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Article

Environmental Threats and Geographical Education: Students' Sustainability Awareness—Evaluation

Magdalena Urbańska [1], Przemysław Charzyński [1,*], Helen Gadsby [2], Tibor József Novák [3], Salih Şahin [4] and Monica Denise Yilmaz [4]

1 Department of Soil Science and Landscape Management, Nicolaus Copernicus University in Toruń, 87-100 Torun, Poland; magdau@onet.eu
2 Faculty of Arts, School of Education, Professional and Social Studies, Liverpool John Moores University, Liverpool L1 9DE, UK; H.D.Gadsby@ljmu.ac.uk
3 Department for Landscape Protection and Environmental Geography, University of Debrecen, H-401 Debrecen, Hungary; novak.tibor@science.unideb.hu
4 Department of Geography Education, Gazi University, Ankara 06500, Turkey; ssahin@gazi.edu.tr (S.Ş.); mony.ylmz@gmail.com (M.D.Y.)
* Correspondence: pecha@umk.pl

Abstract: Teaching geography creates an opportunity for the transfer of knowledge about environmental problems and ways of solving them. Teachers from the Czech Republic, Hungary, Poland, Romania, Turkey, and the United Kingdom indicated strengths and weaknesses of physical geography as well as the selected geographical concepts of: Maps/Cartography, Astronomy/The Earth in the Universe, Atmosphere, Hydrosphere, Endogenic processes, Exogenic processes, and Soils and biosphere. There was a variety in how confident students were around these topic areas. The main types of difficulties identified by the study were: too little time for implementation, difficult terminology, and lack of tools for the proper transfer of knowledge. Moreover, the attractiveness of individual issues for students also varies. The research clearly shows that students lack an awareness of problems related to the environment. There are considerable differences between the level of students' knowledge about climate change or air and water pollution (relatively high awareness of global warming) and issues related to soil and vegetation cover (low awareness of soil depletion, soil pollution, changing the boundaries of the occurrence of plant zones, etc.). To make people aware of the importance of environment, we should take care of education in relation to global challenge and sustainable development.

Keywords: sustainable education; pedosphere; geography; soil science education; environmental threats

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1. Introduction

The main purpose of education is to help people become ready for today and tomorrow [1]. According to the International Charter on Geographical Education, environmental science offers the opportunity to develop skills to understand and appreciate not only how landscapes are formed and how people and environments interact but also the consequences that arise from everyday spatial decisions made by both decision makers and laymen. Geography is concerned with human–environment interactions with crucial issues influencing societies such as natural hazards, impact of climate change, energy supplies, migration, land use, urbanization, etc. This is a kind of bridge connecting natural and social sciences and encourages the 'holistic' study of such issues [2–4]. There are many areas of geographic interest from physical to human geography. Most school subjects are included in the curricula in different levels of formal education. They are perceived by policy makers to be relevant to the goals of the particular education systems. Traditionally geography has been included in school curricula of formal education and has an important relationship with other subjects such as history (geography helps to explain historical events and political processes) or sociology (cultural developments and spatial relationships) [5]. Appropriate geographical education should ensure a more careful use of natural resources by people and increase environmental awareness by making positive changes in their knowledge, attitudes, and behaviors in relation to the environment [6–8].

The prevention of environmental problems before they appear seems to be the most effective solution. However, proper instruction is needed in this case. Moreover, there is a need for sustainable education encompassing all forms of learning about sustainable development [9]. The aim of this teaching is to benefit individuals, society, and all factors that make up the environment [10], as well as to protect nature by making positive changes in the behavior of individuals and by ensuring that they actively participate in finding solutions to problems. Geography education should play an important role in this process.

