International Electronic Journal of Elementary Education, 2015, 8(1), 55-68.

Students' Opinions on the Light Pollution Application

Cengiz ÖZYÜREK*
Ordu University, Turkey

Güliz AYDIN
Muğla Sıtkı Koçman University, Turkey

Received: June, 2015 / Revised: August, 2015 / Accepted: August, 2015

Abstract

The purpose of this study is to determine the impact of computer-animated concept cartoons and outdoor science activities on creating awareness among seventh graders about light pollution. It also aims to identify the views of the students on the activities that were carried out. This study used one group pre-test/post-test experimental design model with 30 seventh graders. The data in the study were collected via open-ended questions on light pollution and semi-structured interview questions. The open-ended questions on light pollution were administered as a pre-test and a post-test. After the post-test was administered, semi-structured interviews were conducted with seven students. The data collected from the open-ended questions and semi-structured interviews were qualitatively analysed and quotes from the students' statements were included. Looking at the answers of the students to questions on light pollution, it was understood that the activities that were carried out were effective. Furthermore, all of the students that were interviewed made positive statements about the activities that were carried out.

Keywords: Light pollution, Concept cartoons, Students' views.

Introduction

Humans are an indispensable part of the environment that they live in. Due to the rapid increase in population, overurbanization, industrialization and, consequently, the excessive use of natural resources, today, environmental issues have become global issues. Currently, light pollution is one of the global issues that are negatively affecting the whole world. Light pollution is defined as the wrong use of light in a way that disturbs living things (Aslan, 2001). Various studies have revealed the reasons and effects of light pollution. Crawford (2001) found that wrong outdoor lighting causes light pollution. Osman, Isobe, Nawar and Morcos (2001) and Çetegen and Batman (2005) stated that light pollution is an important problem for astronomical studies, the environment and the

* Cengiz Özyürek, Department of Elementary Education, Faculty of Education, University of Ordu, Turkey. Phone: +90 452 2265200 E-Mail: cengizozyurek@outlook.com

ISSN:1307-9298

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economy. In their studies, they suggested what could be done. In their study on the reasons, results and solutions to light pollution, Percy (2001) and Hanel (2001) found that people did not have sufficient knowledge on light pollution. Sadık, Çakan and Artut (2011) examined the perceptions of students on environment problems via the pictures that the students drew. They found that the students drew the loss of forests, air pollution, decreasing species, spoiling ozone layer, sound pollution, soil pollution, global warming, etc., as environmental problems in a reason-result relationship. However, they saw that only one student drew a picture about light pollution.

It is necessary to move beyond determining the current state and create educational activities that are aimed towards preventing light pollution and thus, creating awareness among individuals. In Greece and Hungary, which recognized the significance of creating awareness in society on light pollution, various activities are carried out among primary school teachers and students in order to teach the subject and create awareness (Demircioğlu Yıldız & Yılmaz, 2005). Studies that have been conducted have revealed that students do not have enough knowledge on light pollution, which is an interdisciplinary issue concerning many disciplines (Sadık, Çakan & Artut, 2011; Seçgin, Yalvaç & Çetin 2010).

As environmental problems negatively affect all living things, environment education, which is an important part of science classes, has become a significant necessity. The aim of science teaching is to educate science-literate individuals. Enabling students to find solutions to problems primarily in their environment using scientific process skills is an important step towards developing science-literacy. In the seventh grade science teaching curriculum, various environmental problems are discussed. However, light pollution, which is an important issue in ecological, economic and astronomical terms, is not included. This study discusses light pollution, which is included within the topic of environmental problems and their impact in the science classes of seventh graders. This topic aims to teach students about the light pollution topic through computer-animated concept cartoons and outdoor educational activities. The learning outcomes concerning this topic in science and technology classes are given below:

The students collect information on an environmental issue in our country and in the world. They present it to the classroom and discuss its consequences.

The students suggest collaborative solutions towards environmental problems in our country and in the world, and participate in activities.

The research problem of the study can be stated as: “What are the students’ views on computer-animated concept cartoons and outdoor education activities?” In the current study, the scenarios that are related to light pollution are supported by computer-aided concept cartoon animations in order to attract the interest of the students. In teaching through concept cartoons, some alternative ideas concerning scientific facts are drawn on paper as cartoons. However, only one of these given ideas is scientifically correct. The concept cartoons start a discussion concerning the concepts in the characters included in the cartoon and present them (Keogh, Naylor & Wilson, 1998; Keogh & Naylor, 1999). Thus, the aim is to reach the scientifically correct idea. In concept cartoons, generally, the questions or views of three or more characters on a daily issue are given in speech balloons (Uğurel & Moralı, 2006). The ideas are then discussed by the whole classroom through the cartoon characters.

