Exploring fifth–grade Turkish children's solutions and future plans for environmental pollution through their drawings

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Contents

Abstract

The pollution of land, water, air, noise, light etc. threatens people, plants, animals and ecosystems. Environmental literacy is at the heart of environmental education, and environmentally literate people are expected to be aware of how to help solve environmental problems such as pollution. The purpose of the present study is to explore 5th grade Turkish children's solutions and future plans for environmental pollution, as revealed through their

drawings. A total of 40 5th graders (25 girls and 15 boys, aged 10-11 years) completed drawings of their solutions and future plans for environmental pollution. The three themes used to analyse their work were physical action, persuasion and political action. The most recurring solutions in the drawings were collecting litter, putting litter in a bin or recycling bin, planting saplings and public persuasion. Many children in the study knew that littering was an environmental problem, which needs more than one strategy to be dealt with. The children in this study found it difficult to visually express their thoughts related to the themes of persuasion and political action. It therefore appears that it is better to explore children's ideas about persuasion and political action verbally and/or in writing. An instruction based on socio-scientific issues may help children learn about pollutants and their impacts on the environment as they produce solutions and plans for an open-ended problem.

Keywords: environmental education; cognitive skills; pollution; children's drawings

Introduction

One of the greatest problems that the world faces today is that of environmental pollution, which can be defined as 'an undesirable change in the physical, chemical, or biological characteristics of the air, water, or land that can harmfully affect health, survival, or activities of humans or other living organisms' (Trivedi, 2008, p. 132). Most of the world's air pollution, which harms human health, and can cause a variety of environmental effects, such as acid rain, ozone depletion and global climate change, results from the burning of fossil fuels to produce electricity and power our vehicles. Water bodies (e.g., lakes, rivers, oceans and groundwater) become polluted with municipal, industrial and agricultural waste. Water pollution causes negative effects within the environment to animals and their habitats, and can pose health dangers to humans who come into contact with it, either directly or indirectly. Among the causes of land pollution, which can be harmful to people, plants, animals and ecosystems, are waste dumping, deforestation and soil erosion, and agricultural, construction and mining activities. Other forms of environmental pollution include noise, light and visual pollution. In the UN Conference on the Human Environment held in Stockholm, Sweden, in 1972, environmental education was internationally recognized as a tool to address global environmental problems. Building on this conference, the Belgrade (1975) and Tbilisi (1977) Conferences on Environmental Education introduced additional goals, objectives, characteristics and guiding principles of environmental education (De & De, 2004; 'Environmental education,' n.d.). The goal of environmental education is to develop a citizenry that 'is knowledgeable concerning the biophysical environment and its associated problems, aware of how to help solve these problems, and motivated to work toward their

solution' (Stapp et al., 1969, p. 30). Environmental literacy is at the heart of environmental education. In 1995, by analysing environmental education frameworks used in national and state programs, Deborah Simmons identified seven components of environmental literacy, including affect, ecological knowledge, socio-political knowledge, knowledge of environmental issues, cognitive skills, additional determinants of environmentally responsible behavior and environmentally responsible behaviour (Erdogan, Kostova & Marcinkowski, 2009; Erdogan & Ok, 2011; Hollweg et al., 2011). Volk and McBeth (1997) used Simmons's framework as the basis for a review of research, which guided the North American Association for Environmental Education's (NAAEE) National Guidelines for Excellence Project. Researchers have used this framework as a starting point for designing national-scale comprehensive surveys of environmental literacy (e.g., Erdogan & Ok, 2011; McBeth, 2006; Negev et al., 2008). Hsu and Roth (1998), referring to the 1980 Paris Conference, stated that 'environmental education should be developed in the light of the specific ecological, cultural, political, educational, and economic conditions of each country' (p. 230). In Turkey, with the introduction of a new Science and Technology Curriculum for primary schools in the 2004-2005 academic year, topics related to environmental education began to receive greater attention (Erdogan, Kostova & Marcinkowski, 2009). Environmental issues continue to be represented in the present science curriculum for primary schools, which came into effect in 2013. For example, in terms of environmental pollution, eight-year-old 3rd graders are expected: (a) to take action in the cleaning of their environment and (b) to discuss the damage caused to the environment due to improper battery disposal, as well as certain things that should be done to minimize it. In the 4th grade, children research the causes of light and noise pollution and explain their negative impacts on wildlife, observing celestial bodies, human life and the environment; and suggest ways to reduce them. They also discuss how to prevent environmental pollution, learn to keep their environment clean and design projects aimed to protect and beautify the environment. In the 5th grade, children discuss (a) the causes of air, land and water pollution; (b) their negative impacts on the environment and (c) the measures that can be taken to reduce these forms of pollution. Children in 7th grade learn about solid and liquid waste from domestic sources and recycling. They also explain the causes of space pollution and predict the likely consequences of it. Some environmental problems linked to environmental pollution, such as acid rains, ozone depletion and global climate change, are taught in the 8th grade.

