Different perspective on teaching socio-scientific subjects

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Article Info

ABSTRACT

In the ever-changing world based on the needs, curiosity and entrepreneurial drive of the humankind, interest in socio-scientific issues has been increasing every day with the discussion and different approaches in society. It could be suggested that the increase in this interest has been due to both the contribution and damages of these issues to the environment. The present study aimed to analyze the socio-scientific issues instructed with various strategies, methods and techniques in different learning environments in educational institutions as a result of the developments in science and technology due to social needs based on teacher perceptions. The study group included 50 teachers in different fields and employed in various schools in Turkey. The study sample was assigned with criterion sampling technique and the admission criterion was employment in Turkish public schools. In the study, the data were collected with a semi-structured interview form developed by the authors, and the findings were analyzed with content analysis. The study findings demonstrated that the teachers in the study group had different and significant perceptions on the instruction of socio-scientific topics in learning environments.

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1. INTRODUCTION

Throughout history, human beings have been in an effort to meet their needs. It can be said that this effort affects the quality of human life adventure in the world. In order to preserve this quality and raise it to higher levels, human beings are in constant interaction with science and the society in which they live. This interaction process has led to the emergence of new developments based on science and technology. It can be said that these developments, which affect human life both positively and negatively, cause some discussion topics on the basis of science and technology to take place in the education process. These issues, which are based on science and technology, are called socio-scientific issues. Socio-scientific issues include social dilemmas with conceptual, procedural or technological relations with science [1], [2]. It can be said that these subjects are tried to be conveyed to students in learning environments with various strategies, methods, techniques and materials on the basis of many fields of study and disciplines. These subjects, which are taught in the learning environment, increase the awareness of the students about the subject, as well as contribute to the development of their proficiency levels on socio-scientific issues. Therefore, more studies on socioscientific issues in classrooms are needed to improve students' decision-making abilities [3]. For this reason, it is very important that socio-scientific issues come to the fore in the education process.

It can be said that the developments in today's world related to socio-scientific issues affect the necessity of these issues to be included in the education world as a learning area, unit, theme, subject or achievement. It can be stated that the emerging necessity necessitates the examination of scientific articles and book studies on these subjects, international or national projects, research presented at scientific meetings, and the evaluation of the results obtained. Socio-scientific issues, the importance of which continues to increase day by day, and the teaching of these topics are among the most remarkable content and teaching activities of learning environments in the 21st century. Because socio-scientific issues support the development of individuals in scientific issues that concern society. Therefore, when individuals are taught these subjects, it is seen that they gain scientific thinking skills. Socioscientific teaching and learning supports meaningful learning in educational institutions [4]. Teachers who are responsible for conveying these subjects should take care to use activities suitable for the structure of the subjects in order for meaningful and concrete learning to take place. Teachers who enter the course to convey any of the socio-scientific issues can increase the students' curiosity and interest levels when they carry out activities according to the readiness level of the students in the learning environment. For this reason, the teaching of these subjects can be expressed as a very important situation in the education process.

2.   LITERATURE REVIEW

It could be suggested that learning environments acquired different dimensions with the increase in technology-based activities in learning and instruction activities of the study areas and courses in educational institutions. The employment of technologies in learning environments in educational institutions contributed to the development of active learning environments by facilitating the design of adequate instruction material for heterogenous student traits, enrichment of instructional environments and access to educational [5]. The above-mentioned efficiency reflects the increase in the attention, motivation and meaningful learning levels of the students who participate in the learning-instruction process. The level of the effectiveness of these criteria, which determine the efficiency in learning environments, depends on the study subject or discipline instructed in the environment. The characteristics such as the abstract or concrete acquisition of the instructed topics, materials used in interpretation and instruction, and the adequacy of the developed activities for the student level could be decisive in the learning level of the topic in that learning environment. Learning environment is significant especially in the instruction and interpretation of controversial, indefinite or subjective topics. One of the topics that require the above-mentioned function of the learning environments is socio-scientific topics.

