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Sustainable development and education through the eyes of science teachers: A case study in Turkey perspective

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Abstract

The aim of this study is to determine the knowledge of science teachers about sustainable development (SD) and to determine and examine their views on SD, the importance of SD, creating sustainability consciousness (SC), educational practices for sustainable development and the science curriculum within the scope of SD. The method of the research is a case study from qualitative research. The study group consisted of 25 science teachers. Seven semi-structured interview questions developed by the researcher were used as data collection tools. According to the results of the study, more than half of the teachers defined the concept of SD, while the other half could not define it or stated that they had no idea. Teachers who defined SD associated it with the environment, economy and society respectively. Science teachers agreed that SD is important. Teachers stated that SD is beneficial for future generations, that the lives of individuals would be endangered without SD, that there is SC in society and that education is necessary to create SC. In addition to this, teachers stated that education for SD includes or should include environmental education practices such as living by doing, travel, observation and examination, and environmental education practices provided by non-governmental organizations.

Keywords: Sustainable development; sustainability consciousness; education for sustainable development; science teachers; science lesson

1. Introduction

In recent years, our world is the critical crossroads due to serious challenges such as the COVID-19 pandemic, break out wars in Ukraine, Russia, Syria, Yemen, etc., growing economic inequalities, extreme weather events, and high inflation in energy and food prices. Perhaps the most important problem(s) at this crossroads is how to sustain the resources and future of our planet while developing wealth and prosperity for the

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population. This monumental task raises the urgency of a comprehensive transformation towards SD (Boeve-de Pauw, Gericke, Olsson & Berglund, 2015; Ozili, 2022; Stössel, Baumann & Wegner, 2021). Through a comprehensive transformation towards SD, it is possible to achieve a world that future generations also desire. This is because SD aims to meet the needs of present and future generations equally, to design a range of activities to meet those needs, to develop healthy societies, and to protect the life support systems of our planet (Al-Nuaimi & Al-Ghamdi, 2022; Kušljić, 2022; Waas, Hugé, Verbruggen & Wright, 2011). For this goal to be realized and a SD-based change and development to be achieved, all individuals, moreover, society, politicians and countries should support SD initiatives in all areas (Cholewa-Wiktor & Jakubiak, 2020; Şeker, 2023). At this point, education for sustainable development (ESD) is essential. It is aimed to support ESD and thus improve individuals' knowledge, attitudes, values and behaviors on SD. In this way, it will become possible to achieve a sustainable world (Spiropoulou, Antonakaki, Kontaxaki & Bouras, 2007).

ESD refers to the integration of learning and teaching of sustainability issues at both basic and complex levels so that individuals and societies gain first-hand experience in addressing socio-ecological problems (Munkebye et al., 2020). The role of education in SD is to provide individuals with knowledge, skills, attitudes, values and behaviors and to develop an understanding of SD. In this way, individuals will adopt sustainable living and will be able to apply their achievements in their lives (Baena-Morales, Prieto-Ayuso, Merma-Molina & González-Víllora, 2022). The aim is to achieve the personal and social transformation necessary for sustainable and just societies and to support social and economic development by not only combating environmental degradation but also poverty, hunger, etc. (Rieckmann, 2018). In this way, the bad trajectory resulting from the collective activities of human beings may change (Rieckmann, 2018). Although not all this responsibility lies with educators, they are recognized as key actors in steering the world towards sustainability. This change depends on their understanding of SD (Bridsall, 2015; United Nations [UN], 2020; United Nations Educational, Scientific and Cultural Organization [UNESCO], 2005). Therefore, it is very important that teachers, who have such an important role in building sustainable futures, are knowledgeable and equipped about SD and that teacher programs include courses and outcomes related to SD and education (Öztürk-Demirbaş, 2015). The view in many countries, including the United States, the United Kingdom, Canada, Taiwan, Hong Kong and Australia, is that it is difficult to realize SC and understanding of SD without the support of teachers (Yang & Lam, 2009).

ESD has been included in the curricula of many countries (Brandt, Bürgener, Barth & Redman, 2019; Dyment & Hill, 2015; Gustafsson, Engström & Svenson, 2015). In Turkey, the concept of SD was included for the first time in 2013 and later in the 2018 National Education Program. The development of the concept in education programs continues (Aydınlı, 2014; Kılıç, 2023). The content of education for SD includes science, social sciences and humanities as well as multiple disciplines. However, when the topics of SD are taken into consideration, it is seen that they mostly overlap with the topics of science courses (Warburton, 2003). In Turkey, science is one of the courses in which the concept of SD is introduced to students at the primary education level. Science teachers have the potential to shape the future through SD (Aydın & Subaşı, 2021; Er Nas & Şenel Çoruhlu, 2017;

Şeker & Aydınlı, 2023). To provide students with a good SD education, teachers should have sufficient knowledge, positive attitudes and opinions (McKeown, 2002; Summers, Corney & Childs, 2003; Winter & Firth, 2007).

