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A Comparative Analysis of Karplus Learning Cycle Model and Ausubel Meaningful Learning Model on Children's Environmental Pollution Cognition

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Abstract: Environmental education aims to raise individuals who have the necessary environmental knowledge, positive environmental attitudes, and active participation in the solution of environmental problems. It is necessary to use an effective teaching model in environmental education. The study aims comparing the academic success of secondary school students in teaching environmental problems in the light of Karplus's learning cycle model (Inquiry) and Ausubel's meaningful learning model (Direct) in terms of metropolitan-centred students (experimental group) and rural-centred students (control group). In addition, the important thing in questioning is to reveal the relationship of prior knowledge with open-ended questions asked by metropolitan-centred students. In this study, 164 5th-grade students' thoughts on environmental problems, their level of producing solutions, and their academic achievements were examined. A mixed design was used in the research. A case study, which was one of the research methods, was used for qualitative data, and an independent sample t-tests and paired sample t-tests were used for quantitative data. During the data collection process, the experimental and control groups were given a pre-test before the application, then news videos containing environmental problems were watched by the experimental group, while

the control group was taught with universal visuals. At the end of the lesson, the same achievement test was applied to both groups as a post-test and the change was examined. The whole application took a total of 8 lesson hours for both groups. As a result of the study, a statistically significant difference was found between the achievements of the experimental group students and the success of the control group students. In the qualitative data of the experimental group students, it was observed that they mostly commented on water pollution, air pollution, and forest destruction. In addition, the problems that individuals perceived least correctly were the visual pollution, noise pollution, and light pollution, accepted as the normality of big city life intertwined with daily life. It is clear that student-centred teaching models, like the Karpus Learning Cycle model will further increase the learning and student's awareness.

Keywords: environmental pollution, learning cycle model, meaningful learning model.

Introduction

The change of vision in the field of education is one of the most important changes marking the era. The goal in this era is to raise our children as science literate. In short, a science-literate individual has the ability to find solutions to problems encountered in daily life by approaching them from a scientific point of view. Citizens of all ages in society can understand and explain some scientific knowledge at the most basic level and follow technological developments and use them in their lives. The basic principle of achieving this goal is to learn scientific knowledge. In the context of this learning, 2 views come to the fore. The first one is "Inquiry", that is, the view that to learn scientific knowledge, the student reaches their knowledge by researching and questioning like a scientist and using scientific process skills. Since the 1930s, the views of scientists such as Dewey, Bruner, and Karplus have formed the basis. The other view is "Direct", that is, the view that it is difficult for the student to access information in the classroom environment by themselves and that the teacher should go down to the level of the student and explain with plenty of examples and then wait for feedback from the student. Since each student is special and it is time-consuming and difficult for them to access information in the classroom due to individual differences. This view is based on the views of scientists such as Gagne and Ausubel. While the Direct teaching model is combined with passive, rote, lecture, and traditional teaching models at the same conceptual level, the Inquiry teaching model is used in combination with hands-on, active learning (Alozie et al., 2010; Dori et al., 2007; Kanter & Konstantopoulos, 2010), on the contrary, some studies conclude that the Direct teaching model is not equivalent to passive reception and didactic lecture and that the Inquiry model is not equivalent to hands-on (Ausubel et al., 1986; Heppner et al., 2006; Novak, 1979).

In general, the Inquiry-based science teaching has been widely advocated worldwide in recent years through various national and international science education standards, although Direct forms of teaching have dominated past practice. What both perspectives have in common is that the learner realizes that the knowledge to be learned is part of life. If considering that all scientific knowledge is interrelated, it can be said that one of the most important factors affecting learning is the student's existing knowledge. The more this knowledge overlaps with the new scientific knowledge to be learned, the easier learning becomes. For this reason, teaching plans should be made accordingly. In inquiry-based science teaching, the individual's rich prior knowledge is more prominent because it is easier for them to make inferences and attribute meaning to the data students obtain while using scientific process skills in the discovery process (Hattie, 2009). In Direct teaching models, on the other hand, prior knowledge is secondary as long as the teacher can transfer knowledge to the level of the student and enriches it with plenty of examples. One of the easiest subjects to integrate the scientific knowledge with

life is the achievements that include environmental problems and solutions in the context of the "Human & Environment" unit. Since its existence, human beings have been making inventions and discoveries to make their lives easier. As a result of this, a human being, who has reached the position of a creature that dominates nature with his mind, has started to change nature in line with his desires instead of living in harmony with nature. By demanding more from nature than is needed and ignoring the effects of our actions on the environment, people are causing various environmental problems. Today, many elements have started to deplete, many of planet water resources have been polluted, energy shortages have started and the world has started to warm up rapidly. In this context, it is necessary to search for solutions to prevent this negative relationship that harms nature and thus harms people. Considering that a lack of respect for nature and not knowing the importance of nature are among the main reasons for this damage, it is thought that providing environmental education to individuals may be an effective solution (Hoeg & Bencze, 2014; Mahidin & Maulan, 2010; Yörük et al., 2010). Although problems cannot be eliminated with environmental education, it is promising as it can be reduced to a great extent.

