Journal of Modern Education Review, ISSN 2155-7993, USA
April 2021, Volume 11, No. 4, pp. 393–404
Doi: 10.15341/jmer(2155-7993)/04.11.2021/001

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Investigating the Students' Ideas About the Phenomenon of Climate Change: The Study of the Case of the Students of the Sixth Grade of the Primary Schools in the Prefecture of Ioannina

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Abstract: In the present thesis we investigated the ideas of 120 sixth grade students from four primary schools of Ioannina region as well as their knowledge on greenhouse effect mechanism, on the causes, on the consequences and mainly on the actions taken against climate change.

Overall, it is observed that there is a lack of knowledge about the greenhouse effect mechanism and the greenhouse gases. In addition, many children's misconceptions were highlighted. These misconceptions correspond mainly to the following:

- The alternative perception which confuses the phenomenon of the greenhouse effect with the depletion of the ozone layer in the stratosphere and everything else connected with it just like spray use and skin cancer.
- The children's tendency for generalizations, according to which every environmental activity, just like the protection of the rare species and giving up smoking contributes positively to the confrontation of all of the environmental problems.
- Their weakness to spot "the hidden energy".

Key words: hyperreality society, 4th industry, cultural creativity

1. Introduction

One of the main priorities of the Environmental Education or the Education about the Sustainable Development is to form perceptions and provide the individual with the essential cognitive, ethic supplies in order to face the environmental problem effectively and so as to be led in a viable way of life. These perceptions that people form today about the world, the nature, the environment, the way they perceive the man's position in the nature, the man's relationship with the nature are going to be the values of the tomorrow's world and they will determine the framework of the development of the future. The intensity of the environmental problems today has increased rapidly and this constitutes these problems as complex. Undoubtedly, the great number of the relevant research internationally demonstrates that this complexity demands the cultivation of environmentally responsible citizens from the first grades of compulsory education. The study of these issues of the juvenile population and

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especially on the students of the Primary and Secondary Education is of special interest, as these people are invited as the future citizens to form those relationships between the society and the nature which are going to contribute to the building of a viable future (Flogaidi, 2015). The aim of this study is the research of the perceptions and attitudes of the students of the sixth Grade of the primary school, regarding the climate change so as a targeted teaching approach is going to be designed according to empirical data. This approach will contribute to the upgrade of the knowledge and their awareness.

2. Climate Change

Climate change is the "change of the average condition of the climate or its variability as a result of the statistical controls and exists for a long time period, decades or more. Moreover, it refers to every climate change which is observed over time due to the natural variations or the human activities or the modification of the composition of the atmosphere" (IPCC, 2007, p. 30). It is widely accepted on a scientific and on a political level that the climate change and the global warming of the planet are, partly, due to the natural processes and partly due to the human activities.

3. Causes of the Climate Change

The study of the geological study of the planet has led to the conclusion that the climate of the earth has changed many times. Periods of relatively high temperatures in which there was no ice even on the poles came after periods of low temperatures (the Ice Age). These changes took place long before the human activities appeared in such intensity that they could affect the climate. So, apart from the human factors, there are also natural causes that change the climate of the planet.

The research which was conducted on this subject has spotted the following causes of the natural change of the climate (Argiriou & Giannouli, 2010):

a) Change of the circumference of the Earth around the Sun
b) Change of the intensity of the solar radiation
c) Volcanic eruptions
d) Change of the sea currents
e) Change of the concentration of the greenhouse gasses.

4. Global Phenomena of the Climate Change

4.1 The Phenomenon of the Greenhouse Effect

The phenomenon of the greenhouse effect was named after the French maths teacher J. Fourier in 1822 because its natural function is similar to what happens in the greenhouse of the plants in which the plants, on the one hand, are covered with material which allows the admission of the solar radiation and on the other hand this material prevents the escape of the small frequencies of the earth radiation. The greenhouse effect refers to the increase of the temperature of the earth which is caused by the increase of the concentrations of the greenhouse gases in the atmosphere. These greenhouse gases trap the heating (for example just like the glass traps the heating in a greenhouse). This trapping of the supersonic radiation of the specific gases is called the greenhouse effect.

4.2 The Greenhouse Gases

All the gases of the atmosphere which contribute to the greenhouse effect are referred to as the greenhouse gases. The "greenhouse gases" are about 20 and their volume is smaller than the total volume of the atmosphere.

