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Turkish Chemistry Teachers' Views about Secondary School Chemistry Curriculum: A Perspective from Environmental Education

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Abstract

Teachers' views about environmental education (EE) have been regarded as one of the most important concerns in education for sustainability. In secondary school chemistry curriculum, there are several subjects about EE embedded in the chemistry subjects in Turkey. This study explores three chemistry teachers' views about to what extent the subjects related with EE should be integrated into secondary school chemistry curriculum at an individual level of analysis. The findings of the study indicate that there is a consensus among teachers on the inadequacy of secondary school chemistry curriculum for providing students an effective EE. However, there is an inconsiderable divergence among the teachers' views about the placement of subjects about EE in chemistry curriculum and the integration of subjects about EE into the curriculum. Through the results of the study, policy makers and curriculum developers would gain a comprehensive insight about deficiencies in chemistry curriculum for EE from the point of view of chemistry teachers and they would have opportunity to realize the ways for the remedy of this deficiency.

Key words: Environmental education, chemistry curriculum.

Introduction

It is clear for all mankind that the decline in the vitality of the planet is almost everywhere, which mainly results from population growth, industrial discharges, consumption patterns, solid wastes disposal, and domestic wastewater discharges, etc. However, we still have the chance to recover this tendency in declining through taking the necessary precautions before it is too late. Therefore, EE takes its place as one of the key means of reacting in the face of environmental threats (Teksoz, Sahin, & Ertepinar, 2010).

Environmental education can be defined in a general view as the education process dealing with humankind's relationship with the natural and human-made surroundings, and includes the relation of population, pollution, resource allocation and depletion, conservation, transportation, technology, economic impact and urban and rural planning to the total human environment (Peterson, 2007). Thus, the concept EE involves knowledge and comprehension about ecological, social and political processes and their influences (Bartuseviča, Cēdere, & Andersone, 2004). In Tbilisi Declaration which was created in the first Intergovernmental Conference on Environmental Education, the goals of EE stated as (1) to foster clear awareness of, and concern about, economic, social, political, and ecological, interdependence in urban and rural areas; (2) to provide every person with opportunities to acquire the knowledge, values, attitudes, commitment, and skills needed to protect and improve the environment; (3) to create new patterns of behavior of individuals, groups, and society as a whole towards the environment (UNESCO, 1977). The Tbilisi Declaration has been used as a grounding document to outline what EE is and how it should be taught in various contexts.

There are many advantageous aspects of EE. The teachers perceived that EE was not only a way to teach about the environment, but also an innovative way to achieve basic educational goals like reading and student skills Besides becoming more aware of the environment and environmental issues, students would learn to care about the environment and appreciate nature, students would learn of their impact on the environment, and students would realize their responsibility for the earth (Middlestadt, Ledsky, & Sanchack, 1999).

Environmental education has a wide extent ranging from environmental pollution (water pollution, air pollution, soil pollution, noise pollution, solid wastes, and hazardous wastes), global warming (climate

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change), environmental cycles (C, H₂O and N₂ cycles), biodiversity, energy usage, health education, to resolution of environmental problems (recycling, renewable energy sources, population and environment)

(Teksoz, Sahin, & Ertepinar, 2010). EE subjects are interdisciplinary in nature, thus the extent to which discipline-oriented teachers are able to deal with interdisciplinary subjects is the limiting factor for introducing environmental issues as an integral part of the science curriculum (Gough, 2002). The issues within the scope of EE should be integrated into the curriculum of all the natural sciences because the environmental issues are not separate from problems of chemistry, physics and biology (Bartuseviča, Cēdere, & Andersone, 2004). In addition, the issues related to EE should be in the core of science curriculum. According to Edelson (2007), the reasons why the issues related to EE should be included in the core of secondary school science curriculum are (i) they are important for students and society; (ii) they are representative of contemporary science in ways that the disciplinary courses that currently comprise the core curriculum are not; (iii) they create an opportunity for students to experience an applied science; (iv) they are particularly engaging context for learning fundamental science. Implementation of EE in secondary school depends on both school curricula and teachers' environmental competencies.

