade, and 5 of them are from 12th grade. In Table 7, units of ESD related objectives and objectives codes written in the curriculum are given.

Table 7 ESD related units and objectives with codes as written in the curriculum

Grades	Units	Number of Objectives	Number of ESD related Objectives	Codes of ESD related Objectives in Curriculum
9th GRADE	Introduction to Physical Science	4	-	-
	Properties of Matter	4	-	-
	Motion and Force	11	1	9.3.1.4
	Energy	8	3	9.4.4.1. 9.4.4.2. 9.4.5.1.
	Heat and Temperature	13	3	9.5.4.2. 9.5.4.3. 9.5.4.5
	Electrostatics	4	-	-
10th GRADE	Electricity and Magnetism	9	3	10.1.2.4. 10.1.4.1. 10.1.4.2.
	Pressure and Buoyancy Force	4	-	-
	Waves	12	2	10.3.4.1.

Table 7 (Cont'd): ESD related units and objectives with codes as written in the curriculum

				10.3.5.2.
	Optics	14	1	10.4.7.1.
11th GRADE	Motion and Force	33	1	11.1.1.3.
	Electricity and Magnetism	29	-	-
12th GRADE	Circular Motion	12	1	12.1.1.4.
	Simple Harmonic Motion	5	-	
	Wave Mechanic	8	-	
	Introduction to Atomic Physics and Radioactivity	11	2	12.4.3.3.
	Modern Physics	15	1	12.5.3.5.
	Application of Modern Physics in Technology	14	6	12.6.1.1. 12.6.2.3. 12.6.2.4. 12.6.2.5. 12.6.3.2. 12.6.4.3.

According to Table 7, out of 6 units there are only 3 units which have ESD related objectives in the 9th grade. These units are Motion and Force, Energy, and Heat & Temperature. Also, there are 4 units in 10th grade level but 3 of them have ESD related objectives. For the 11th grade, although there are 2 units, only 1 of them has an objective related to ESD. Finally, the 12th grade curriculum has 6 units and 4 of them have ESD related objectives.

As mentioned in Table 1, Table 2 and Table 3, there are chapters for each dimension and issues for each chapter as written in Agenda 21. In the following sections of this chapter, selected ESD related objectives from the curriculum and excerpts of them

from the physics course textbooks are given as examples in detail to explain how dimensions of SD are represented in both curriculum and textbooks clearly.

4.1 Environmental Dimension

According to Table 1 there are 13 chapters for the environmental dimension of SD. These chapters are, protection of atmosphere, integrated approach to the planning and management of land resources, combating deforestation, managing fragile ecosystems combating desertification and drought, managing fragile ecosystems sustainable mountain development, promoting sustainable agriculture and rural development, conservation of biological diversity, protection of the oceans, all kind of seas, including enclosed and semi-enclosed seas, and coastal areas and the protection, rational use, and development of their living resources, protection of the quality and supply of freshwater resources application of integrated approaches to the development, management and use of water resources, environmentally sound management of toxic chemicals, including prevention of illegal international traffic in toxic and dangerous products, environmentally sound management of hazardous wastes, environmentally sound management of solid wastes and sewage related issues, and safe and environmentally sound management of radioactive wastes.

Protection of Atmosphere

In this chapter of environmental dimension of SD, there are 6 issues according to Agenda 21. These are ozone layer depletion, greenhouse gases, climate change, transboundary atmosphere pollution, renewable energy sources, and alternative energy sources. There are 5 outcomes from the curriculum for this chapter. For each of the issues, one example from the curriculum and excerpts from physics textbook is given with explanation.

- *Ozone Layer Depletion:*

12.5.3.5. Gives examples of applications of photoelectric effect in daily life. The positive (such as ensuring hygiene in faucets) and negative effects of the photoelectric effect in daily life (such as the use of sunglasses) are emphasized.

“...As sunlight passes through the atmosphere, ozone is filtered through the strata. During this filtration, the ozone layer traps the harmful rays. However, ultraviolet rays reach the earth due to the thinning or perforation of the ozone layer...”

While explaining the subject about the objective given above in the physics textbook, the thinning and damage of the ozone layer is mentioned in the daily life example given for the photoelectric effect.

- *Greenhouse Gases and Climate Change:*

9.5.4.5. Develops a project for measures to be taken against global warming.

(b) Attention is drawn to the causes of global warming.

(c) About the necessity of being sensitive to the environment and the contribution that can be made individually discussion is provided.

“... It is accepted that 90% of the climate changes in the last century are caused by human activities. Global warming is the increase in the average temperature of the earth's surface due to the greenhouse effect. The greenhouse effect is the long-term exposure of the sun's rays in the atmosphere as a result of the accumulation of gases such as carbon dioxide, sulfur dioxide and carbon monoxide in the atmosphere due to excessive use of fossil fuels and deforestation. Global warming causes adverse effects such as warming of the oceans, melting of glaciers, rising sea levels, decreasing snow cover, increasing heavy rainfall events, increasing acidity in the oceans, and the extinction of living species. Worldwide studies are carried out against global warming and contracts are signed between countries. With the United Nations

Framework Convention on Climate Change, which was adopted in 1992 and entered into force in 1994, the basis of the global response to the problem of climate change was established. The main purpose of the protocol is to keep the greenhouse gas density in the atmosphere at a level that will not affect the climate. In addition, the protocol envisages encouraging practices and compelling sanctions to reduce emissions...”

Excerpt taken from the textbook gives information about climate change and greenhouse gases. It is mentioned that both climate change and greenhouse gases have negative effects on the Earth. Also, in the excerpt taken from the physics textbook, global action is mentioned to pay attention to the importance of environmental problems due to climate change and greenhouse gases.

- *Renewable Energy Sources:*

9.4.5.1. Evaluate advantages and disadvantages of renewable and nonrenewable energy sources.

(a) Cost, accessibility, ease of production, society, technology, and environmental impacts of energy resources are considered.

(b) The necessity of using energy resources economically is emphasized.

Table 8 Comparison of energy resources

	Renewable Energy Sources							Non-Renewable energy sources	
	Sun	Hydroelectric	Wind	Geothermal	Biomass	Hydrogen	Wave	Fossil Fuels	Nuclear Energy
Cost	Low	High	High	Low	High	High	High	Low	High
Accessibility	Depends on place, season, time interval	Depends on place	Depends on place	Depends on place	Easy	Easy	Depends on place	Easy	Difficult
Ease of Production	Easy	Easy	Easy	Easy	Easy	Difficult	Difficult	Depends on place	Difficult
Society	Low	High	Low	High	High	Low	Low	High	Low
Technology	High	Low	Low	Low	Low	High	High	High	High
Environmental	Eco-friendly	Eco-friendly	Eco-friendly	Eco-friendly	Eco-friendly	Eco-friendly	Eco-friendly	High	Low

In Table 8, which is taken from 9th grade physics textbook both renewable and non-renewable energy sources are compared. Also, it is mentioned that renewable energy sources play the leading role in sustainable energy.

- *Alternative Energy Sources:*

12.4.3.3. Explains nuclear fission and fusion phenomena.

(a) Research on systems working with nuclear energy is provided.

(b) The effects of nuclear reactors on science, technology, national economy, and the environment are emphasized.

(c) The destructive effects of atomic bomb are explained through historical facts and the world's nuclear disarmament importance for peace.