The first time the concept of environmental education was used during the International Union for the Conservation of Nature Conference held in Paris in 1948 (Ünal & Dımışkı, 1999). Environmental awakening, on the other hand, began in the 1960s and was popularised by the 1972 Stockholm Environment Conference (Hulme, 2016). According to the 1977 UNESCO-UNEP declaration, environmental education aims raising individuals with high environmental awareness and sensitivity, with the necessary environmental knowledge, positive environmental attitudes, and the ability to be active participants in solving environmental problems (Yücel & Özkan, 2014). This definition has been expanded over the years. Palmberg and Kuru (2000) stated that environmental education should aim providing individuals with attitudes, values, skills, knowledge, motivation, and the ability to solve environmental problems. Şimşekli (2004) stated that the main purpose of environmental education was to protect nature and natural resources, to create positive changes in individuals behaviours in addition to the information to be given to individuals, and to enable individuals to effectively participate in solving problems, while Ors (2012) emphasised that environmental education should aim to instil environmental awareness in individuals of all ages and segments and to create permanent changes in their behaviour. According to Karataş and Aslan (2012), environmental awareness can be developed in individuals throughout their lives, but it makes a big difference if its foundation is formed in childhood. This point of view reflects that it is recommended that environmental education should be included as an environmental education course in teacher training and the secondary school science curriculum and that teachers should make lesson plans by extensively using out-of-school environments (Yılmaz et al., 2016). The research with teacher's participation revealed that there are many practical obstacles to using out-of-school environments in the context of environmental education. These barriers were identified as 'administrators, administrative support, planning difficulties, costs, student management problems, lack of knowledge and skills related to outdoor teaching, and safety concerns'. In this case, the best solution is to bring nature into the classroom with the help of technology if there is no possibility to take children out into nature (Jose et al., 2017). Children, who are already a part of nature, have been found in studies to have an impact on children's perception of the environment not only through environmental education and practices but also through their cultural context. Many cultural elements such as the places children go to, the opinions of their families, their daily routines, the movies they watch, and neighbourhood patterns shape the environmental perceptions of individuals (Aguirre-Bielschowsky et al., 2011). Recently, it has been concluded that students are particularly influenced by the media and daily life and that these have an impact on environmental concepts. The media has the role of a mediator between science and society, enabling them to see the effects of science on society (Hulme, 2016).

Karplus's learning cycle model includes 3 phases.

Exploration; students conduct research, collect data and make sense of the data they collect by using scientific process skills.

The term Introduction; students share their inferences with their friends and reach scientific knowledge by discussing and being guided by the teacher.

The concept Application; students solve problems with the scientific knowledge they have acquired and apply it to daily life (Marek & Cavallo, 1997).

Ausubel's model of meaningful teaching includes 3 phases.

Phase 1. Advance Organiser; clarify the aim of the lesson and relate the organiser to students' prior knowledge.

Phase 2. Presentation of Learning Task or Material; the concept is explained with examples.

Illustrate the topic until it is understood and engage students in meaningful learning activities.

Phase 3. Strengthening Cognitive Organization; examples and problem solutions are made to show that the student has learned (Safdar et al., 2012).

In addition, the aim is to reveal the importance of the individual's prior knowledge and the importance of having this knowledge from students' immediate environment with videos containing current and regional environmental problems in the applications.

In literature, environmental studies mostly include research at the conceptual level of "environmental attitudes and behaviours", "environmental problems", "environmental awareness/environmental knowledge" and "environmental education" (Bahar & Kiris, 2017). Altın et al. (2014) studied secondary school students' awareness of environmental issues and problems. Their study showed a high level of environmental awareness among participant students. However, it is understood that environmental disclosures made in schools are insufficient and the participation level of students in environmental activities is low. Chaudhari (2015) examined the awareness of secondary school students about environmental pollution and environmental changes. He found that most of the students were familiar with the environment and environmental factors, were conscious of the environment and human existence, were familiar with the factors that polluted the environment, and were aware of the remedies to prevent environmental pollution. However, the students said that they had fewer activities at school, ordinary things were done, and out-of-school excursions were insufficient. A similar study was conducted by Salleh et al. (2016). They declared that secondary school students were found to possess substantial knowledge of environmental issues and good attitudes toward the environment. However, they have moderate awareness of environmental issues examined through their knowledge and attitudes. Yalçınkaya & Çetin (2018) examined the attitudes of secondary school students towards the environment and their views on environmental education (EE) and made suggestions for organising activities that would increase the environmental awareness and energy efficiency, where the education given in schools was insufficient. Ablak & Yeşiltaş (2020) studied to measure 524 students from 5–8 grades secondary school student's level of awareness about environmental education concepts and found that secondary school students had a high level of awareness about the concepts of environmental education overall. In Vemula and Devendar's (2021) study, the environmental awareness of public and private secondary school students was compared. As a result of their research, the environmental awareness was at a medium level, and private school students were more sensitive. For environmental education, public schools should organise exhibitions, activities such as tree planting, and movie/documentary screenings, and cooperate with non-governmental organisations in the environmental issues of understanding the subject and the principle

of teaching from close-to-far. The recent environmental education studies emphases conservation outcomes focusing on local issues, partnerships, and action in environment which is also called outdoor environmental education program. There is also some constructivist learning-based and active learning-based environmental education research in literature (Arık & Yılmaz, 2020; Jorgenson et. al. 2019; Mónus, 2022). There are no studies showing the effect of comparative current teaching models on children's learning about the environment.

Research Problem

Based on the carried-out literature analysis, many studies are the subject of studies at the conceptual level of environmental attitudes and behaviours, environmental problems, environmental awareness/environmental knowledge and environmental education. The comparative studies are almost non-existent in terms of teaching models. Thus, the research problem is "In the teaching of environmental problems, is the direct teaching perspective or the Inquiry teaching perspective more effective?"

Research Focus

In terms of teaching models related to environmental problems and comparative studies of Rural-Metropolitan-centred 5th-grade secondary school students are negligible, this is the focus of this study. This type of comparative research will contribute to which models should be used primarily for students' learning, especially in environmental studies, and will guide education administrators for reform studies.

Research Aim and Research Questions

This study aims to compare the academic achievement of middle school students in the teaching of 8 objectives in the context of Human & Environment unit in the light of Karplus's learning cycle model and Ausubel's meaningful learning model in terms of metropolitan-centred students (experimental group) and rural-centred students (control group) and to measure the preliminary thoughts of metropolitan-centred students about environmental problems with open-ended questions asked in the "Exploring" step, which is the first step of Karplus's learning cycle model. In this context, answers to the following questions were sought.

1. Is there a difference between the mean pre-test scores of the experimental and control group students in the Human & Environment unit achievement test?

2. Is there a difference between the mean achievement test scores of the experimental and control group students in the Human & Environment unit?

3. Is there a difference between the pre-test and post-test mean scores of the Human & Environment unit achievement test among the experimental and control group students?

4. What is the experimental group students' prior knowledge of current environmental problems?

Research Methodology

Research Design

In the study, a quasi-experimental design with pre-test and post-test control group was used in order to examine the effect of the teaching models used in learning 8 different acquisitions of the Human & Environment unit in 5th grade Science. In addition, the students in the experimental group were asked

open-ended questions about their knowledge and solution suggestions about the current environmental problems and were shown videos. This process, which is a case study, is also expressed as a type of design that allows an in-depth and detailed examination of the targeted situation and aims to reveal social facts (Creswell, 1998; Yıldırım & Şimşek, 2008).