Science and society have continued to influence each other since their first existence, and while science has fulfilled to the needs of the society, society has been affected by scientific studies [6], [7]. Today, individuals who are the elements of the society are more interested in scientific issues such as renewable energy sources, nuclear energy, genetically modified organisms (GMO), global warming, and these topics are part of the daily life [7], [8]. Furthermore, controversial current scientific issues such as genetics, global warming, euthanasia, vaccination, nuclear power plants and hydroelectric power plants has increased and decisions on these issues would affect the future of societies both regionally and globally [7], [9]. It could be argued that social awareness that has been effective on globalization and was a result of science and technology-based scientific literacy emphasized several scientific requirements. This led to the emergence of different social perspectives on the scientific changes and developments in different dimensions of life due to the interaction between science and society. These perspectives are socio-scientific issues that represent social dilemmas and problems associated with relative health, environment and techno-scientific innovations that are not based on precise outcomes but involve complex and controversial social and scientific [1], [10]. Socio-scientific issues that were the main theme of the present study have two main characteristics. These characteristics are the fact that the topics are associated with scientific topics and the social significance and importance of the topics [10], [11]. Since socio-scientific topics instructed in the instructional process in educational institutions include the themes that support the cognitive, affective and social development of individuals in socio-scientific topics, it could be suggested that the inclusion of these topics in education, instruction and curricula is a reflection of scientific literacy [12], [13]. Thus, it could be argued that it is an important indicator of socio-scientific topics in the process of decision-making on social issues associated with science in scientific literacy [13].

With the transfer of socio-scientific issues, which became significant in education in recent years, to the learning environment, various perceptions have formed among teachers, who are the instructor of these topics, and learners about the effectiveness of these topics [14], [15]. It could be suggested that these perceptions positively affected the perspectives on these issues in the instruction process. Although socio-scientific issues are mostly associated with the goals of science education [15], [16], these topics are based on events, facts and situations encountered in daily life, and it could be suggested that are associated with

several fields of study and science due to factors such as the fact that they were based on a controversial approach rather than an objective perspective of the society.

It could be suggested that the instruction of socio-scientific topics could be conducted with various methods in a world that has been transformed into a small village due to globalization. The propagation of socio-scientific issues by the media [17], which were described as one of the most important goals of modern science education by the American association for the advancement of science (AAAS), leads to certain problems for the comprehension of these issues by the society [18], [19]. Lack of activities based on learning by doing in the instruction of socio-scientific issues could be considered as one of the above-mentioned problems. The solution of these problems is associated with the competence levels of teachers, who are one of the important variables in learning-instruction environments, in the instruction of socio-scientific issues. acquisition of the required levels of knowledge and skills by the teachers could facilitate the solution of the problems. Due to the population growth in recent years, the need for increased diversity led to the interest in socio-scientific issues in Turkey. It could be suggested that this increasing trend still continues today with the scientific studies conducted to reveal the positive and negative effects of these issues on society and the environment.

The present study, which is a part of the same trend and conducted to analyze the necessary steps to eliminate the problems encountered in the instruction of socio-scientific topics based on the teacher perceptions, could be considered significant since it adopted a different dimension. In the present study conducted based on the above-mentioned significance, the remarkable perceptions of the teachers in the study group about the instruction of socio-scientific topics in learning environments were scrutinized. In the present study, which aimed to determine and analyze teacher perceptions about the instruction of socio-scientific topics in learning environments, the research questions on the study topic were determined: i) In your opinion, what are the most important characteristics of socio-scientific topics?; ii) Which strategies, methods, and techniques do you employ in the instruction of socio-scientific topics?; iii) In your opinion, what are the things that should be done in the learning environments where socio-scientific topics are instructed?; iv) Which problems you experience in the instruction of socio-scientific topics in learning environments?.

