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Comparative Evaluation of Socioscientific Issues in Secondary Physics Curriculum and Textbooks

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Abstract

Socioscientific issues (SSI) provide an essential framework for understanding and managing the effects of scientific research and technological developments in physics on society. In this study, it was aimed to comparatively evaluate the secondary physics curriculum (9th, 10th, 11th and 12th grades) published in 2018 in Turkey and the 9th, 10th, 11th and 12th-grade physics textbooks approved by the Ministry of National Education within the framework of this curriculum in terms of SSI. A qualitative research method was utilised in the study. The study's data source comprised a secondary physics curriculum and textbooks. The research data were analysed using document analysis. As a result of the study, it was determined that only 14 out of 213 objectives in the secondary physics curriculum contained SSI content. It was determined that the grade level with the most socioscientific content was nine and then 12. In the study, as a result of the comparative analysis of the secondary physics curriculum and physics textbooks, it was determined that there was no equivalent for an outcome in the 9th-grade physics textbook that included SSI content in the curriculum. In this context, this study determined that the current education reform is incompletely reflected in the textbooks. Based on this, it can be suggested that the secondary physics course curriculum updated in 2024 is aimed to present a curriculum that includes objectives that will support students to understand the social, environmental and ethical dimensions of scientific knowledge, to increase the SSI content in the curriculum and to enrich physics textbooks with examples and activities with SSI content in line with the curriculum.

Keywords: Socioscientific issues, physics textbooks, physics curriculum, activities.

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Introduction

Today, changes in science and technology cause dilemmas in the social sphere. This situation reveals various discussion topics within society. These discussions and dilemmas are called socioscientific issues (SSI) in the literature (Akbaş & Çetin, 2018). SSI affects many aspects of our daily lives and is encountered in many fields, especially education. These areas include, for example, health and medicine. Here, discussions on the ethical dimensions of genetic research, human health and medical practices occur as part of SSI (Badeo & Duque, 2022). In the environmental context, environmental issues such as climate change, depletion of natural resources, and waste management are addressed within the framework of SSI. These issues play an essential role in the environmental impacts of our personal and social behaviours, sustainability and environmental protection policies (Kumar, Choudhary, & Singh, 2024). With a focus on technology, SSI determines how we use technology and its impact on society. For example, issues such as the effects of artificial intelligence and automation on the workforce, digital privacy and security, and so on provoke socioscientific debates (Johnson, Macalalag, & Dunphy, 2020). In terms of the education system, SSI plays a role in reducing social inequalities and promoting social mobility. Issues such as educational policies, student achievement, teacher quality and educational opportunities can be examined from a socioscientific perspective in the literature (Yun, Shi, & Jun, 2020). All these examples show that SSI is encountered in many different areas of our daily lives. Here, SSI enables individuals and societies to act in an informed and responsible manner while shaping their decisions (Novak & Treagust, 2022).

Controversial SSI requires students' evidence-based reasoning. SSI has personal significance for students and provides them with a contextual framework for developing understanding. SSI requires moral judgment and ethical evaluation in the decision-making process regarding potential solutions (Zeidler, 2003). While it is seen that SSI has a role in many fields, its relationship with the field of science is also observed quite clearly in daily life. While science deals with scientific research and discoveries to understand natural phenomena and the physical world, SSI examines the effects of science on society and how people perceive and use scientific knowledge. Therefore, SSI provides an essential framework for understanding and managing the impacts of scientific research and technological developments in science on society. In this context, it can be stated that including SSI in science education enables students to associate scientific knowledge with daily life and approach social problems sensitively (Johnson, Macalalag, & Dunphy, 2020; Karisan & Zeidler, 2017). It is also stated that the integration of SSI into science education supports students' critical thinking and problem-solving skills (Gutierez, 2015), interdisciplinary learning (Johnson et al., 2020), ethical and moral development (Zeidler, Sadler, Simmons, & Howes, 2005), effective citizenship education (Chowdhury, Holbrook, & Rannikmäe, 2020), cultural and social awareness (Hwang, Ko, Shim, Ok, & Lee, 2023) and scientific literacy (Zeidler & Kahn, 2014). At this point, it comes to mind that socioscientific topics mainly increase students' scientific literacy levels (Zeidler & Sadler, 2023). Because SSI teaches students how to use scientific knowledge in their daily lives, evaluate scientific evidence, and participate in scientific processes (Hwang et al., 2023). SSI constitute a context for scientific literacy. SSI support scientific literacy more in the context of reasoning and associating issues with daily life. In other words, individuals can develop their scientifically literate skills while researching or thinking about SSI. Accordingly, people with scientific literacy can examine critically, decide on social matters, and provide reasoned answers to whatever situation they encounter (Zeidler et al., 2005). According to Dawson and Venville (2010), scientific literacy in this context helps students participate more effectively in scientific discussions. Furthermore, socioscientific concerns help scientifically literate people strengthen their critical thinking, problem-solving, communication, and reasoning abilities and their comprehension of the nature of science (Leung, 2022; Tunç Şahin, 2022). As a result, students can assess how scientific and technical advancements have affected society and learn how to tackle complex issues from several angles. The benefits of scientific literacy for science courses have also been studied in the literature (Urhan, 2016; Yapıcıoğlu & Kaptan, 2017). Urhan (2016) discovered that students can achieve different argument levels in other situations in SSI with high scientific literacy levels. Yapıcıoğlu and Kaptan (2017) found that the socioscientific case-based teaching technique enhances scientific literacy.