Vapors H_2O. They result from the vaporization of the water and constitute a stage of the cycle of the water in the hydrosphere. They are produced from the vaporization of the water or from the sublimation of the ice. The water vapors are the main gas of the greenhouse and are responsible for the largest part of the greenhouse. The water vapors create the clouds. These prevent the heating from leaving the earth atmosphere and as a result the temperature increases. The increase of the temperature causes more water vapors and consequently the temperature increases and the global warming is created.

Carbon dioxide (CO_2) — 56%. It is produced mainly from fossil fuel combustion (just like oil, coal, natural gas) for the production of the electric power, solid wastes, the trees and the wood products. Moreover, it is released in the atmosphere from the production of the minerals, from the production of the metals and the use of oil products.

Merthane (CH_4) — 18%. It comes from the rot of organic material with the influence of bacterias in anaerobic conditions in swamps and wetlands. It is produced mainly during the bacterial decomposition of the organic material (anaerobic rot) in the rice cultivation, in landfills and from the digestive system of the ruminants, as well as crude oil refining process and its transfer and storage.

The nitrogen oxide (N_2O) — 6%. It is produced from bacterial activity in the water and in soil from the decomposition of nitrogen fertilizers and the fossil fuel combustion. Every year its levels increase 0.25–0.4% and it can remain in the atmosphere up to 170 years. Its contribution to the greenhouse effect is 4–6% (Melas, Asonitis et al., as stated).

The Fluorinated hydrocarbons (HFCS) — 13%. They belong into a larger category of the fluorinated gasses. They are used as refrigerants at the refrigeration equipment, at the air conditioning and heat pumps, as a swelling element of foaming material, and as solvents. They are also used in the fire extinguishers and in the aerosols.

The perfluorocarbons (PFCs). They are used in the pharmaceutical industry, in the fields of electronics and cosmetics. In the past they were used in the systems of the fire extinguishers. Their increasing tendency is due to the fact of the replacement and the phasing out of chlorofluorocarbons and the Hydrochlorofluorocarbons because they were considered as substances responsible for the damage of the ozone layer.

4.3 Extreme Weather Conditions

The extreme weather conditions are those conditions which diverge from the normal situation of the climate and weather systems. They are rarely observed phenomena and as a result their effect on the average index of the most climate parameters is not very important. During the last year the extreme weather conditions are mentioned very often. These conditions are related to some of the biggest dangers which can be caused by the weather, the climate change on the human safety, on his health, on his goods and his activities (Melas Asonitis et al., 2000). Objectively, it is very difficult to define a size index over which a weather condition will be characterized as extreme and this happens because many factors are taken into account when a condition is characterized as extreme. When an extreme weather condition has a bad influence on the human well-being then it is called climate disaster.

5. Effects of the Climate Change

5.1 Biodiversity and Ecosystems

The biological diversity or biodiversity is defined as the diversity of life on the earth. The current form of the biodiversity is the result of an evolution which took place in billions of years through natural processes and the intervention of the human being[1]. Biodiversity is an integral part of the human being, as it totally depends on it. The climate change is mentioned as the main threat of biodiversity and of the changes on the services of the ecosystems on a global level, while on a European scale it is recognized as a serious threat with many effects, just like on the survival percentages, on the reproduction, on the consequences through biotic and abiotic interactions (Bank of Greece, 2011).

5.2 The Consequences of the Climate Change on Agriculture

During the upcoming decades the agriculture will be affected from the climate change in the European Union and the world as well. The global alertness, year by year is intensified as the data about the severity consequences of the climate change are more and more worrying. According to the United Nations, only in Africa 220 million people suffer every year from the lack drinking water due to the climate change. The production of the agriculture is in danger due to the loss of arable land, of the smaller arable periods and of the insecurity due to the kind and the time of the installation of specific crops. It is estimated that in this specific continent the income from the agriculture may decrease up to 90% until 2100.

5.3 Climate Change and Fishery

The increase of the temperature, the concentration of the carbon dioxide of the water and the sea lever rise are considered as the main components of climate change in the case of water collections in a global level. The decrease of the atmospheric precipitation and the expected increase of the temperature are possible to cause fluctuation of the river provision, as well as ecological disturbance in the water collection of the river mouths. As a result, the increase of the temperature of the water causes increase in the growth rate of diverse aquatic animal organisms. Thus a rise in the production of the farmed fish is expected. If this rise continues to happen with the implementation mainly of the applied intensive care system is not excluded to cause ecological-environmental problems, mainly in the cases of use of floating cases for marine species, in coastal areas.