To realize the ultimate goal of SD at micro, medium and macro levels, it is of great importance to take the views of science teachers who educate future generations on this issue. Because if science teachers' knowledge about SD is limited and their views are negative, the students they will educate may be unconscious and reluctant to take some actions to solve problems, and in such a case, it will become impossible to solve the problem (Rydzewski, 2023). On the other hand, the quality of education provided by science teachers who are conscious and equipped about SD and education will increase and individuals will lead a sustainable life and it will become possible to achieve a sustainable world (Çobanoğlu & Türer, 2015; Mckeown, 2012). Therefore, it is necessary to determine science teachers' knowledge and understanding of SD.

Considering the studies on sustainable development towards teachers; determining their views on SD (Aydın & Subaşı, 2021; Borg, Gericke, Höglund & Bergman, 2013; Dal & Okur Akçay, 2021; Er Nas & Şenel Çoruhlu, 2017; Ferguson, Roofe & Cook, 2021; Gustafsson, Engström & Svenson, 2015; Roger, 1998; Salite & Pipere, 2006; Türkmen, 2022), ESD (Arslan & Yağmur, 2022; Baena-Morales, Prieto-Ayuso, Merma-Molina & González-Víllora, 2022; Maidou, Plakitsi, & Polatoglou, 2019; Saqib, Zhang, Ou, Saqib, Majeed, & Razzaq), education and competencies for SD (Şeker & Aydınlı, 2021), SC (Çobanoğlu & Türer, 2015; Öztürk-Demirbaş, 2015), and education practices for SD (Anyolo, Kärkkäinen, & Keinonen, 2018; Dube & Lubben, 2011; Kang, 2019) are included. When the literature is examined, it is seen that there are relatively few studies to examine science teachers' comprehensive and holistic views on SD, although there are a wide variety of studies on SD.

The concept of SD is not well known and fully understood by teachers (Burmeister & Eilks, 2013; Karpudewan, Ismail & Mohamed, 2013; Summers & Childs, 2007; Summers, Corney & Childs, 2003). The fact that this study was conducted in a certain region in Turkey at a certain time is important because of the dynamic concept of the SD issue and because it reflects the views of teachers. In addition, taking the views of teachers will be a guide for the measures to be taken and policies to be developed with SD. In this direction, the aim of the study is to determine the knowledge of science teachers about SD and to determine and examine their views on SD, the importance of SD, creating SC, educational practices for SD and the science curriculum within the scope of SD in a comprehensive and holistic manner.

2. Method

2.1. Method of research

The design of this research based on qualitative research method is a case study. In a case study, at least one person, event, process or program is investigated in depth (Creswell, 2008). The main objective of the research is to reveal the views of science teachers who are predicted to have a certain knowledge and experience about SD, which is the subject of the research. Case studies have a nature of investigating a current situation

(Yin, 2003). Considering all these aspects, the case study design was preferred in this study since the views of science teachers on SD, which is a current issue, were examined and described in detail.

2.2. Study group

The study group of the research was determined by using homogeneous sampling technique, one of the techniques based on purposive sampling. With the use of this technique, it is aimed to create a small group that is like each other and to understand/define this group in depth (Creswell, 2008). In this context, the study group of the research consisted of 25 science teachers working in a relatively small provincial center in Turkey in the spring semester of the 2022-2023 academic year and willing to participate in the study. In order to create a homogeneous sample, teachers were selected with similar characteristics. In this context, all of the teachers were undergraduate graduates of the Department of Science Teaching. 18 of them were female and 7 were male; their professional seniority ranged between 10-15 years.

In Turkey, science teachers are trained with a four-year undergraduate education. During their undergraduate education, they take elective or compulsory courses related to environmental science and education such as Natural Energy Resources, Special Topics in Chemistry, Environmental Science, Conservation of Natural Life, Current World Problems, Biological Richness of Turkey, Science and Technology Related Problems, Chemical Wastes and Environmental Pollution, Renewable Energy Resources, SD and Education (Higher Education Council [HEC], 2018). Among these courses, the course named SD and Education, which is directly related to the subject of this study, has been added to the teacher training program as of 2018. In other words, considering the seniority of the science teachers participating in the study, it can be stated that they have not taken this course. However, SD is included as a unit in the Environmental Sciences course program, which is one of the compulsory courses in the program before 2018 (HEC, 2018).