A review of Turkish and international literature on environmental education revealed that studies associated with cognitive skills were quite limited (Erdogan, 2009; Erdogan, Marcinkowski & Ok, 2009). Simmons (1995, as cited in Erdogan & Ok, 2011, p. 2378) describes cognitive skills as 'those abilities required to analyse, synthesize, and evaluate

information about environmental problems/issues and to evaluate a select problem/issue on the basis of evidence and personal values. This category also includes those abilities necessary for selecting appropriate action strategies, and for creating, evaluating, and implementing an action plan'. The sub-components of cognitive skills are problems and issue investigation skills, issue analysis skills, variable and research question skills, data collection skills, data analysis skills and action skills (Erdogan & Ok, 2011). In an attempt to investigate 5th graders' environmental related cognitive skills, Erdogan (2009) developed an instrument with two questions. In the first question, the children were asked to order the steps involved in identifying the cause of water pollution in a lake. Of the 2410 children, only 120 children provided the correct order. Erdogan stated that this result could be partly explained by insufficient instruction in scientific process skills (SPS) for the environment related problems. Among the reasons for this insufficient instruction were (a) crowded classrooms, (b) limited equipment and materials, (c) time constraints and (d) teachers' lack of knowledge and competency in SPS instruction. In the second question, the children were asked to write their own solutions and future plans to address the pollution in the lake. 83.8% (n = 2019) of the children provided an answer to the second question. Many of these children provided only one solution. Three types of behaviour, namely physical action, persuasion and political action were identified through the content analysis of the responses. Some of the most repeated solutions and plans in the category of*physical action* were (a) picking up/collecting the garbage over and around the lake, (b) doing clean-up activities, (c) asking for help from the family and teachers for cleaning up the lake and (d) taking water samples from the lake in order to investigate the amount of water pollutants. Some of the most repeated solutions and plans in the category of *persuasion* were (a) encouraging other people to keep the lake clean, (b) talking with the people who were picnicking around the lake, (c) asking their friends and their siblings not to drop their garbage in and around the lake, (d) asking factory managers not to discharge their waste water into the lake, (e) preparing posters, wall signs, banners and writing essays and (f) distributing brochures to people in the street. Some of the most repeated solutions and plans in the category of *political action* were (a) planning to talk to the ministers, the mayor, governor and executive officer of a district to take necessary precautions to prevent environmental problems in the lake and (b) encouraging the officials to penalize people who pollute the lake (Erdogan & Ok, 2011, pp. 2390-2391). Guler (2013) used these two questions to explore 182 8th graders' environmental related cognitive skills in Turkey, and reported similar findings with regard to children's solutions and future plans to address the pollution in the lake. In these studies the focus of the two questions mentioned was to elicit children's solutions and future plans in the context of water pollution. More studies are needed to explore the children's work in the context of other forms of environmental pollution.