5.4 Industry, Infrastructure and Human Settlements

Industry is considered to be the field which will be affected mainly from the climate change compared to the agriculture and the ecosystems. However, some of the activities mainly the ones that are related to the natural resources, seem to be vulnerable to the extreme weather conditions, due to their direct dependence on the natural habitat and they will cause important financial consequences (Bank of Greece, 2011).

5.5 Climate Change and Health

It is widely known that the climate and the weather conditions are important components that affect the human health. This means that the climate change which is observed globally changes the data that are related to the population's health and well being. It is about a measurable effect, which is not taken very often into account since most people consider that their personal health depends mainly on their behavior (e.g., nutritional habits, work out), the heredity and the easy access to the health services. The climate change could be considered as an

[1] https://www.cbd.int/2010/biodiversity/.

important danger for the human population during the 21st century. The climate change affects the health through the natural ecosystems leading a) to lower quality of water, of air and of food b) to the changes of the ecosystems, of farming, of industry, of settlements and of economy, c) to various consequences, which are caused by populations, which suffer from the environment degradation and from the financial problems due to climate change (e.g., nutritional or psychological problems). Calculable implications are observed on the human health due to population movement, due to the rise sea level and the increased frequency of the extreme weather conditions. The floods may force the communities to relocate.

6. Environmental Education

According to Unesco "The Environmental Education is a continuous process through which the individuals and the social groups will realize their habitat and they will gain the knowledge, the values, the abilities, the experience and the willingness that will allow them to act individually and in groups aiming at the solution of the current and the future problems of the environment" (UNESCO-UNEP, 1988).

6.1 Aims and Objectives of Environmental Education

The aims, the objectives, the principles and the guiding lines of the Environmental Education were initially formed and imprinted on the "Map of Belgrade", a text which includes the conclusions of the Conference held in 1975 in Belgrade by UNESCO and UNEP. In chapter III the aims of the Environmental Education are defined:

1) Awareness: To make individuals and social groups aware and sensitive to the environment and its problems as a whole.
2) Knowledge. To understand the environment as a whole as well as its problems.
3) Attitude: To adopt social values of interest and disposition for active participation.
4) Skills: To acquire skills for solving environmental problems.
5) Ability to evaluate: To be able to evaluate environmental parameters and educational programs in terms of ecological, political, economic, social, aesthetic and educational factors.
6) Participation: To develop a sense of responsibility towards the environment and an understanding of the need to solve its problems (UNESCO, 1976).

6.2 References on Climate Change and Other Environmental Issues in Primary School Textbooks

According to the Interdisciplinary Unified Curriculum Framework (DEPPS) one of the basic principles of the educational process is the awareness of children about the need to protect the natural environment and the adoption of appropriate standards of behavior. It is recognized that in order to achieve this goal, an appropriate education is required, which can be provided mainly by the school for all students-citizens of tomorrow. Based on these principles and within the framework of the interdisciplinary approach, an attempt has been made to adopt two different, but at the same time complementary, design strategies of the APS with the establishment of single independent "interdisciplinary" teaching subjects/courses and the horizontal interconnection of cognitive objects which are taught independently. With the revision of the Greek curricula in 2014, the focus is on sustainable development, aiming at redefining the needs of the human at the individual and collective level and at reviewing the value system that has been adopted until today (Plakitsi et al., 2013).

As a result of this principle, we observe that there are certain chapters in the primary school textbooks, mainly in the course of Environmental Studies, which deal with modern environmental problems, while most

common are the simple references to them in many parts of the textbooks of different subjects. Observing the above references of primary school books, we point out that although they raise the awareness of children, they do not usually allow them to deal in depth with specific topics. Especially the global environmental problem of climate change is approached only through three paragraphs. The fact that some information is inserted in different sections, favors the interdisciplinary approach, but may not ensure their use due to the plethora of material that the teacher has to manage, his ability and willingness to deal with this issue.

7. Experimental Research: The Children and the Environment

Students as a group have, in a way, been marginalized in the geographical study (Matthews & Limb, 1999 in Elise Ho, 2009). While there are doubts about whether the children should become objects of study, there is, however, a need to study their views and perceptions. Stefanovic's study (2004) by Elise Ho (2009), which deals with children's perceptions of the countryside, shows that their perceptions of nature and the environment differ from those of adults and require the integration and recognition of the children's views in environmental study and discussion.