“...According to the report published by the International Atomic Energy Agency of Turkey, there are nuclear power reactors in 31 countries in the world. As long as the waste of nuclear reactors is kept safely, it is a clean type of energy. Nuclear power

plants are an environmentally friendly energy source since carbon dioxide emissions are low...”

In the textbook, to produce electricity in a different way as an alternative energy source is mentioned as nuclear power plant.

Integrated Approach to The Planning and Management of Land Resources:

In this chapter of environmental dimension, there are 2 issues. These are land resources and ecology. There are 2 objectives from the curriculum for this chapter. Related example from the curriculum and the physics textbook for the land resources issue is given.

- *Land Resources:*

12.4.3.3. Explains nuclear fission and fusion phenomena.

(a) Research on systems working with nuclear energy is provided.

(b) The effects of nuclear reactors on science, technology, national economy, and the environment are emphasized.

(c) The destructive effects of atomic bomb are explained through historical facts and the world’s nuclear disarmament importance for peace.

“... Nuclear energy will ensure the protection of natural land resources for a long time...”

While talking about the advantages of nuclear energy in the textbook, it is mentioned that natural resources will be protected for a long time. This is an indication of the necessity of protecting natural resources and the fact that the protection of natural resources creates a positive situation.

Combating Deforestation

In this chapter of environmental dimension of SD, there are 3 issues which are deforestation, forest rehabilitation and afforestation. There are 2 objectives for this chapter from the curriculum. One objective related to deforestation issue are given with excerpt from the textbook as an example.

- *Deforestation:*

10.4.7.1. Explain the characteristics of lenses and type of lenses.

(b) Glass bottles and shards act as lenses, causing forest fires is explained. The importance of environmental cleanliness and protection of natural life is emphasized.

“... A significant portion of the fires in the world and in Turkey during the summer months are caused by the igniting of the dry grass as a result of the glass bottles and shards thrown into the forests acting as lenses and collecting the rays from the sun...”

While explaining the lenses it is mentioned that deforestation is because of fires.

Managing Fragile Ecosystems: Sustainable Mountain Development

In this chapter of environmental dimension of SD, there are 4 issues which are soil erosion, loss of habitat, genetic diversity, and mountain ecosystems. There are 2 related objectives with this chapter. One of them from the curriculum and excerpt from the physics textbook for the loss of habitat issue is given with the represented issue as an example.

- *Loss of Habitat:*

9.5.4.5. Develops a project for measures to be taken against global warming.

(b) Attention is drawn to the causes of global warming.

(c) About the necessity of being sensitive to the environment and the contributions that can be made individually discussion is provided.

“... Global warming causes adverse effects such as warming of the oceans, melting of glaciers, rising sea levels, decreasing snow cover, increasing heavy rainfall events, increasing acidity in the oceans, and the extinction of living species...”

In the textbook, while mentioning global warming, loss of habitat as extinction of living species is also considered.

Conservation of Biological Diversity

In this chapter of environmental dimension of SD, there are 2 issues which are biodiversity and protection of ecosystems. Also 2 objectives are related to this chapter from the curriculum. One example is given for each issue of this chapter.

- *Biodiversity and Protection of Ecosystems:*

10.1.4.2. Explains the results of the Earth's magnetic field.

(b) It is stated that living things such as bees, migratory birds, and some cattle are affected by the Earth's magnetic field to find their way.

“... Earth's magnetic field significantly affects life. The magnetic field, besides acting as a shield against radiation, which poses a life threat to living things, also provides convenience for people and some living things to find their way. Earth's magnetic field also helps bees, migratory birds, and some cattle to navigate. These living species make use of the Earth's magnetic field while finding their way. Some living things have sensors in their bodies that detect magnetic fields. Living things find their way through these receptors. Scientific studies on which living things perceive the earth's magnetic field have not been completed yet. However, it is thought that many living things can find their way by making use of the Earth's magnetic field. It has

been proven that robin, rhino, bird, caretta caretta, monarch butterfly, stork, snow goose, spiny lobster, pigeon, bee, and salamanders find their way in this way...”

While explaining the results of Earth’s magnetic field, it is also considered some species in the nature and protection of living things due to the magnetic field.

Protection of The Quality and Supply of Freshwater Resources: Application of Integrated Approaches to The Development, Management, and Use of Water Resources:

In this chapter of the environmental dimension of SD, there are 5 issues which are hydrological cycle, climate change, atmospheric pollution, freshwater scarcity, and flood prevention. There is only one related objective to this chapter and it is given for freshwater scarcity issue from the curriculum and the excerpt from the textbook.

- *Freshwater Scarcity:*

12.5.3.5. Gives examples of applications of photoelectric effect in daily life. (The positive (such as ensuring hygiene in faucets) and negative effects of the photoelectric effect in daily life (such as the use of sunglasses) are emphasized.)

“... Thanks to the photocell faucets, personal hygiene is ensured by running water in the washbasins in the public areas without touching the taps. In a world where water and energy resources are rapidly depleted, the importance of being economical emerges once again. Thanks to photocells, savings can be achieved by controlling the electric current or the water in the tap...”

In the textbook, it is mentioned the importance of saving water while giving examples to use of photocells in daily life.

Environmentally Sound Management of Solid Wastes and Sewage-Related Issues:

In this chapter of environmental dimension of SD, there are 6 issues which are solid wastes, life cycle management, waste reuse and recycling, waste disposal and treatment, and sewage disposal. There is one objective from the curriculum and it is given as an example to the waste reuse and recycling issue.

- *Waste Reuse and Recycling:*

11.1.10.3. Design a secure system of simple machines to make life easier.

(a) Students should be encouraged to benefit from waste materials and information technologies.

(b) For measures to increase occupational health and safety in areas where simple machine systems are used, research is provided.

(c) Emphasizing that the original designs can be patented, the students participating in the project competitions should be encouraged to participate.

“... Take care to choose your tools from waste materials as much as possible...”

In the textbook, it is asked to design a project for the objective. In the direction of the project, it is mentioned that student should use recycled and waste materials...”

Safe and Environmentally Sound Management of Radioactive Wastes:

In the last chapter of the environmental dimension of SD there is only 1 issue which is radioactive waste. There are 2 objectives related to this chapter from the curriculum. One related objective and excerpt from the textbook is given under this issue as an example.

- *Radioactive Waste:*

12.4.3.3. Explains nuclear fission and fusion phenomena.

(a) Research on systems working with nuclear energy is provided.

(b) The effects of nuclear reactors on science, technology, national economy, and the environment are emphasized.

(c) The destructive effects of atomic bomb are explained through historical facts and the world's nuclear disarmament importance for peace.

“... Working reactors are responsible for electricity production in the world. It provides 10-15%. As long as the waste of nuclear reactors is kept safely, it is a clean type of energy...”

While considering nuclear power as a clean energy, it is mentioned that the only way is to keep away the radioactive waste.

4.2 Economic Dimension

According to Table 2, there are 6 chapters under the economic dimension of SD. These chapters are international cooperation to accelerate sustainable development in developing countries and related domestic policies, combating poverty, changing consumption patterns, demographic dynamics, and sustainability, promoting sustainable human settlement development, integrating environment and development in decision-making.

International Cooperation to Accelerate SD in Developing Countries and Related Domestic Policies:

In this chapter of economic dimension of SD there are 4 issues. These issues are national economic policies, international economic relations, multilateral trading system, market access for developing countries. There are 3 objectives related to this

chapter. One objective for each issues are given as an example with the excerpts from physics course textbooks.