Study Group

The population of the research consists of 5th-grade students studying in the centre and the rural area of a metropolitan city. The study group was selected by convenience sampling method. In convenience sampling, the researcher selects a situation that was easy to access and, in this context, the researcher gains speed and practicality (Yıldırım & Şimşek, 2008). The reason for choosing the students from the school in the city centre is that they are intertwined with environmental problems, and the reason for choosing the school students in the rural area is that they have encountered less environmental problems. While the experimental group students were selected from a secondary school in the centre of the metropolitan city, the control group students were selected from a secondary school in the rural area of the metropolitan city. The experimental group consisted of 98 students from 4 different branches of a metropolitan middle school and the control group consisted of 66 students from 3 different branches of a rural middle school. In total, 164 students participated in the study. In addition to the principle of volunteerism, the principle of confidentiality was also given importance in the research and each participant was given the codes K1, K2, K3, ... K96 codes were given to each participant respectively.

Data Collection Tools

As data collection tools, the achievement test developed by Çiçek Şentürk and Selvi (2021) in 2021 for the 5th grade "Human & Environment" unit was used for quantitative data, and the interview form developed by the researcher was used to collect qualitative data. The achievement test used for quantitative data consisted of 27 items. The item difficulty of the test was 0.62, the average item discrimination was 0.47, and the KR-20 reliability coefficient was 0.82.

Table 1

Unit Outcomes and Achievement Test Questions

Unit Outcomes	**Questions**
1. Questions the importance of biodiversity for natural life	1-27
2. Discusses the factors that threaten biodiversity based on research data	2-6-12-19-22
3. Expresses the importance of the interaction between "Human & Environment"	3-7-13-25
4. Offers suggestions for the solution of an environmental problem in their immediate environment or our country	15-17
5. Makes inferences about the environmental problems that may occur in the future as a result of human activities	9-20-23-24
6. Discusses benefit and harm situations in human-environment interaction on examples	5-16-18
7. Explains destructive natural phenomena caused by natural processes	4-10-21-26

8. Expresses ways of protection from destructive natural events	8-11-14

Qualitative data consisted of 3 open-ended questions:

(1) What do you think is the problem and its cause in this video?

(2) How do you think this problem can be prevented?

(3) Where did you learn the information?

The questions were included in the research process after being approved by 3 experts in the field. Open-ended questions were preferred because they enabled students to give original answers and make personal comments. In the 5th-grade science curriculum, environmental pollution under the Human & Environment unit is divided into 4 areas and these are defined as (1) water, (2) air, (3) noise, and (4) visual pollution. In addition, light pollution is specifically mentioned as a separate heading within visual pollution. The current issue of forest destruction is also included in the study. In this framework, 4 current news videos reflecting 6 environmental problems were used. In the video on water pollution, the content includes mucilage, sea pollution, dead fish washed up on the beach, oil waste leaking from the ship, and factory water entering the rivers. The video on air pollution included dark skies, people wearing masks, factory chimneys, and car exhaust fumes. The forest video includes images of fires, picnic areas, illegal logging, and zoning of forest areas. The Visual-Light-Noise video includes images of day and night work density in a metropolitan city and images of urbanisation.

Data Collection process

The achievement test of the Human & Environment unit was used as a pre-test before the start of the lesson for the experimental and control group students. Then, in the light of Karplus Learning Cycle model, current news videos were shown to the experimental group in silence mode (except for the noise pollution video) and open-ended questions were asked after each video. While each video lasted between 3-4 minutes, students were given an average of 5 minutes to answer the open-ended questions (Figure 1). In addition, the videos were played repeatedly while the students answered the questions. Each news video process took an average of 10-15 minutes, and a total of 2 lesson hours of data collection was realized. Then, students talked to each other about answers, and the topic was summarized in the term introduction phase. After that, the teacher asked some questions, matching, multiple choice, and concept cartoon-type questions, about the topic to check the students' learning, in the concept application phase.

Figure 1

Experimental Group Visuals from Media Videos

	
Water Pollution (Mucilage, Istanbul)	Air Pollution (Izmir)
	
Forest destruction (Izmir)	Light-Visual Pollution (Izmir)

In the control group, unlike the experimental group, the teacher clarified the aim of the lesson and relate the organiser to students' prior knowledge, then the Human & Environment unit concepts were explained with many examples. The teacher taught the lesson enriched with visuals in the context of the Ausubel teaching model through lectures and plenty of examples. The visuals were selected from distant countries that students were unlikely to have seen before (Figure 2). After that like the Karplus Learning cycle model of the last phase, the teacher asked some questions, matching, multiple choice, and concept cartoon-type questions, about the topic. In the end, the achievement test was used again as a post-test for both groups. The whole application took a total of 8 lesson hours for both groups.

Figure 2

Control Group Visuals

	
Water Pollution (India)	Air Pollution (China)
	
Deforestation (Rain forest Brasil)	Light-Visual Pollution (New York)

Data Analysis

Since the quantitative data obtained were normally distributed, an Independent sample t-test was used. In addition, the Levene test, which is a hypothesis test to evaluate the equality of variances for a variable calculated for two or more groups, was also applied. For qualitative data, the content analysis method was used to analyse the data to draw meaningful conclusions, explain the data and reveal the relationship between them. When conducting content analysis, the data must first be coded, then organized, and finally, themes must be created according to these codes (Yıldırım & Şimşek, 2018). Thanks to the themes created, the relationship between the data is easily revealed. A total of 3 themes were created within the scope of this study.

Research Results

According to the achievements of the Human and Environment unit and the results of the pre-test academic achievement test of the experimental and control group students, it is visible that there was no statistically significant difference ($p>0.05$) between the pre-test ($\bar{X}$: 8.47) score of the students in the experimental group and the pre-test ($\bar{X}$: 7.08) score of the students in the control group [$t(163)=2.63$, $p>0.05$]. The standard deviation was a statistical measure of the spread of data relative to the mean. If many data were close to the mean, the standard deviation was small. The standard deviation value of the control group (2.94) was smaller than the experimental group (4.74), because it was closer to its mean score. In addition, since the p-value found as a result of Levene's test was greater than $0.094>0.05$, it can be said that there was no difference between the groups, that was, the variances were not equal (homogeneous) (Table 2).