Teachers are important transmitters of knowledge also in the context of sustainability. A young student shapes his view of environmental problems on the base of information from various sources, but geography education should influence students' deep understanding of sustainability thinking on a local and global scale. Teaching methods and educational tools used in schools should meet the needs of the recipient. Teachers' self-efficacy is equally important. The ability of teachers to interpret the education program policy is widely recognized in the literature and is influenced by their cognitive skills [11–15]. These skills may be reinforcing or distracting with the ability to interpret and implement the education program policy. James P. Spillane [16] developed a framework that can help curriculum researchers understand these abilities which interact with contextual factors, obstructing processes development and the implementation of the curriculum. Teachers have an important responsibility to raise the environmental awareness of students through geographical education. From this point of view, the level of teachers' self-efficacy is significant [17].

This study aims at:

- Analyzing the sustainability concepts in teaching geography;
- Comparing the most common teaching methods regarding the effectiveness;
- Indicating the difficulties in learning geography for a high school student;
- Making education policy makers as well as teachers and scientists aware of strong and weak aspects of geographical education under the aspect of sustainability;
- Proposing changes in school curricula in order to increase the awareness of sustainable development.

2. Materials and Methods

2.1. Procedure and Participation

2.1.1. Survey among Teachers

The data collected from the survey aims to evaluate high school geography education related to environmental issues. It consisted of a random selection of participants based on non-probability sampling. One hundred and ninety-eight (198) teachers living in the Czech Republic, Hungary, Poland, Romania, Turkey, and the United Kingdom participated in the study.

The survey consisted of 7 questions relating to the geography issues: Maps/Cartography, Astronomy/The Earth in the Universe, Atmosphere, Hydrosphere, Endogenic processes, Exogenic processes, and Soils and biosphere.

Questions:

- Select the tools/methods you use in geography teaching (lecture, multimedia presentation, educational movie, educational game).
- Which of the units of physical geography discussed in geography lessons are (according to your observations) difficult and which are easy for a student? The answer should be based on the results of tests checking the scope of the student's knowledge.
- Indicate the causes of difficulties in the effective implementation of educational units (difficult content, difficult terminology, too little time for implementation, lack of tools for the proper transfer of information, inadequate methods, no difficulties).
- What results do students get from tests covering the content of each unit?

- How many lessons do you spend on the implementation of each educational unit?
- How students perceive the attractiveness of each educational unit?
- The list below shows threats/problems in the natural environment. Which of them are the student aware of before implementing/discussing at school? (Floods, global warming, soil depletion, wildfires, water pollution, air pollution, soil pollution, desertification, ozone hole, melting of glaciers, reduction of biodiversity, intensification of extreme weather phenomena, changing the boundaries of the occurrence of plant zones, change of flora and fauna species, bad waste disposal).

Moreover, the questionnaire included information about the respondents (age, sex, seniority at school, type of school, and self-assessment of the ability to use ICT—information and communication technologies in geography lessons). A total of 198 respondents—teachers—participated in the study to answer the questions (Table 1).

Table 1. Information on the teachers.

Sex	%
Female	45
Male	55
Age	
24–35	35
35–45	32
45–55	28
55–65	4
>65	1
Seniority at school	
0–5 years	19
5–10 years	16
10–15 years	15
15–20 years	25
20–25 years	16
25–30 years	5
30–35 years	2
35–40 years	2
Type of school	
High school	74
Vocational high school	8
Artistic (vocal) high school	1
Other	17
Self-assessment of the ability to use ICT in geography lessons (1—poor, 5—high)	
1	1
2	4
3	20
4	48
5	27

The survey was conducted via the Internet and then collated for data analysis. The study was based on the results of a survey addressed to a group of teachers. The questionnaire was constructed as a "Google Form" and sent to recipients via e-mail or distributed through social media. The authors of this publication invited people involved in teacher education, preparation of external exams, and geographic competitions to cooperate. Facebook social groups associating geography teachers ("Nauczyciele Geografii"—Poland; "Cool Geography Teachers Group"—United Kingdom; "Učitelé humanitních oborů"—Czech Republic; "Földrajztanárok Klubja"—Hungary) were also involved in distributing the survey.