- *National Economic Policies & International Economic Policies:*

12.4.3.3. Explains nuclear fission and fusion phenomena.

(a) Research on systems working with nuclear energy is provided.

(b) The effects of nuclear reactors on science, technology, national economy, and the environment are emphasized.

(c) The destructive effects of atomic bomb are explained through historical facts and the world's nuclear disarmament importance for peace.

“... The benefits of nuclear energy to the country's economy is that it will reduce external energy dependence, and it will provide price stability in energy...”

While the textbook is mentioning about the advantages of nuclear power energy, Turkey's dependence to the other countries for energy and price stability of energy is considered. These issues are related with economical condition in national and international areas of a country.

Changing Consumption Patterns:

In this chapter of economic dimension of SD, there are 4 issues which are economic growth, patterns of consumption and production, minimizing waste, and rules and regulations for industry. There are only 1 outcome for this chapter from the curriculum. This objective and textbook excerpt which represent the rules and regulations for industry issues is given as an example.

- *Rules and Regulations for Industry:*

11.1.10.3. Design a secure system of simple machines to make life easier.

(a) Students should be encouraged to benefit from waste materials and information technologies.

(b) For measures to increase occupational health and safety in areas where simple machine systems are used, research is provided.

(c) Emphasizing that the original designs can be patented, the students participating in the project competitions should be encouraged to participate.

“... Conduct research on measures to increase occupational health and safety in areas where simple machines are used...”

In the textbook, it is asked from students to conduct a design in a areas where simple machines are used. While asking this research from student, occupational health and safety is mentioned which is a demonstration of rules and regulation conditions of industries.

Promoting Sustainable Human Settlement Development:

In this chapter of economic dimension of SD, there are 6 issues which are city planning, transportation, renewable energy, life cycle cost and sustainable construction industry. There are 5 objectives from the curriculum under this chapter. One example for each issue of the chapter is given textbook excerpts for the chapter.

- *Transportation:*

12.6.3.2 Give examples of uses of superconductors in technology. (The working principles of high-speed trains and particle accelerators are emphasized.)

“... The formation of a magnetic repulsion force as a result of the superconductors expelling the magnetic field forms the basis of high-speed trains. Maglev trains are elevated on a special track by supercooled superconducting magnets located at both ends of the train. When the train moves, the electric current supplied to the conductors in the track creates a thrust and the train accelerates. When the train exceeds 100 km/h, its wheels fold in and begin to take off...”

Maglev trains are a kind of public transportation. To give an information for a transportation type is also supporting it with a different way to give students sensibility.

- *Sustainable Construction Industry:*

10.3.5.2. Develops solutions to prevent loss of life and property caused by earthquakes.

“... A large part of Turkey is in the earthquake zone. For this reason, great earthquakes have occurred in different parts of our country throughout history. The time of the earthquake cannot be known in advance, but measures can be taken to protect from its damage. Earthquake-resistant buildings should be built by engineers, and it should be checked whether the existing buildings are durable. An earthquake plan should be created and safe places at the time of the earthquake and ways to exit the building after the earthquake should be determined in this plan...”

In the course book, the precautions to be taken regarding the material and moral losses due to the earthquake are included, but especially the things to be considered about the construction of the building are mentioned.

Integrating Environment and Development in Decision Making:

In this chapter of economic dimension of SD, there are 2 issues which are research and development and science and technology. There are 7 objectives related to this

chapter in the curriculum. One example of this objectives are given with physics textbook excerpt.

- *Research & Development:*

12.6.4.3. Gives examples of usage areas of nanomaterials in technology. (The impact of nanomaterials on the development of science and technology is emphasized.)

“... Nanotechnology is constantly evolving with the diversity of materials produced, the ability to develop new materials by developing them, and the contributions of nanoscience. By using the physical properties of the material at nanometer scales, technological revolutionary products have been obtained in informatics, communication, electronics, biotechnology, pharmacology, medicine, defense, textile, machinery, and construction industries. Self-cleaning wall paints, dirt-repellent carpets and fabrics, wrinkle-free clothes have entered daily life thanks to nanotechnology. Automobile windows that do not need wipers because they repel water, self-cleaning building exteriors, ship exterior paints that do not adhere to algae and sea animals, and frictionless exterior surfaces will be produced in the near future...”

In the course book, the development of technology and its contribution to humanity as a result of this development and what it will add in the future are evaluated.

- *Science & Technology:*

12.6.2.3. Give examples of places where LED technology is used.

“...With the developing technology, the need of human beings for energy is increasing day by day. The limited natural resources, the threat of the produced energy against the natural balance, the thought of leaving a livable world to future generations, necessitated the elimination of possible problems from today. Lighting, which has an important share in electrical energy consumption, is a point that should

be emphasized in terms of energy production. LEDs are preferred because they have a longer life, are more robust, smaller size, and lower cost than other lighting systems...”

In the course book, an indication of what science offers in daily life with the development of technology is given.

4.3 Social Dimension

According to Table 3, there are 6 chapters for the social dimensions of SD. These are combating poverty, changing consumption patterns, demographic dynamics, and sustainability, protecting and promoting human health conditions, promoting sustainable human settlement development and integrating environment and development in decision-making.

Changing Consumption Patterns:

In this chapter of social dimension of SD, there are 4 issues. There are 6 objectives from the curriculum examined under this chapter. One example for each issue is given with physics textbook excerpt.

- *Sustainable Consumption Patterns:*

12.6.2.3. Give examples of places where LED technology is used.

“...With the developing technology, the need of human beings for energy is increasing day by day. The limited natural resources, the threat of the produced energy against the natural balance, the thought of leaving a livable world to future generations, necessitated the elimination of possible problems from today. Lighting, which has an important share in electrical energy consumption, is a point that should be emphasized in terms of energy production. LEDs are preferred because they have a longer life, are more robust, smaller size, and lower cost than other lighting systems...”

In the text it is mentioned that LED technology gives sustainable solution for using of electrical energy with some useful advantages. It is supported to use LED in everyday use in this way.

- *Promotion of Energy Efficiency:*

9.4.4.1. Explain the efficiency. (The relationship between energy saving and energy efficiency is explained through energy identity documents.)

“... The ratio of the work done in a system to the energy consumed in that system is called efficiency. For example, incandescent bulbs work with about 10% efficiency. Lighting is provided with only 10% of the energy consumed on the bulb. The rest of the energy turns into non-targeted energy such as heat. Therefore, the efficiency of incandescent lamps is quite low. In order to increase efficiency, energy loss must be minimized...”

In the text energy efficiency is mentioned via incandescent lamps. Also, the need to provide energy efficiency is also mentioned to give the message to students in the textbook.”

- *Minimizing Waste:*

10.4.7.1. Explain the characteristics of lenses and type of lenses.

(b) Glass bottles and shards act as lenses, causing forest fires is explained. The importance of environmental cleanliness and protection of natural life is emphasized.

“...Many objects seen in the environment can act as lenses. For example, many objects such as water droplets on the objects, the bottom and side parts of bottles and glass glasses, glass or plastic bottles containing liquid act as lenses. Waste thrown into the environment causes environmental pollution and deterioration of the balance in nature. For this reason, keeping the environment clean and protecting it is important for the protection of natural life...”