Children innately enjoy drawing. Thomas and Silk (1990, as cited in Barraza, 1999, pp. 49-50) state that 'children's drawings provide a "window" into their thoughts and feelings, mainly because they reflect an image of his/her own mind'. The analysis of children's drawings can reveal many different interpretations of the concepts and phenomenon under investigation as well as different drawing strategies to develop these concepts and phenomenon (Brooks, 2009a). In the literature on environmental education, researchers have successfully used drawings to explore children's understanding of the environment (e.g., Alerby, 2000; Barraza, 1999; Jonssona, Sarrib & Alerby, 2012; Ozsoy, 2012; Ozsoy & Ahi, 2014; Yilmaz, Kubiatko & Topal, 2012), ozone depletion and global warming (Vasilia, Vassilia & Anastasia, 2009), the greenhouse effect (Libarkin, Thomas & Ording, 2015), nuclear power stations (Brown, Henderson & Armstrong, 1987), tropical rainforests (Bowker, 2007), water (Havu-Nuutinen, Kärkkäinen & Keinonen, 2011), the water cycle (Dove, Everett, & Preece, 1999) and decomposition (Ero-Tolliver, Lucas & Schauble, 2013). The purpose of the present study is to explore 5th grade Turkish children's solutions and future plans for environmental pollution as revealed through their drawings. The research question guiding the study is 'What are the characteristics of 5th grade children's solutions and future plans for environmental pollution in their drawings?' The study builds on Erdogan and Ok's (2011) categorisation of children's solutions and future plans for water pollution in a lake. It extends their study by asking 5th graders to communicate their solutions and future plans for environmental pollution in general through drawings, which is a form of visual thought (Brooks, 2009b).

Methodology

A total of 40 5th graders (25 girls and 15 boys, aged 10-11 years) completed drawings of their solutions and future plans for environmental pollution. Drawings were collected from a classroom at a public school in the province of Izmir. At the time of data collection, the Turkish science curriculum for primary schools was going through a transition phase. As a result, before 5th grade, the participants had been taught the Science and Technology Curriculum for primary schools introduced in the 2004-2005 academic year. However, in 5th grade, they began to be taught the science curriculum for primary schools introduced in 2013. Before 5th grade, the participants were expected to:

- know what light pollution is;
- list the negative impacts of light pollution on wildlife and observing celestial bodies;
- present the findings of their research on light pollution;
- explain the measures that can be taken to reduce light pollution;
- suggest their own solutions for the problem of light pollution;

- realize that irregular and loud sounds cause noise pollution;
- identify the areas of high noise pollution intensity through observation;
- design and present a model representing noise pollution intensity in different areas through observation;
- explain the negative impacts of noise pollution on human health and the environment;
- research the measures that can be taken to reduce noise pollution in their environment;
- identify certain materials and personal actions that help reduce noise pollution;
- research and present the measures that can be taken to prevent air, land and water pollution;
- become aware of the forms of pollution in their environment, and list the pollutants causing them;
- develop simple methods in order to clean the environment; and
- discuss the damage caused to the human health and the environment due to improper battery disposal.

In the 2013 science curriculum for primary schools, children are expected to suggest ways to solve the environmental problems caused by human activities. As part of this task, each child in this study was asked to produce a drawing of his/her solutions and future plans for environmental pollution on a piece of A4 paper. They were free to choose the form(s) of environmental pollution on which they would like to focus, and were allowed to annotate their drawings. The reason for selecting this school and classroom was because, by the time of investigation, some of my science trainee teachers were doing their school practice in this classroom, and the teacher of the classroom agreed to participate in this study.

Results and Discussion

In order to reveal the meaning of each drawing, the solutions and plans were recoded into written language. The annotations were used to clarify the messages conveyed in the drawings. Then, each code was placed in one of the three thematic categories suggested by Erdogan (2009). Figure 1 is a drawing produced by one of the children participating in the study.

The drawing is entitled 'Sensitive Robot'. The annotation at the bottom of the drawing reads '*A robot which recycles, cleans the streets, warns people, plants saplings, and erects pro-environmental signboards*'. From this annotation it becomes clear that (a) the signboard reading 'extinguish fires' is intended to encourage people to extinguish fires, (b) the plant is a sapling to be planted, (c) the sweeper and the dustpan are for cleaning the streets, (d) the four squares on the robot is for recycling plastics, waste cooking oil, glass and paper; and (e) the

robot is able to warn people. This drawing is placed into two categories. The signboard encourages people to extinguish fires and the robot warns people to be responsible for the environment, so these two codes (i.e., a and e) are placed in the category of persuasion. The other three codes are related to different physical actions (i.e., planting a sapling, cleaning the streets and recycling), so they were placed in the category of physical action.