2.1.2. Survey among Students

A total of 204 students from High School No. 10 in Toruń (Poland) participated in the study. The students indicated (by marking) the issues/problems in the natural environment: floods, global warming, soil depletion, wildfires, water pollution, air pollution, soil pollution, desertification, ozone hole, melting of glaciers, reduction of biodiversity, intensification of extreme weather phenomena, changing the boundaries of the occurrence of plant zones, change in flora and fauna species, and bad waste disposal that they were aware of before starting high school. Information on the respondents is presented in Table 2.

Table 2. Information on the surveyed students.

Sex	Number of Indications	%
Female	125	61
Male	79	39
Sum	204	100
Age		
15–16	158	77
17–18	46	23
Sum	204	100

The research was conducted between 7 and 13 June 2021 during geography lessons. Responses were counted and analyzed using a quantitative approach to test knowledge of sustainability issues.

2.1.3. Analysis

Respondents' answers were analyzed using a quantitative approach to investigate the knowledge about geography education related to sustainability issues. To indicate the difficulty level of particular issues of MapsCartography, Astronomy/The Earth in the Universe, Atmosphere, Hydrosphere, Endogenic processes, Exogenic processes, and Soils and biosphere, the Difficulty Index (DI) has been introduced. The frequency of three difficulty levels (easy, medium, hard) for the issues above was the basis for assigning "difficulty scores" within each type of level: (a) easy—multiplied by 1 point; (b) medium—×2 points; and(c) hard—×3 points. The Difficulty Index (DI) providing information about the difficulty level of each geographical issue was calculated according to the formula below:

DI = (e1 + m2 + h3)/N (DI—Difficulty Index, e1—sum of "easy" indications multiplied by 1, m2—sum of "medium" indications multiplied by 2, h3—sum of "hard" indications multiplied by [3].

Kruskal–Wallis's one-way analysis of variance was used to determine the level of differentiation of environmental threats indicated by respondents. The threats were divided into three groups corresponding to individual spheres of the Earth: Atmosphere, Hydrosphere, and Soils and biosphere. A significant Kruskal–Wallis test indicates that at least one sample (group) stochastically dominates one other sample (group). Due to the fact that this test does not identify where the stochastic dominance occurs Dunn's test was used for analyzing the specific sample pairs for stochastic dominance.

3. Results and Discussion

The types and use of educational methods and tools were analyzed obtaining the results presented in Figure 1. During geography lessons, lectures and multimedia presentations are most often used, whereas educational games are not used at all or are rarely used. Lectures are often perceived by the students as the least effective method used but the lecture time involving students is usually regarded as a more effective learning tool [18–20]. During the lecture, the teacher is able to share information with a large number of students, and it can be effective in transmitting factual information [21,22], but the implementation of didactic goals is accomplished by various methods which are selected by the teacher. Properly used digital media can contribute to more effective education. Some of them will help to activate students and involve them in the teaching–learning process. The multiplicity of information allows teachers to individualize the learning process and achieve better results in geography education [23]. However, it requires a certain level of skill in using different educational tools. Teachers from analyzed countries assessed their ICT skills at a "good" level, and they use different methods (lectures, multimedia presentations, and educational movies).