Table 2

Comparison of Pre-test Scores of Students in Experimental and Control Groups

Group	**N**	$\bar{X}$	**sd**	**df**	**t**	**P**
Experimental group	98	8.47	4.74	163	2.63	. 48
Control group	66	7.08	2.94			

Levene: 0.094

Considering the post-test results applied at the end of the lesson, the achievement test average result of the experimental group students was calculated as 23.07, and the achievement test average result of the control group students was calculated as 18.5. The standard deviation value of the control group (4.14) and the experimental group (3.98) were very close, both were close to theirs mean score. There was a statistically significant difference [t (163) = 3.013, p<0.05] between the post-test mean achievement scores of the students in the experimental and control groups (Table 3).

Table 3

Comparison of Post-test Scores of Students in Experimental and Control Groups

Group	**N**	$\bar{X}$	**sd**	**Df**	**t**	**p**
Experimental group	98	23.07	3.98	163	3.013	.018
Control group	66	18.5	4.14			

While there was a statistically significant difference in the comparison of the pre-test and post-test paired sample t-test for both groups of students, it is visible that the achievement means scores of the students in the experimental and control groups increased. While the pre-test and post-test standard deviation values (4.47-3.98) of the experimental group were close to each other, this situation increased in favour of the post-test (2.94-4.14) in the control group. The academic achievement mean score of the experimental group students increased from 8.47 to 23.7. The academic achievement mean score of the control group students increased from 7.08 to 18.5. It is seen that there is a greater increase in the number of students in the experimental group (Table 4).

Table 4

Comparison of Pre-test and Post-test Scores of Students in Experimental and Control Groups

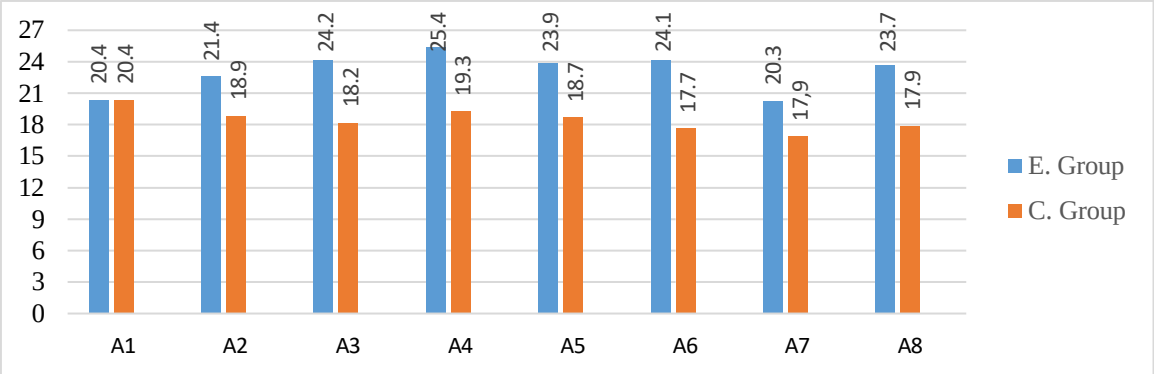
Experimental group	**N**	$\bar{X}$	**sd**	**df**	**t**	**p**
Pre-test	98	8,47	4.47	97	1.652	.00
Post-test	98	23.07	3.98			
Control group						
Pre-test	66	7.08	2.94	65	1.376	.00
Post-test	66	18.5	4.14			

When analysing the achievement post-test scores for both groups, it can be seen that the biggest differences are Achievement 3. Expresses the importance of the interaction between "Human & Environment" (difference 4); Achievement 4. Offers suggestions for the solution of an environmental problem in his/her immediate environment or our country (difference 6.1); Achievement 5. Makes inferences about environmental problems that may occur in the future as a result of human activities (difference 5.2); Achievement 6. Discusses the benefit and harm situations in human-environment interaction on examples (difference 6.4); Achievement 8. Expresses ways of protection from destructive natural events (difference 4.8). This result is especially related to scientific knowledge about the

definition, causes, and solutions of 6 different environmental problems.

Figure 1

Experiment & Control Group Academic Achievement Test Scores



Within the scope of the study, a total of 4 themes were formed "*students' perceptions about environmental pollution*", "*students' level of knowledge about the effects of environmental pollution*", "*students' level of knowledge about the solutions to environmental pollution*" and "*source of information*". In order to ensure the external validity of the research, direct quotations from the participants' opinions were included under each table.

Perceptions of Environmental Pollution

Students were asked to define the problem in the news video with water pollution. From this point of view, it was investigated whether the students perceived the problems of water pollution. Considering the data obtained, all students observed and defined water pollution. Water pollution was analysed in 2 themes water pollution caused by chemical waste and water pollution caused by garbage. It is seen that students are mostly aware of water pollution caused by garbage. As the cause of water pollution, the answers of littering (f:73), marine pollution (f:34), gasoline-oil-oil spillage (f:28), and pollution of water resources (f:27) (Table 5).

Table 5

Students' Perceptions of the Water Pollution Video

Themes	**Correct perceptions**	**f**	**Misperceptions**	**f**
Water pollution from chemical waste	Spilling gasoline-oil-oil into the sea	34		-
	Pollution of water resources	27		-
Water pollution from garbage	Littering in the sea	73		-
	Bad-dirty scene	17		-
	Disposing of waste materials into the sea	8		-

P21: *"It is very obvious that the sea is filthy, garbage has been thrown into it, caretta carettas can eat this garbage and die."*

P45: "*At the beginning, the sea looked very beautiful and clear, but then there was waste and the oil leaking from the ship would kill the fish*".

P61: "*I think that foam in the sea is dirt, especially in the scene inside the sea, even the fish and algae cannot be seen*".