In addition, SSI allows students to apply scientific and technological knowledge to real-world problems and enables students to think creatively and critically while finding solutions to problems. In

the meantime, it allows students to express their ideas clearly and effectively, as well as to understand the perspectives of others and to collaborate (Dawson & Carson, 2020). SSI increases students' ability to understand, analyse, and critically evaluate scientific and technological texts. Here, students are expected to make rational decisions on complex problems based on scientific evidence and apply these decisions effectively (Leung, 2022). In this context, SSI also increases students' sensitivity to social issues. Finally, SSI develops the ability to make connections between different disciplines (e.g., providing the opportunity to integrate knowledge from various fields, such as technology, into physics). Here, enabling students to participate in scientific and technological developments allows them to shape a better future through social change (Ram, 2020). In addition, SSI creates a context for science literacy. SSI supports science literacy more in the context of reasoning and associating topics with daily life. In other words, individuals can develop their science literacy skills while researching or thinking about SSI (Newton & Zeidler, 2020). In short, when SSI is presented to students in a scientifically correct context, it provides effective teaching. Therefore, it is seen that SSI has become one of the essential components of science and physics education, and it has made positive contributions to the learning environment because SSI contributes to the progress of society along with the personal development of individuals (Yavuz Topaloğlu & Balkan Kıyıcı, 2018).

Physics Phenomena

One of the main goals of physics education is to help students understand and be taught socioscientific themes since these subjects get their content from real-world events (Albe, 2008; Walker & Zeidler, 2007). Therefore, the importance of SSI in physics education is relatively high. This is because physics provides an understanding of natural phenomena and forms the basis for scientific and technological progress in our society. Including SSI in physics education encourages students to understand the impact of scientific developments on society. For example, students can address topics such as energy production and consumption, environmental impacts, nuclear technology, etc., and their social and ecological consequences. At this point, physics education provides the basic knowledge necessary to adapt to technological innovations. This is because including SSI in physics learning allows students to understand the social impacts of new technologies and how to manage these technologies. In addition, teaching physics with SSI content helps students evaluate scientific evidence and understand complex issues (e.g., energy crisis, global problems such as climate change, requiring solutions based on scientific and technological knowledge) (Jumadi & Dwandaru, 2023). As a result, these subjects are included in the physics curricula of many nations to increase students' comprehension of these subjects. As a result, SSIs are essential in physics education, as they improve students' ability to apply scientific knowledge to their daily lives. It enables them to find solutions to the complex problems faced by society with scientific approaches. For this reason, there is a place for SSI in physics education. By teaching SSI, students can deepen their scientific understanding and make more informed decisions for their societies (Aldahmash, Mansour, Alshamrani, & Almohi, 2016). From this point of view, the teaching of SSI can be based on this; it can be stated that SSI has an essential position in physics education as it contributes to the holistic development of students (Novak & Treagust, 2022). However, studies reveal that students lack the necessary skills to decide about socioscientific problems. Educators must discuss or at least sufficiently handle these topics in their lessons. Considering that teachers educate individuals who will shape society, are knowledgeable about SSI, and are aware of risk factors, teachers themselves should be mindful of SSI and be conscious of these issues (Sadler, 2009). Proper direction from teachers through instructional programs can help with this.

SSI in Curriculum and Textbooks

Curricula and textbooks reveal how and in what form SSI takes place in the education and training environment. The education and training environment is created based on the curriculum, and the achievements in the curriculum are transferred to the classroom environment through textbooks. At this point, textbooks are defined as an essential part of the curriculum (Arık Güngör & Saraçoğlu, 2023). Teachers follow the curriculum and use textbooks to create teaching approaches (McDonald, 2016; Yapıcıoğlu & Kaptan, 2017). Curricula and textbooks are among the effective materials for students and teachers. Because students' learning can be realized through a well-designed curriculum and textbook (Arık Güngör & Saraçoğlu, 2023). In recent years, SSI has gained importance with its

support for many skills and has taken its place in curricula and textbooks (Leung, 2022). With the inclusion of SSI in curricula, teachers have started to be asked to design learning environments that will develop students' higher-order thinking skills, student-centred, based on research and inquiry, and include reasoning in a discussion environment, and to use them in teaching activities (Badeo & Duque, 2022). At this point, the content of curricula and textbooks teachers use has started to play an even more critical role. Because it is known that the SSIs in the curriculum and textbooks constitute the reference point of teachers during teaching (Chou, 2021), it was thought that it was necessary to address how and to what extent the SSIs in the secondary physics course curriculum and textbooks, which are effective in students' learning and are expected to be compatible with each other, were addressed in the research. When the literature was examined, studies were found in which the secondary physics curriculum was reviewed in the context of SSI and other science curricula (Aydın & Silik, 2020; Et & Gömleksiz, 2021). Therefore, studies on how SSI is addressed in science curricula have also been found. For example, it has been stated that SSIs are included in science curricula to encourage students to make solutions and decisions supported by evidence-based arguments (Owen, Zeidler, & Sadler, 2017). Lee and Witz (2009) stated that SSIs are included in the science curriculum by highlighting the science-technology-society relationship that encourages students to participate in decision-making. In addition, Tsai (2018) stated that SSI is included in the curriculum by aiming for scientific competence in science and Thurrodliyah, Prihatin and Novenda (2020) focused on developing reasoning skills. In addition, in the literature, while there was a study in which science textbooks were examined in the context of SSI (Et, 2023), there was no study in which physics textbooks were reviewed in the context of SSI. Although studies investigating the impact of the science-technology-society relationship on society have been found in the literature (Lumpe & Beck, 1996), it is known that these studies do not address content as comprehensively as SSI. Because SSI addresses a more comprehensive content by requiring ethical and moral evaluations (Fang, Hsu, & Lin, 2019), for this purpose, considering the need for a detailed analysis in terms of physics course, it was requested to examine the secondary physics curriculum and textbooks together in terms of SSI. Considering that the content of the textbooks is prepared in line with the curriculum, to conduct a qualified physics education study, curriculum materials such as the curriculum and textbooks were considered as a whole in the survey and handled comparatively together. In other words, the study sought to answer how SSI is reflected in the secondary physics curriculum and textbooks. With the examination, it was among the expectations that the textbook should be consistent with the content of the curriculum. Because it is known that textbooks should be prepared to reflect the curriculum (Doğan, 2021).