Children's connection to the environment and their sensitivity to environmental issues tends to be greater than that of adults. Matthews and Limb present seven main distinctions between children and adults that should be considered in geographic research:

- "Children's perceptions" differ from those of adults.
- The use of the concept of rural by children differs from the corresponding use of the concept of rural by adults.
- Children's freedom of expression differs from that of adults.
- Children's environmental fears and sense of danger are different from those of adults.
- Children's fears are different from those of adults.
- Environmental decision-making by children differs from that of adults, and
- Finally, the democratic responsibility of children differs from that of adults.

7.1 Children's Perceptions of Climate Change in International and Greek Educational Research Activity

Ho (2009) studied the ideas of 11–12 year old in 9 schools in Ontario on climate change, through 88 illustrated responses and 78 interviews. Students were asked to draw an answer to the question "What does climate change mean to you?" A comparison was made with corresponding adult responses, as found in the literature. She concluded that the perceptions of children and adults are similar in issues such as the relationship between climate change and stratospheric ozone depletion, pollution and waste reduction.

In Greece, Voudrislis (2007) in his work, after researching the perceptions of 112 students of the sixth grade of three primary schools in the greater Thessaloniki area, proceeded to a teaching intervention with the help of maps, in order to help students understand the effects of overheating and link the melting of ice to floods. In her work, Davidoudi (2012) investigated the environmental attitude of 118 sixth grade students in four primary schools in the greater Thessaloniki area, as well as their knowledge of climate change. According to the findings of the study, students' perceptions of how to deal with climate change are presented. In order to reduce the phenomenon, students suggest reducing cars, planting trees, proper garbage management and especially recycling, saving electricity and raising public awareness.

However, there have been several misconceptions about the inability of children to detect "hidden energy", the fact that they link the greenhouse effect to the ozone hole, and their tendency to generalize.

7.2 Purpose — Objectives of the Research-Research Questions

The purpose of this study was to investigate knowledge and perceptions about climate change in students of the 6th grade of Primary Schools in different areas of the prefecture of Ioannina. Based on the previous literature review, we formulated the following hypotheses, which we tried to investigate with our research:

Hypothesis 1: Students do not know enough about the mechanism of the greenhouse effect.

Hypothesis 2: Students confuse the phenomenon of the greenhouse effect with the "ozone hole".

Hypothesis 3: Students consider pollution, which may be due to exhaust fumes from cars or factories, to be a major cause of climate change.

Hypothesis 4: Students believe that actions that are generally considered environmentally friendly, such as the protection of endangered species, can help reduce global warming.

Hypothesis 5: Schoolchildren in non-urban areas may have more limited knowledge on the issue of the climate change than those from urban backgrounds.

7.3 Data Collection Method — Sample Description

For the data collection, the questionnaire was chosen as the most appropriate tool, through which information can be collected very easily as it is a handy methodological tool. A sample of our research were 120 students of the 6th grade of four primary schools of the prefecture of Ioannina. Sixth grade students were selected for the sample, because from this age the so-called formal logical operations appear, that is, the mental operations that take place on abstract concepts and are a characteristic feature of the adolescent and then of the adult. The questionnaire given to the students was designed based on the exploratory questions, the aims and the objectives of this research process, after first becoming completely clear and understandable. A similar questionnaire was used as a basis given by Ms. Athanasia Davidoudi in a relevant survey in 2012 in four schools in the prefecture of Thessaloniki. The questionnaire was developed around the following main themes:

a) the environmentally friendly attitude of the children
b) their knowledge of the mechanism of the greenhouse effect
c) the causes of climate change
d) its effects and the actions that can help reduce it, as well as the search for those responsible for its control.

7.4 Data Processing

The data from the closed type questions were entered and processed with Microsoft Excel and the open type statistical package jamovi 1.2. In order to process the open-ended questions, we proceeded to a "categorization" of the answers given and the creation of categories. In other words, in a sense, we turned the questions into closed ones in order to allow their quantitative-statistical processing.

8. The Debate

8.1 The Phenomenon of the Climate Change

The findings from the processing of both types of research tool which we used, namely the open and closed

questionnaire, converge with each other. The students of our research ignore the main elements of the mechanism of the greenhouse effect and the basic gases associated with it. One in three children is unaware of the contribution of carbon dioxide, the most important greenhouse gas, while almost half of the children are unaware of the contribution of the second most important gas, methane. 67% of students mistakenly believe that oxygen is an important greenhouse gas, while 65% of the children believe that the phenomenon is due only to anthropogenic activities. In the corresponding research of Davidoudis (2012) only half recognize the action of carbon dioxide as a greenhouse gas (respectively percentages 60% according to Boyes, Chuckran & Stanisstreet (1993), 83% according to Voudrislis (2007) who points out that they do not know the sources of its emission or the consequences of its use, while according to Boyes & Stanisstreet (1993) the majority of students do not recognize CO_2 as a greenhouse gas).