The purpose of this study is to create awareness among seventh graders about light pollution through computer-animated concept cartoons and outdoor science activities. It also aims to enable the students to develop solutions and reveal their views concerning the activities and practices that are carried out.

Within the scope of outdoor educational activities, sky brightness was measured with a sky quality meter during the night in selected settlements of Ordu province, which is located in the Black Sea coast of Turkey, in selected dark locations and natural living environments. In addition to numerical measures, the photographs of the sky were taken with a camera with a wide-angle lens and thus, light pollution is shown visually. In addition, the students took photographs showing the light pollution within the city and conducted studies towards removing the existing light pollution. With this study, the studying and thinking environments in which the students were active and carried out activities towards solving an everyday problem were created. In order to ensure meaningful learning on light pollution and create awareness among the students about the importance of the issue, computer-animated activities, which were enriched with concept cartoons and outdoor educational activities, were carried out. The students' views on the activities that were carried out were taken. We found that the results of previous studies indicated the positive impact of materials that had been prepared using animations in computer-aided teaching in student achievement and in removing misconceptions (Yılmaz & Saka, 2005; Rotbain, Marbach-Ad & Stavy, 2008; Çepni, 2009; Özyılmaz Akamca & Hamurcu, 2009). Taking such results into consideration, the current study used animations in preparing the concept cartoons concerning light pollution. One of the most efficient activities that are used to make education more fun and interesting is computer animations (Arıcı & Dalkılıç, 2006). With their colours and motions, animations increase retention and make it easier to materialize abstract concepts or things and to visualize them in mind (Rieber, 1990; Çakır, 1999). Thus, it is possible to create rich learning environments for students.

In this study, which aims to create awareness among students about light pollution, scenarios and concept cartoons concerning the reasons and effects of light pollution were prepared, considering the negative impacts of light pollution in ecological, economic and astronomic terms (Osman et al., 2001; Percy, 2001; Demircioglu Yıldız & Yılmaz, 2005). We tried to make the concept cartoons visually interesting for the students through computer animations. In addition, work sheets that were prepared for each animation with concept cartoons were administered to the students. Only one of the character's statements on light pollution in the concept cartoons is scientifically correct. In the activities that were prepared and developed, the students were asked which concept cartoon's idea they agreed with. Thus, a discussion was started and they were made to reach the correct one. The students worked in groups and stated which cartoon character's idea they agreed with.

The scientific content of the concept characters in the computer animations were examined by two experts working in the field of science. Furthermore, the draft animations were examined by experts who prepare animations in flash programme and thus, the identified gaps were filled.

Method

Participants

As this was an experimental study, a study group was taken instead of choosing a sample. This study was carried out with 30 seventh grade students (18 males and 12 females) studying at a secondary school in Ordu province during 2014-2015 academic year.

Research Design

One group pre-test-post-test experimental design model was used in this study. In this model, assessments both before the experiments (pre-test) and after the experiment (post-test) were made (Karasar, 2014). Research design is shown in Table 1.

Table 1. *Experimental design*

Before the experiment	Experimental process	After the experiment
Pre-test (T_1)	Instruction through computer-animated concept cartoons and outdoor science activities.	Post-test (T_1, T_2)

T_1: Open-ended questions related to light pollution
T_2: Semi-structured interview form

Data collection

The data in this study were collected through open-ended questions and semi-structured interview questions on light pollution, which were prepared and developed by Aydın (2015) and used by Özyürek and Aydın (2015) in their project study. The open-ended questions related to light pollution were administered both as a pre-test and post-test. The experimental study took two weeks. In the first week of the experiment, five computer animated concept cartoon activities were carried out during four class hours. The pilot study of the activity was carried out with 19 seventh grade students. The activities carried out were: "Why are the roads dark?", "Where is the sea?", "The migratory routes", "What unconscious lighting causes" and "Where should I make astronomical observations?"