In the textbook, some of the waste generated in the environment are given as examples. It has been mentioned that these wastes pollute the environment. Therefore, the message of reducing the generation of environmentally harmful wastes is given.

- *Awareness & Responsibility:*

10.1.2.4. Explains the health and safety precautions to be taken against the dangers that electric current may create.

“... Electricity is an indispensable part of life, but it can be dangerous, if necessary precautions are not taken. One of these measures is the warning sign. The warning sign states that high voltage lines should be avoided. Some precautions to be taken to prevent electrical accidents are electrical warning signs must be followed, safety caps must be fitted to the sockets, more than one plug should not be inserted into a socket, electrical devices should not be used on wet floors, Earth sockets should be used in homes, care should be taken that the cables are not crushed, metal and similar substances should not be inserted into the sockets, sockets that have come out of their sockets and have exposed wires should be repaired, no electrical work should be done before the fuse is turned off, the instructions for use of electrical appliances must be followed, unused electrical appliances should not be left plugged in.”

In the course book, the methods to be taken against the electric current are specified, and responsibility and awareness are instilled in daily life in this regard.

Protecting and Promoting Human Health Conditions:

In this chapter of social dimension of SD, there are 3 issues which are human health, quality of life, protecting vulnerable groups. There are 5 objectives related to this chapter. One objective is given for each issue with excerpt from the textbook as an example.

- *Human Health and Quality of Life:*

10.3.4.1. Explains the basic notions of sound waves with examples.

(b) The concepts of hum, noise and sound pollution are mentioned.

“...Noise is the sound pollution caused by the intense sound of many unwanted sounds that can cause environmental and health problems...”

In the textbook, noise pollution was given as an example, and human health so that quality of life was emphasized.

- *Protecting Vulnerable Groups:*

10.3.5.2. Develops solutions to prevent loss of life and property caused by earthquakes.

“...After the earthquake, the earthquake victims should be helped by participating in search and rescue efforts...”

In the course book, the protection of vulnerable groups was supported by giving examples of reaching the earthquake victims, search and rescue, and aid, especially in the earthquake.

Promoting Sustainable Human Settlement Development:

In this chapter of the social dimension of SD, there are 5 issues listed. They are shelter for all, urbanization, living and working environments, sustainable transportation, and raising awareness. There are 4 objectives from the curriculum under this chapter. One objective from these is given as an example with textbook excerpt from each issue.

- *Living and Working Environments:*

11.1.10.3. Design a secure system of simple machines to make life easier.

(a) Students should be encouraged to benefit from waste materials and information technologies.

(b) For measures to increase occupational health and safety in areas where simple machine systems are used, research is provided.

(c) Emphasizing that the original designs can be patented, the students participating in the project competitions should be encouraged to participate.

“...Conduct research on measures to increase occupational health and safety in areas where simple machines are used. Determine and note down the safety precautions you need to take while designing...”

In the textbook, attention to safety precautions is emphasized where simple machines are used. It sets an example that supports the creation of suitable environments in living and working spaces.

- *Sustainable Transportation:*

9.3.1.4. Explain the average velocity. (The working principle of the green wave system in traffic is emphasized.)

“...Traffic congestion is becoming a bigger problem in cities that are getting more crowded and the number of vehicles is increasing day by day. Different measures are being taken to eliminate this problem. One of the solutions developed for the flow of traffic in an orderly manner is the green wave application. In the green wave application, there are speed limit signs on the relevant road route. It is planned that the vehicles moving at the average speed of the value written on the plates will proceed without encountering the red light at the traffic lights. If you move with the average speed at the specified value, you can travel without hitting the red light...”

It is emphasized in the textbook that some sustainable measures can be taken by complying with the determined limits thanks to the green wave system in traffic.

These measures are some regulations that have emerged for society. In addition, the message of disadvantage of the car crowd in traffic is given.

- *Raising Awareness:*

10.3.5.2. Develops solutions to prevent loss of life and property caused by earthquakes.

“... A large part of Turkey is in the earthquake zone. For this reason, great earthquakes have occurred in different parts of our country throughout history. The time of the earthquake cannot be known in advance, but measures can be taken to protect from its damage. Earthquake-resistant buildings should be built by engineers, and it should be checked whether the existing buildings are durable. An earthquake plan should be created and safe places at the time of the earthquake and ways to exit the building after the earthquake should be determined in this plan. Items that can tip over in the event of a jolt should be stabilized and an earthquake bag containing the necessary supplies should be prepared. After the earthquake, the earthquake victims should be helped by participating in search and rescue efforts...”

Taking measures to reduce the loss of life and property in an earthquake and helping earthquake victims help raise the awareness of the society on this issue. This is the message given in the textbook.

Integrating Environment and Development in Decision Making:

In this chapter there are 5 issues listed. They are policy & planning & management, legal and regulatory framework, education, public awareness, legal and regulatory instruments. There are 2 objectives related to this chapter in the curriculum. Related objectives for the issues are given as examples with the excerpts from textbooks.

- *Policy & Planning & Management:*

12.4.3.3. Explains nuclear fission and fusion phenomena.

(a) Research on systems working with nuclear energy is provided.

(b) The effects of nuclear reactors on science, technology, national economy, and the environment are emphasized.

(c) The destructive effects of atomic bomb are explained through historical facts and the world's nuclear disarmament importance for peace.

“... According to the report published by the International Atomic Energy Agency of Turkey, there are nuclear power reactors in 31 countries in the world. Working reactors are responsible for electricity production in the world. It provides 10-15%. As long as the waste of nuclear reactors is kept safely, it is a clean type of energy. The benefits of nuclear energy to the country's economy and the environment are given below.

1. It will reduce external energy dependence.

2. It will ensure the protection of natural resources for a long time.

3. The country will have nuclear technology. This technology will make significant contributions to countries in fields such as medicine, informatics, and defense industry.

4. It will provide price stability in energy...”

In the textbook, while the use of nuclear energy and its contribution to the country's economy are mentioned, it is emphasized that the power plants established for the use of nuclear energy should be built with a certain policy, plan and management arrangement.

- *Legal and Regulatory Framework:*

12.1.1.4. Calculates the related safe turning conditions of vehicles on horizontal, vertical, and sloping floors. (The importance of obeying the speed limit for safe cornering is emphasized.)

“...Traffic warning signs on highways inform drivers about the characteristics of the road and it gives information about the speed limits to be followed. The left dangerous bend sign indicates that a left-turning part of the road is approaching, while the right dangerous bend direction sign informs that a right bend with a short visibility and narrow radius is approaching. When the bend is horizontal or sloping, it is possible to take the bend safely. Required speed limits must be observed. If the speed of the vehicle is not reduced to the safe speed limit, control is lost. In this case, both the driver and the safety of pedestrians in traffic is endangered...”

In the textbook, it is underlined that everyone in society must comply with the limits set. An example of the regulations determined for society is given with the speed limit from the relevant unit.

- *Public Awareness:*

9.5.4.5. Develops a project for measures to be taken against global warming.

(b) Attention is drawn to the causes of global warming.

(c) About the necessity of being sensitive to the environment and the contributions that can be made individually discussion is provided.