Integrating the issues related EE into secondary school chemistry curriculum would be an effective means in order to come over the problem of discrepancy between the chemistry curriculum and the information necessary for life in modern society and to gain students a meaningful mode of chemical thinking and understanding attitude towards environmental processes and skills which are useful for practical life (Feierabend, Jokmin, & Eilks, 2011). Therefore, in secondary school chemistry curriculum, an approach that establishes a joint between chemistry and environmental issues should be adopted by curriculum designers. Moreover, many researchers have suggested that teaching chemistry in the context of real-world issues as a way that motivates and interests students (Hofstein, Eilks, & Bybee, 2011; Holbrook & Rannikmae, 2007, 2009; Marks & Eilks, 2009, 2010). Thus, integrating more environmental issues in chemistry curriculum would provide students a better understanding about the relation of chemistry with daily-life. According to the findings of the study of Mandler, Mamlok-Naaman, Blonder, Yayon, and Hofstein, (2012) using more environmental examples in teaching chemistry increase students' awareness towards environmental issues, especially issues that are connected to their everyday lives and students see chemistry as a way of better understanding and as a better way of solving environmental problems. Moreover, a five-year evaluation report on Chemistry in the Community (ChemCom) which was published in 1992 concluded that students wanted to learn chemistry through environmental contexts (Sutman & Bruce, 1992).

According to the literature, there is a clear consensus among researchers about integrating environmental issues in science curriculum in general and in chemistry curriculum in particular (Edelson, 2007; Ernst, 2007; Hofstein, Eilks, & Bybee, 2011; Holbrook & Rannikmae, 2007, 2009; Lieberman & Hoody, 1998; Marks & Eilks, 2009, 2010; Sutman & Bruce, 1992). In the last decade many studies have been conducted about the integration of EE in science education and implementation of EE in secondary schools (American Chemical Society, 2006; Benett & Lubben, 2006; Hofstein & Kesner, 2006). However, in science education literature there has not been any study that directly studies on the extent to which subjects related with EE should be integrated into science or chemistry curriculum. This study aims to fill this gap in the literature. The purpose of this study is to explore Turkish chemistry teachers' views about to what extent the subjects related with EE should be integrated into secondary school chemistry curriculum at an individual level of analysis. The findings of this study would be mainly important for curriculum designers and policy makers on the account of the fact that it reflects chemistry teachers'-as implementers of curriculum- views about how and to what extent EE can be embedded into chemistry curriculum. Through the findings of this study, policy makers and curriculum developers would have opportunity to comprehend and realize what the deficiencies are in chemistry curriculum and problems in implication of the curriculum for conveying EE in chemistry. The research question of this study is "To what extent the subjects related with EE should be integrated into secondary school chemistry curriculum according to Turkish chemistry teachers?" and the sub research questions used in this study are as follows:

- (1) To what extent, do chemistry teachers regard the chemistry curriculum including subjects for environmental education?
- (2) According to the chemistry teachers, which subjects about EE should be added on or removed from the secondary school chemistry curriculum and what are the reasons for those additions or removals?
- (3) According to the chemistry teachers, what should be the placements of the subjects about EE in chemistry subjects in secondary school chemistry curriculum and what are the reasons for those placements?

The Study

The case-study approach was chosen as a research method in the study due to its robust grounding in reality, accessibility to teachers and its ability to generate a detailed and rich narrative. Generalization takes the form of ‘theoretical inference’ in which the conclusions move beyond the individual cases to a more general and a theoretical level (Hammersley, 1998).

Participants

The findings presented in this paper are based on detailed interviews undertaken with three experienced chemistry teachers, Sevil, Enis and Ersin in three secondary schools located in different cities in Turkey as a part of research. Table 1 provides some brief biographical details about the participants involved. Each participant has been working in different cities in Turkey. All of the participants have never before taken any courses on EE in their undergraduate education and they also have not attended any in-service training about environmental education.