3.   RESEARCH METHOD

Socioscientific issues require individuals to make decisions on the grounds that they contain social dilemmas. Various skills can be gained by structuring these subjects in learning environments. For this reason, it is important how these subjects are taught in order to make effective decisions on socioscientific issues. In the present study, where the teacher perceptions on the instruction of socio-scientific topics in learning environments, the qualitative research method was employed. The detail of research method is presented in Figure 1.
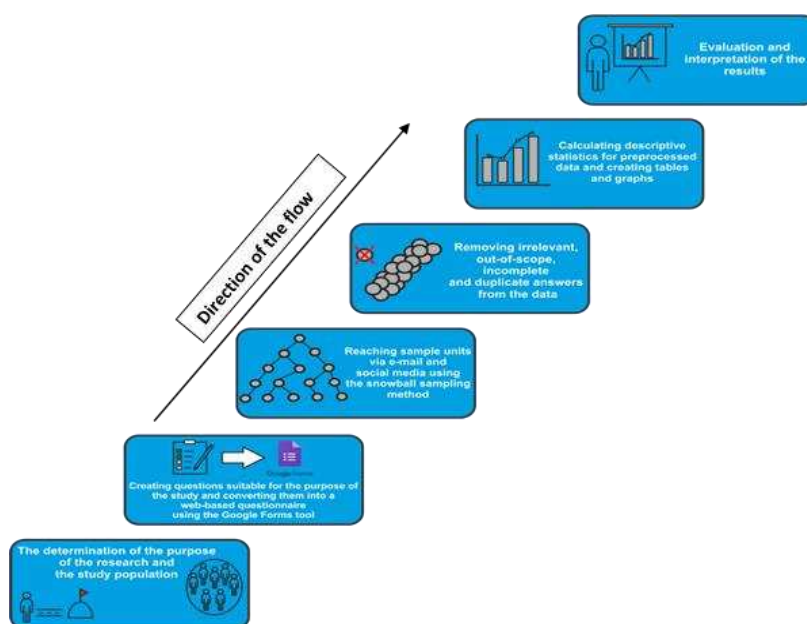

Figure 1. Methodological steps

3.1. Research design

The present study that aimed to analyze the instruction of socio-scientific topics in learning environments based on the perceptions of teachers, was designed as a phenomenological study. The phenomenological design focuses on cases that we are aware of but do not have an in-depth and detailed knowledge on. Facts could appear in various forms such as events, experiences, perceptions, concepts and situations in the world we live in. Phenomenology is an adequate ground for research on topics that are not entirely unknown but could not be fully comprehended [20], [21]. In this model, the researcher is interested in the personal (subjective) experiences of the participants and investigates the perceptions of the individuals and the meanings they attribute to the events. Phenomenology is a descriptive research method. Thus, it only aims to define facts, and do not generalize [21], [22].

3.2. Participants

In the present study that aimed to analyze the instruction of socio-scientific topics in learning environments based on the perceptions of teachers, the study group included 50 middle school teachers employed in public middle schools in Malatya, Kayseri, Konya, and Elazığ provinces in Turkey. Purposive sampling method was employed to assign the study group. The assignment criterion was employment as a teacher in public middle schools. The participation was on volunteer basis and each participant was informed about this fact prior to the study. To maintain the confidentiality of the participants, they were mentioned with codes in the study. The participant demographics are presented in Table 1.

Table 1. Demographic characteristics of the participants

Participant departments	Male (f)	Female (f)
Turkish teacher	5	5
Science teacher	9	6
Social studies teacher	8	7
Painting and music teacher	6	4

3.3. Data collection instrument

A semi-structured interview form developed by the authors was used to collect the study data on the perceptions of the teachers employed in various middle schools in Turkey about the instruction of socio-scientific topics in learning environments. During the development of the semi-structured interview form, initially the questions associated with the subject of the study were determined. Easy-to-understand, open-ended, focused questions that avoided guidance and multi-dimensionality were selected and they were organized logically [23], [24]. To ensure the content validity of the interview form employed in the study, the views of measurement and evaluation experts employed in Inonu University School of Education were obtained. It was stated that the form prepared by the experts was suitable for the purpose of the study and the questions were understandable. In addition, when the form was examined in the context of the content of the questions, it was concluded that it was in a balanced way. In this context, it can be said that the form as a whole and the questions in the form serve the purpose and represent the content of the subject. The semi-structured interview form was finalized based on the views and suggestions of these experts. The form included 4 questions. The participants answered these questions in writing and the completed forms were collected and analyzed by the authors.

3.4. Data analysis

In the study, the perceptions of the teachers in the study group that were collected with a semi-structured interview form were analyzed using the content analysis technique. Qualitative analysis was conducted on the semi-structured interview forms. The data were analyzed with a computer. The data analysis results and the developed sub-themes are presented with computer-generated figures. The sub-themes determined by the authors in the study were based on similar participant responses to the semi-structured interview form questions. Thus, the data on teacher perceptions about the instruction of socio-scientific topics in learning environments were analyzed by grouping participant views into certain themes with the content analysis technique. To ensure the reliability of the study, the expert opinions were obtained. The authors and experts developed the main and sub-themes. The themes that were determined in the analyses were classified and visualized to exhibit the correlations. The number of the participants that mentioned the theme and similar views were classified in 4 categories and presented as K.1, K.2, K.3, and K.4. The agreement and disagreement between the authors and the experts were determined for each theme. The analyses were conducted by the authors and the two experts and the agreement rate was calculated with the Miles and Huberman [25] formula.