Purpose of the Study

It is stated that with the inclusion of SSI in the secondary physics course curriculum and textbooks, attention is drawn to the elements that concern society, students are allowed to express their opinions and experiences, and meaningful learning can occur. At this point, it is essential to determine how SSI, which is also a factor in achieving the goal of science literacy, is handled in the secondary physics curriculum and textbooks (Yenilmez Türkoğlu & Öztürk, 2019). The 2018 curriculum published by the Ministry of National Education (MoNE) includes 'Objectives', one of the curriculum elements, in detail. However, the content element is only included in the secondary physics curriculum as subject headings. Therefore, there is a need to examine the centrally used textbooks to make sense of the content pointed out by the objectives because the textbook's content is binding for all schools in Turkey.

SSI was included in the secondary physics curriculum in Turkey for the first time in 2013 under basic skills with the statement "Perceives the relationship between Science-Technology-Society-Environment and perceives the relationship between Science-Technology-Society-Environment, reasoning about SSI, discusses, poses problems and produces solutions." The 2018 curriculum's importance continued to be emphasized among its basic philosophy and general objectives: "It is aimed to make inferences about socioscientific events related to the use of different energy sources" (MoNE, 2013; MoNE, 2018). In this context, as in the literature (Mohamad & Shaaban 2021), SSI is considered an essential context in the secondary physics curriculum in Turkey.

In line with all these statements, this study aims to comparatively evaluate the secondary physics curriculum (9th, 10th, 11th, and 12th grades) published in 2018 and the 9th, 10th, 11th, and 12th-grade physics textbooks approved by MoNE within the framework of this curriculum in terms of SSI. The sub-problems of the research are given below:

1. What outcomes are related to SSI in the secondary physics (9th, 10th, 11th and 12th grades) curriculum published in 2018?

2. What are the SSI activities in the 9th, 10th, 11th and 12th grade physics textbooks approved by MoNE?

Method

This study aimed to comparatively evaluate the secondary physics curriculum (9th, 10th, 11th and 12th grades) published in 2018 and the 9th, 10th, 11th and 12th-grade physics textbooks approved by the MoNE within the framework of this curriculum in terms of SSI. For this purpose, the qualitative research method was utilized. With qualitative research method, it is desired to reveal the process, situation or understanding of the phenomena (Yıldırım & Şimşek, 2016).

Data Source

The data source of the study consists of the secondary physics curriculum published in 2018 and the MoNE secondary physics 9th, 10th, 11th and 12th-grade textbooks. The curriculum and textbook are provided to teachers and students by MoNE for use in the teaching process.

The data source of the study, the Secondary Education Physics (9th, 10th, 11th and 12th grades) Curriculum published in 2018, was accessed through the MoNE Curriculum Monitoring and Evaluation System (https://mufredat.meb.gov.tr/ProgramDetay.aspx?PID=351) (MoNE, 2018). The MoNE secondary physics 9th, 10th, 11th and 12th-grade textbooks to be included in the study were accessed from https://ogmmateryal.eba.gov.tr/etkilesimli-kitaplar/fizik. The Education Information Network (EBA) is a social electronic content network established by the MoNE of the Republic of Turkey. At this point, four physics textbooks were included in the study, one textbook for each grade level on EBA. These textbooks: Secondary Physics 9 Textbook (Sever, Türeci, Atar, & Dağ, 2019), Secondary Physics 10 Textbook (Kaderoğlu, Kaya, Karaaslan, & Koç, 2021), Secondary Physics 11 Textbook (Döyen et al., 2021) and Secondary Physics 12 Textbook (Çifci, Bozkurt, & Nalbant, 2022). The authenticity and originality of the data sources were confirmed by accessing them from their official websites. Primary sources related to the research topic were accessed (Sak, Şahin Sak, Şendil, & Nas, 2021).

Data Analysis

The study data sources were analysed through document analysis. Document analysis provides a systematic analysis of the content of written documents. The document analysis process in the research is detailed in Figure 1 (Yıldırım & Şimşek, 2016).

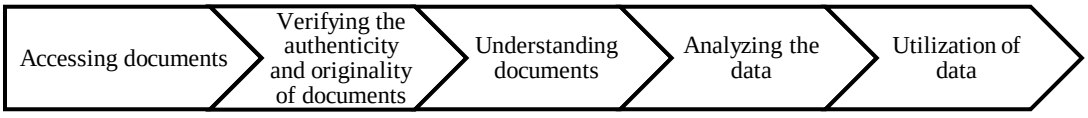

Figure 1. Document Analysis Process in the Research

A detailed explanation of the document analysis process is given below in Figure 1.

1. The authenticity and originality of the sources were confirmed by accessing the data sources from their official websites.

2. The obtained sources were analysed in detail and comparatively within the scope of descriptive analysis.

3. The curriculum outcomes to be included in the analysis regarding SSI and the activities in the textbooks prepared in line with these outcomes were determined. While deciding on these learning outcomes and activities, SSI content expressions for discussion, generating ideas, inferring, interpreting, questioning and proposing solutions were considered. Because SSI inherently involves

the skills expressed, the objectives and activities involving these skills were reviewed and included in the analysis after deciding whether they included SSI (Zeidler & Nichols, 2009).

For example, “9.4.5.1. Evaluate renewable and non-renewable energy sources regarding advantages and disadvantages.” has an SSI in its content and is oriented towards interpretation and questioning, as stated by Zeidler and Nichols (2009), which was included in the analysis. This outcome statement corresponds to the activity in the textbook. Sample activity visual in the textbook (Sever et al., 2019, p. 203):

> Your Turn 23
>
> If you were the manager of your city, which source would you use to generate electricity for the town? Explain the reasons for your choice regarding cost, accessibility, ease of production, community, technology and environmental impacts.

4. Tables were created to present the analysis in detail to the readers.

5. The tables included the grade level, unit name, subject name, and outcome statements evaluated regarding SSI in the curriculum.

6. Then, the relevant outcome statement and the SSI activity in the textbook were indicated in the tables.

7. While sharing research results/data, research results were included in a way that would not harm or benefit the institutions, organisations or individuals in the documents.