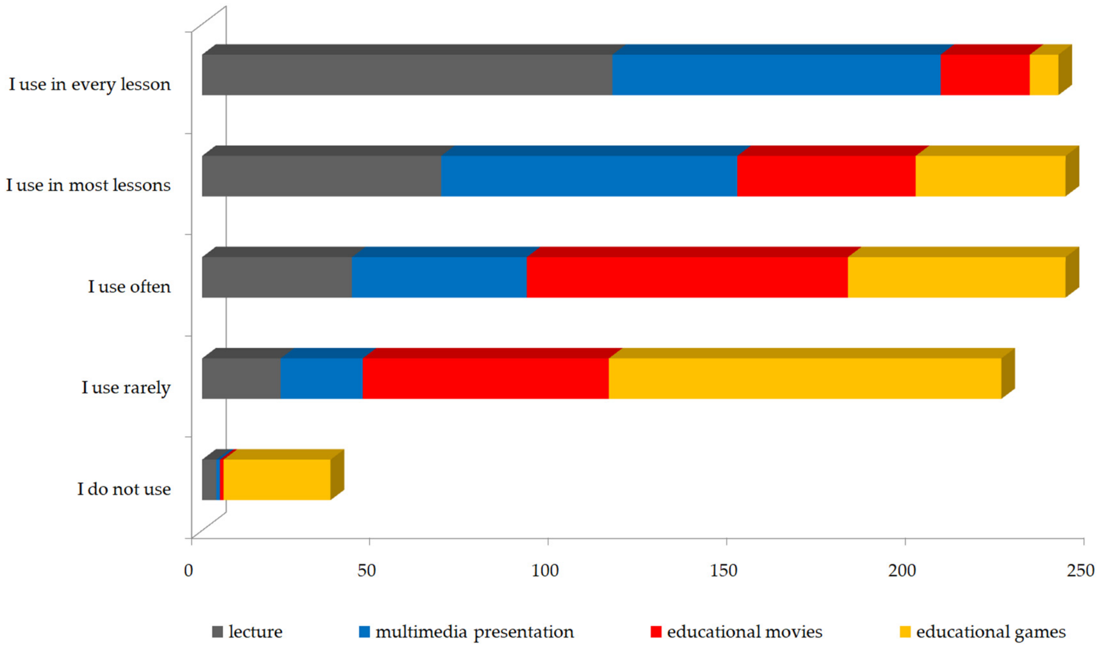

Figure 1. Educational methods using in geography teaching.

According to teachers' observations and the results of tests checking the students' knowledge, the most difficult parts of physical geography discussed during school lessons are Astronomy (DI = 2344) and Endogenic processes (DI = 2292) (Figure 2). The Hydrosphere is the least difficult for students (DI = 1656). On the horizontal axis of Figure 2, there is the average number of lessons provided for the implementation of individual issues estimated on the basis of the average number of lessons indicated by teachers for implementation of a given part. For the implementation of the most difficult, as well as the least difficult parts of physical geography a similar number of lessons are noticed. This lack of differentiation can cause low test scores and difficulties in discussing issues.

The types of difficulties in the implementation of individual parts are presented by Figure 3. The most common problem (the largest number of indications) were having too little time for the implementation the geographical concepts (Maps/Cartography, Exogenic processes, Astronomy, Soils and biosphere), difficult content and terminology (Endogenic processes, Exogenic processes, Astronomy, Soils and biosphere), and a lack of tools for the proper transfer of information (Soils and biosphere, Maps/Cartography). The teachers indicated the Hydrosphere as the geographical section with the least difficulties in implementation. One of the most problematic areas (many different difficulties) is Soils and biosphere. Teachers indicated that almost every educational inconvenience, including inadequate methods, e.g., lack of activating methods.