4. RESULTS

4.1. The characteristics of socio-scientific topics

The responses of the study group teachers to the semi-structured interview form question "What do you think are the most important characteristics of socio-scientific topics" were analyzed with content analysis and the data are presented in Figure 2. As seen in this figure, the analysis of the sub-themes determined based on the perceptions of the participants revealed that the teachers in the study group had different and significant perceptions. The sub-themes based on the participant perceptions included openness to discussion (f-16), and interpretability (f-14). The fact that socio-scientific topics were open to discussion according to the teachers could suggest that teachers were aware that socio-scientific topics were not based on an objective perspective. Sample views of the participating teachers on the findings presented in Figure 2 are presented:

> *"As a science teacher with 10 years of experience, I can respond this question, where the most important characteristic of socio-scientific topics was asked, by stating that they promote debate in the society. Examples of these topics include nuclear power plants. The controversial aspect of this is that a part of the society supports the view due to positive economic results of the construction of these plants, while others argue that they should not be constructed due to environmental problems. Therefore, I can say that the most important characteristic of these topics is that they are open to discussion."* (Participant 7)

> *"In my opinion, the most important characteristic of socio-scientific topics is that they are associated with daily life. I think that their content includes daily life situations, making these issues easier to understand and learn for the students in learning environments. I also think that the interest in these issues was due to their association with daily life."* (Participant 49)
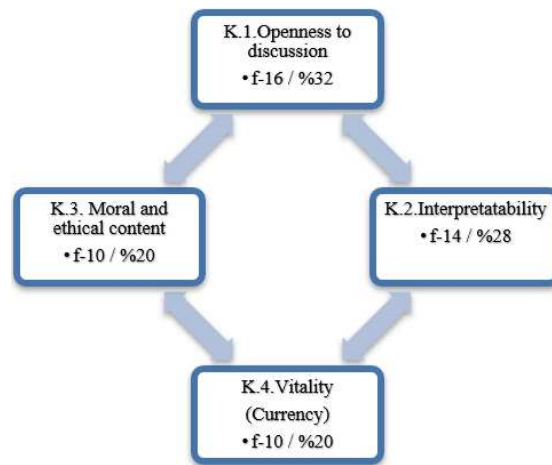

Figure 2. Perceptions on the characteristics of socio-scientific topics

4.2. The introduction of socio-scientific topics

The responses of the study group teachers to the semi-structured interview form question "What are the strategies, methods and techniques you employ in the instruction of socio-scientific topics" were analyzed with content analysis and the data are presented in Figure 3 in sub-themes. As seen in Figure 3, the analysis of the sub-themes determined based on the perceptions of the participants revealed that the teachers in the study group had significant perceptions. The review of Figure 3, where the findings of the second question in the semi-structured interview form are presented, demonstrated that there were significant sub-themes. The review of Figure 3, where the study findings are presented, demonstrated that the participating teachers emphasized the use of various strategies, methods and techniques in the instruction of socio-scientific topics. Based on this observation, it was determined that the predominant findings in Figure 3 included research, investigation-discussion-experiment (f-18) and discovery-discussion-laboratory (f-14). Sample views of the participating teachers are presented.