Validity and Reliability

After the data collection and analysis process, two experts with doctoral degrees in physics education examined the written and visualized documents for the validity and reliability of the research. The data are observable, testable, and based on digital and printed sources. The experts examined the objectives and activities presented for evaluation in terms of the SSI, taking into consideration the characteristics of the SSI (having a scientific basis, requiring making choices or generating ideas at a personal/social level, involving value and ethical reasoning, being a current social issue from life, etc.) and the statements that are intended for discussion, generating ideas, making inferences, interpreting, questioning, and proposing solutions as stated by Zeidler and Nichols (2009) (Ratcliffe & Grace, 2003). The experts first analysed each other independently. After the first analysis, the number of “agreements” and “disagreements” among the experts was calculated for the reliability of the research (Miles & Huberman, 1994). The percentage of agreement calculated due to the first coding was 96%. Then, the experts came together to compare the data obtained. The experts discussed the differences between their coding, and this process continued until 100% agreement was achieved (Yıldırım & Şimşek, 2016). The research data were finalized and presented to the readers in the findings section.

Findings

This study aimed to comparatively evaluate the secondary physics curriculum (9th, 10th, 11th and 12th grades) published in 2018 in Turkey and the 9th, 10th, 11th and 12th-grade physics textbooks approved by the MoNE within the framework of this curriculum regarding SSI. In line with this purpose, two sub-problems were identified in the study, and the findings obtained for these problem statements are presented in detail below.

Outcomes Related to SSI in the Secondary Physics Curriculum

In the secondary physics curriculum (9th, 10th, 11th and 12th grades), 72 lesson hours were allocated for 44 objectives in six units in 9th grade, 72 lesson hours for 39 objectives in four units in 10th grade, 144 lesson hours for 62 objectives in two units in 11th grade, and 144 lesson hours for 68 objectives in six units in 12th grade. The objectives in the secondary physics curriculum were examined in terms of SSI. The objectives include "discussing, generating ideas, making inferences, interpreting, questioning, offering solutions", among the skills expected by SSI (Zeidler & Nichols, 2009). The findings obtained in this context are explained in detail in Table 1.

Table 1.
Outcomes Related to SSI In The Secondary Physics Curriculum

Grade	Unit Name	Topic Name	Outcome
9	9.1.Introduction to Physical Science	9.1.4. Science research centres	9.1.4.1. Explains the importance of science research centres for physics.
	9.2.Matter and its Properties	9.2.2. Resilience	9.2.2.1. Explains the concept of durability.
	9.4. Energy	9.4.4. Yield	9.4.4.2. Develop recommendations to increase the efficiency of a sample system or design.
	9.4. Energy	9.4.5. Energy Resources	9.4.5.1. Evaluate renewable and non-renewable energy sources regarding advantages and disadvantages.
	9.5.Heat and Temperature	9.5.4. Energy Resources	9.5.4.1. Explains energy transmission pathways with examples.
	9.5. Heat and Temperature	9.5.4. Energy transmission pathways and energy transmission rate	9.5.4.3. Designs for the insulation of living spaces for energy conservation.
	9.5. Heat and Temperature	9.5.4. Energy transmission pathways and energy transmission rate	9.5.4.5. Develop projects for measures against global warming.
10	10.3. Waves	10.3.5. Earthquake Waves	10.3.5.2. Develop solutions to prevent loss of life and property damage caused by earthquake waves.
11	11.2. Electricity and Magnetism	11.2.5. Alternating Current	11.2.5.2. Compares alternating current and direct current.
12	12.1.Circular Motion	12.1.2. Rotational Translation Motion	12.1.2.3. Explains the variables on which the kinetic energy of an object undergoing rotational and translational motion depends.
	12.2.Simple Harmonic Motion	12.2.1. Simple Harmonic Motion	12.2.1.4. Determines the variables on which the period depends in a spring and simple pendulum.
	12.4. Introduction to Atomic Physics and Radioactivity	12.4.3. Radioactivity	12.4.3.3. Explains nuclear fission and fusion events.
	12.4. Introduction to Atomic Physics and Radioactivity	12.4.3. Radioactivity	12.4.3.4. Explains the effects of radiation on living organisms.
	12.6. Applications of Modern Physics in Technology	12.6.2. Semiconductor Technology	12.6.2.4. Explains the operation of solar cells.

Table 1 shows seven objectives at the 9th-grade level, one at the 10th-grade level, one at the 11th-grade level and five at the 12th-grade level in the secondary physics curriculum were determined to be related to SSI by considering the objective descriptions. In total, 14 of the 213 objectives in the curriculum were found to be associated with SSI. Considering these learning outcome statements, the findings related to the second sub-problem of the study are presented in detail below.

SSI Activities in Physics Textbooks

In the study, 9th, 10th, 11th and 12th-grade physics textbooks approved by the MoNE were analysed regarding SSI, and the results obtained are given in Table 2. In Table 2, the type of activity and the SSI activity in the physics textbooks are provided in return for the outcome number of the outcome statement in the curriculum. The ones that were not named in the SSI activities were called by the researcher, considering the content of the activity.

Table 2.
Findings Related to SSI Activities In Physics Textbooks

Outcome No	Activity Type In Physics Textbooks	SSI Activity
9.1.4.1.	Your Turn (p. 46)	Scientific Discovery
9.4.4.2.	Your Turn (p. 196)	Sustainable Living
9.4.5.1.	Your Turn (p. 203)	Energy Sources

Table 2 continuing

Outcome No	Activity Type In Physics Textbooks	SSI Activity
9.5.4.1.	Your Turn (p. 241)	Energy Sources
9.5.4.3.	Your Turn (p. 245)	Energy Sources
9.5.4.3.	Your Turn (p. 246)	Environmentally Friendly
9.5.4.5.	Project (p. 250)	Climate Change
10.3.5.2.	Project (p. 173)	Natural Disasters
11.2.5.2.	Activities (p. 356)	Scientists
12.1.2.3.	Research (p. 41)	Electric Transportation Vehicles
12.2.1.4.	Research (p. 92)	Energy Sources
12.4.3.3.	Research (p. 177)	Nuclear Armament
12.4.3.4.	Research (p. 178)	Radiation Effect
12.6.2.4.	Research (p. 239)	Energy Sources

As seen in Table 2, 14 activities with SSI content were identified in physics textbooks. It is seen that there is no activity in the textbook for each outcome statement in Table 1. In the secondary physics textbook, no SSI activity proposal was found for the outcome statement "9.2.2.1. Explains the concept of durability." under the subject title "9.2.2. Resilience". In addition, as stated in Table 1, it was determined that SSI activities were primarily included in the 9th-grade level. It was determined that SSI activities were primarily included in the textbooks under the 'it's your turn' title.