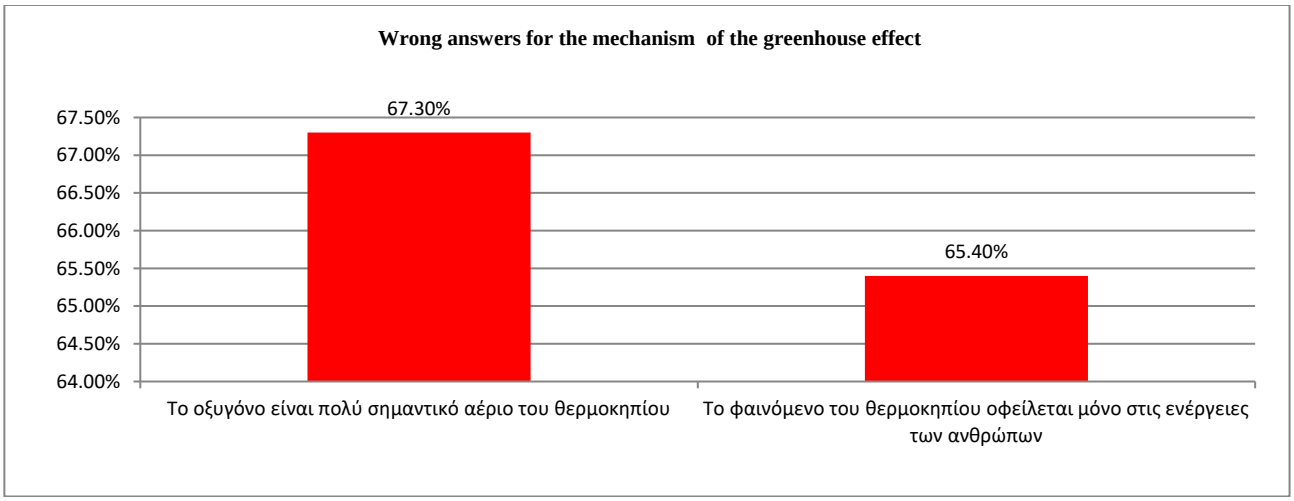

Figure 1 Wrong Answers for the Mechanism of the Greenhouse Effect

8.2 Causes of the Climate Change

As far as the causes of overheating are concerned, as our research has shown according to the children's views, the main ones are the exhaust fumes of cars and factories. Another very important cause is the destruction of tropical forests, but it is not certain that students understand the way it is responsible for global warming. The contribution of the use of coal and oil from the power plants of the Public Electricity Company is recognized by about 72% of students. This percentage is not considered very satisfactory, in relation to the fact that the consumption of electricity is linked to the activities of all of us and can be controlled through our daily actions. In the respective research of Davidoudis (2012) the percentage reached 62%. Almost half of the students are not aware of the contribution of heating and cooling of houses (through air conditioners) to the climate change. The processing of the open questionnaires showed that many students associate climate change with pollution/infection (children do not distinguish between the two terms), which may be related to exhaust fumes or garbage (Boyes, Chuckran, & Stanisstreet, 1993). And in this case, however, they do not seem to understand how waste enhances global warming. According to Francis, Boyes, Qualter, & Stanisstreet (1993) children think that pollutants are bad, because their effects are undesirable (shores with garbage, global pollution), so all pollutants (as undesirable) are associated with all environmental problems including overheating.