Figure 1. A sample drawing from the study

There was a reference to land pollution in 47 drawings. The same figure was 4 for water pollution and 3 for air pollution. Despite the fact that noise and light pollution were part of the science curriculum in 4th grade, none of the children in 5th grade referred to them in their drawings. Land pollution was the most prominent form of environmental pollution in the drawings. Ten of the children referring to land pollution were interviewed about their choice. They stated that they were aware of other forms of pollution, but the commonest form of pollution around them was land pollution. Because of that, they were not concerned about other forms of pollution. In other words, they stated, they did not consider them as pollution.

Solutions and Plans regarding Physical Action

There was evidence of physical action(s) in 36 out of 40 drawings (90%). In 44.4% of the 36 drawings (16 drawings) the children suggested *collecting litter*. In 10 of these 16 drawings a robot was doing the job. Figure 2 is a drawing in which two robots were collecting litter. The annotation reads '*a flying skateboard entertains while it makes it easy to collect litter by sucking them in through the pipe beneath it. Robot grasses planted alongside a creek collect*

litter from it'. The robots in Figure 6 were both collecting and consuming litter. In these 10 drawings, the physical action of litter collection was carried out by robots instead of people. Figure 3 is one of the 6 drawings in which litter was collected by people. The annotation reads '*a few people coming together and riding a bike with a broom attached to its back*'. Unlike Figure 2, the agent in Figure 3 was a person, using a tool such as a broom to collect litter.

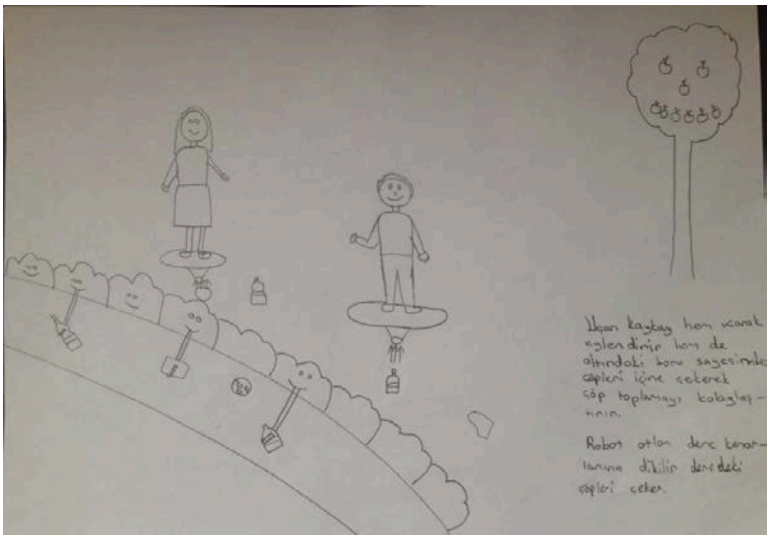

Figure 2. Robots collecting litter

Figure 3. People collecting litter

In 80.5% of the 36 drawings (29 drawings) the children suggested *putting litter in a bin or recycling bin*. Figure 4 depicts a person putting litter in a bin. The annotation reads '*1) dispose of batteries in a battery bin, 2) dispose of plastic bottle lids in a bottle lid bin, 3) dispose of litter in a litter bin*'. The second suggestion in the list is related to a campaign designed by the Turkish Paraplegic Association. In the campaign, the lids recycled are used to raise money to purchase wheelchairs for the paralyzed people who cannot afford them. In the 29 drawings, there was more than one type of recycling bin. For instance, the robot in Figure 1 is also a recycling bin. Another type of recycling bin was a device converting waste cooking

oil into water. In the drawings, a child drew a robot charging batteries disposed in it. In other words, the recycling bins in the drawings were different; not only in the form they had but also in the way they functioned.