2.3. Data collection tool

Semi-structured interviews with the study group were used as data collection tools. In this context, the researcher created a draft interview form based on the research topic and containing seven open-ended questions in parallel with the research question (Appendix A). The draft form was submitted to the review of three field experts and two science teachers. Then, a pre-application was conducted with three teachers to make sure that the questions worked well and to confirm whether there were any problems in the data collection process. No problems were encountered in the pre-application process and in the analysis of the data obtained from this application. Therefore, it was decided to use the form as is. The form includes items focused on SD and the importance and benefits of SD, SC and ESD

2.3.1. Data collection

Before the semi-structured interviews with the study group were conducted, a planning was made by contacting each teacher. A calendar was created according to the plans made in line with the day and time convenient for the teachers. The data were collected by the

researcher in an empty classroom in the schools where the teachers were working by adhering to this schedule. During the data collection process, the interviews were recorded with a voice recorder after obtaining the permission of the teachers. Before the interviews, the teachers were informed about the subject and purpose of the research, the importance of their sincere opinions for the research was emphasized, it was stated that no right or wrong answer was sought, and it was stated that their identity information would be kept confidential and the data would only be used for a scientific study. During the interviews, care was taken not to direct the teachers and notes were taken to prevent any data loss. The interviews lasted an average of 20 minutes per person and 498.7 minutes in total. At the end of the interviews, the audio recordings were transferred to the computer, transcribed one-to-one and turned into MS Word documents.

2.3.2. Data analysis

Preliminary preparations were made before starting the data analysis process. In this context, firstly, each interview was coded as T_1, T_2,...T_{25} in order to hide the names of the teachers. Then, the data analysis phase started. The data obtained through semi-structured interviews were analyzed using descriptive analysis and content analysis together. Content analysis was conducted by adopting Creswell's (2008) three-stage approach. This three-stage approach is the preliminary exploratory analysis, coding process and thematic analysis. In this context, in the preliminary exploratory analysis stage, all the data were read twice to gain a holistic perspective on the data and to get a general idea, and notes were taken on how the data could be organized during the readings. Afterwards, the Coding process was started as the second stage and coding was carried out at this stage. Following the individual coding, similar codes were grouped and unnecessary codes were discarded. In this process, another coding process was carried out to prevent a possible error and data loss. After the coding was completed, the third stage, thematic analysis, was started. At this stage, themes were created in related codes. To finalize the data, the coders came together and first discussed the main themes. After reaching a consensus on the main themes, the number of teachers and their number under each theme were discussed. As a result, the themes and the people in the themes were determined. In addition, while presenting the data, direct quotations from teachers' opinions were included. Criteria such as strikingness, explaining the theme in the best way, diversity and presenting extreme examples were taken into consideration in the selection of quotations (Ünver, Bümen & Başbay, 2010).

2.3.3. Validity and reliability

Some measures were taken to ensure the validity and reliability of this qualitative research. The validity of the research was ensured by informing the teachers about the interview before the interviews, consulting expert opinions while creating the interview form, confirming the teacher responses during the interviews, explaining the role of the researcher and including direct quotations while presenting the findings. To ensure the reliability of the research, the collected data were stored in a computerized environment,

the research process was reported in detail, and the codes and themes obtained through data analysis were discussed with another expert.

2.3.4. Role of the researcher

As a qualitative researcher, subjective judgments, opinions and thoughts were not included in this study both while collecting data (during the interview process) and while analyzing the data. While conducting interviews with teachers, care was taken not to direct them and to create an environment where they could express their thoughts comfortably. The stages of data collection and data analysis were described in detail and objectively. In addition, the researcher who conducted this study is an academic who has studies on ESD and conducts SD education courses. Therefore, it can be stated that the researcher also has a perspective on the subject and a certain level of knowledge. It is thought that this situation has positive reflections to manage the research process well.

3. Results

The findings obtained as a result of the analysis of the data collected to examine the views of science teachers on SD were grouped under the themes of definition and importance of SD, creating SC and ESD. Figure 1 shows these themes:

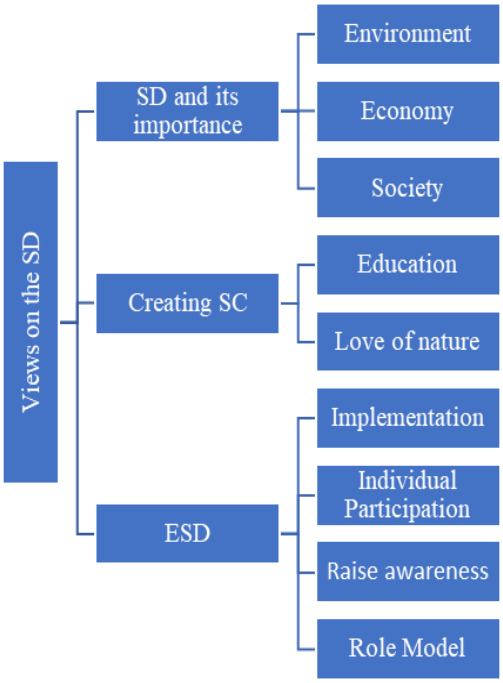

Figure 1. Themes formed regarding science teachers' views on SD

3.1. Views on sustainable development and its importance

The first question sought to be answered in the study is how science teachers define SD. In this context, the teachers were asked *"Have you ever heard of SD? What do you understand from this expression? How would you define SD?"*. When the teachers' definitions of SD were analyzed, a striking finding was that 9 of the science teachers could not give an answer to define SD or answered as "I have no idea". The views of T_{12} and T_{16}, who stated that they could not define SD or had no idea about the subject, are as follows, respectively:

T_{12}: *"Honestly, I have no idea. It's on the agenda a lot these days, but I don't know"*.