Table 1. Details of research participants

	Teacher 1: Sevil	Teacher 2: Enis	Teacher 3: Ersin
Years teaching	8	11	12
Gender	Female	Male	Male
School type	Public	Private	Public
School size	1000	500	1200
School situation	Urban	Urban	Urban
Age	33	35	37

Data collection

The researcher conducted semi-structured interviews with experienced chemistry teachers for the purpose of gathering information directly from participants’ mind. One-on-one interviews were conducted by telephone by using open-ended interview questions in Table 2. Therefore, the response modes used in the interview was unstructured. Each interview lasted for about 30 minutes and interview protocols were used during the interviews.

Table 2. Interview questions in relation to the research questions

Interview Questions	Relation to the Research Question
To what extent is chemistry curriculum related to environmental education?	1 st research question
In chemistry curriculum which subjects include topics related to environmental education?	1 st research question
<i>Are they adequate for an effective environmental education?</i>	1 st research question
<i>Do you emphasize sufficiently on those subjects?</i>	1 st research question
Which of the following environmental issues should be in the chemistry curriculum? Why? a. Water pollution b. Solid wastes c. Hazardous wastes d. Global warming e. Air pollution f. Loss of biological diversity g. Consumption patterns	2 nd research question

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- h. Deforestation
 - i. Noise pollution
 - j. Soil pollution
 - k. Population and environment

- l. Environmental cycles (C, H₂O and N₂ cycles)
- m. Energy usage

2nd research question

In which chemistry subjects should those be integrated?

Beyond the scope of current chemistry curriculum, are there any environmental issues which are discussed in the class? 2nd research question

If yes, in which chemistry subjects should those subjects be taught? Why?

3rd research question

Do you think that environmental education should be a separate must course rather than being in chemistry curriculum? Why? 3rd research question

Analysis of Data

The Turkish secondary school chemistry curriculum was investigated in detail and related to EE the aims and the subject matters were listed in order to validate what the interviewees stated about the curriculum and the curriculum itself. During the interviews, I checked whether interviewees' statements matched up with the curriculum or not and the issues which were not overlapped were questioned to clarify whether the interviewees omitted those issues in the lessons or forgot to state to the interviewer. Moreover, in order to validate the accuracy of findings, I got feedback from participants about the final reports about the interviews. All participants affirmed the reports without a disagreement. Furthermore, an expert scholar in the field reviewed and asked questions about the study from beginning to the end.

Findings

The study revealed a remarkable degree of similarity among the views of the three chemistry teachers on the inadequacy of chemistry curriculum for providing students an effective EE. Moreover, data from all chemistry teachers suggest that subjects related to EE were not taught appropriately in the lessons. However, despite their apparent agreement about inadequacy of chemistry curriculum, the picture which emerged from detailed analysis of the interview data showed that there is a disagreement about the integration of EE subjects into the chemistry curriculum and proper placements of those subjects in the chemistry curriculum.

To what extent, do chemistry teachers regard the chemistry curriculum including subjects for environmental education?

All of the teachers agreed that the chemistry curriculum was inadequate for providing students an effective EE and the chemistry curriculum did not treat environmental subjects in a wide coverage:

I think our curriculum doesn't include subjects related with environmental issues, its relation to EE is superficial and narrow-scoped, and also it's not sufficient to develop students an understanding about environmental issues. (Sevil)

The chemistry curriculum doesn't mention a lot about the importance of environment and the effects of people's behaviours on environment ... and although chemistry is very closely related to environment, the curriculum doesn't give chance for an effective environmental education. (Ersin)

Moreover, all teachers similarly stated that existing subjects related to EE were not taught appropriately due to several reasons which were the time allocated for those subjects, the placement of those subjects in the curriculum and technical reasons in that teachers could not test some subjects as they were taught after the final examination of the semester:

There are only two subjects related with environmental education that I focus in lessons. One of them is a separate unit titled as 'Chemistry in Life'. It's the last unit of ninth grade chemistry course ... I can't teach the unit in detail as it's taught after the final exam of the semester. The other one is taught as a short part in the 'Radioactivity' unit. Here, the only focus is on the effect of radioactivity on living things ... These two subjects aren't adequate of course for a good environmental education. (Enis)

The specified lesson hours in the curriculum for subjects related with EE are so few that it's impossible to provide students an understanding about environment and to gain them an environmental perspective... (Ersin)

The only unit that wholly allocated to environmental issues is "Chemistry in Life". This is the last unit of the ninth graders and because students become tired and remain indifferent toward all lessons, they can't learn it efficiently. If this unit hadn't been at the end of the second semester of the year, it'd probably have been more effective in terms of EE. (Sevil)

According to the chemistry teachers, which subjects about EE should be added on or removed from the secondary school chemistry curriculum and what are the reasons for those additions or removals?

There was a disagreement among teachers' views on inclusion of subjects which were related to EE in chemistry curriculum. One of the teachers (Sevil) proposed that all the subjects within the scope of EE should be in the chemistry curriculum and a comprehensive integration of EE and chemistry should be established in order to provide an effective EE claiming that chemistry is the most suitable branch of science for realization of that purpose:

Because EE subjects are more relevant to chemistry rather than other branches of science, it should be the main platform to teach environmental issues. Moreover, all of the other branches of science should include subjects related EE as well as chemistry. ... As all of the subjects of EE are closely related to chemistry, they can be taught in chemistry lessons except a few such as biological diversity and noise pollution. (Sevil)

On the contrary, the other two teachers (Ersin and Enis) suggested that some subjects related to EE should be immersed in chemistry curriculum to a certain extent. Water, soil and air pollution, consumption patterns energy usage, and climate change should be involved in the chemistry curriculum. However, they opposed EE subjects to be included in the core of chemistry curriculum due to the fact that chemistry subjects may face the danger of being undervalued and omitted in the curriculum:

It's not possible for chemistry curriculum to cover all the environmental issues but environmental pollution and consumption patterns may be involved in the curriculum due to their importance for our life. We use up our water resources by using chemicals such as detergents and fertilizers. ... Beyond the scope of curriculum, in lessons, sometimes students ask about consumption patterns and their effects on environment, and we talk over the issue. ... I want my students be more aware students of environmental issues and I want to teach them some subjects about environmental issues but I'm a chemistry teacher in the first place. (Enis)

Some subjects about EE should be taught by immersing in chemistry subjects such as water pollution, solid wastes and global warming ... If the curriculum included all the subjects in the scope of environmental education, how we would achieve to teach chemistry in detail. ... Will it be a chemistry lesson or an environmental chemistry lesson? (Ersin)

According to the chemistry teachers, what should be the placements of the subjects about EE in chemistry subjects in secondary school chemistry curriculum and what are the reasons for those placements?

There was not an agreement among teachers' views on both placement of the subjects related EE in the chemistry curriculum and how to teach EE subjects; through integrating chemistry course or as a separate course on EE. On the one hand, Ersin and Enis had the idea of teaching EE subjects as a separate course; on the other hand Sevil suggested that the EE subjects should be integrated into chemistry curriculum rather than being taught as a separate course for a better understanding:

EE subjects should be taught together with chemistry subjects, in this way students will understand the scientific background of the issues and chemistry will be a more enjoyable lesson for the students. (Sevil)

The ideas of teachers about the placements of subjects in the scope of EE into chemistry subjects are shown in Table 3.