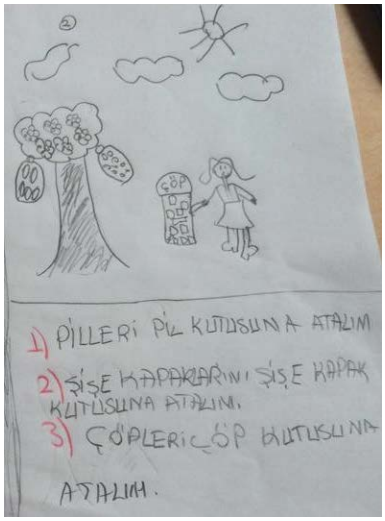

Figure 4. A person putting litter in a bin

In 30.5% of the 36 drawings (11 drawings) the children suggested *planting saplings*. Figure 5 depicts a robot designed to plant saplings. The annotation reads '*This robot plants 10000 saplings everyday*'. The saplings to be planted were drawn inside the robot. The people planting and watering saplings or trees were evident in the drawings, in which the agents were not robots but people (for example, see Figure 6). However, the reason for planting saplings was specified only in one of the 11 drawings (i.e., preventing landslides). In the 10 other drawings there was no reference to the form of environmental pollution to be addressed by planting samplings. Therefore, it was assumed that these 10 drawings were about reducing land pollution. Forests help to fight against global climate change and erosion. Reforestation played an important role in the drawings. In this study, it was not possible to conduct in-depth interviews with the children about their drawings, and the annotations were not enough to clarify the reason(s) for the physical action of reforestation. It appears that, in some instances, it is important to interview children about their drawings in order to reveal their various meanings. Therefore, the lack of in-depth interviews is a limitation of this study.

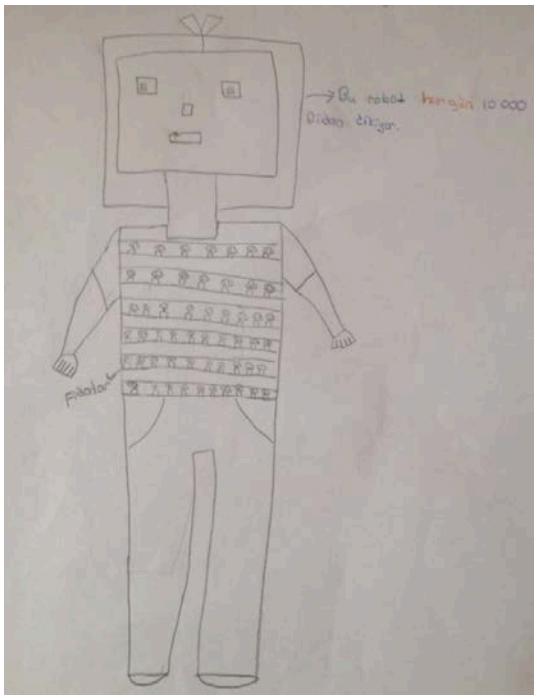

Figure 5. A robot planting saplings

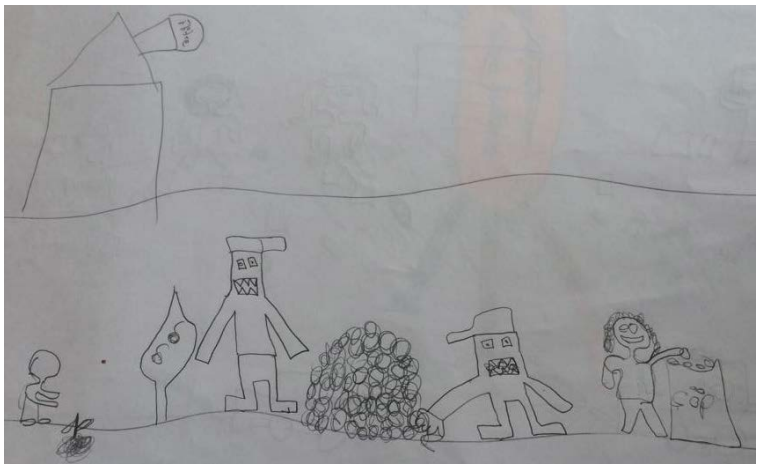

Figure 6. A building with a chimney filter

In only 8.3% of the 36 drawings (three drawings) the children suggested *using a chimney filter*. One of these three drawings is presented in Figure 6. The annotation written on the building in the upper left corner reads '*filter*'. This drawing also refers to the other three sub-categories of the category of physical actions, namely, collecting litter, putting litter in a bin or recycling bin and planting saplings.