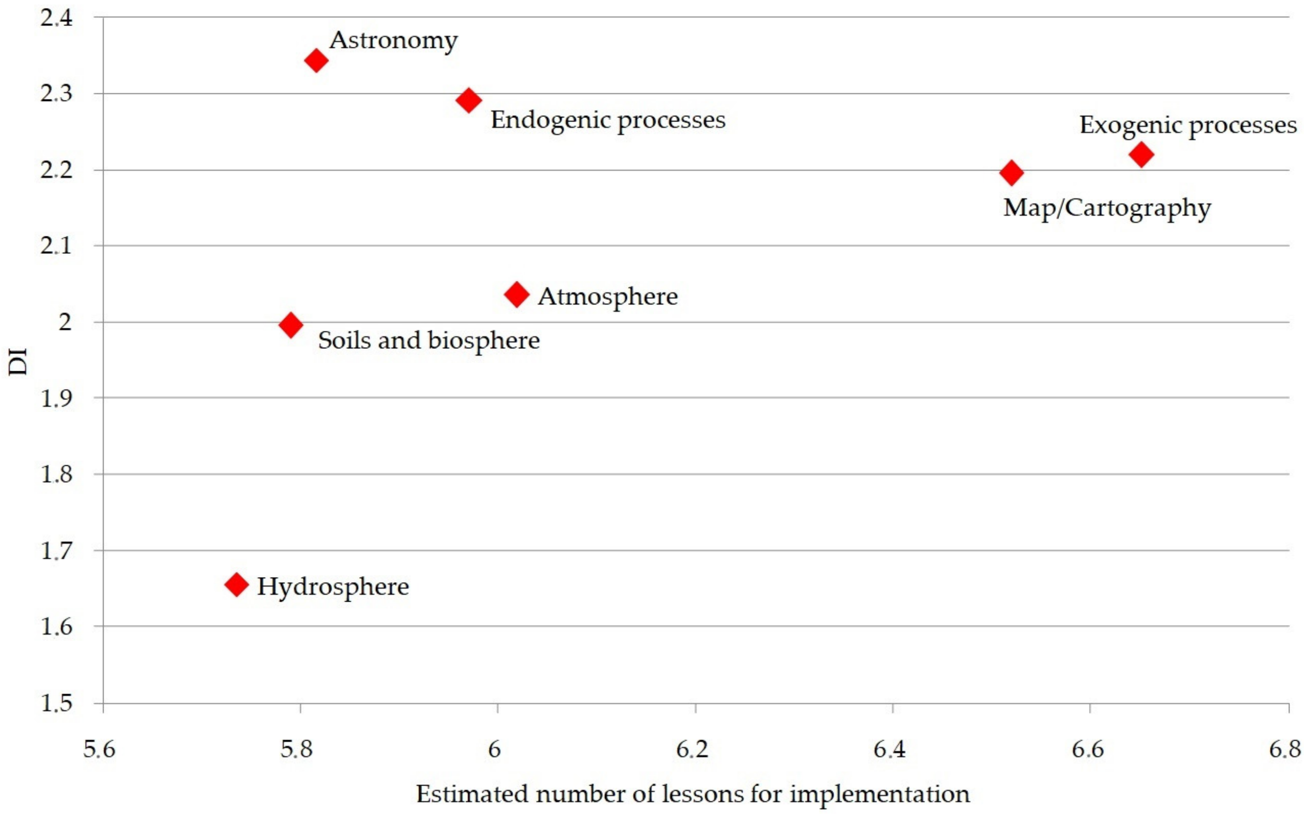

Figure 2. Difficulty Index of individual geographical issues and estimated number of lessons for implementation.