Discussion and Conclusion

In this study, the secondary physics curriculum and textbooks were comparatively evaluated regarding SSI. In line with the aim of the research, information about the current situation of the curriculum and textbooks in terms of SSI was obtained. As a result of the study, 14 acquisitions with SSI content were found. It was determined that the grade level with the most intense SSI content was 9th and then 12th. One acquisition and activity with SSI content was identified at the 10th and 11th grade levels. When the secondary physics curriculum and physics textbooks were examined comparatively by the researchers, it was observed that the 9th-grade physics textbook did not include any SSI activity in the 9th-grade physics textbook in response to the socioscientific outcome statement "9.2.2.1. Explains the concept of durability." under the subject heading "9.2.2. Resilience " in the curriculum. Therefore, this study also revealed to what extent the textbooks were prepared according to the curriculum guidelines regarding SSI matter. In other words, this study demonstrated how the current educational reform is reflected in the textbooks. It is stated in the literature that this incompatibility between the textbook and the curriculum will negatively affect student achievement (Anderson & Krathwohl, 2001). It is argued that students' cognitive process skills develop directly to the curriculum and textbooks' objectives, teaching-learning processes, and assessment-evaluation steps. Therefore, it is emphasized that the harmony between the curriculum and textbooks is crucial for effectively realising the teaching process. In other words, it is stated that the higher this harmony is, the more achievements can be reached at the desired level (Kalender & Baysal, 2021). In addition, it can be stated that this kind of deficiency is mainly mentioned in the research because there is a centralized teaching system in Turkey (Koyunlu Ünlü & Şen, 2018). To put it more clearly, the 2018 curriculum published by MoNE includes 'objectives' among the curriculum elements in detail, and textbooks are developed and used to make sense of the content element these objectives point to. The content of the curriculum and textbooks is determined by MoNE, and these books are printed and distributed free of charge to school students. All students studying physics throughout the country complete their education through almost the same curriculum and textbooks. Therefore, teachers use the curriculum and textbooks as their primary sources. From this point of view, in Turkey's education and training environment, the content of textbooks has a significant role in achieving the goals of education and training, especially the curriculum (Yapıcıoğlu & Atabey, 2020). Therefore, as a result of this research, it was aimed to draw attention to the need to increase SSI activities in line with the aim of the physics curriculum by determining the deficiency in the textbook and revealing that there is limited space for acquisitions and activities with SSI content in teaching tools. This result expressed in the study is also supported by Mohamad and Shaaban (2021). In the literature, it is known that students' skills in explaining natural phenomena, problem-solving, critical thinking and scientific understanding will improve with SSI activities that are increased as a result of such studies or included in teaching (Doğan, 2021; Novak & Treagust, 2022). In addition, it is also stated in the literature that classroom environments dominated

by superficial science understanding should enable teachers to include comprehensive inquiry activities with the main teaching tools (Khine & Liu, 2017). In short, it is thought that education and training environments should be supported with powerful teaching tools and SSI content, with the findings of the literature supporting the research result. Therefore, it is believed that efforts should be made to place SSI context in most physics subjects. Jumadi and Dwandaru (2023) also support the research result and argue that teaching in an SSI context should be supported to understand physics topics that encourage understanding the effects of scientific developments on society. In this way, it is argued that the social and environmental consequences of issues such as energy production and consumption, energy crisis, climate change and nuclear technology, which have been on the agenda in recent years, can be addressed by students. In another respect, it is also emphasized that physics education provides the basic knowledge necessary to adapt to technological innovations.

In addition, when the outcomes with SSI content stated in the research were analysed, it was seen that these outcomes were completed with the predicate expressions "explains the importance, develops suggestions, evaluates, designs, compares". By the nature of the SSI, it can be stated that this is an expected result. SSI requires students to acquire different skills with the developments and changes in science, technology, and society. Therefore, it comes to mind that curricula are being developed and updated by considering the need for individuals who question and produce in society with the outcomes of SSI content. For this reason, it is observed that individuals who explain, offer suggestions and evaluate are desired in the outcome statements (Et, 2023). In addition, with these updates in the curriculum, it is thought that the expectations from individuals are increasing daily by putting the existence and interaction of society and science in the foreground. This relationship concerns all subjects that have social importance in physics. Therefore, it comes to mind that the importance of the link established between physics subjects within the scope of knowledge and societal interaction is increasing daily (Chen & Xiao, 2021).

In addition, it is thought that the recent addition of technology to the interaction of science and society and the realization of this questioning within the framework of science-society-technology has led to increased dilemmas and discussions on these issues (Yun et al., 2020). All the factors in this spiral affect the emergence of SSI and their frequent agenda in the education system. SSI is considered in the literature as an issue that concerns society, is scientific, can be discussed, and has an ethical context (Leung & Cheng, 2023). In line with all these statements, considering that SSI with multiple dimensions involves individuals in a scientific research process and that individuals make scientific decisions and find themselves in scientific discussions (Melton, Saiful, & Shein, 2022), it is thought that the use of SSI in curricula and textbooks will enable students to approach social problems sensitively and consciously while strengthening their scientific thinking skills. Therefore, it is believed that the integration of SSI into teaching tools will make science education more comprehensive and meaningful, and thus, students will be able to use scientific knowledge more effectively in their daily lives (Jumadi & Dwandaru, 2023; Salloum, 2021).