Additionally, in the second week, outdoor education activities were carried out with the students. Using a sky quality meter, the sky brightness measurements were made in the school garden, city centre and Yoroz City Forest during the night. Thus, areas where there was light pollution were identified and the common features of these places were discussed. Similarly, Aydın and Özyürek (2015) used a sky quality meter for night sky brightness measurements in their study. In addition, the students were made to take photos of wrong lighting, which could cause light pollution. The wrong lighting practices, as well as the solutions to them, were discussed through the photographs that the students took. After the experimental study was completed, post-tests were administered. With seven students among the 30 participating students of the study, semi-structured interviews were made to determine the students' views on the activities conducted, and these interviews were recorded.

Analysis of data

The students' answers to the open-ended questions were descriptively analysed. The data were reduced, categorized and put into tables. The data collected via the open-ended questions from 30 students were analysed by two researchers. To ensure its reliability, the consistency between the two analyses was controlled. The reliability rate was found to be 93%.

According to Miles and Huberman (1994), the analysis of the data collected from an interview follows a consecutive three-step that affect each other: reduction of data, data display and conclusion drawing and verification. In order to reduce the data, raw data are coded based on certain categories (Patton, 1990). Within the framework of these categories, the data are coded, the essential parts are extracted and the remaining parts are taken out. The decodings of the semi-structured interviews were recorded by a tape recorder and controlled by two researchers. This ensured that the decodings were correct. The two researchers examined the data from the interviews and the themes and codes of the interviews were formed. The reliability percent between the two was found to be 95%. The data that were collected from the descriptive analysis of the interviews were summarized and interpreted according to the pre-set themes. Furthermore, in order to

reflect the opinions of the individuals that were interviewed, direct quotations were included.

Findings

The purpose of this study is to determine the impact of computer-animated concept cartoons and outdoor science activities on creating awareness among seventh graders about light pollution. It also aims to identify the students' views on the activities that were carried out. The findings of the study are presented within the framework of a descriptive analysis of open-ended questions and themes from the semi-structured interviews, which were carried out with seven students among 30 participating students to whom open-ended questions were administered.

Table 2 includes the frequencies and students' statements concerning their answers to the types of pollution that could be considered as an environmental problem today.

Table 2. *The frequencies of and students' statements to "What do you think are the types of pollution that could be considered as an environmental problem today?" question.*

Types of environment pollution	Pre-test (*N*= 30)		Post-test (*N*= 30)	
	f	Student statements	*f*	Student statements
Air	18	Air pollution, drying up of water resources, not making forestation, light pollution (2nd student).	20	Air, light, environment and sea pollution are significant environment issues (2nd student).
Water	12	That people throw litter after they have a picnic and this litter is not collected. That factories throw their litter into water and do not attach filters to their chimneys (7th student).	16	Light pollution, air pollution, water pollution and soil pollution, etc. (7th student).
Light	20	Throwing litter on the ground, spitting on the ground, unnecessary lighting of street lights, etc. (11th student).	30	Light pollution, air pollution, water pollution, environment pollution (11th student).
Soil	1	Throwing litter on the ground, spitting on the ground, that factories throw litter into the sea, cigars polluting the air (13th student).	15	Light pollution, sea pollution, and soil pollution (13th student).
Sound	14	Light pollution, sound pollution, air pollution, environment pollution and water pollution (23rd student).	8	Light pollution, sound pollution, soil pollution, environment pollution and water pollution (23rd student).

As Table 2 shows, the students saw air, water, light, soil and sound pollution as types of pollution that could be considered as environmental issues today. Furthermore, there was an increase in the students' answers on all types of pollutions in the post-test and they all mentioned light pollution.

Table 3 shows the frequencies and students' statements concerning their answers to what kind of negative effects light pollution has on the environment question.

Table 3. *The frequencies of and students' statements to "What kind of negative effects do you think light pollution has on the environment?" question.*

Negative effects of light pollution	Pre-test (*N*= 30)		Post-test (*N*= 30)	
	f	Student statements	*f*	Student statements
On animals	13	There will be excessive light, which disturbs both humans and animals and thus, causes light pollution (23rd student).	22	There will be excessive light and the migrating birds move towards these lights and therefore, they lose their way. Sea turtles hatching move towards the light instead of the sea and they could die (23rd student).
On humans	17	Light pollution negatively affects the human eye: eyes prone to excessive light lose their seeing ability (12th student).	18	Light pollution might affect us economically. It could cause problems in our eyes (12th student).
On economy	4	Excessive light causes us to lose our energy. Excessive lighting in a place causes to unnecessary use of light (2nd student).	11	It causes animals, for example, Caretta Carettas, to move towards the coast instead of the sea due to the lighting and to die, as a result. Similarly, it causes us to lose our energy (2nd student).
On astronomical studies	-	-	6	We cannot see the stars during the night because there is so much light, we spend a lot of energy (3rd student).