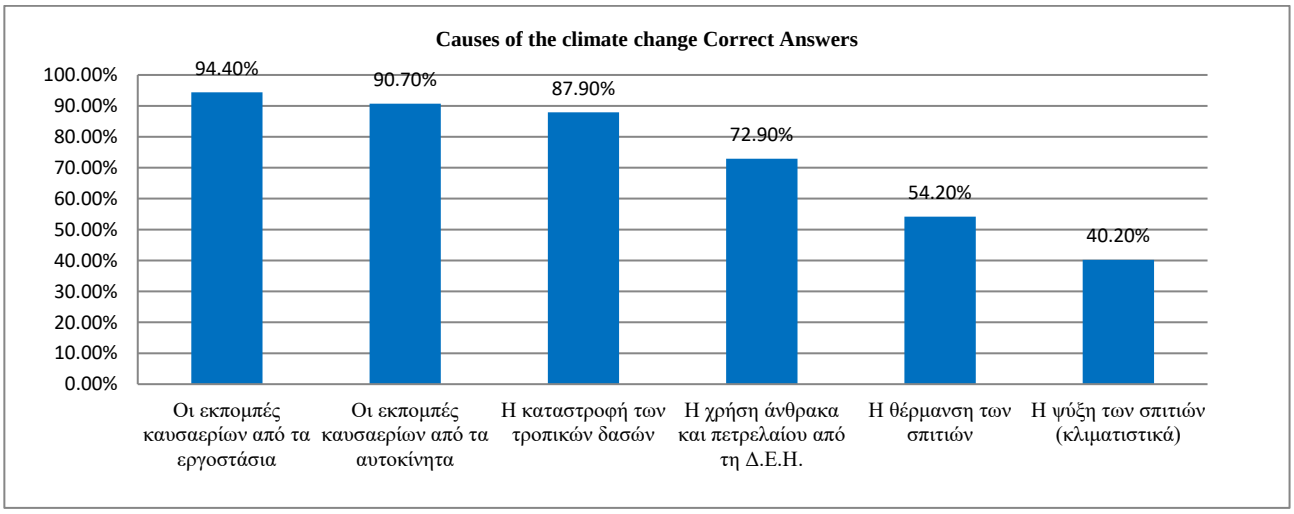

Figure 2 Correct Answers to the Causes of Climate Change

8.3 Consequences of the Climate Change

The students of our research seem to be satisfactorily informed (95%–90%) about the consequences of climate change and especially about the extinction of some species, which converges with corresponding research, (Voudrislis, 2007; Davidoudi, 2012), the melting of ice (Boyes, Chuckran & Stanisstreet, 1993; Koulaidis & Christidou, 1999; Voudrislis, 2007; Davidoudi, 2012), the increase in temperature (Boyes, Chuckran & Stanisstreet 1993) and the worsening of drought, while less seems to be their knowledge about floods (73%). They may have difficulty in understanding the diversity of climate change and the simultaneous existence of floods and droughts.

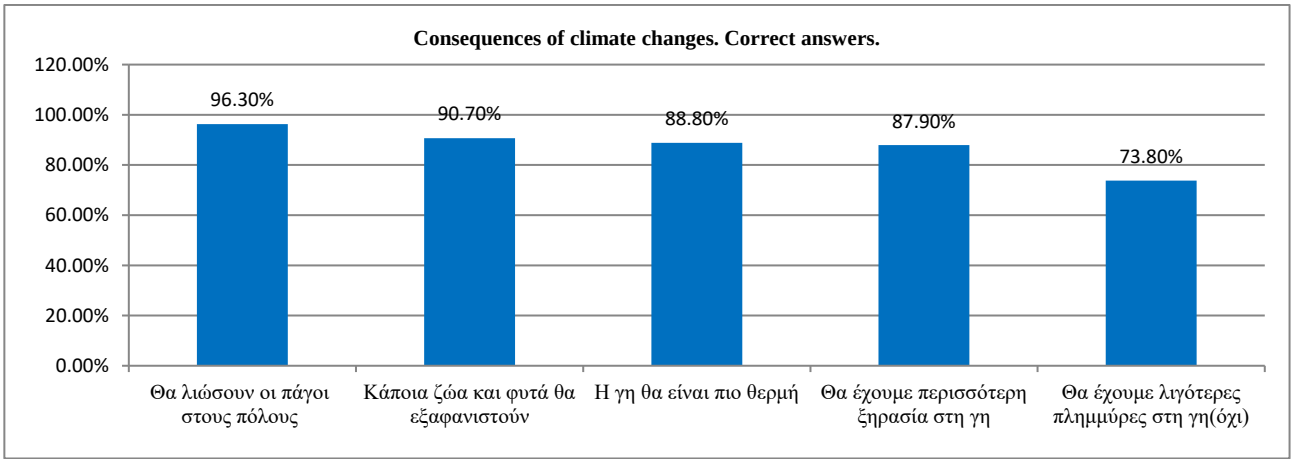

Figure 3 Correct Answers to the Consequences of Climate Change

8.4 Ways of Facing Climate Change

In terms of actions that can help mitigate the phenomenon, those suggested by most students (more than 90%) are to limit the use of cars and smaller (less energy-intensive) cars. This solution is largely indicated when completing the open questionnaire and is combined with previous students' answers, according to which car exhaust fumes have a great effect on climate change, but it is also combined with the findings of other research (Davidoudi, 2012). More than half of the students recommend replacing cars with bicycles and walking. It is

worth mentioning that a large percentage that proposes bicycles refers to the urban fabric of the city of Ioannina, while in the two provincial towns due to the terrain the percentages are very small, with walking prevailing. Tree planting is also suggested as a solution by many children (89%), which is in line with the view of 88% of students that the destruction of rainforests is responsible for climate change, as well as the findings of other research (87%). According to Boyes, Chuckran, & Stanisstreet, 1993; Francis, Boyes, Qualter, & Stanisstreet, 1993; Davidoudi, 2012). Another solution suggested by many students is recycling (89% in closed questions).