"Since I think that socio-scientific topics should be instructed with learning by doing oriented activities in the learning-instruction process in the learning environment, it is necessary to use strategies, methods and techniques that involve them in the process and make them active in the process. In these, I think that research and investigation strategy, discussion method, experimentation technique should be adopted." (Participant 20)

"*If we aim our students to learn socio-scientific topics in a meaningful way in our learning environments, we should organize the learning environment based on the material we would use. However, sometimes it is not enough to do this. To increase the competence level, we should pay attention to the choice of strategy, method and technique in the instruction of topics. I think that the discovery strategy, discussion method and laboratory technique that could reveal the subjective perspective of the student should be used in socio-scientific topics."* (Participant 21)
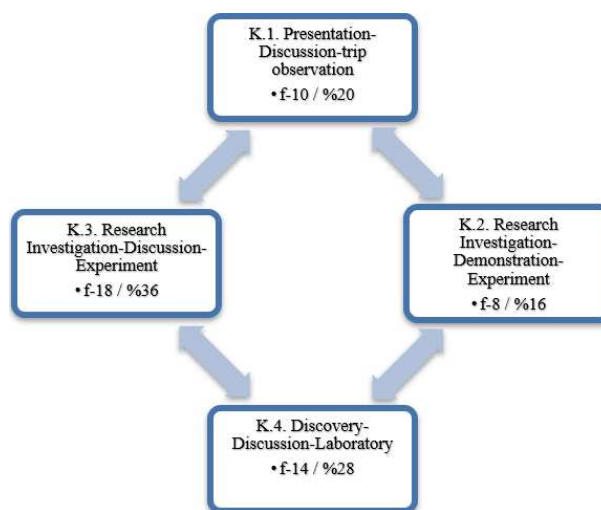

Figure 3. Perceptions on the strategies, methods, and techniques employed in the instruction of socio-scientific topics

4.3. The learning environments where socio-scientific topics are instructed

The responses of the study group teachers to the semi-structured interview form question "What do you think should be done in learning environments where socio-scientific topics are instructed" were analyzed with content analysis and the data are presented in Figure 4 in sub-themes. As seen in Figure 4, the analysis of the sub-themes determined based on the perceptions of the participants revealed that the teachers had significant perceptions. The review of Figure 4, where the findings on the perceptions of the participating teachers are presented demonstrated that they had different perceptions including 4 sub-themes associated with the required organization of the learning environments where socio-scientific topics are instructed. Based on these perceptions, it was observed that the sub-themes based on frequencies and percentages included multiple learning environments (f-15) and organization of reflection and instruction-based activities (f-13). Sample views of the participating teachers are presented.

"As a teacher, I think socio-scientific topics should be instructed with an interdisciplinary design. Therefore, I do not think that these topics could be instructed effectively in learning environments where courses are instructed. Learning environments should be organized to include the tools and material suitable for the content of these topics. Selection of technological material could allow more effective instruction. For example, I believe that a social studies teacher instructing global warming would benefit from technology in the classroom and allow the students to watch global warming videos would improve the quality of the learning-instruction process." (Participant 11)

"In learning environments where socio-scientific topics are instructed, we, the teachers, who are the managers of the course, should include different applications on the topic. These applications should include diverse methods, tools and activities. I think that this diversity would contribute to the organization of multiple learning environments. I think that instruction of these remarkably current topics in multiple learning environments would improve the meaningful learning levels." (Participant 4)
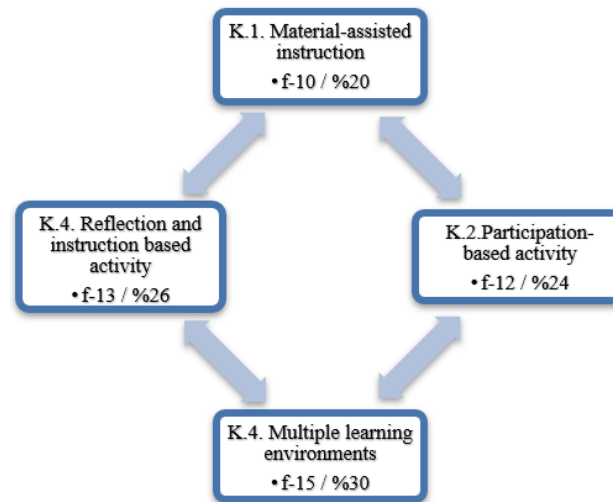

Figure 4. Perceptions on the instruction environments of socio-scientific topics

4.4. The problems encountered in the instruction of socio-scientific topics

The responses of the study group teachers to the semi-structured interview form question "What are the problems you encounter in the instruction of socio-scientific topics in learning environments" were analyzed with content analysis and the data are presented in Figure 5 in sub-themes. As seen in Figure 5, the analysis of the sub-themes determined based on the perceptions of the participants revealed that the teachers had significant perceptions. The fact that teachers had different perceptions could suggest that they encountered problems in the instruction of sociological socio-scientific topics in learning environments. The diversity of the problems faced by participating teachers in learning environments associated with socio-scientific topics may indicate that the competency of the teachers who instructed the course was not at a desired level.