Suggestions

The inclusion of SSI in curricula and textbooks enables students to use scientific knowledge effectively in their daily lives, develop many skills, be sensitive to social problems and act as active citizens. Therefore, SSI has an essential place in education. It is known that the use of SSI in curricula and textbooks is becoming increasingly important to help students connect scientific knowledge to their daily lives and understand social contexts. Recent studies support this importance by revealing that renewed or updated curricula focus on scientific research and innovative skills (Atakan & Akçay, 2022; Bayır & Kahveci, 2022). It is believed that this study will provide a perspective to the expert field educators who create the content of the physics curricula and textbooks to be updated.

In this context, it was determined that there was a discrepancy between the secondary physics curriculum published in 2018 and the textbooks examined comparatively in terms of SSI at the 9th-grade level. At this point, the researcher developed an SSI activity proposal to overcome the deficiency since there is no SSI activity in the textbook for the unit name '9.2. Matter and its Properties', the subject name '9.2.2. Resilience' and outcome '9.2.2.1. Explains the concept of durability.' it was paid attention that the SSI activity suggestion developed by the researcher (see Table

3) was related to the outcome, related to daily life, necessary for humanity and society, and offered students the opportunity to discuss (Atabey, Topçu, & Çiftçi, 2018).

Table 3.
SSI Activity Suggestion

Outcome No	Activity Type	SSI Activity
9.2.2.1.	Your Turn	Urban Transformation
With zoning permission, a new settlement centre will be created in a large area. Considering the growing population, state authorities prefer to build high-rise buildings in this area. However, scientists state that as the size of the buildings increases, unsolvable durability problems arise—the engineers who will work in this region state that durability is a prerequisite for building structures. If a house were to be built for you in this region, how would you react to the situation, considering durability? Explain.		

The suggestion in Table 3 was prepared as a discussion question. This SSI activity suggestion presented by the researcher can be considered a step towards eliminating the deficiency in the 9th-grade physics textbook.

In addition to this, some suggestions are given below by mentioning some critical issues in terms of SSI in a general framework and considering the secondary physics curriculum updated in 2024:

1. Presenting a curriculum that includes objectives to support students' understanding of the social, environmental and ethical dimensions of scientific knowledge,

2. Enriching physics textbooks with examples and activities involving SSI,

3. Supporting meaningful learning by showing students how science can be related to daily life through textbooks enriched with SSI,

4. The physics curriculum and textbooks should address issues such as social responsibility, environmental protection, and technology ethics, allowing students to apply their scientific thinking to social problems,

5. The methods used in teaching SSI in the physics textbook include discussion, project-based learning, field studies and interactive simulations,

6. Through these methods used in physics teaching, students are allowed to explore the social contexts of scientific knowledge and develop critical thinking skills,

7. Provide support to teachers by including the integration of SSI into teaching and helpful teaching strategies in teacher handbooks,

8. Linking SSI related to physics subjects with disciplines such as social sciences, mathematics, and technology can help students gain the ability to address and solve complex social problems.

Finally, in future studies, it can be suggested to comparatively evaluate the secondary physics curriculum (9th, 10th, 11th and 12th grades) published in 2024 and the 9th, 10th, 11th and 12th-grade physics textbooks approved by MoNE within the framework of this curriculum in terms of SSI and to discuss the current situation with the results of this research.

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References

Akbaş, M., & Çetin, P. S. (2018). The investigation of gifted students' argumentation level and informal reasoning related to socioscientific issues. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education, 12*(1), 339-360. doi:10.17522/balikesirnef.437794

Albe, V. (2008). When scientific knowledge, daily life experience, epistemological and social considerations intersect: Students' argumentation in group discussions on a socio-scientific issue. *Research in Science Education, 38*(1), 67-90. doi:10.1007/s11165-007-9040-2

Aldahmash, A. H., Mansour, N. S., Alshamrani, S. M., & Almohi, S. (2016). An analysis of activities in Saudi Arabian middle school science textbooks and workbooks for the inclusion of essential features of inquiry. *Research in Science Education, 46*, 879-900. doi:10.1007/s11165-015-9485-7

Anderson, L. W., & Krathwohl, D. R. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives: Complete edition*. Addison Wesley Longman, Inc.

Arık Güngör, B., & Saraçoğlu, S. (2023). Evaluation of high school transition system (LGS) science question in terms of context-based learning approach. *SDU International Journal of Educational Studies, 10*(2), 22-46. doi:10.33710/sduijes.1318492

Atabey, N., Topçu, M. S., & Çiftçi, A. (2018). The investigation of socioscientific issues scenarios: A content analysis research. *OPUS International Journal of Society Researches, 9*(16), 1968-1991. doi:10.26466/opus.474224

Atakan, M., & Akçay, B. (2022). Representation of changes about nature of science in Turkish middle school science textbooks. *Science & Education*, 1-30. doi:10.1007/s11191-022-00403-6

Aydın, F., & Silik, Y. (2020). An investigation of how pre-service elementary school teachers relate socio-scientific issues in the scope of learning outcomes of 2017 science education curriculum (Grade 3 and 4). *Inonu University Journal of the Faculty of Education*, *21*(2), 740-756. doi:10.17679/inuefd.648944

Badeo, J. M., & Duque, D. A. (2022). The effect of socio-scientific issues (SSI) in teaching science: A meta-analysis study. *JOTSE: Journal of Technology and Science Education*, *12*(2), 291-302. doi:10.3926/jotse.1340

Bayır, E., & Kahveci, S. (2022). Examination of secondary school science textbooks in terms of scientific process skills. *Cumhuriyet International Journal of Education, 11*(1), 253-262. doi:10.30703/cije.1026825

Chen, L., & Xiao, S. (2021). Perceptions, challenges and coping strategies of science teachers in teaching socioscientific issues: A systematic review. *Educational Research Review, 32*, 100377. doi:10.1016/j.edurev.2020.100377

Chou, P. I. (2021). The representation of global issues in Taiwanese elementary school science textbooks. *International Journal of Science and Mathematics Education, 19*, 727-745. doi:10.1007/s10763- 020-10083-9

Chowdhury, T. B. M., Holbrook, J., & Rannikmäe, M. (2020). Socioscientific issues within science education and their role in promoting the desired citizenry. *Science Education International, 31*(2), 203-208. doi:10.33828/sei.v31.i2.10

Çifci, A., Bozkurt, H., & Nalbant, M. (2022). *Ortaöğretim Fizik 12 Ders Kitabı* [Secondary Physics 12 Textbook]. Ankara: Ministry of National Education.