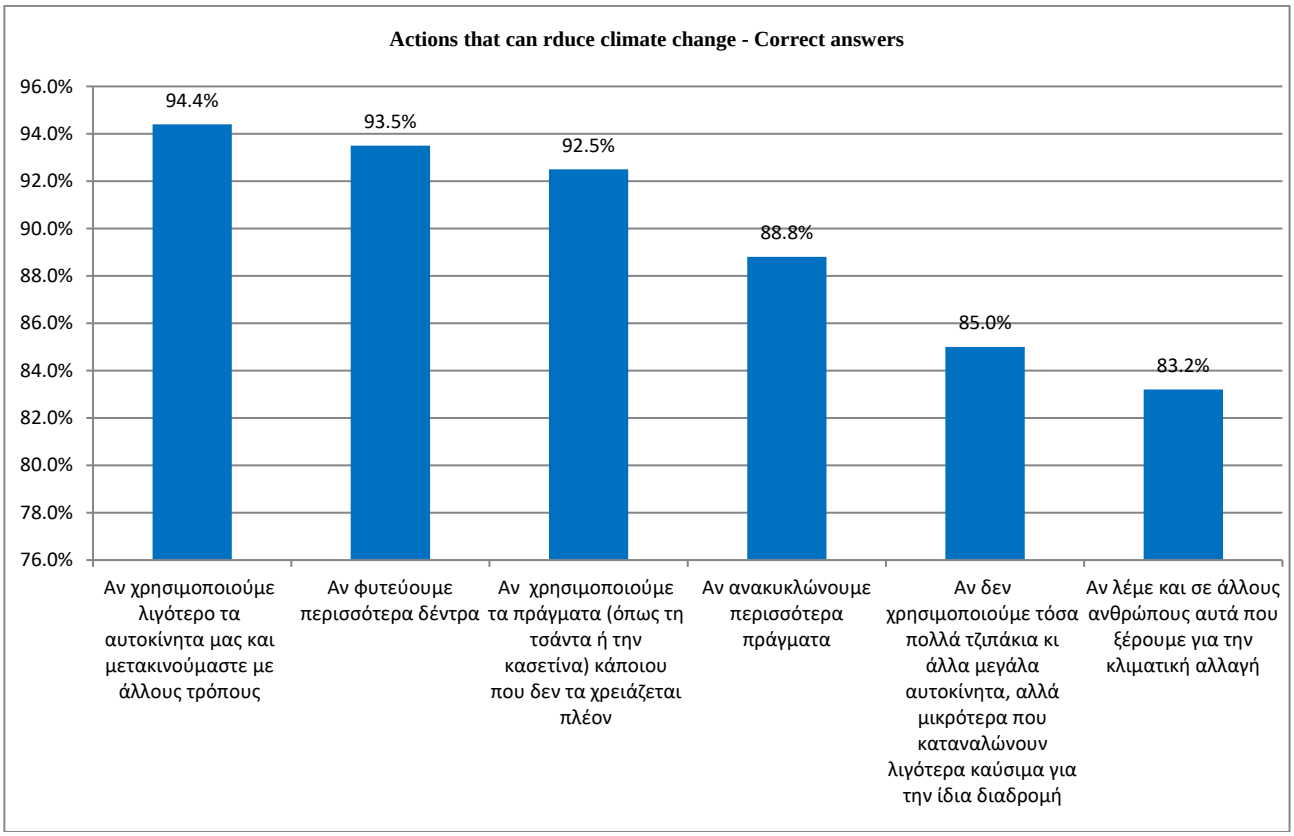

Figure 4 Correct Answers on Actions That Can Reduce Climate Change

8.5 Alternative Perceptions

However, in addition to the correct perceptions from our research, various alternatives emerged, mainly related to the difficulty of locating the hidden energy, the conceptual confusion between major environmental problems, such as climate change and stratospheric ozone depletion and a trend of generalization by the children. Students seem to face difficulty in recognizing hidden energy since about half do not realize that actions such as the consumption of less meat and limiting consumption (through buying fewer clothes) can have positive effects on climate change. The corresponding percentages in the research of Davidoudi (2012) reach ¾ of the students. Less are the children who do not understand the value of reuse, while the answers for the consumption of products that are not transported from far away are shared. The other alternative is related to the confusion of climate change with the ozone hole, as three-quarters of students believe that limiting sprays, which they consider responsible for their ozone hole, helps deal with overheating. Protecting rare animals and plants is considered a way that can reduce overheating by many students (78%).