As it is seen in Table 3, the students indicated that light pollution has negative impacts on animals, humans, economy and astronomical studies. There was an increase in the frequency of students' answers to the negative effects of light pollution on the environment after the application. Meanwhile, there was no student who could state that light pollution could negatively affect astronomical studies. There were six students in the post-test who mentioned this fact.

In order to find out the opinions of the students on the activities and practices that were carried out, they were asked: "Were there any differences between how the light pollution topic and other topics were previously taught?". All of the students indicated that there were differences in how the light pollution topic was taught, compared to the other topics that were previously taught.

Table 4 shows the students' statements concerning what kind of differences the students see between how the light pollution topic was taught, compared to other topics that they were taught before.

Table 4. *The frequencies of and students' statements to "What kind of differences did you see in how the light pollution topic in science class was taught compared to other topics that were taught before?" question.*

Differences in how the light pollution topic was taught	*f*	Student statements
Measurements that were made	3	In other classes, it was mere teaching but when we were taught about light pollution, we conducted activities and made measurements (8th student).
Outdoor education activities that were made	5	In the activities that were related to light pollution, we carried out outdoor education activities. However, in other topics, we only made activities within the school; the difference is doing activities outside (10th student).
Activities that were carried out	4	With the visual activities that we carried out, I learnt more (23rd student).

In Table 4, it is seen that the interviewed students stated that there were such differences as making measures, carrying out outdoor education activities and practices in how the light pollution topic was taught in science classes, when compared to other topics of the same course.

Table 5 shows the views of the students about what caught their attention the most when the light pollution topic was taught.

Table 5. *The frequencies of and students' statements to "What caught your attention the most when the light pollution topic was taught?" question*

Things that caught the students' attention when the light pollution topic was taught	*f*	Student statements
Animations of migrating birds	2	I was very impressed with the slowing down, hindering and even stopping of the migration of migrant birds and, as a result, with their death (25th student).
Caretta-Carettas animations	3	That Caretta Carettas could not move towards the sea because of the artificial lighting and they died (27th student).
Taking measurements using a sky quality meter	2	Measuring light pollution with a sky quality meter (3rd student).
Astronomy animations	1	I was impressed with whether or not we see the stars and the brightness of the activity of the stars (8th student).

It is seen in Table 5 that the students stated that they were impressed with the animation of migrant birds, Caretta-Carettas animations, taking measurements with the sky quality meter and astronomy animations while the light pollution topic was taught.

Table 6 shows the views of the students on what they think about the activities and studies that were carried out while the light pollution topic was taught.

Table 6. *The frequencies of and students' statements to "What do you think about the activities and studies that were carried out while the light pollution topic was taught in science classes?"*

Opinions on the light pollution activities	*f*	Student statements
Fun	3	It was fun to tell our personal ideas and discuss them with the group that was formed after we watched the animations on light pollution... (27th student).
Interesting	3	Outdoor education activities were fun. It was interesting and enjoyable to have the chance to make measurements with the sky quality meter... (10th student).
Easy to remember	2	In science classes, it is easy to remember the things that were prepared with animations (25th student).
Didactic/informative	5	First of all, with these activities, I produced an idea, I mean, I did not know much about light pollution and I learnt more (23rd student).

Table 6 shows that the students stated that the activities and studies that were carried out while the light pollution topic was taught were fun, interesting, easy to remember and didactic/informative.

Table 7 shows the views of the students on the activity that they liked the most while the light pollution topic was taught.

Table 7. *The frequencies of and students' statements to "Can you please tell the activity you liked most while you were taught light pollution? Why did you like that activity?" question*

The activity that the students liked the most	*f*	Student statements
Taking measurements using the sky quality meter	5	…The data that we measured with the sky quality meter and, in particular, the data from the city forest attracted my attention. For example, I did not know that there was so much light pollution around the school. We learnt it more easily with that device. In other words, we learnt more... (23rd student).
Group discussions and decision-making after the animations	1	...The activity that I liked the most was the animations and the activities in which our opinions were asked. We expressed our ideas freely and learnt about the topic (25th student).
Caretta Carettas animations	3	I most liked the Caretta Carettas animations and I was very sad that they die because of light pollution (8th student).