Dawson, V. M., & Venville, G. (2010). Teaching strategies for developing students' argumentation skills about socioscientific issues in high school genetics. *Research Science Education, 40*(2), 133–148. doi:10.1007/s11165-008-9104-y

Dawson, V., & Carson, K. (2020). Introducing argumentation about climate change socioscientific issues in a disadvantaged school. *Research in Science Education, 50*, 863-883. doi:10.1007/s11165-018-9715-x

Doğan, O. K. (2021). Methodological? or dialectical? Reflections of scientific inquiry in biology textbooks. *International Journal of Science and Mathematics Education, 19*(8), 1563-1585. doi:10.1007/s10763-020-10120-7

Döyen, A. G., Çetinol, A., Erbek, E., Turan, M., Alagöz, N. E., & Özübek, U. (2021). *Ortaöğretim Fizik 11 Ders Kitabı* [Secondary Physics 11 Textbook]. Ankara: Ministry of National Education.

Et, S. Z., & Gömleksiz, M. (2021). Evaluation of science, biology and physics curriculum in terms of socioscientific issues. *Fırat University Journal of Social Sciences, 31*(2), 745-756. doi:10.18069/firatsbed.872628

Et, S. Z. (2023). Analysis of secondary school science textbook activities in terms of socioscientific issues: A document analysis. *Journal of Curriculum and Educational Studies, 1*(1), 53-80. doi:10.5281/zenodo.8101729

Fang, S. C., Hsu, Y. S., & Lin, S. S. (2019). Conceptualizing socioscientific decision making from a review of research in science education. *International Journal of Science and Mathematics Education, 17*, 427– 448. doi:10.1007/s10763-018-9890-2

Gutierez, S. B. (2015). Integrating socio-scientific issues to enhance the bioethical decision-making skills of high school students. *International Education Studies, 8*(1), 142-151. doi:10.5539/ies.v8n1p142

Hwang, Y., Ko, Y., Shim, S. S., Ok, S. Y., & Lee, H. (2023). Promoting engineering students' social responsibility and willingness to act on socioscientific issues. *International Journal of STEM Education, 10*(11), 1-16. doi:10.1186/s40594-023- 00402-1

Johnson, J., Macalalag, A. Z., & Dunphy, J. (2020). Incorporating socioscientific issues into a STEM education course: Exploring teacher use of argumentation in SSI and plans for classroom implementation. *Disciplinary and Interdisciplinary Science Education Research, 2*(9), 1-12. doi:10.1186/s43031-020-00026-3

Jumadi, J., & Dwandaru, W. S. B. (2023). Socio-scientific issues in physics learning to improve students' critical thinking skills. *Revista Mexicana de Física E, 20*(1), 010202-1. doi:10.31349/RevMexFisE.20.010202

Kaderoğlu, A., Kaya, N., Karaaslan, V. E., & Koç, Y. S. (2021). *Ortaöğretim Fizik 10 Ders Kitabı* [Secondary Physics 10 Textbook]. Ankara: Ministry of National Education.

Kalender, B., & Baysal, Z. N. (2021). Öğretim programı ve ders kitaplarının program ögelerinin uyumu açısından incelenmesi: Hayat bilgisi örneği [Examining the curriculum and textbooks in terms of the compatibility of curriculum elements: Life science example]. *Bogazici University Journal of Education, 38*(2), 75-96. doi:10.52597/buje.990925

Karisan, D., & Zeidler, D. L. (2017). Contextualization of nature of science within the socioscientific issues framework: A review of research. *International Journal of Education in Mathematics, Science and Technology, 5*(2), 139-152. doi:10.18404/ijemst.270186

Khine, M. S., & Liu, Y. (2017). Descriptive analysis of the graphic representations of science textbooks. *European Journal of STEM Education, 2*(3), 06. doi:10.20897/ejsteme/81285

Koyunlu Ünlü, K., & Şen, Ö. (2018). The investigation of 5th grade science textbooks activities in terms of scientific inquiry and engineering design process. *Sakarya University Journal of Education, 8*(4), 185-197. doi:10.19126/suje.448331

Kumar, V., Choudhary, S. K., & Singh, R. (2024). Environmental socio-scientific issues as contexts in developing scientific literacy in science education: A systematic literature review. *Social Sciences & Humanities Open, 9*, 100765. doi:10.1016/j.ssaho.2023.100765

Lee, H., & Witz, K.G. (2009). Science teachers' inspiration for teaching socio-scientific issues: disconnection with reform efforts. *Internation Journal of Science Education, 31*(7), 931-960. doi:10.1080/09500690801898903

Leung, J. S. C. (2022). Shifting the teaching beliefs of preservice science teachers about socioscientific issues in a teacher education course. *International Journal of Science and Mathematics Education, 20(*4), 659–682. doi:10.1007/s10763-021-10177-y

Leung, J. S. C., & Cheng, M. M. W. (2023). Prioritizing emotion objects in making sense of student learning of socioscientific issues. *Journal of Research in Science Teaching, 60*(2), 357-389. doi:10.1002/tea.2180

Lumpe, A. T., & Beck, J. (1996). A profile of high school biology textbooks using scientific literacy recommendations. *The American Biology Teacher, 58*(3), 147-153.

McDonald, C. V. (2016). Evaluating junior secondary science textbook usage in Australian schools. *Research in Science Education, 46*(4), 481-509. doi:10.1007/s11165-015-9468-8

Melton, J. W., Saiful, A, J., & Shein, P, P. (2022). Interdisciplinary STEM program on authentic aerosol science research and students' systems thinking approach in problem-solving. *International Journal of Science Education*, *44*(9), 1419-1439. doi:10.1080/09500693.2022.2080886

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook (2nd edition).* California: Sage

Ministry of National Education. (2013). *Ortaöğretim fizik dersi (9, 10, 11 ve 12. Sınıflar) öğretim programı* [Secondary school physics course (Grades 9, 10, 11 and 12) curriculum]. Ankara: Talim ve Terbiye Kurulu Başkanlığı.