Students were asked to interpret the problem related to the video about air pollution. While the number of students who could perceive the problem of air pollution was 87, eleven students could not perceive the problem. Participants who have a misperception about air pollution confuse the problem with light pollution and visual pollution. They also did not see fog and the abundance of factories and buildings as a problem. In addition to saying air pollution directly, students attributed pollution to car and factory fumes (Table 6).

Table 6

Students' Perceptions of the Air Pollution Video

	Codes	**f**		**Codes**	**f**
Correct perceptions	Air pollution	41	**Misperceptions**	Light pollution	6
	Smoke from car exhausts	25		Fog	3
	Factory fumes	21		Visual pollution	
	No view of the landscape	10		The high number of factories/buildings	1
	Unhealthy air	8		No problem	1

P26: *"There is a lot of light pollution and it catches people's eyes."*

P55: *"There are factory chimneys, if there are no filters installed on them, filters should be installed."*

P47*: "I've seen it in Aliağa, but I've never seen so much fog in Folkart. Yes, there is a problem here, a weather problem."*

In the news video on forest destruction, students' answers were grouped under the themes of forest destruction and forest fires. While there was no misperception about forest fires, 12 students could not define the problem in the theme of forest destruction. While the forest fire was clearly defined, failures to protect nature and animal deaths were also mentioned, cutting down trees (f:77), mining exploration in the forest (f:33), failure to protect nature (f:22), building houses in the forest (f:17), decreased rainfall (f:16) and failure to plant trees (f:15) were mentioned in the theme of forest destruction, (Table 7).

Table 7

Students' Perceptions of the Forest Destruction Video

Correct perceptions		f	**Misperceptions**	f
Forest Fire	Forest fire	98		-
	Failure to protect nature	52		
	Animals die	41		
Forest destruction	Cutting of trees	77	No problem	12
	Mining exploration in the forest	33		
	Failure to protect nature	22		
	A house in the forest	17		
	The rains diminish	16		
	Failure to plant trees	15		

P8: "Our forests were burned, trees and animals died".

P11: "Yes there is a problem, houses have been built instead of trees, and the trees seem to have dried up, which reduces rainfall".

P77: "They have literally carved the mountain to search for minerals, what if they don't find any".

The latest news video shown to the students contains light and noise pollution as well as visual pollution.

It was observed that 26 students had wrong perceptions about general visual pollution, while 72 students had no perceptual problem with visual pollution. The wrong perceptions were landslides (f:13), earthquakes (f:8), small houses (f:2), and no problem (f:3). Under the theme of correct perceptions, two sub-themes were formed as the direct effects of visual pollution and the effects of urbanization. The answers with the highest frequency under the themes were found to be visual pollution (f:60) and the fact that the houses are intertwined (f:24) (Table 8).

Table 8

Students' Perceptions of the Problem of Visual Pollution

Correct perceptions		**f**	**Misperceptions**	**f**
Direct effects	Visual pollution	60	Landslide	13
	Crowd-crowded scene	13	Earthquake	8
	Unattractive scene	11	Small Houses	2
Effects of urbanization	Intertwined houses	24	No Problem	3
	Lack of trees	12		
	Overbuilding	11		
	Destruction of nature	11		
	Animals losing their home	2		

P5: *"Since they build houses everywhere, it looks bad and nature is being destroyed. Animals' homes are disappearing, this is important."*

P21: "There *might have been an earthquake in these photos.*"

P27: "*There are also tall buildings, but there are more small houses. Big buildings should be built."*

While 42 students were aware of the problem of light pollution, 56 were not. The most frequent answers of the individuals who perceive light pollution as a problem are as follows, respectively: light pollution (f:31), excessive use of light (f:17), visual pollution (f:13), waste of electricity (f:12) and general environmental pollution (f:9) (Table 9).

Table 9

Students' Perceptions of the Problem of Light Pollution

Correct perceptions	**f**	**Misperceptions**	**f**
Light pollution	31	No problem	56
Excessive use of light	17		
Visual pollution	13		
Electricity waste	12		
Environmental pollution	9		

P5: *"Yes, too much light is used everywhere for nothing."*

P7: *"There is a problem here. There are lights everywhere, those lights are always on in the buildings, so there is no need for those lights at night. I don't think this is beautiful, it is also visual pollution."*

It is seen that noise pollution is the area with the most problems in perception. The 59 students confused noise pollution with general environmental pollution. The 39 students who identified noise pollution were defined as direct noise pollution (f:29), sound pollution (f:15), horn sounds (f:12), and car sounds (f:7) (Table 10).

Table 10

Students' Perceptions of the Noise Pollution Problems Shown in Photographs

Correct perceptions	**f**	**Misperceptions**	**f**
Noise pollution Sound pollution Honking horns	29 15 12	Environmental pollution	59
Car sounds	7		

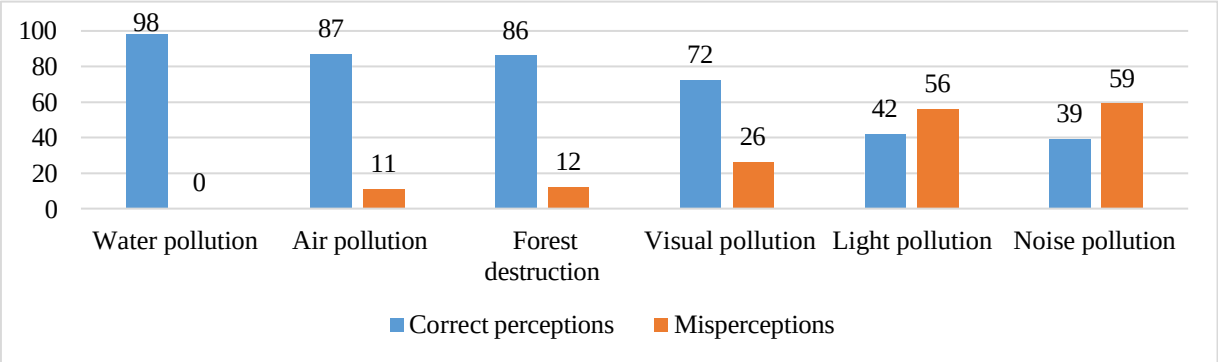
P26: *"Garbage is thrown on the ground, there is both environmental pollution and too many cars here, cars should be reduced."*

P58: "The *problem here is noise pollution; cars make too much noise. When cars make too much noise, it can harm people."*

Regarding the 6 environmental problems in the news video containing 4 current environmental problems, students correctly perceived 100% water pollution, 89% air pollution, 88% deforestation, and 73% visual pollution, while this rate decreased to 43% for light pollution and 40% for noise pollution (Graph 2).