Children's solutions and future plans for environmental pollution are affected by their understanding of it. In a study investigating children's understanding of the pollution process, Brody (1991) found that 4th graders needed to see, feel, smell, or taste pollution for it to exist since these children were sensory in their approach to the world. In the drawings produced in the present study, littering, a form of land pollution, caught their attention. Many children were aware that the most effective way to reduce littering was not to litter in the first place, and suggested putting litter in a bin or recycling bin. It seems that they were able to identify the cause of the problem, which is throwing objects on the ground, and the solution was proper disposal of litter. However, there were already lots of objects lying on the ground, waiting to be disposed properly. Therefore, some children focused their attention to litter collection. Both solutions required physical action on a personal level.

In Brody's study, 8th graders had a more conceptual understanding of pollution, and 11th graders had a more complex and interconnected vision of pollution. The findings of Rodríguez, Kohen and Delval (2015) are also consistent with that of Brody (1991). Therefore, the characteristics of children's solutions and future plans for pollution are likely to change with time as children's understanding of pollution processes develops. For example, in their drawings 5th graders used robots (a) to collect litter, (b) to recycle and (c) to plant saplings. It would be interesting to know if this tendency to use robots in reducing environmental pollution continues to exist as children grew older.

Solutions and Plans regarding Persuasion

Erdogan (2009) divided the category of persuasion into three sub-categories: *warning, individual persuasion and public persuasion*. In the sub-category of warning, children give verbal warnings to the people polluting the environment. In the sub-category of individual persuasion, children encourage people not to pollute the environment. In the sub-category of public persuasion, children encourage people not to pollute the environment through signboards, slogans, brochures, environmental non-governmental organizations, etc. In this study, there was evidence of persuasion in 14 out of 40 drawings (35%). In 92.9% of the 14 drawings (13 drawings) there was public persuasion. Figure 7 is an example of this sub-category. The annotation on the robot-like figure reads '*the materials which can be recycled are not litter*'. The other annotation is a slogan and reads '*a litter means a life. Let's put our litter in the litter bin*'. Erdogan (2009) reported that some children in his study suggested encouraging people to be a member of environmental non-governmental organizations. He placed this suggestion in the sub-category of individual persuasion. However, in this study, some children suggested setting up an environmental non-governmental

organization. This suggestion was placed in the sub-category of public persuasion since such non-governmental organizations encourage the public not to pollute the environment.