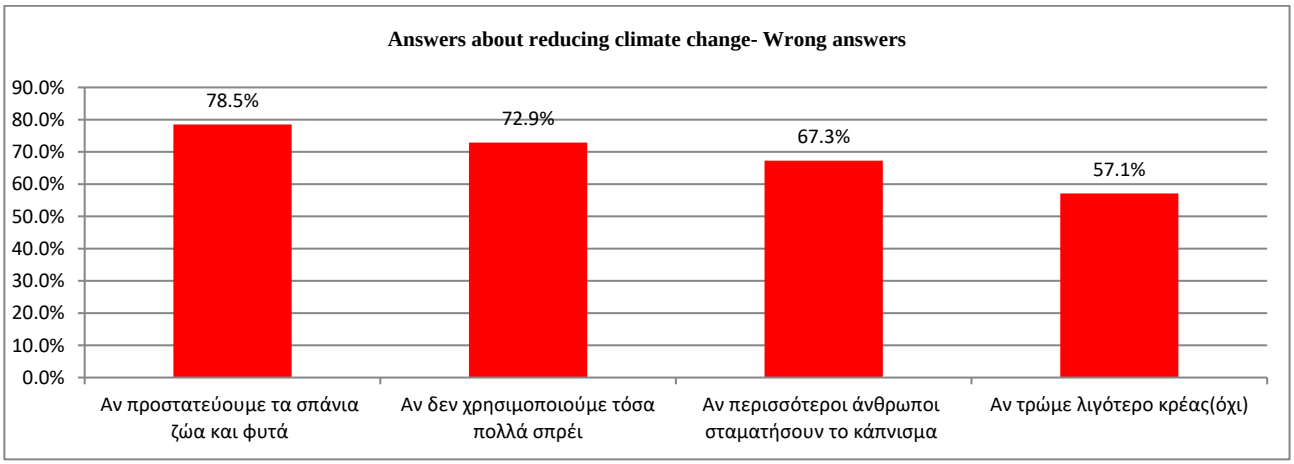

Figure 5 Wrong Answers About Actions That Can Reduce Climate Change

According to Davidoudi (2012), this misunderstanding is probably due to the wrong generalizations of children, who seem to adopt a single construct of "environmental problems", in which various issues are confused (Francis, Boyes, Qualter, & Stanisstreet, 1993). Children are also especially sensitive through the school curriculum and the references in the books about endangered species. Protecting them is considered an important environmental act, so it can help solve all the problems of the environment, even climate change. Finally, 67% of students sees giving up smoking as a way to deal with the problem (60% according to Davidoudi, 2012). Smoking creates smoke, which is considered an exhaust by some children and contributes to climate change.

9. Conclusions and Recommendations

In the present study, we investigated the perceptions of school-age students (6th grade), of four primary schools (six departments) of the prefecture of Ioannina on climate change. According to the results of the research, the children, without knowing and understanding in depth the mechanisms and the nature of the phenomenon, possess some general knowledge mainly about the consequences and the ways of dealing with it. However, the basic alternative concept that emerged from all types of our research tool, concerns the confusion of climate change with the ozone depletion of the upper atmosphere and of the factors associated with them. Students seem to be more informed about the consequences of the phenomenon, especially in terms of global warming, the disappearance of some animals and plants and the melting of ice, which is closely linked to rising sea levels. As we have already pointed out, references to Greek primary school textbooks on climate change and the greenhouse effect are very limited. However, we believe that the breadth and intensity of the problem necessitates the existence of a more complete presentation of the relevant topics in the textbooks and the allocation of time for their teaching through the curricula. We would generally claim that the substantial and long-term success of any educational attempt, and especially in the field of environmental education, which not only aims at enhancing knowledge, but mainly at changing attitudes and behaviors, requires the coexistence of various factors and not just individual and piecemeal actions. In this way we will be able to ensure sustainability and quality of life for our children and future generations.

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