“... It is accepted that 90% of the climate changes in the last century are caused by human activities. Global warming is the increase in the average temperature of the earth's surface due to the greenhouse effect. The greenhouse effect is the long-term exposure of the sun's rays in the atmosphere as a result of the accumulation of gases such as carbon dioxide, sulfur dioxide and carbon monoxide in the atmosphere due

to excessive use of fossil fuels and deforestation. Global warming causes adverse effects such as warming of the oceans, melting of glaciers, rising sea levels, decreasing snow cover, increasing heavy rainfall events, increasing acidity in the oceans, and the extinction of living species. Worldwide studies are carried out against global warming and contracts are signed between countries. With the United Nations Framework Convention on Climate Change, which was adopted in 1992 and entered into force in 1994, the basis of the global response to the problem of climate change was established. The main purpose of the protocol is to keep the greenhouse gas density in the atmosphere at a level that will not affect the climate. In addition, the protocol envisages encouraging practices and compelling sanctions to reduce emissions...”

The causes and consequences of global warming are mentioned in the textbook. In addition, examples of measures taken at the global level are given. Students' knowing the cause and result of a problem that concerns the whole world provides a social awareness about this problem.

CHAPTER 5

DISCUSSION, IMPLICATION AND RECOMMENDATION FOR FURTHER STUDIES, AND CONCLUSION

There are three sections in this chapter. The first section comprises discussions concerning the results of the study, the second chapter includes the recommendations for further studies, and the last section encapsulates the conclusion.

5.1 Discussion

In this section, the discussions about the results of the content analysis for the objectives and explanations within the Turkish National High School Physics Curriculum (2018-present) were presented in two stages. In the first stage, based on the first research question of the study, it was evaluated to what extent the achievements of the national high school physics curriculum included the dimensions of sustainable development. For this purpose, the distribution of achievements related to education for sustainable development across all levels of the curriculum was delineated. In addition, the extent to which each of the dimensions of sustainable development is reflected by the curriculum achievements was discussed. Finally, comparative evaluations are provided drawing from the previous studies in the field of science education in Turkey, as expounded in the literature review chapter of the study.

In the second stage, the second research question of the study was elaborated by focusing on how compatible the high school physics textbooks were with the educational principles and concepts for sustainable development.

According to the Table 5 given in the findings section of the research, there are four levels in the Turkish National High School Physics Curriculum as 9th, 10th, 11th, and 12th grades. There are 213 objectives in total for these four levels. According to the findings of the research, 24 of the 213 objectives were associated with education for

sustainable development. It is almost equal to 11% of total objectives. Also, distribution of ESD related objectives for each level are given in figure 1 for a comparison.

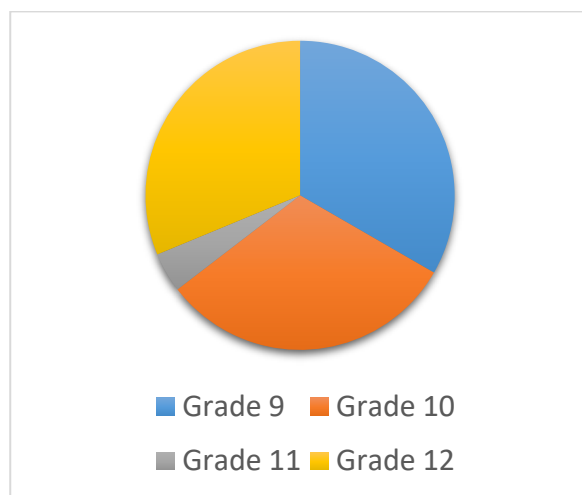


Figure 2 Distribution of ESD Related Objectives for Each Grade in National High School Physics Curriculum of Turkey (2018-present)

The year in which the curriculum started to be implemented was stated as 2018 on the curriculum booklet, according to the Board of Education (see Appendix A). Also, understanding the importance of physical science in understanding the universe and understanding the impact of physical science on social life, economy, and technology are among the main objectives of the high school physics curriculum (MoNE Commission, 2018). The fact that a curriculum that has the stated goals and was put into practice in the years when the importance of integrating sustainable development goals into school curricula was emphasized at a global level has an overall ESD-related attainment rate of 11%. When we look at the distribution of 24 ESD-related achievements according to each dimension, it is seen that there are 54% environmental, 58% economic and 70% social dimensions. A similar result emerged in the studies given as examples in the literature review section of the study. According to Barak et al. (2022), in a study comparing Turkish and German curricula, revealed that Turkish curricula were more dominant in terms of social dimension in the high school curricula examined (social sciences, geography, nature and

technology), while German curricula were dominant in environmental terms. As a result of the research, the least rate was found in the environmental dimension. Again, in a case study mentioned before, Erten et al (2022) Turkey, America and Canada curricula were compared in terms of environmental education integration, and it was concluded that Turkish curricula should be developed in terms of environmental dimension. Therefore, it is seen that the results are consistent with the previous studies.

In addition, when the distribution of objectives related to ESD for each level is examined, the highest rate is 16% at the 9th grade level, followed by the 10th and 12th grade levels with 15%. However, at the 11th grade level, this rate drops down to approximately 2%. While ESD-related objectives of 9th, 10th, and 12th grades are compatible with each other, the 11th grade level is not. For the 11th grade level, the availability of physics content, sustainable development dimensions and education for sustainable development content should be integrated into the level achievements of the relevant objectives. The balanced and equitable distribution of the dimensions of sustainable development in the curriculum is very important for the role of education programs in achieving educational goals for sustainable development (Lee et al., 2016). When Table 6 in the findings section is examined, it is seen that the number of objectives related to the environmental, economic, and social dimensions, which are the three dimensions of sustainable development, are very close to each other and have a balanced distribution within themselves. However, when the distribution of sustainable development dimensions for each level in the curriculum is examined, it is seen that there is not a balanced distribution at the 9th and 10th grade levels. This is because certain units at the corresponding grade levels have specific thematic topics for education for sustainable development. However, studies (McKeown & Hopkins, 2003) suggest holistic approaches for the integration of sustainable development into curricula with units covering specific thematic topics. When the studies in the field of science in Turkey are examined, it has been revealed in the study conducted on the secondary school science curriculum that the objectives

related to ESD are not evenly distributed at the secondary school levels, especially at least 6 of the 17 achievements are at the 8th grade (Tatliloğlu, 2019).

In addition, in a study conducted on the high school chemistry curriculum implemented before 2018, it was concluded that the 11th and 12th grade level objectives were insufficient in terms of educational goals for sustainable development. According to the results of this study, there are 4 ESD related objectives at 9th grade level and 10 ESD related objectives at 10th grade level but there are not any ESD related objectives for the 11th and 12th grade level. Compared to the chemistry curriculum implemented between 2013-2018, physics course curriculum implemented since 2018 is more integrated with ESD.

Among the educational goals for sustainable development, there is the aim of raising individuals with awareness for the future of society. As mentioned before, the importance of education and training is very great in raising these individuals. Raising individuals with this awareness in education and training will be possible by integrating education programs with education for sustainable development. Therefore, education programs should be consistent with ESD targets at all levels and integrate sustainable development dimensions into objectives with a balanced distribution. This unbalanced distribution, which emerged in previous studies, is unfortunately also seen in the national high school physics course curriculum, which has been implemented since 2018.