Table 3. Placement of subjects of EE into chemistry subjects

Subjects related to EE	Chemistry Subjects according to Teachers		
	Teacher 1: Sevil	Teacher 2: Ersin	Teacher 3: Enis
Water pollution	Compounds & Solutions	Solutions	Compounds & Solutions
Solid wastes	Chemical Reactions	Chemical Reactions	-
Hazardous wastes	Compounds/ Radioactivity	& Compounds/ Electrochemistry	-
Global warming	Gaseous State	-	-
Air pollution	Gaseous State	Gaseous State	Gaseous State
Loss of biological diversity	-	-	-
Consumption patterns	Organic Chemistry	-	Compounds & Chemical Reactions
Deforestation	Organic Chemistry	-	-
Noise pollution	-	-	-
Soil pollution	Solutions	Compounds & Periodic Table	Compounds & Solutions
Population and environment	-	-	-
Environmental cycles	Gaseous State	-	-
Energy usage	Energy in Chemical Reactions	Energy in Chemical Reactions	-

Discussion and Conclusion

This study confines itself to interviewing three chemistry teachers working in high schools. The scope of the study is narrowed by secondary school chemistry curriculum and its approach to environmental education. Furthermore, affective domains such as chemistry teachers' attitudes, self-efficacy beliefs, or motivations toward environmental issues are beyond the scope of this study. On the other hand, the limited number of participants can be seen as a potential weakness for the study. However, due to the fact that participants are quite experienced and they have been in the field as the implementers of the curriculum, the findings of the study can be regarded as quite valuable and significant.

In Turkey EE is still not a part of the core secondary school chemistry curriculum and adopted curriculum does not provide a means for an effective EE and what is worse, it includes only a few subjects related with environmental education. Generally these subjects even were not taught appropriately by chemistry teachers due to some reasons such as insufficiency of amount of time allocated for those subjects and the placements of those subjects in the curriculum. Although there is not a consensus about teachers on the integration of EE subjects into chemistry curriculum, previous researches indicate that through integrating EE in chemistry,

students may gain a meaningful mode of chemical thinking and understanding attitude towards environmental processes and skills (Feierabend, Jokmin, & Eilks, 2011; Hofstein, Eilks, & Bybee, 2011). Thus, curriculum designers and policy makers should take necessary measures according to the findings of the study owing to the importance of environmental education; the subjects for EE should be immersed and integrated in secondary school chemistry curriculum urgently. In order to realize this, in-service teachers should be trained on EE by Ministry of Education, and in chemistry departments of education faculties, there should be at least one undergraduate must course about environmental education.

For further researches, quantitative studies can be conducted to reveal the deficiency and the needs in chemistry curriculum from EE perspective and to assess the competence of chemistry teachers in EE. Further analysis may also reveal the differences between the Turkish curriculum and those of other countries' from the point of chemistry teachers' views through an environmental perspective.

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Appendix

INTERVIEW PROTOCOL

Date:
 Gender:
 Age:
 Experience:
 Duration:

Questions	Interviewer Notes	Reflective Notes
To what extent are chemistry curriculum related to environmental education?		
In chemistry curriculum which subjects include topic related to environmental education?		
Are they adequate for an effective environmental education?		
Do you emphasize sufficiently on those subjects?		
Which of the following environmental issues should be in the chemistry curriculum? Why? a. Water pollution b. Solid wastes c. Hazardous wastes d. Global warming e. Air pollution f. Loss of biological diversity g. Consumption patterns h. Deforestation i. Noise pollution j. Soil pollution k. Population and environment l. Environmental cycles (C, H ₂ O, and N ₂ cycles) m. Energy usage		
In which chemistry subjects should those be integrated?		
Beyond the scope of current chemistry curriculum, are there any environmental issues which are discussed in the class?		
In which chemistry subjects should those subjects be taught? Why?		
Do you think that environmental education should be a separate must course rather than being in chemistry curriculum?		
Do you think that environmental education should be a separate must course rather than being in chemistry curriculum? Why?		
Do you think that environmental education should be a separate must course rather than being in chemistry curriculum? Why?		
Is there anything that you want to add?		