Figure 2

Right-Wrong Perceptions About Environmental Issues



The level of knowing the effects of environmental pollution and solutions

The answers given by the students about the effects of water pollution were grouped under 3 themes; personal discomfort, effects on living life, and effects on nature. The most common answers given under these 3 themes were as follows; not being able to swim (f:55), death of fish (f:77), and depletion of water resources (f:12). The solutions suggested to prevent were also combined under the 3 themes; ways to prevent garbage, ways to prevent waste and educational solutions. The most common

answers under each theme are listed respectively; garbage should not be thrown into the sea (f:69), sewage should not be poured into the sea (f:41), and people should be warned (f:33) (Table 11).

Table 11

Level of Knowledge of Water Pollution Problem, Its Effects, and Solutions

Levels of knowing the effects of environmental problems		***f***	**Levels of knowing the solutions**		***f***
Personal discomfort	Not being able to go to the sea	55	Ways to prevent litter	Garbage should not be thrown into the sea	69
	Getting infected - getting sick	33		The sea must be cleaned	34
Effects on living life	Fish dying	77		Garbage must be collected	26
	Dying of moss	37		Garbage should be thrown in the garbage bin	14
	Poisoning fish and humans	32		Nets should be installed in the sea	10
	Negative impact on land animals	24		Organize garbage collection events	10
Impact on nature	Depletion of water resources	12		Fine	9
	Pollution of the environment	11	Ways to prevent waste	Sewage should not be dumped into the sea	41
	Garbage odour	7		Oils should not be dumped into the sea	21
				Installing purification in factories	31
			Educational solutions	People should be warned	33
				People should be made aware	11

P8: "*When we enter the sea to swim, we encounter a lot of garbage and it is difficult to swim.*

P88: "*We should not throw garbage or a net can be attached to the sea. After a week, when the net is removed, the garbage is cleaned.*

The answers obtained from the students about the effects of air pollution were grouped under 2 themes; individual effects and effects on living things. The most common answers under these 2 themes are as follows; damage to the eyes (f:63), inability to breathe clean air (f:42), damage to living things (f:55), death of birds (f:42) are the codes with the highest frequency. When the answers obtained regarding the solutions were analysed, 4 themes were formed. Respectively, legal regulations, educational-attractive, light pollution solutions, and not specifying a solution. The most frequently given answers regarding the 5 themes are; filters should be installed in factories (f:62), people should be warned (f:41), light sources should be reduced (f:10), and there is no solution (f:2). One of the interesting points here is that students integrated the concept of light pollution into the concept of air pollution (Table 12).

Table 12

Level of Knowledge of Air Pollution Problem, Its Effects, and Solutions

Levels of knowing the effects of environmental problems		**f**	**Levels of knowing the solutions**		**f**
Individual effects	Damage to the eyes	63	Legal regulations	Install filters in factories	62
	Inability to breathe fresh air	42		Stoves and nuclear power plants should not be used	32
	Poisoning-death	22		Complaining to the municipality	31

	Inability to go out	18	Educational-Attention-grabbing	People should be warned	41
				A banner should be prepared	11
Effects on living things	Damage to living things	55	Solutions to light pollution	Reducing light sources	10
	Birds dying	42		Less use of light	9
	Disorientation	11	Failure to specify a solution		2

P13: *"Both our eyes will be damaged and the birds will be affected, they will not be able to find their destinations.*

P43: *"As a solution, filters should be installed in factory chimneys*

P59: *"It does not affect us, but we can use less light to fix it*

Impacts and solutions to forest degradation were categorized under three themes. The themes are as follows respectively: effects on living things, effects on nature, and solutions to protect forests. While the codes with the highest frequency in the themes determined under the effects of forest destruction were the destruction of the habitat of living things (f:39) and the decrease in oxygen (f:45), the codes with the highest frequency in the theme determined for the solutions were determined as trees should be planted (f:68) and trees should not be cut down (f:49) (Table 13).

Table 13

Level of Knowledge of the Problem of Forest Destruction, Its Effects, and Solutions

Levels of knowing the effects of environmental problems		**f**	**Levels of knowing the solutions**		**f**
Impact on living things	Destruction of habitat	39	To protect forests	Trees should be planted	68
	The inability of living things to feed	37		Trees should not be cut down	49
	Animals dying	33		Nature must be protected	35
	Psychological distortion	22		Forest area should be increased	33
Impact on nature	Decreased oxygen	45		Nature must not be polluted	20
	Destruction of natural areas	44		Buildings should not be built	20
	There may be a landslide	27		Call the fire brigade	18
	Tree depletion	25			
	Disasters happen	19			

P8: "*If there is not plenty of greenery, natural disasters will happen frequently. Living things cannot feed"*.

P11: "*Animals' homes have been destroyed.*

P58: "*We should protect nature instead of building houses and cutting down trees"*. P71: "*I would build a huge forest and it would be home to all animals"*.

In line with the data obtained from the students, the effects of the visual pollution problem were collected under 2 themes; direct effects, effects of urbanisation, and solutions were gathered under 4 themes; to protect the equal area, to prevent clutter/chaos other, and no solution. The codes with the highest frequency in the themes created on the effects are eye strain (f:54), decrease in living comfort

(f:26). The codes with the highest frequency in the themes related to solutions are trees should be planted (f:34), fewer buildings should be built (f:30), large buildings should not be built (f:31), no solution (f:15) (Table 14).