Physics textbook content analysis based on ESD-related goals and the three dimensions of sustainable development provides important information about the economic and social dimensions of sustainable development, as well as the environmental issues expected at the beginning of the study. According to the findings, the physics textbooks published by the Board of Education have rich content, including daily life examples, compatible with the achievements related to ESD at all levels. In the textbooks, texts, visuals, projects, and daily life examples related to almost all of the units specified for each dimension of sustainable development are presented. While the most prominent contents related to the

environmental and economic dimension are in the 12th grade, the social dimension contents are mostly seen in the 9th and 10th grade levels. Examples of daily life, texts, images, and projects given in the content of the books are compatible with the current and global sustainable development issues of the 21st century. It has the quality to search for solutions to current sustainable development problems. However, since the curriculum does not have a holistic approach to education for sustainable development, unfortunately, the units that do not contain ESD targets do not have a counterpart in this field in the textbooks.

5.2 Implication and Recommendation for Further Study

While many achievements in the curriculum could be easily integrated with education for sustainable development, unfortunately they could not be included in any dimension due to incomplete and inadequate explanations in the curriculum and textbook. For example, in the objective of the green wave traffic system, which is among the 9th grade learning objectives, the statement that explains the green wave system is insufficient. If there is an additional statement that focuses on the environmental, economic, and social advantages of the green wave system in the outcome, it will set an example of sustainability with an appropriate content in these textbooks. Due to incomplete and inadequate statements, some objectives could not be coded as ESD objectives and this shows that the Turkish National High School Physics Curriculum is less compatible in terms of educational integration for sustainable development. For this reason, additional expressions and rearrangements should be considered by curriculum authors and content developers for many infrastructure objectives. This study only makes a content analysis the physics course curriculum that has been implemented since 2018. Since the history of sustainable development given in the literature review section is examined, analyzing the curricula applied from the past to the present will reveal how much progress and change has been made in the field of education for sustainable development and the deficiencies, if any, from the past to the present, and will provide important data for

curriculum developers. At the high school level, there are Physics, Chemistry, and Biology courses under the title of Science. In order to make inferences under the title of Science in the field of education for sustainable development and to take remedial and developing steps for the future, it will be more holistic to reach a conclusion by analyzing the Chemistry and Biology course curricula. As a result of the research, it is seen that the dimensions of sustainable development and the content related to education for sustainable development do not have the same distribution at all levels, and they never appear in certain units. Curriculum developers should consider these shortcomings and address the existing shortcomings as a whole with the subject content and ESD objectives of the relevant levels. As mentioned in the limitations of the study, this study only examines the content of the physics course books. However, there are many resources in the field of education and training, which are written according to physics objectives and used as subject books. Content analysis in these books will be beneficial for the authors who prepare the contents of the textbooks for improvement and development in the field of education for sustainable development. Among the educational objectives for sustainable development, only curriculum and textbook content analyses are not sufficient for raising responsible individuals with high awareness of sustainable development. While curriculum and textbook content play a crucial role in shaping students' knowledge and understanding, the practical application of sustainability principles in the learning environment is equally important.

5.3 Conclusion

In this study, National High School Physics Curriculum of Turkey and physics course textbooks approved by MoNE were analyzed. The aim of this qualitative study is to reveal the status of inclusion of curriculum achievements reflecting ESD in the National High School Physics Curriculum, which has been implemented since 2018. To achieve this aim, data was gathered from both the National High School Physics Curriculum of Turkey and physics course textbooks sanctioned by the Board of

Education of MoNE. The study employed the conceptual framework of sustainable development encompassing its environmental, economic, and social dimensions. The analysis revealed that the number of objectives linked to Education for Sustainable Development (ESD) fell short by 11% of the anticipated count. Furthermore, instances were identified within the curriculum where units lacked alignment with any of these dimensions. According to findings 13 objectives are related to environmental dimension, 14 objectives are related to economic dimension, and 17 objectives are related to social dimension out of a total 24 EDS related objectives in the curriculum.

In a contrasting observation, the alignment between the physics course textbook approved by the Board of Education of MoNE and the ESD-related objectives of the curriculum was found to be fitting and suitable. This investigation has effectively demonstrated the interrelation between the National High School Physics Curriculum, physics textbooks, and the principles of sustainable development. Moreover, it has illuminated the integration of these components within the realm of education for sustainable development.

REFERENCES

- Intergovernmental Conference on Environmental Education. (1977). Tbilisi Declaration. Retrieved from <https://www.gdrc.org/uem/ee/tbilisi.html>
- Balsiger, J., Mader, C., Förster, R., & Sironi, H. (2017). Transformative Learning and Education for Sustainable Development. *Ecological Perspectives for Science and Society*, 26(4), s. 356-359. doi:10.14512/gaia.26.4.15
- Barak, B., & Avci, G. (2022). Comparative Analysis of Turkey and Germany (Bavaria) Secondary Education Curricula in Terms of Education for Sustainable Development. *Discourse and Communication for Sustainable Education*, 13(2), s. 108-132. doi:DOI: 10.2478/dcse-2022-0022
- Bilgili, M. Y. (2017). Economic, Ecological and Social Dimensions of Sustainable Development. *The Journal of International Social Research*, 10(49), s. 559-569. Retrieved from <https://www.researchgate.net/publication/344906597>
- Borreguero, G. M., Jimenez, J. M., Nunez, M. M., & Correa, F. L. (2019). Knowledge Analysis of The Prospective Secondary School Teacher on a Key Concept in Sustainability: Waste. *Sustainability*, 11(4:1173). doi:10.3390/su11041173
- Bozdoğan, R. (2005). Historical Back Plan of Sustainable Development Concept. *Journal of Social Politics Conferences*(50), s. 1011-1028. Retrieved from <http://ist-univ.dergipark.gov.tr/iusskd/issue/891/9943>
- Campbell, S. (2007). Green Cities, Growing Cities, Just Cities?: Urban Planning and the Contradictions of Sustainable Development. *Journal of the American Planning Association*, 62(3), s. 296-312. doi:10.1080/01944369608975696
- Carson, R. (1962). *Silent Spring*. London: Fawcett Publications.
- Creswell, J. W. (2007). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Thousand Oaks: Sage Publications.
- Çamurcu, H. (2005). The Increase of the world population and the problems it causes. *Journal of Balıkesir University Social Sciences*, 8(13), s. 87-105. Retrieved from <https://dergipark.org.tr/tr/pub/baunsobed/issue/50339/651864>
- DESD. (2005). *UN Decade of Education for Sustainable Development*. Paris: UNESCO. Retrieved from www.unesco.org/education/desd
- Dietz, T., Fitzgerald, A., & Shwom, R. (2005). Environmental values. Annual Review of Environmental Resources. *Psychology*, 30, s. 335-372. Retrieved from <http://dx.doi.org/10.1146/annurev.energy.30.050504.144444>