According to Table 7, it is seen that, of all the activities conducted while the light pollution was taught, what the students liked the most were making measurements using the sky quality meter, group discussions and decision-making after the animations and Caretta Carettas animations.

Table 8 shows the views of the students on whether they would like other topics to be taught in the way that light pollution was taught.

Table 8. *The frequencies of and students' statements to "Would you like to learn other topics in Science classes in the way you were taught light pollution? Why?" question*

The reasons for demanding other topics to be taught in the way that light pollution was taught	*f*	Students' statements
Fun	3	Sure I would want that. First of all, it was fun. We normally do not do such wide scale activities at school - what we normally do is very limited (10th student).
Interesting	4	There are more visual activations and I liked them more, they were more interesting (23rd student).

According to Table 8, the students stated that the reasons behind demanding other topics to be taught in the way that light pollution was taught are because it is fun and interesting.

Table 9 shows the opinions of the students on what kind of benefits learning science classes in the way that light pollution was taught would bring.

Table 9. *The frequencies of and students' statements to "What kind of benefits do you think learning Science classes in the way you were taught light pollution will bring?*

Benefits of learning science in the way that light pollution was taught	*f*	Students' statements
Detailed /comprehensive learning	3	...In other subjects, we cannot spend as much time as we did on light pollution... (27th student). … For example, I did not know that there was so much detail and information about light pollution. With such things as outdoor observations, I believe I will learn a lot more (23rd student).
More permanent learning	3	…It is more permanent and we learn better (11th student).
Easy to learn	2	We learn more easily when we are doing enjoyable activities or experiments ... (10th student).
Fun	1	...For example, while we are taught a topic, we are sometimes bored and do not want to listen to the teacher or we cannot understand because we are bored. However, the measures we take outside of school are fun and permanent (10th student).
Creates awareness/ raises consciousness	3	For example, before we did the activities and practices concerning light pollution, I would not realize the places where there is light pollution and would just pass by (25th student).

It is seen in Table 9 that the students stated that learning other topics in science class in the way that light pollution was taught would be beneficial. This is because it will ensure more detailed/comprehensive learning and permanent learning. It will also make learning easier and more fun, as well as creating awareness and raising consciousness.

Discussion, result and suggestions

Computer-supported concept cartoons that enabled the students to fill work sheets, which are made up of concept cartoons, in groups and outdoor school activities increased the rate of correct answers to the open-ended questions in the post-test. While the number of students who indicated light pollution as an environmental issue was quiet small in the pre-test, this number increased in the post-test. Similarly, Sadık, Çakan and Artut (2011) examined 206 fifth grade students' perceptions on environment problems studying at three different primary schools from different socio-economic levels via the pictures that the students drew. They saw that the students drew the loss of forests, air pollution, decreasing species, spoiling ozone layer, sound pollution, soil pollution, global warming, etc., as environmental problems in a reason-result relationship. However, they saw that only one student drew a picture about light pollution. Additionally, Taşlıdere (2013) indicated in his study that the work sheets that were enriched with concept cartoons had positive effects on the students' conceptual learning.

It is believed that the activities that are carried out with seventh grade students concerning light pollution will ensure that the students have awareness on the ecologic, astronomical and economic results of light pollution and that they will develop solutions towards preventing light pollution.

All of the interviewed students from the classroom, in which computer-animated activities enriched with concept cartoons and outdoor education activities were carried out, stated positive views on the activities that were conducted. The students stated that they learnt the reasons and impacts of light pollution well. In addition, it was seen during the interviews that the students did not think that light pollution could harm some living things. The students also indicated that they enjoyed making computer-animated activities and outdoor education activities.

The students stated that the way light pollution was taught was different from the way that other science topics were taught and that they did activities, outdoor education activities and measurements.

All of the students stated that they wished science classes were taught in the way that light pollution was taught. They also stated that learning in this way is more enjoyable and interesting.

The students stated that the activities were fun, interesting, informative and easy to remember.

The following suggestions can be made for further studies:

Concept cartoons, which prevent misconceptions and support students to learn by searching and questioning, can be used to determine and remove misconceptions.

It is believed that including light pollution by emphasizing its ecological, astronomical and economic significance within the scope of a science teaching programme will create awareness of the topic among students - in other words, among the future generation.

It is believed that using computer-aided concept cartoons in learning environments and learning science through outdoor education activities will contribute to meaningful learning among students and will make classes more interesting for them.

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APPENDIX – A

Picture 1: An outdoor science education activity with students

Picture 2: An example for light pollution

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