T_{16}: *"I cannot (think) of an explanation"*.

The 16 science teachers who knew and defined SD associated SD mostly with the environment (f=13), economy (f=9) and society (f=5) respectively. Teachers' views on the environment dimension are mostly in the form of leaving a cleaner, more livable world for future generations. In accordance with this theme, T_1's *"SD, i.e. sustainability, is to leave a cleaner natural environment for the people, generations and other living things that will live after us."* and T_7's "*SD is to strive to leave a more livable world to future generations. If the world continues to be misused at this rate, its expiration date will come."* In addition, T_{15} stated "*countries that ensure sustainability create a beautiful world for themselves and future generations. Also, the country's economy develops. Individuals live in a more prosperous environment."* and T_{18}'s statements *"SD protects the environment, develops the economy and enables individuals to live both comfortable and happy in a country with a developed economy and without environmental problems."* can be given as examples of the social and economic dimensions of SD.

Another question sought to be answered within the scope of the research was the views of the science teachers participating in the research on the importance of SD. Regarding the importance of SD, the teachers were asked the question *"What do you think is the importance of SD? Why do you think so? Can you explain?"* was asked and answers were received. In this context, all science teachers stated that they agreed on the importance of SD. The 9 teachers who could not provide a definition of SD and stated that they had no idea about it were asked why they thought SD was important despite their answers. These teachers stated that they knew and heard that SD is an issue that has been emphasized especially in recent years, but they did not know exactly what it was. The other 16 teachers who defined SD stated that SD is important in "creating a more livable world" and that it contributes to this. Teachers also stated that SD is important because it benefits the environment, economy and society.

It was determined that 15 science teachers who stated that SD is important because it provides benefits for the environment focused on leaving a more livable world to future

generations, protecting the natural balance and preventing environmental problems. Sample quotations regarding these views of the teachers are as follows:

T_{11}: *"Environmental problems are too many now and SD plays a role in both preventing and solving them. In this way, both the balance of nature is preserved and people are comfortable and live in a beautiful world. Countries develop".*

T_{21}: *"SD is the ability of the current generation to meet its own needs, but in this process, it is the ability to meet the needs of future generations. In other words, both current people and future people can live in safety. SD is a plan that aims for this. Poverty is eliminated, the planet is protected".*

T_{24}: *"Humans, animals and plants are part of nature. Natural resources are very important for each of us. If we want to benefit from these natural resources for many years, we need SD. With SD, humans, animals and plants can benefit from natural resources for many years".*

The science teacher who stated that SD is important because it provides benefits for the economy focused on development (f=10) and production diversity (f=3). Sample quotations regarding these views of the teachers are as follows:

T_8: *"SD makes a great contribution to the national economy. Savings are achieved, product diversity increases and resources are protected".*

T_{15}: *"Thanks to SD, countries develop economically, the balance of nature is preserved, and thus both the current generation and future generations have the chance to live happily and prosperously".*

T_{20}: *"SD is one of the prerequisites for social welfare. SD first develops the economy and then provides social welfare. We see that issues such as SD are very important in prosperous societies. Resources are protected and future generations are considered. When the economy is in place, the individuals who make up the society live at certain living standards both materially and spiritually".*

Teachers' views on the benefits of SD for society focused on future generations (f=18), social welfare (f=12), improving living standards (f=10), meeting the needs of individuals (f=9) and making people happy (f=7). Sample quotations regarding these views of the teachers are as follows:

T_3: *"SD is primarily important for future generations to be able to live comfortably, that is, in terms of leaving resources for them, and for us to live well, that is, happy".*

T_8: *"Why SD? Because we have needs that we need to meet from nature and it is necessary for their continuity".*

The views of science teachers on the importance of SD were once again analyzed with the question "If SD cannot be ensured, what are the foreseen damages? Can you explain?" question. The answers given by the teachers to the question of what would happen if SD were not given the necessary importance and sustainability is not ensured are presented in Table 1.