- Döyen, A. G., Çetinoğlu, A., Erbek, E., Turan, M., Alagöz, N. E., & Özübek, U. (2022). *Secondary School 11th Grade Physics Course Textbook [Ortaöğretim Fizik 11. Sınıf Ders Kitabı]*. Ankara: Ada Publications.
- Eckerman, I. (2005). *The Bhopal saga: cause and consequences of the world's largest industrial disaster*. New Delhi: Universities Press.
- Elkhalek, A. M. (2021). Education for Sustainable Development: A Critical Analyses. *International Journal of Economics and Finance*, 13(6), s. 181-188. doi:10.5539/ijef.v13n6p181
- Erten, S., Köseoğlu, P., & Gök, B. (2022). Environmental Education in Science Teaching Programs: The Case of Turkey, Canada, America. *Journal of Mehmet Akif Ersoy University Education Faculty*(63), s. 220-246. doi:10.21764/maeuefd.1019038
- ESCAP. (2015). Integrating the three dimensions of sustainable development: A framework and tools. . United Nations.
- Feriver, Ş., Olgan, R., & Teksöz, G. (2019, January). Achieving Education for Sustainable Development (ESD) in Early Childhood Education Through Critical Reflection in Transformative Learning. *Learning, Design and Technology*. doi:10.1007/978-3-319-17727-4_154-1
- Feriver, Ş., Reid, A., Teksöz, G., & Olgan, R. (2016). Training early childhood teachers for sustainability: towards a learning experience of a different kind. *Environmental Education Research*, 22(5), s. 717-746. doi:10.1080/13504622.2015.1027883
- Fraenkel, J. R., Wallen, N. E., & Huyn, H. H. (2012). *How to Design and Evaluate Research in Education* (8nd Ed b.). McGraw-Hill.
- Gooch, M., Rigano, D., Hickey, R., & Fien, J. (2008). How do primary pre-service teachers in a regional Australian university plan for teaching, learning and acting in environmentally responsible ways? *Environmental Education Research*, 14(2), s. 175-186. doi:10.1080/13504620801951715
- Goodland, R. (1995). The concept of Environmental Sustainability. *The Annual Review of Ecology, Evolution and Systematic*, 26(1).
- Hamiti, S. W., & Wydler, H. (2014). Supporting the Integration of Sustainability into Higher Education Curricula-A case study from Switzerland. *Sustainability*(6), s. 3291-3300. doi:10.3390/su6063291
- Hungerford, H. R., & Volk, T. L. (1990). Changing Learning Behaviour Through Environmental Education. *The Journal Of Environmental Education*, 21(3), s. 8-21. doi:10.1080/00958964

- Jauhariyah, M. N., Prahani, B. K., Syahidi, K., Deta, U. A., Lestari, N. A., & Hariyono, E. (2021). ESD for physics: how to infuse education for sustainable development (ESD) to the physics curricula? *Journal of Physics: Conference Series-MISEIC2020*, 1747(2021)012032. doi:10.1088/1742-6596/1747/1/012032
- Kaderođlu, A., Kaya, N., Karaaslan, V. E., & Koç, Y. S. (2022). *Secondary School 10th Grade Physics Course Textbook [Ortaöđretim Fizik 10. Sınıf Ders Kitabı]*. Ankara: Ada Publication.
- Kaderođlu, A., Kaya, N., Karaaslan, V. E., & Koç, Y. S. (2022). *Secondary School 12th Grade Physics Course Textbook [ortaöđretim Fizik 12. Sınıf Ders Kitabı]*. Ankara: Özgün Publications.
- Karaaslan, G., & Teksöz, G. (2016). Integrating Sustainable Development Concept into Science Education Program Is Not Enough; We Need Competent Science Teachers for Education for Sustainable Development--Turkish Experience. *International Journal of Environmental and Science Education*(11), s. 8403-8425.
- Krippendorff, K. (2004). *Content Analysis: An introduction to Its Methodology* (2nd Edition b.). Thousand Oaks: Sage Publications.
- Lee, S. W., Ma, S. C., & Lee, N. (2016). Practising the integration of education for sustainable development (ESD) into the school curriculum-The Hong Kong Experience. *International Journal of Comparative Education and Development*, 18(4), s. 219-245. doi:10.1108/IJCED-07-2016-0015
- Mckeown, R., & Hopkins, C. (2003). EE is not equal ESD: Defusing the worry. *Environmental Education Research*, 9(1), s. 117-128.
- MoNE Comission. (2018). *National High School Physics Course Curriculum*. Ankara: Ministry of National Education of Republic of Turkey, Board of Education and Morality. retrieved from http://mufredat.meb.gov.tr/Dosyalar/201812103112910-orta%C3%B6%C4%9Fretim_fizik_son.pdf
- Montemerle, T., Augereau, J. C., Chaussidon, M., Gounelle, M., Marty, B., & Morbidelli, A. (tarih yok). 3. Solar System Formation and Early Evaluation: the First 100 Million Years. *Earth, Moon, and Planet2006*, 98, s. 39-95. Retrieved from <https://doi.org/10.1007/s11038-006-9087-5>
- Müller, P. A., Baeumer, T., Silberer, J., & Zimmermann, S. (2020). Using research methods courses to teach students about sustainable development- a three phase model for a transformative learning experience. *International Journal of Sustainability in Higher Education*, 21(3), s. 427-439. doi:10.1108/IJSHE-08-2019-0252
- Orr, D. W. (1994). *Earth In Mind: On Education, Environment, and Human Prospect*. Washington DC: Island Press.

- Pawlowski, A. (2007). How Many Dimensions Does Sustainable Development Have? *Sustainable Development*, 16(2), s. 81-90. doi:10.1002/sd.339
- Perez, R. B., & Bua, V. E. (2019, August). Greening the Curriculum for Sustainable Development. ERIC. doi:ED600473
- Pingali, P. (2012). Green Revolution: Impacts, Limits and the Path Ahead. *Proceedings of the National Academy of Sciences of the United States of Amerika (PNAS)*, 109(31). Retrieved from <https://doi.org/10.1073/pnas.0912953109>
- Reid, C. T. (2016). Education for sustainable development and the professional curriculum. *The Law Teacher*, 50(3), s. 300-306. doi:10.1080/03069400.2016.1262986
- Roth, C. (1992). *Environmental Literacy, Its Roots, Evolution, and Directions in the 1990s*. Ohio: ERIC/CSMEE Publications, The Ohio State University.
- Scharenberg, K., Waltner, E.-M., Mischo., C., & Riess, W. (2021). Development of Students' Sustainability Competencies: Do Teachers Make a Difference. (P. Prus, Dü.) *Sustainability*. Retrieved from <https://doi.org/10.3390/su132212594>
- Sever, C., Türeci, D., Artar, N., & Dağ, O. (2022). *Secondary School 9th grade Physics Course Textbook [Ortaöğretim Fizik 9. Sınıf Ders Kitabı]*. Ankara: Özgün Publications.
- Şahin, E., Teksöz, G., & Ertepinar, H. (2009). Implications for a green curriculum application toward sustainable development. *Hacettepe University Journal of Education*, s. 123-135. Retrieved from <http://efdergi.hacettepe.edu.tr/yonetim/icerik/makaleler/496-published.pdf>
- Tanriverdi, B. (2009). Analyzing Primary School Curriculum in Terms of Sustainable Environmental Education. *Education and Science*, 34(151), s. 89-103. Retrieved from <https://www.researchgate.net/publication/279648912>
- Tatlilioğlu, E. (2019). *Analysis of science curriculum and textbooks in terms of sustainable development goals: a case study*. Ankara: Middle East technical University. Retrieved from <http://etd.lib.metu.edu.tr/upload/12624370/index.pdf>
- Teksöz, G. (2011). Managing Air Pollution: How Does Education Help? *the Impact of Air Pollution on Health, Economy, Environment and Agricultural Sources*, s. 397-422. doi:10.5772/16679
- Teksöz, G. (2016). Çevre Eğitiminden Sürdürülebilir Kalkınma İçin Eğitime: Tarihçe ve Gündem. *Boğaziçi Üniversitesi Eğitim Dergisi*, s. 73-97.
- Tilbury, D. (1995). Environmental Education for Sustainability: defining the new focus of environmental education in the 1990. *Environmental Educational Research*, 1(2), s. 195-212. doi:10.1080/1350462950010206