Ministry of National Education. (2018). *Ortaöğretim fizik dersi (9, 10, 11 ve 12. Sınıflar) öğretim programı* [Secondary school physics course (Grades 9, 10, 11 and 12) curriculum]. Ankara: Talim ve Terbiye Kurulu Başkanlığı.

Mohamad, A., & Shaaban, K. (2021). *Addressing the STSE issues in the Lebanese National Science curriculum and textbooks*. Lebanese American University: Department of Education.

Newton, M. H., & Zeidler, D. L. (2020). Developing socioscientific perspective taking. *International Journal of Science Education, 42*(8), 1302-1319. doi:10.1080/09500693.2020.1756515

Novak, A. M., & Treagust, D. F. (2022). Supporting the development of scientific understanding when constructing an evolving explanation. *Disciplinary and Interdisciplinary Science Education Research, 4*(1), 1-22. doi:10.1186/s43031-021-00043-w

Owen, D., Zeidler, D., & Sadler, T. (2017). Controversial issues in the science classroom. *Phi Delta Kappan, 99*(4), 45-49. doi:10.1177/0031721717745544

Ram, R. (2020). Engaging young people in science education through socioscientific issues of biosecurity. *Kōtuitui: New Zealand Journal of Social Sciences Online, 15*(1), 22-37. doi:10.1080/1177083X.2019.1637908

Ratcliffe, M., & Grace, M. (2003). *Science education for citizenship: Teaching socio-scientific issues*. UK: McGraw-Hill Education.

Sadler, T. D. (2009). Situated learning in science education: Socio-scientific issues as contexts for practice. *Studies in Science Education, 45(1),* 1-42. doi:10.1080/03057260802681839

Sak, R., Şahin Sak, T., Şendil, Ö., & Nas, E. (2021). Document analysis as a research method. *Kocaeli University Journal of Education, 4*(1), 227-250. doi:10.33400/kuje.843306

Salloum, S. (2021). Intertextuality in science textbooks: implications for diverse students' learning. *International Journal of Science Education, 43*(17), 2814-2842. doi:10.1080/09500693.2021.1992530

Sever, C., Türeci, D., Artar, N., & Dağ, O. (2019). *Ortaöğretim Fizik 9 Ders Kitabı* [Secondary Physics 9 Textbook]. Ankara: Ministry of National Education.

Thurrodliyah, N., Prihatin, J., & Novenda, I. (2020). The Development of Brain-Based Learning Model based on Socioscientific Issues (BBL-SSI) for Biology Learning in Senior High School. *Electronic Journal of Science Education, 3*(2), 31-42.

Tsai, C. Y. (2018). The effect of online argumentation of socio-scientific issues on students' scientific competencies and sustainability attitudes. *Computers & Education, 116*, 14-27. doi:10.1016/j.compedu.2017.08.009

Tunç Şahin, C. (2022). The argumentation levels of social studies undergraduate and graduate students regarding socio-scientific issues. *Milli Eğitim Dergisi, 51*(236), 3031-3060. doi:10.37669/milliegitim.953144

Urhan, G. (2016). *An Examination of students' quality of arguments and informal reasoning skills in argumentation based learning environments* (Unpublished doctoral dissertation). Gazi University, Ankara.

Yapıcıoğlu, A. E., & Kaptan, F. (2017). A mixed method research study on the effectiveness of socioscientific issue-based instruction. *Education and Science, 42*(192), 113-137. doi:10.15390/EB.2017.6600

Yapıcıoğlu, A. E., & Atabey, N. (2020). Evaluation of trends in theses on socio-scientific issues: The case of Turkey . *International Journal of Progressive Education, 16*(4), 115-134. doi:10.29329/ijpe.2020.268.8

Yavuz Topaloğlu, M., & Balkan Kıyıcı, F. (2018). The effect of the activities carried out in out-of-school learning environments based on socio-scientific issues on the decision-making of the students. *Kastamonu Education Journal*, *26*(5), 1667-1678. doi:10.24106/kefdergi.2200

Yenilmez, Türkoğlu, A., & Öztürk, N. (2019). Pre-service science teachers' mental models of socio-scientific issues. *Başkent University Journal of Education*, *6*(1), 127-137.

Yıldırım, A., & Şimşek, H. (2016*). Sosyal bilimlerde nitel araştırma yöntemleri [Qualitative research methods in the social sciences]*. Ankara: Seçkin.

Yun, A., Shi, C., & Jun, B. G. (2020). Dealing with socio-scientific issues in science exhibition: A literature review. *Research in Science Education*, *52*, 99–110. doi:10.1007/s11165-020-09930-0

Walker, A. K., & Zeidler, L. D. (2007). Promoting discourse about socioscientific issues through scaffolded inquiry. *International Journal of Science Education, 29*(11), 1387-1410. doi:10.1080/09500690601068095

Zeidler, D. L. (2003). *The role of moral reasoning on socioscientific issues and discourse in science education.* Kluwer Academic Press.

Zeidler, D. L., Sadler, T. D., Simmons, M. L., & Howes, E. V. (2005). Beyond STS: A research-based framework for socioscientific issues education. *Science Education, 89*(3), 357-377. doi:10.1002/sce.20048

Zeidler, D. L., & Nichols, B. H. (2009). Socioscientific issues: Theory and practice. *Journal of Elementary Science Education*, *21*(2), 49-58. doi:10.1007/BF03173684

Zeidler, D. L., & Kahn, S. (2014). *It's debatable!: Using socioscientific issues to develop scientific literacy K-12*. NSTA Press.

Zeidler, D. L., & Sadler, T. D. (2023). Exploring and expanding the frontiers of socioscientific issues: Crossroads and future directions. In N. G. Lederman, D.L. Zeidler, & J.S. Lederman (Eds.), *Handbook of Research on Science Education, Volume III (pp. 899-929).* Routledge.