Table 1. Analysis of teachers' views on the anticipated harms if SD

Theme	f	%
Individuals' lives are endangered	21	84
Natural resources are depleted	18	72
Future generations will be left in the lurch	17	68
Environmental problems increase	15	60
Living things become extinct	14	56
Natural balance is disturbed	8	32
Economy deteriorates	3	12

When Table 1 is analyzed, almost all the teachers stated that the lives of individuals would be endangered if SD is not achieved. In addition, more than half of the teachers stated that future generations would be in a difficult situation and living things would become extinct. Only 3 teachers stated that the economy would deteriorate. Sample quotations regarding these views of the teachers are as follows:

T_{19}: *"Not giving importance to SD actually means disrupting the balance of nature and the whole world. As a result, natural resources are depleted, the lives of existing individuals are endangered, future generations are in a difficult situation. The animal generation, the quality of life of people, everything deteriorates. Diseases like covid and so on will always increase".*

T_{25}: *"Future generations may be in trouble. The lives of both individuals and other natural elements (such as animals and plants) may come to an end. At least their comfort level will decrease, this is clear. Resources are depleted and then the economy suffers. Environmental problems, perhaps disasters, natural disasters, increase. Living populations and the ecosystem are damaged. We may be endangered both economically and vitally. The habitats of animals and plants may shrink, all kinds of living populations may be harmed".*

3.2. Views on creating sustainability consciousness

In this theme, the teachers were first asked the question *"Do you think there is SC in Turkish society? Why do you think so? Can you explain?"* and the answers were obtained. All the science teachers think that there is no SC in Turkish society. The sample quote of a teacher regarding this view is as follows:

T_{3}: *"Regardless of the cultural level in our society, there is no awareness and knowledge of sustainability efforts and giving importance to it. Including us teachers".*

Then the teachers were asked the question *"What needs to be done to creating SC in individuals? Explain."* was asked and answers were received. One of the prominent findings related to this theme was education. Almost all the science teachers think that the most important way to creating SC is education (f=23). Under the education category, science teachers emphasized early education (f=13), family education (f=11), environmental problems awareness education (f=8), through lifelong learning policy, SD and environmental education (f=6). In addition, teachers think that there is a need for

various educational practices on SD for both students and adults. Sample quotations regarding these views of the teachers are as follows:

T_4: *"Environmental education is important for creating SC, and this should start at an early age before school. This alone is not enough, families should also be educated in this process".*

T_5: *"This SC should start to be created through education as a child. Again, adults should be given training to everyone around the child, especially the family. These trainings should be awareness oriented".*

T_{17}: *"People take lessons, they know something about environmental problems, but they probably do not act sensitively because they are not convinced of this. For this reason, effective education should be given at a young age and families should also be educated. All individuals from seven to seventy should have environmental awareness".*

In addition to these, a small number of science teachers believed children should be taught to love nature from an early age in order to creating SC (f=4). Science teachers who expressed this view stated that if love for nature or attitudes towards the environment are not formed in individuals from an early age, it is difficult for them to transform the knowledge they acquire into behaviors in their later lives. According to these teachers, parents should be role models and an intense contact with nature should be provided from an early age to create a love of nature in children. Sample quotations regarding these views of the teachers are as follows:

T_8: *"Children should be instilled with a love of nature when they are young. The best way to do this is to ensure that children spend a lot of time in nature and that families set an example with their behavior. When a child who loves nature grows up, it is easy to educate him/her about the environment. Otherwise, he knows the subject but does not act like it. You can post warnings everywhere if you want, but only those who love the environment will protect it. SD education is based on this foundation".*

T_{20}: *"SD education should be based on a solid foundation. This basis is to raise children who love the environment and then try to create awareness in them. The family should set a good example for the child and should not confine the child to homes".*

3.3. Views on educational practices for sustainable development

Science teachers were asked the question *"What kind of practices do you do within the scope of SD education? Could you explain?"* and answers were received. Fifteen of the science teachers stated that they do (or should do) practical activities based on learning by doing and experiencing. At this point, 13 of the teachers suggested that travel-observation-study activities, 8 of them suggested that environmental education activities organized by non-governmental organizations, and 5 of them suggested that environmental education with the theme of SD for everyone should be organized. Within the scope of environmental education activities organized by non-governmental organizations, teachers stated that they mostly participated in tree planting activities through TEMA foundation. Within the scope of SD-themed environmental education awareness training for all, teachers argue that SD-themed seminars should be organized for both children and adults, public service

announcements, and attention-grabbing posters and brochures should be prepared. Sample quotations regarding these views of the teachers are as follows:

T_1: *"From an early age, individuals should be given the opportunity to have a life intertwined with nature and the love of nature should be instilled. Afterwards, field trips would be very useful for SD, there may be public service announcements or posters".*

T_{18}: *"We cannot ignore that learning by doing and experiencing is more permanent, so SD education should be in this way. In this direction, field trips, active participation in non-governmental organization activities, inviting experts to schools and giving information to both students and families by organizing seminars would be useful".*

T_{10}: *"There was something like baby TEMA for the little ones, I can't remember exactly, it could be tiny TEMA, starting from there and participating in activities such as planting trees. There are many such organizations. Then, through field trips and observation, children can be trained and families can be made aware. This is the kind of education I would recommend for SD".*