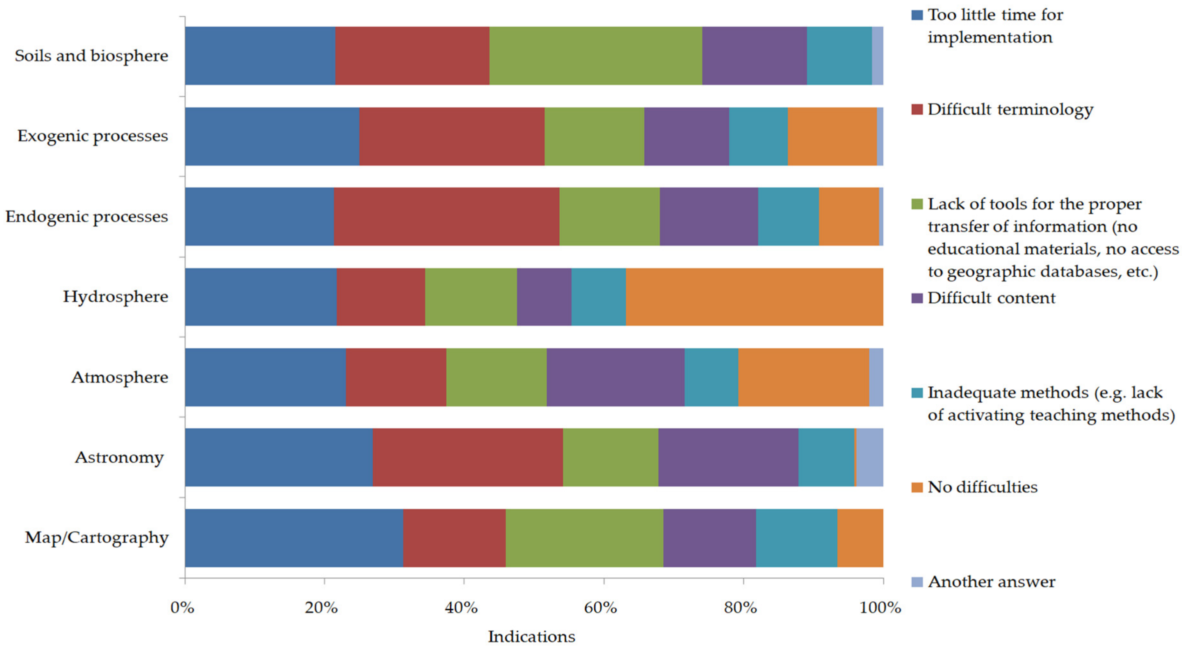

Figure 3. The types of difficulties indicated by teachers in the implementation of individual parts of geographical education by number of indications.

The results which students usually obtain from the assessment tests covering the content of each part were on the medium level (50–80%). The higher results (above 80%) were scored in Hydrosphere tests, whereas the lowest scores were in Astronomy tests (Figure 4), and this analysis correlates with previous results concerning the level of difficulty of particular issues.

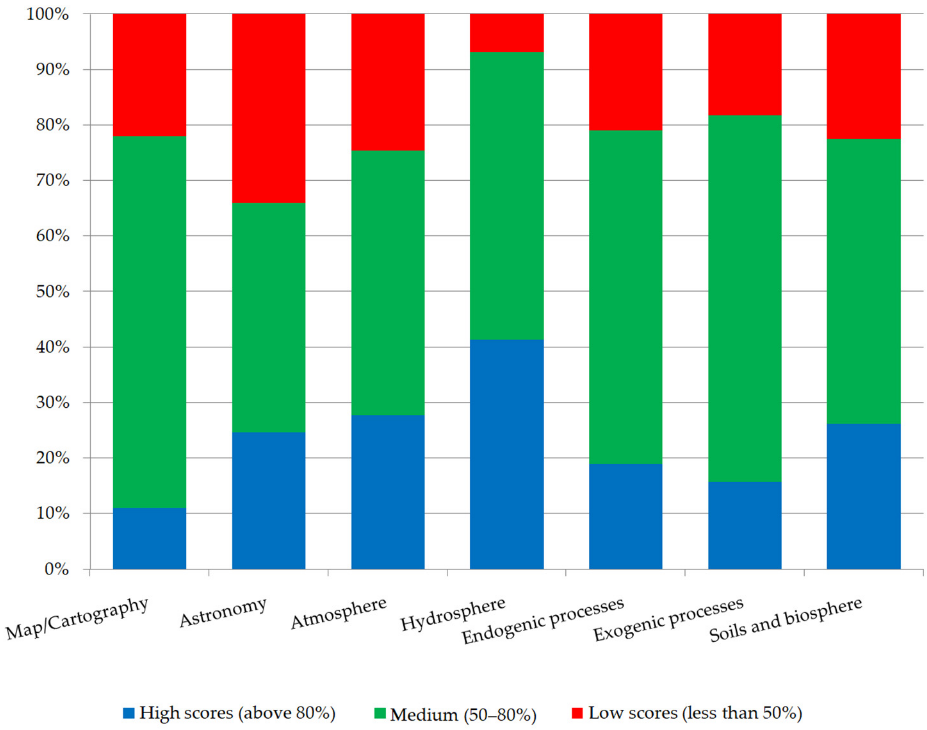

Figure 4. Knowledge test results (in teachers' opinion).