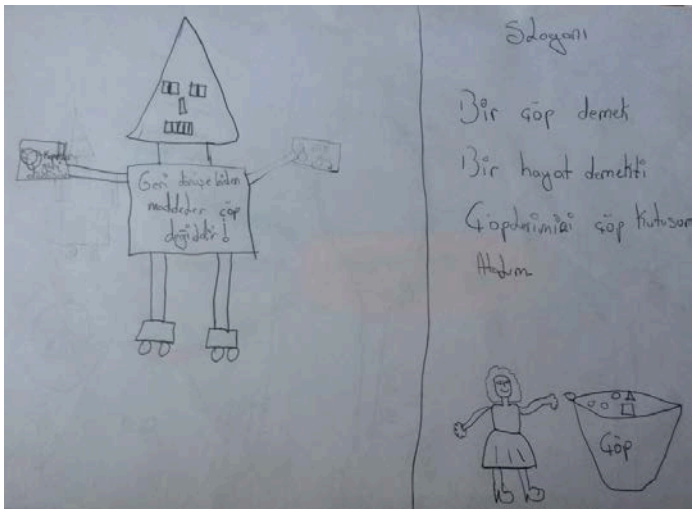

Figure 7. Examples of public persuasion

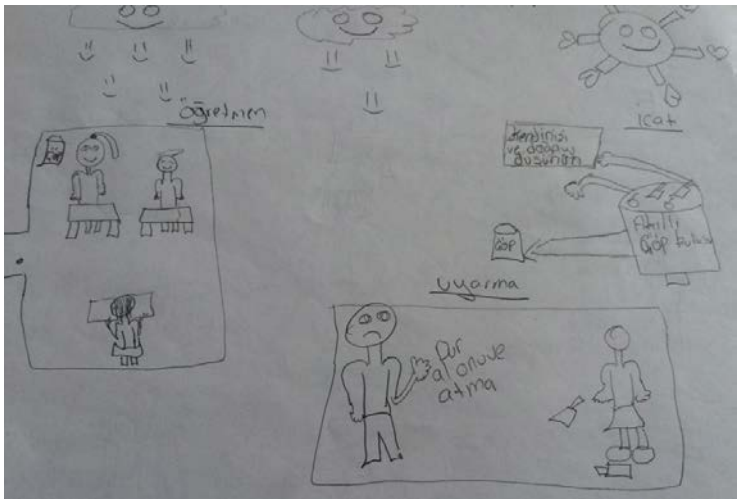

Figure 8. Examples of the sub-category of persuasion

In 14.3% of the 14 drawings (2 drawings) there was individual persuasion. The same figure was 21.4% (3 drawings) for the sub-category of warning. Figure 8 exemplifies all three sub-categories of persuasion. On the left side of the drawing, a teacher seems to be talking with the children. This part of the drawing is placed in the sub-category of individual persuasion. In the lower right corner, a person is warning another not to litter. This part of the drawing is placed in the sub-category of warning. The signboard in the upper right corner reads '*do care about yourself and the environment*'. This part of the drawing is placed in the

sub-category of public persuasion. Compared with the sub-category of public persuasion, the sub-categories of individual persuasion and warning were less frequent. Perhaps 5th graders found it more difficult to produce drawings related to these two sub-categories. Maybe they would have felt more comfortable if they had been asked to express their thoughts related to these sub-categories in written or verbal form.

Solutions and Plans regarding Political Action

This category was evident in only one out of 40 drawings (2.5%). The suggestion was imprisonment for littering (see Figure 9). On the left side of the paper, the drawing depicts a person littering. On the right side of the paper, the person is jailed and says '*I wish I did not litter*'. In Turkey, people are not jailed for littering. Therefore, the drawing may be seen as a call for legislators to take the offense of littering more seriously. The category of political action was the least frequent category in this study. Perhaps 5th graders found it difficult to visually express their political thoughts about reducing environmental pollution. Therefore, it may be better to explore children's ideas about political action verbally and/or in writing.

Figure 9. An example of the sub-category of political action

Some children in this study were aware that they needed the help and cooperation of other people in the community in order to reduce litter, and consequently tried to persuade them not to litter. Even the option of imprisonment was on the table. It appears that many children in this study knew that littering was an environmental problem, needing more than one strategy to be dealt with. These strategies mostly required physical action and public persuasion.

Conclusions

This study explored the characteristics of 5th grade children's solutions and future plans for environmental pollution in their drawings. It found that these solutions and plans were affected by the children's conception of pollution. Many children were familiar with littering around them. Therefore, they used this drawing activity mainly to present their solutions and plans for littering. One way to improve children's understanding of this issue may be to use an instruction based on socio-scientific issues (SSI) in the classroom. Sadler (2011) describes SSI as science related controversial social issues, and states that:

> *'they are open-ended problems without clear-cut solutions; in fact, they tend to have multiple plausible solutions. These solutions can be informed by scientific principles, theories, and data, but the solutions cannot be fully determined by scientific considerations. The issues and potential courses of action associated with the issues are influenced by a variety of social factors including politics, economics, and ethics. SSI may be global in nature such as climate change and the use of genetic technologies or local such as addressing a neighborhood environmental crisis or determining the location of a new power plant' (p. 4).*

During SSI instruction, children learn about pollutants and their impacts on the environment as they produce solutions and plans for an open-ended problem. SSI may prove to be an effective way of teaching all forms of environmental pollution with its unique emphasis on their solutions.

It appears that the analytical framework developed by Erdogan (2009) is useful for analysing children's solutions and plans for pollution. More studies are needed to better understand the characteristics of these solutions and plans at different grades. Although drawings are useful tools to achieve this aim, they have certain limitations and should be used in conjunction with other research tools, such as interviews.

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