In addition, 3 teachers stated that parents and teachers should be role models for the SD education process to result in positive learning outcomes. Sample quotations regarding these views of the teachers are as follows:

T_{11}: *"Children should participate in afforestation activities, have pets in the classroom or school, grow flowers, be given opportunities to spend time in nature, so that they first learn to love the environment and nature. Then, on the education side, nature trips should be organized and the teacher should be a model".*

T_{22}: *"First of all, students should be informed that no natural resource is infinite and will end one day. This is very important because if children have the perception that these resources will never end, it is very difficult to correct this. Then, attention should be drawn to situations related to SD such as energy saving at every opportunity, activities should be carried out to raise awareness of children on this issue, and the teacher should be a role model".*

Teachers were asked the question *"How do you evaluate the current science curriculum in the context of SD education?"* and answers were received. All the teachers stated that the Science curriculum is insufficient for SD education. Twenty of the science teachers stated that SD education came to the agenda for the first time in the eighth grade and that it was too late, that the subject was handled in a theoretical structure rather than a practical one, that the achievements were insufficient and that the course hours were too few. Sample quotations regarding these views of the teachers are as follows:

T_2: *"It is a subject that is covered only in the eighth grade and without going into too much detail. There is also ecological footprint calculation and look, even I, as a teacher, could not remember it after not being in this class for a few years. It will be similar for students".*

T_4: "*There is the subject of SD in secondary school eight. Eighth grade is too late. Children should receive this education as early as possible. Also, it is a unit that is recommended for*

six hours in eight, but a significant part of these six hours is focused on recycling and energy saving. So, the lesson time is also insufficient".

T_{10}: *"Education is a process, but when you include it in a single unit, this process is not provided. Children should be able to learn by doing and experiencing through methods such as projects. But this is almost impossible in the proposed time. In addition, the subject is handled very superficially".*

T_{24}: *"Of course, having a subject for the program alone will not be enough. It should be an application-oriented subject that supports students to learn by doing and experiencing".*

4. Discussion

Being aware of issues related to SD is very important for all citizens, especially for science teachers due to their roles mentioned above. Therefore, the first part of the study consists of science teachers' views on SD and its importance, the second part consists of their views on creating SC and the third part consists of their views on educational practices for SD. In this section, the topics are presented in this order.

4.1. Science teachers' views on sustainable development and its importance

While 16 of the science teachers participating in the study defined SD, 9 of them could not define SD and stated that they had no idea about the subject. Besides, the interesting result is that 9 of the science teachers could not define SD or stated that they had no idea about the subject. As a matter of fact, T_{12} stated *"Honestly, I don't have a complete idea. It is on the agenda a lot these days, but I don't know."*. The view of T_{12} creates the impression that even if the teacher has heard about SD, he/she cannot define SD because he/she is not aware of the concept or does not have sufficient knowledge. This unfortunately shows that a significant number of science teachers do not have any experience/opportunity to learn and work on SD. In the literature, there are similar studies indicating that teachers/pre-service teachers have not heard of SD or cannot define it and have no idea about it (Alkış & Öztürk, 2007; Arslan & Yağmur, 2022; Birdsall, 2015; Er Nas & Şenel Çoruhlu, 2017; Kang, 2019; Selvi, Selvi, Yıldırım, & Köklükaya, 2018; Spiropoulou, Antonakaki, Kontaxaki & Bouras, 2007). In Turkey, SD has been included in science curricula since 2018 (Ministry of National Education [MONE], 2018). It is quite thought-provoking and regrettable that science teachers do not hear, know or express any opinion on the subject of SD in the science curriculum. The prerequisite for the adoption of sustainability is hearing, knowing, taking responsibility, changing behavior and making it a way of life. Therefore, teachers who have not heard of SD or have no knowledge on the subject can neither be expected to lead a sustainable life nor to raise students in a well-equipped manner. Teachers' deficiencies in this regard will also negatively affect students (Çobanoğlu & Türer, 2015). However, teachers are just like students, they learn, teach and develop throughout their lives, and the teacher is seen as a sculptor who shapes the next generation (Anđić, 2020). In a study conducted by Şeker & Aydınlı (2021) with science teachers, it was found that teachers' being equipped and conscious about SD, transforming the knowledge they have acquired into a way of life and producing projects are among the competencies that teachers should have. The results of the study show that science

teachers' competencies in SD are also limited. Perhaps, when implementing SD in schools, it would be a more rational step to first mention these concepts to both teachers and students, to attract their interest in this issue and to make them aware of the issue.