Table 14

Level of Knowledge of the Effects and Solutions to the Problem of Visual Pollution

Levels of knowing the effects of environmental problems		**f**	**Levels of knowing the solutions**		**f**
Direct effects	Eye strain	54	To protect green space	Trees should be planted	34
	Creating a bad scene	22		Build houses in treeless areas	11
Effects of urbanization	Decreased comfort of life	26	To avoid confusion	Fewer buildings	30
	Deforestation and oxygen depletion	24		Proper planning is needed	24
	Damage to living things	13	Construction sector	Big buildings should not be built	31
	Decrease in natural areas	12	No solution		15
	Demolition of buildings	9			

P9: "*There is a very complex scene, it tires our eyes."*

P9: "*If there were fewer buildings and more trees, our eyes would not get tired and we would be more comfortable.*

Students' answers about the effects of light pollution were combined under 2 themes; its effect on living things and its effect on the environment. The codes related to these themes are harming living things (f: 44), tiring and spoiling the eyes (f: 34), wasting energy (f: 34), and causing accidents (f: 32). When the solutions produced were analysed, 4 themes were formed; direct solutions, solutions to attract attention, legal regulations and no solution. Examples of the codes belonging to these 4 themes are as follows; reducing the use of light at home (f:52), reducing the lighting of buildings (f:31), taking action (f:23), the municipality should turn off the lights (f:17), no solution (f:23) (Table 15).

Table 15

Level of Knowledge of the Problem of Light Pollution, Its Effects, and Solutions

Levels of knowing the effects of environmental problems		**f**	**Levels of knowing the solutions**		**f**
Impact on living things	Harm to living things	44	Direct remedies	Reduce the use of light at home	52
	Tiring and deteriorating eyes	32		Building lighting should be reduced	31
	It prevents living things from navigating	12		Savings must be made	14
	Animals cannot sleep	17		The necessary lights must be turned on	10
	Rapid shedding of tree leaves	11	For attracting attention	Action must be taken	23
Impact on the Environment	Energy waste	34		The complaint must be filed	22
	Causing accidents	32	Legal regulation	The municipality should turn off the lights	17

	Creating visual pollution	11	No solution		23

P15: *"Too much light can spoil our eyes and disturb living things, they need to sleep in the dark too.*

P15: *"Not every building has to be lighted, this problem will disappear if only the necessary lights are turned on. We can protest in front of the governorship or Gediz Electricity*

Based on the answers given by the students, the effects of noise pollution were grouped under 2 themes, and the solutions were grouped under 4 themes. The themes created about the effects are the effect on hearing and the effect on living things. The most frequent codes of these themes were deafness (f=12) and disturbance of living things (f=14). The themes created for solutions were solutions to traffic-related noise pollution, solutions to human-induced noise pollution, solutions to construction sector noise pollution, and no solution. The codes with the highest frequency for these 4 themes are: not honking (f:64), not shouting (f:44), noiseless building construction (f:37), and no problem (f:13) (Table 16).

Table 16

Level of Knowledge of the Problem of Noise Pollution, Its Effects, and Solutions

Levels of knowing the effects of environmental problems		**f**	**Levels of knowing the solutions**		**f**
Impact on hearing	Deafness	12	Solutions for traffic-related noise pollution	Failure to honk the horn	64
	Ear and head diseases	8		Reduction of cars	21
Impact on living things	Disturbance of living things	14		Cars without horns	9
	Spooking of animals	8		Replacing car exhausts	9
	Interferes with communication	4	Solutions to human-induced noise pollution	Not shouting	44
				Don't talk unnecessarily	15
			Construction industry noise pollution solutions	Noiseless building construction	37
			No solution		13

P6: "*People cannot even understand what each other is saying because of the noise.* "

P15: "*It will be solved if people don't shout "Come sister, come sister" and honk their horns in the markets."*

P8: *"Cars without horns should be produced. "*

P7: *"The world population is increasing every day and noise pollution will continue to increase. It cannot be prevented*

Environmental Pollution Information Source

When the knowledge level of the questions asked about the 4 current news videos and the source of their solutions were questioned, the answers received from the students were gathered under 4 themes, which were social environment, visual media, written media, and social media. The highest frequency as a source of information was TV (f:70), followed by parents (f:57), and the lowest frequencies were newspapers (f:9) and books (f:5) (Table 17). It was interesting to note that social media has a frequency that is not underestimated in this age group.

Table 17

Students' source of information

Theme	Codes	f	%
Social environment	Parents	57	22
	Friends	36	13.8
Visual media	TV	70	27
Written Media	Journal (Science-technical)	25	9.6
	Newspaper	9	3.4
	Books	5	1.7
Social Media	Tik-Tok / Reel video	34	13.1
	Instagram	23	8.8

Discussion

Due to the comparative nature of the study, it was seen that there was no difference between the academic achievement pre-test results of metropolitan-centred students and rural students. This ultimately gave us the opportunity to apply teaching models with two different perspectives. After the applications, a significant difference was found between the pre-test and post-test comparisons of both experimental and control groups. This result shows that both Karplus's learning cycle teaching model and Ausubel's meaningful teaching model contribute to students' learning. This is a parallel result of Archer and Hughes (2011), Peterson (2011), Lins et al. (2020), and Nurhasanah et al. (2022) studies, which found this accelerated students' learning and problem-solving in the use of "direct" teaching perspective. On the other hand, many of articles, such as Secker (2002), Tretter and Jones (2003), Minner et al. (2010), Furtak et al. (2012), Oliver et al. (2021) supporting for its effectiveness in improving content learning, science process skills, and student attitudes, have been published on inquiry instruction in the sciences. In addition, when the post-test results of the experimental and control groups were compared, there was a statistically significant difference in favour of the experimental group. That means Karplus's learning cycle teaching model gives a more effective result than Ausubel's meaningful teaching model. This result is similar to Johnson and Lawson (1998) Vlassi and Karaliota (2013), Ramnarain and Schuster (2014) studies.

The current environmental problem videos used in the research and the student's level of readiness clearly affected this success. Among the 8 achievements in the achievement test, there was a big difference in favour of metropolitan students, especially in the achievements related to the interaction between humans and the environment and the formation of environmental problems as a result of this interaction (A3), and producing solutions (A4-8) to these problems.