The review of Figure 5, where the problems encountered in the instruction of socio-scientific topics in learning environments were grouped under four sub-themes based on the perceptions of the teachers, demonstrated that the prominent sub-themes were "technology-based instruction problems (f-15) and program-based problems (f-13). The prominence of these sub-themes was due to the frequencies and percentages of these themes. Sample views of the participating teachers are presented.

"As a social studies teacher, I can say the following in response to the question on the subject. When I answer your question based on my course, I experience time constraints when instructing socio-scientific topics such as global warming, nuclear energy and power plants, and environmental problems. The main reason for this is the insufficient achievements and activities on these issues in the programs." (Participant 3)

"The problems we encounter in the instruction of socio-scientific topics in learning environments vary based on the course and the curriculum. Since I am a science teacher, we cover many of these topics in our course. However, if you ask if it is sufficient for meaningful learning, I would say no. Because although these are current issues in daily life, I think that the lack of diverse resources that include various perspectives is the most important problem." (Participant 44)
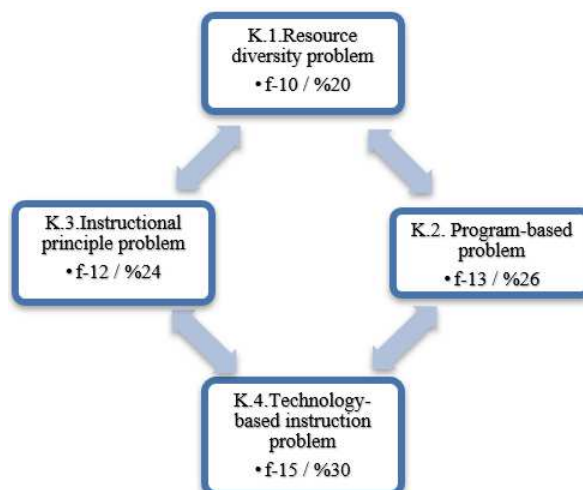
Figure 5. Perceptions on the problems encountered in the instruction of socio-scientific topics

5. DISCUSSION

The participant perceptions that they experienced instructional problems were consistent with the report by Tosunoğlu and İrez [26] that the instruction of socio-scientific topics in the learning-instruction process should be directly associated with the social and activities. Furthermore, this study finding was similar to reports by Aikenhead [27], Ratcliffe and Grace [28] that studies on the instruction of socio-scientific topics, primarily students were interested in real topics that could be encountered in daily life and they were motivated to learn such topics. Socio-scientific topics are directly or indirectly included in several study areas and the curricula of several disciplines, and especially in science education in Turkey. When the currency and significance of these topics are considered, technology-assisted material should be used in the learning-instruction process. Although there are several videos on these topics in the ministry of national education (Education Information Network/EBA) system, the fact that they were not used in the process was emphasized as a problem in the present study. Employment of these resources could contribute to the improvement of the meaningful learning level of students and their participation in the learning process.

The finding about the necessity of including activities that allow students to participate in the learning-instruction process in the learning environments where socio-scientific topics are instructed was consistent with the report by Ekborg *et al*. [29] that the students who were active in the instruction of socio-scientific topics improve their evaluation, analysis, decision making and collaboration skills that contribute to scientific literacy, while contributing to the field content and the report by Dawson [30] that the students who were active in the instruction of socio-scientific topics acquired high reasoning skills and improved their field knowledge, as well as their level of awareness on these topics and argumentation skills. It could be suggested that the study finding on the necessity of the organizations for the instruction of these topics with reflection-instruction and participation-based activities in learning environments were important in contributing to the learning outcomes of the students. This finding scientifically supported the report by Zengin *et al*. [17] that active participation-based instruction of socio-scientific topics increased environmental sensitivity and critical thinking skills of the students as well as their sensitivity towards social issues.