It was concluded that the 16 teachers who stated that they had heard of SD and defined it were associated with the environment, economy and society dimensions of SD, respectively. This finding is in parallel with the environment, economy and society themes of SD in the literature (Arslan & Yağmur, 2022; Burmeister & Eilks, 2013; Güven Yıldırım, Önder, Tasdelen & Özel, 2022; Summers & Childs, 2007). However, as in other studies, it was determined that energy, politics, health and other dimensions of SD were not referred to (Alkış & Öztürk, 2007; Summers & Childs, 2007; Summers, Corney & Childs, 2005; Selvi, Selvi, Yıldırım, & Köklükaya, 2018). In addition, there are also studies indicating that individuals think that economic growth is necessary for the protection of the natural environment (Rydzewski, 2023). In this study, it was also determined that teachers' definitions of SD were generally in the form of leaving a clean and livable world for future generations. It can be concluded that teachers have some correct statements about SD, but there is no precise definition. This finding can be compared with other results in the literature. For example, Er Nas & Şenel Çoruhlu (2017) found that 38% of pre-service science teachers defined SD as *"transferring natural resources to future generations"* Similarly, in the study conducted by Selvi, Selvi, Yıldırım, & Köklükaya (2018) with pre-service science teachers, it was determined that students defined SD as meeting the needs of future generations, human-nature balance, protection of non-renewable energy resources, and no decrease in resources, respectively. In Alkış & Öztürk's (2007) study, pre-service teachers defined SD as long-term development, effective use of natural and energy resources, and management of both development and natural resources for future generations. When the views of science teachers on the importance of SD were analyzed within the scope of the research, it was concluded that all of the teachers agreed on the importance of SD. Especially when the opinions of the teachers who had no idea about SD or did not define SD were examined, it was concluded that the teachers knew the importance of the subject in recent years, heard about the subject, but did not know what SD was. On the other hand, teachers who defined SD and stated SD is important; stated that is considered as SD necessary and important for a more livable world, that SD is beneficial to the environment, economy, society and future generations, and that social welfare and the number of happy people will increase thanks to SD.

In cases where SD is not achieved, science teachers stated that the lives of individuals would be endangered, natural resources would be depleted, future generations would be in a difficult situation, the economy would deteriorate and the generations of living things would perish. Science teachers stated that if SD is not realized, the end of living things and the world will almost come to an end. Er Nas & Şenel Çoruhlu (2017) stated that science teachers consider SD necessary in terms of increasing the quality of life, raising awareness of individuals, establishing the balance between human and nature, and contributing to the country's economy and development. In the study conducted by Selvi, Selvi, Yıldırım & Köklükaya (2018) with pre-service science teachers, students stated that SD is important for future generations, not depleting resources, increasing the quality of life and preventing environmental pollution. presenting the results, you are in a position to evaluate and interpret their implications, especially with respect to your original

hypotheses. Here you will examine, interpret, and qualify the results and draw inferences and conclusions from them. Emphasize any theoretical or practical consequences of the results. (When the discussion is relatively brief and straightforward, some authors prefer to combine it with the Results section, creating a section called Results and Discussion.)

Open the Discussion section with a clear statement of the support or nonsupport for your original hypotheses, distinguished by primary and secondary hypotheses. If hypotheses were not supported, offer post hoc explanations. Similarities and differences between your results and the work of others should be used to contextualize, confirm, and clarify your conclusions. Do not simply reformulate and repeat points already made; each new statement should contribute to your interpretation and to the reader's understanding of the problem.

Your interpretation of the results should take into account (a) sources of potential bias and other threats to internal validity, (b) the imprecision of measures, (c) the overall number of tests or overlap among tests, (d) the effect sizes observed, and (e) other limitations or weaknesses of the study. If an intervention is involved, discuss whether it was successful and the mechanism by which it was intended to work (causal pathways) and/or alternative mechanisms. Also, discuss barriers to implementing the intervention or manipulation as well as the fidelity with which the intervention or manipulation was implemented in the study, that is, any differences between the manipulation as planned and as implemented.

4.2. Science teachers' views on creating sustainability consciousness

Science teachers were asked whether Turkish society is sustainability consciousness. In this regard, science teachers stated that there is no sustainability consciousness in Turkish society. As a matter of fact, T_3 said, *"Regardless of the cultural level in our society, there is no sustainability consciousness and knowledge such as an effort for sustainability and giving importance to it. Including us teachers."* can be given as an example. According to the Environmental Performance Index - 2022, which focuses on environmental awareness within the scope of SD and is conducted by Yale University every two years, Turkey ranked 172nd among 180 countries (Environmental Performance Index [EPI], 2022). This finding supports the views of science teachers because if there was sufficient a sustainability consciousness in all segments of society, Turkey could be ranked higher. Kaya, Çobanoğlu & Artvinli (2010) stated that there are not enough printed and visual materials raising public sustainability consciousness in Turkey and that qualified education is not provided in primary, secondary and higher education. Yüksel & Yıldız (2019), in a study conducted with high school students, found that 74% of the students were not aware of the concept of sustainability consciousness, and those who were aware of it were moderately aware of it. Kalsoom & Khanam (2017) emphasize that teachers' sustainability consciousness is low due to the paper, cardboard, and signs spent due to special day celebrations. Sustainability consciousness is a complex of cognitive and affective learning and its development requires transformative learning experiences. At this point, efforts should be made to increase the sustainability consciousness of Turkish society on SD to leave a more sustainable world for future generations (Erten, 2012; Karataş, 2014). Almost all the science teachers stated that education is the most important way to raise sustainability consciousness (Borg, Gericke,