- Tilman, D. (1998). The greening of the green revolution. *Nature*, 396, s. 211-212. Retrieved from <https://doi.org/10.1038/24254>
- Türkmen, C. (2018). An Analysis of Secondary School Chemistry Curriculum In Terms of Education For Sustainable Development A Case From Turkey. 8-13.
- UNCED. (1993). Agenda 21: Programme of Action for Sustainable Development. *United Nations Conference on Environment and Development, 3-4 June 1992, Rio de Janeiro, Brazil*. New York: NY: United Nations Department of Public Information.
- UNCED. (2002). 57/25. United Nations Decade of Education for Sustainable Development. Retrieved from <http://www.un-documents.net/a57r254>
- UNCHE. (1972). Declaration of the United Nations Conference on the Human Environment. Retrieved from <http://www.un-documents.net/unchedec.htm>
- UNEP. (1972). Environmental Law Guidelines and Principles. *Stockholm Declaration*. Retrieved from <http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=97>
- UNESCO. (2017). Global Action Programme Goals and Objectives. Retrieved from <https://en.unesco.org/gap/goals-and-objectives>
- Vinte, C., Smeureanu, I., Dardala, M., & Reveiu, A. (2021). Sustainable Development in Education- Automating Curriculum Assessment. 27(5), s. 1159-1185. Retrieved from <https://doi.org/10.3846/tede.2021.15018>
- Ware, P., & Scott, W. (2007). Learning for a Change: Exploring the Relationship Between Education and Sustainable Development. *Journal of Education for Sustainable Development, Vol1(2)*, s. 191-198. doi:10.1177/097340820700100209
- Wattner, E. M., Scharenberg, K., Hörsch, C., & Riess, W. (2020). What Teachers Think and Know About Education for Sustainable Development and How They Implement It in Class. *Sustainability, 12(4)*. doi:10.3390/su12041690
- WCED. (1987). Brundtland Report : Our Common Future. *Report of the World Commission on Environment and Development* . Geneva.
- WCESD. (2017). UNESCO Global Action Programme on Education for Sustainable Development. Retrieved from <http://unesdoc.unesco.org/images/0024/002462/24620e.pdf>
- World Commission on Environment and Development . (1987). Our Common Future. Oxford: Oxford University Press.
- Yapıcıoğlu, A. E. (2021). Analysis of the outcomes of the Turkish science curriculum in terms of science process skills, nature of science, socioscientific issues, and STEM.

International Journal of Curriculum and Instruction, s. 925-949. Retrieved from <https://files.eric.ed.gov/fulltext/EJ1291982.pdf>

Zguir, M. F., Dubis, S., & Koç, M. (2022). Integrating sustainability into curricula: Teachers' perceptions, preparation. *Journal of Cleaner Production*(371). Retrieved from <https://doi.org/10.1016/j.clepro.2022.133167>

APPENDICES

A. BOARD DECISION ON PHYSICS CURRICULUM IN ENGLISH

REPUBLIC OF TURKEY
MINISTRY OF NATIONAL EDUCATION
Board of Education and Morality

Number	28	
Date	19/01/2018	Subject: Secondary School
Discussion Date	13/01/2018	Physics Course (9 th , 10 th ,
Previous Ruiling Date and Number	17/07/2017-89	11 th , and 12 th Grades)
	01/02/2013-10	

In accordance with the provisions of subparagraph (a) of paragraph 6 of Article 28 of the Decree Law No. 652 on the Organization and Duties of the Ministry of National Education, the secondary education physics course curriculum, which was updated in line with the monitoring and evaluation studies by our presidency, has been offered at all grade levels since the 2018-2019 academic year.

The first applications of the draft textbooks to be prepared according to the program in question are received between February 15-28, 2018, and the calendar for their acceptance and announcement is determined by the board later.

It is proposed that the Secondary School Physics Course Curriculum (9th, 10th, 11th, and 12th grades), which was accepted with the decision of our Board dated 17/07/2017 and numbered 89, and the Secondary School Physics Course Curriculum (9th, 10th, 11th, and 12th grades), which was accepted with the decision numbered 10, dated 01/02/2013, be abolished at all grade levels as of the 2018-2019 academic year.

Dr. Hüseyin KORKUT
Member

Assoc. Prof. Dr. Erkan DİNÇ
Member

Dr. Hasan KAVGACI
Member

Kamil YEŞİL
Member

Dr. Mehmet SÜRMEİ
Member

Dr. Hüseyin ŞİRİN
Member

Alparslan DURMUŞ
Director of Board

İsmet YILMAZ
Minister of National Education

B. BOARD'S DECISION ON PHYSICS CURRICULUM IN TURKISH

T.C.
MİLLÎ EĞİTİM BAKANLIĞI
Talim ve Terbiye Kurulu Başkanlığı

Sayı	28	Konu: Ortaöğretim Fizik Dersi (9, 10, 11 ve 12. Sınıflar) Öğretim Programı
Tarih	19/01/2018	
Kurulda Gör. Tarihi	13/01/2018	
Önceki Kararın Tarih ve Sayısı	17/07/2017-89 01/02/2013-10	

652 sayılı Millî Eğitim Bakanlığının Teşkilat ve Görevleri Hakkında Kanun Hükmünde Kararnamenin 28. maddesinin 6. fıkrasının (a) bendi hükmü gereğince Başkanlığımızda oluşturulan komisyon tarafından izleme ve değerlendirme çalışmaları doğrultusunda güncellenen **Ortaöğretim Fizik Dersi (9, 10, 11 ve 12. Sınıflar) Öğretim Programı**'nın 2018-2019 eğitim ve öğretim yılından itibaren tüm sınıf düzeylerinde ekli örneğine göre uygulanması,

Söz konusu programa göre hazırlanacak taslak ders kitaplarının Başkanlığa ilk başvurularının 15-28 Şubat 2018 tarihleri arasında alınması, kabul ve duyurusuna ilişkin takvimin ise daha sonra Kurulca belirlenmesi,

Kurulumuzun 17/07/2017 tarihli ve 89 sayılı kararıyla kabul edilen Ortaöğretim Fizik Dersi (9, 10, 11 ve 12. Sınıflar) Öğretim Programı ile 01/02/2013 tarihli ve 10 sayılı kararıyla kabul edilen Ortaöğretim Fizik Dersi (9, 10, 11 ve 12. Sınıflar) Öğretim Programı'nın 2018-2019 eğitim ve öğretim yılından itibaren tüm sınıf düzeylerinde uygulamadan kaldırılması

hususunu uygun görüşle arz ederiz.

Dr. Hüseyin KORKUT
Üye

Doç. Dr. Erkan DİNÇ
Üye

Dr. Hasan KAVGACI
Üye

Kâmil YEŞİL
Üye

Dr. Mehmet SÜRMEİ
Üye

Dr. Hüseyin ŞİRİN
Üye

Alpaslan DURMUŞ
Kurul Başkanı

UYGUNDUR
.../.../2018

İsmet YILMAZ
Millî Eğitim Bakanı