One of the findings on the instruction of socio-scientific topics in learning environments based on the perceptions of teachers was the data on the characteristics of socio-scientific topics. These study findings were consistent with the report by Zohar and Nemet [31] that socio-scientific topics are those that allow the individual to acquire critical thinking, questioning and scientific discussion skills, and with the report by Zeidler and Nichols [32] that socio-scientific topics include certain moral judgments and ethical assessments. It was noteworthy that the participating teachers emphasized the necessity of the employment of the method of discussion in the instruction of socio-scientific topics among the sub-themes determined in the study. It could be suggested that the emphasis on this method in socio-scientific topics that are not based on objective judgments was significant since these topics could be interpreted based on subjective approaches. It could be suggested that the emphasis on this method in socio-scientific topics that are not based on objective judgments could be due to the fact that these issues could be interpreted based on different subjective approaches. This study findings was consistent with the report by Gülhan [19] that the instruction of socio-scientific topics with discussion activities provides more meaningful learning when compared to constructivist approach activities and increases student literacy.

Based on the findings on instruction techniques sub-theme presented in Figure 3, it could be observed that the trip technique was included among others. The preference of this technique in the instruction of socio-scientific topics could contribute to the concrete, permanent and meaningful learning by providing concrete experiences for the students based on learning by doing and living. This study finding was consisted with the report by Topçu and Atabey [33] that field trips on socio-scientific topics improved students' argumentation skills and more students started questioning after the field trip. When the results of the studies carried out are compared, it is seen that the excursion technique is preferred in the teaching of socioscientific issues. This result shows that the excursion technique can provide individuals with a permanent and meaningful learning opportunity with concrete data, and can gain scientific thinking skills. The preference of this technique in the instruction of socio-scientific topics could contribute to the concrete, permanent and meaningful learning by providing concrete experiences for the students based on learning by doing and living.

6. CONCLUSION

In the present study, where the instruction of socio-scientific topics in learning environments was analyzed based on teacher views in Turkey, several significant findings were obtained. The findings suggested that teachers had different perceptions on the instruction of socio-scientific topics in learning environments in Turkey. In the study, significant findings were obtained on the topic based on the content analysis conducted on teacher perceptions obtained with a semi-structured interview form on the instruction of socio-scientific topics. The study findings were detailed in four categories. These are presented in the form of findings associated with the problems encountered in the instruction of socio-scientific topics, the instruction environment, the method of the instruction of socio-scientific topics (strategy, method and technique) and socio-scientific topics. One of the categories where study data was analyzed with content analysis included the findings associated with the problems encountered in the instruction of the topics. These findings included the recognition of instructional principles in the instruction of socio-scientific topics in learning environments (from concrete to abstract, clarity, association with daily life, currency, from unknown to unknown, from close to far, from simple to complex), insufficient resource diversity on these topics, curriculum and technology-based instruction of the topics.

Inclusion of concrete and current activities associated with daily life and necessary for social life in the instruction of socio-scientific topics in learning environments could contribute to a better comprehension of these topics by the students. One of the findings on the instruction of socio-scientific topics in learning environments based on the perceptions of teachers was the data on the characteristics of socio-scientific topics. Based on teacher perceptions, findings that included four different sub-themes were obtained. These findings were openness to discussion, interpretation, moral - ethical content and currency. Hence, the participating teachers described socio-scientific topics as current, debatable, moral and ethical issues. Another significant study finding was on the things that should be done in learning environments where socio-scientific topics are instructed. Based on the findings obtained with the participating teacher perceptions, significant sub-themes were developed.

Based on the study findings, there are several recommendations about the instruction of socio-scientific topics in learning environments in Turkey. The learning environments should be organized based on the characteristics of the socio-scientific topics instructed in courses in Turkey. Inclusion of further socio-scientific topics in the learning environments for different study areas and disciplines should be planned in Turkey. The strategies, methods, and techniques that would allow the active participation of the student in the instruction of these topics should be preferred in learning environments in Turkish educational institutions. Technology-assisted activities on the characteristics of socio-scientific topics should be developed and these should be employed in learning environments to allow concrete learning. Diverse resources on these topics should be provided to include activities that would allow the improvement of the student awareness.

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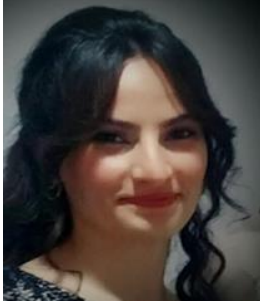
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