Höglund & Bergman, 2013; Şeker & Aydınlı, 2023). In addition, it was concluded that science teachers emphasized the importance of early education, family education, environmental problems awareness education, lifelong learning, environmental education and nature love in order to raise sustainability consciousness. ESD provided in a holistic and applied manner will provide students with a new understanding of sustainability and a sense of responsibility in terms of environmental, economic and social dimensions. To ensure the continuity of SD, it is essential for individuals and society to become conscious, and in this way, as a result of the conscious choices made by each individual who makes up the structure of society, society will also become conscious and the world will become more livable (Alkış & Öztürk, 2007; Er Nas & Şenel Çoruhlu, 2017).

4.3. Science teachers' views on sustainable development education practices

Science teachers were asked what kind of practices they do in ESD and answers were received. When their opinions were evaluated within the scope of SD education, it was found that most of the teachers stated that they were or should be doing practices based on learning by doing and experiencing within the scope of SD practices. In addition to this, the teachers had suggestions that travel-observation-study activities, environmental education activities organized by non-governmental organizations and SD-themed trainings for everyone should be organized for SD education. Here, non-governmental organizations working for the benefit of society show activities to achieve a more sustainable world, and this view of teachers supports SD practices (Ateş, 2018).

Science teachers evaluated the current science curriculum in terms of SD and almost all the teachers stated that students first came up with SD in the eighth grade and that this was too late, that the subject was handled in a theoretical structure rather than a practical one, that the achievements were insufficient and that the course hours were too few. In a study conducted by Türkmen (2022) with science teachers, teachers stated that the course hours, intensive curriculum and exam-based education system prevented the implementation of SD. In a study conducted by Stössel, Baumann & Wegner (2021) with pre-service teachers, teachers stated that course hours and teaching materials are limited in educational practices for SD. Alkış & Öztürk (2007) examined the barriers of pre-service teachers in ESD practices. As a result, pre-service teachers stated that there were obstacles due to the curriculum, field experts, relevant politicians, lack of resources and time.

5. Conclusions

SD will only be realized when it is reduced to the lives of individuals. In this sense, individuals need to be knowledgeable, conscious and sensitive about SD and make it a way of life. Teachers are the ones who raise individuals at any level. In this direction, science teachers were selected as the study group since science subjects and SD issues are directly or indirectly related. Unfortunately, some of the science teachers participating in this study did not have sufficient knowledge and understanding of SD. Teachers associated SD with the environment more than the economy and society dimensions. Therefore, when science teachers' views on SD are evaluated holistically, it can be inferred that they do not

have sufficient knowledge. From this point of view, it is important that SD, which has a great importance for the future of our world, should be assimilated and adopted in all aspects by science teachers who play a key role strategically.

Teachers agree on the importance of SD and think that SD is important because it will benefit the environment, economy and society respectively. In addition, teachers think that if SD is not realized, the lives of individuals and living things will be endangered, natural resources will be depleted, environmental problems will increase and the economy will deteriorate. Teachers stated that there is no awareness of SD in the society and this awareness can only be realized through education. In addition, it was stated that for SD, environmental education practices organized by non-governmental organizations, such as living by doing, travel, observation and examination, and environmental education practices organized by non-governmental organizations are or should be included in educational practices. In the science curriculum, it was stated that it was late to include SD in the eighth grade, that it should be taught at a younger age, that the subject remained more theoretical than practical, and that it was insufficient in terms of achievement and time.

Although it may seem that educators have the biggest duty for the realization of SD all over the world, in fact, all individuals should take responsibility at this point. Teachers in other branches, especially science teachers, should be conscious and well-equipped about the subject and act in accordance with SD in their daily lives and be role models for individuals. Therefore, it is recommended that SD should be included in all branches starting from pre-school to higher education. Thanks to individuals who are conscious and knowledgeable about SD, their active participation in the face of regional and global problems can be ensured and thus SD goals can be achieved at the global level.

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Appendix A. semi-structured interview questions

1- Have you ever heard of SD? What do you understand from this expression? How would you define SD?

2- What do you think is the importance of SD? Can you explain why you think so?

3- What are the foreseen damages if SD is not achieved? Can you explain?

4- In your opinion, is there sustainability consciousness (SC) in Turkish society? Can you explain why you think so?

5- What needs to be done to creating SC in individuals? Could you explain?

6- What kind of practices do you do within the scope of ESD? Could you explain?

7- How do you evaluate the current science curriculum in the context of SD education?