When the results obtained from the open-ended questions are analysed it is seen that the problem that the students make the most comments about is water and air pollution, while the environmental problems that students have the lowest correct perception are noise pollution and light pollution. Students correctly perceived water pollution, especially water pollution caused by garbage, and mentioned its harm to living things. In addition, personal discomforts caused by water pollution were mentioned and creative solution suggestions were presented. Based on the fact that individuals stated

not being able to go to the sea as a result of water pollution as a personal discomfort, we can attribute the reason why individuals are more sensitive about water pollution to because of their regional close relationship with the sea. The fact that individuals are living in a metropolis with a seashore and close to coastal areas may be a factor. In support of this idea, many studies show that children develop an emotional connection with nature through their experiences with nature (Aguirre-

Bielschowsky et al., 2011). When the data on air pollution are analysed, it is seen that the level of perception of the problem of air pollution ranks second. The perception of air pollution, especially factory fumes and car exhausts come to the forefront, while students who confuse it with light and visual pollution and fog stand out at a small rate. Air pollution continues to increase today and is widely discussed in the media. It is seen that the effects of these events taking place in their environment on humans and animals and the reasons that cause this are put forward. Interestingly, since the students live in a metropolitan city and the heating is natural gas, the dirty smoke coming out of the chimneys of the houses is not mentioned in the reasons for air pollution. Although this reason is not a part of their lives in this data, the dense industrial zones around them, especially the large number of factories, concentrated the perception on dirty gases coming out of factory chimneys rather than houses. As a result, it is natural that they are sufficiently aware of this. It cannot be expected to propose a solution to a problem that is not recognised. In addition, the other problem with a high level of correct perception is forest destruction. The fact that these events, such as cutting down trees related to forest destruction and opening areas for mining exploration, building Hydroelectric Power Plants, even cutting down even limited trees in the city and building shopping malls, and forest fires in the region, are talked about a lot in visual and written media as well as in social media, is the possibility that individuals have heard or seen these problems at least once. Considering the answers given by the students as a solution to this situation, it is noteworthy that the answer with the highest frequency is 'planting trees'. Based on this, it can be concluded that individuals are aware of how trees and forests are being slaughtered and that trees are a source of life for both us humans and other living things, and they see the reduction of green areas in natural environments as a serious problem. Mahidin and Maulan (2010) stated that a lack of respect for nature and not knowing the importance of nature are the main sources of crimes against nature. In this context, the fact that the individuals participating in the study are aware of the importance of trees and appreciate nature promises hope for preventing the problems experienced. What is missing here is that the environmental problems experienced by the individuals are not given as a whole under a cause-and-effect relationship. It is possible reaching the environmental awareness one aims for in children only when individuals make sense of problems under the cause-and-effect relationship.

Based on the findings, it seems that the problem of noise pollution is a part of individuals' daily lives and this situation is accepted. Considering that one of the most basic activities in human life is communication and that the ear can hear sounds above 20 decibels, this noise pollution will inevitably cause health problems in the future, but it is seen that the students do not care much. Light pollution, on the other hand, is seen as a part of normal life with the excess of large buildings and the colourful lighting of not only shopping stores but also normal residential buildings with neon or led lights under the name of modernity. From this point of view, it can be interpreted that individuals cannot associate light pollution with large buildings. Based on both problems, it has been determined that the problem that individuals are least aware of is that they cannot adequately see the problems they encounter most in their daily lives. This result contradicts the study of Yılmaz et al. (2016), which emphasises that individuals are more attentive to the problems they directly encounter in their environment.

As a result, it is seen that students have an undeniable level of prior knowledge about environmental pollution. While the source of these knowledge levels of individuals is generally their immediate environment and TV, the use of social media, which is the popular source of information of the age, is undeniably high. While this media monitoring contributes to the student's level of readiness, the fact that they are fully aware of what is going on in their environment reveals an interesting situation. As metropolitan children, it is sad that they do not pay attention to light and noise pollution and see the situation as normal.

These findings are important for informing those planning to develop environmental education programs or curricula. The Ministry should inform their teachers about more learning-centred and

inquiry-based teaching models in their science curricula by providing in-service training to teachers and enable them to teach more concrete-oriented lessons in their science lessons. This process should be accelerated, especially as students gain concrete experiences through field trips.

Conclusions and Implications

In this study, the achievements of 5th-grade students in the context of the Human and Environment unit were compared with the difference in academic achievement between students in metropolitan cities and students in rural areas in the perspective of Karplus's learning cycle model and Ausubel's meaningful learning model. In addition, the perception, foreknowledge, and solution status of the current environmental problem videos shown in the discovery step of the learning cycle model of the metropolitan-centred (experimental group) students were investigated.

It is obvious that learning becomes easier when current events are presented to students in a solid way, especially in the context of close-to-far teaching principle. If teaching the scientific information, it should be taught to students by using student-centred teaching models such as Karplus's learning cycle model. By allowing them the access to the information and techniques that include current and concrete problems/examples within these models, it is obvious that students' learning and awareness will increase even more. On the other hand, it is certain that using instructional technologies in planning will speed up the process, taking into account what the age of developing technology brings. In some cases, problems may arise in the environment, in such cases technology is always the closest helper.

When the effects of environmental problems were analysed in general terms, it was observed that individuals mostly talked about the reflections of environmental problems on their own lives and relatively less about their effects on other living things. From this point of view, it can be inferred that individuals have deficiencies in seeing the environment as a whole and see humans at the centre of the world. While efforts are made to raise environmental awareness in individuals, mentioning only the effects on their lives would support this naive view. In this context, one should also be able to reflect to individuals that humans occupy a small place in the world and that the world does not consist of us.

Although today's environmental problems are scientifically proven, individuals will have difficulty accepting these problems unless they can see the reflections of events in society. Therefore, the first thing to do is to help individuals improve their perception of what is happening around them, to help them recognise existing problems, and to encourage them to use problem-solving skills.

Suggestions for Science Teachers

- Teaching models should be used in the way they enable students to access scientific information on their own.
- It is important to support each environmental issue with concrete examples in order to ensure meaningful learning for students.
- While explaining environmental problems, it is necessary adopting the principle of cause-effect relationship and the examples or events given in a close-to-far teaching principle, that are, examples from the daily lives of individuals should be used first.

Suggestions for Future Research

Based on the study findings, there are some recommendations for further studies. The level of prior knowledge that may affect the results of the study can be compared with the qualitative methods for the experimental and control groups. The study could also be extended in the light of larger subjects and factors such as socioeconomic gender.

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