The number of lessons allocated to the implementation of a given issue is not without significance. Due to the fact that in the analyzed countries the total number of hours devoted to geography lessons is different, it is difficult to indicate the share of particular issues. However, it can be concluded that some issues are given more time than others. Teachers usually spend from two to five lessons on the implementation of each part of the identified geographical concepts (Figure 5). Despite the fact that the Hydrosphere tests were higher than all the other concepts few teachers discuss these issues in more than 15 lessons. Cartographic topics are usually taught the longest (above 15 lessons), and yet, as mentioned above, teachers lack the time to sufficiently explain these issues.

The next important matter especially with regard to sustainability is to understand what environmental problems the student is aware of before discussing them in school. It turned out that some problems were sufficiently known to students (from the media or early education), while many other problems did not become known to students until high school (Figure 6). According to teachers' opinions, the best-known issues are related to air pollution and global warming. Students are also quite aware of floods and water pollution. Unfortunately, only a few of them are aware of problems related to soils. Students are generally unaware of the effects of deforestation leading to landslides, loss of biodiversity, and ecological soil functions. They probably do not know the examples of Haiti or Mexico, where the human impact on the topsoil led to the collapse of the economy in these places [24,25]. It is difficult to imagine a proper approach to the issues of sustainable development without an equal knowledge of the underlying threats. Therefore, more emphasis should be placed on those issues that the student is the least aware of.

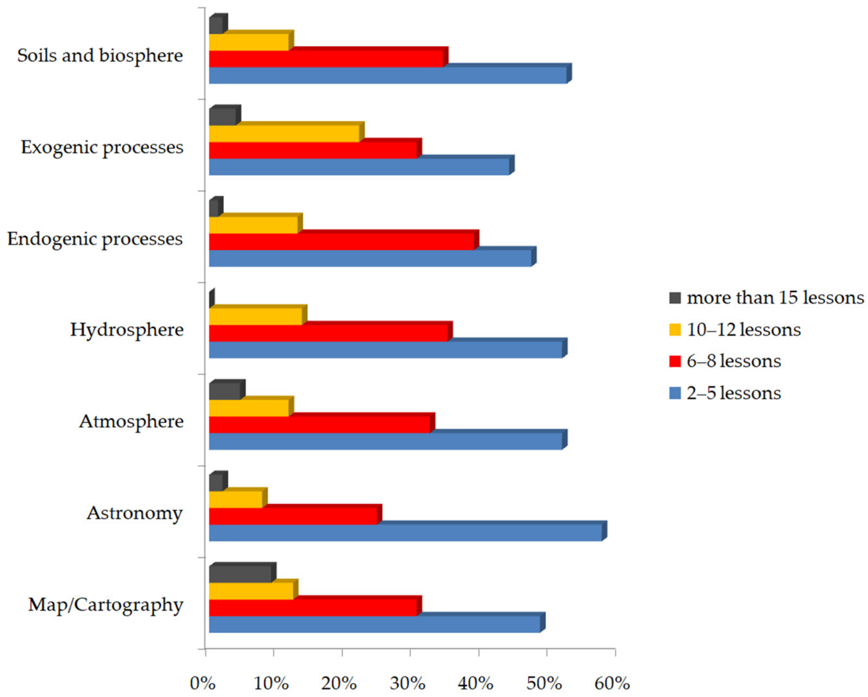

Figure 5. The number of lessons devoted to the implementation of specific issues.

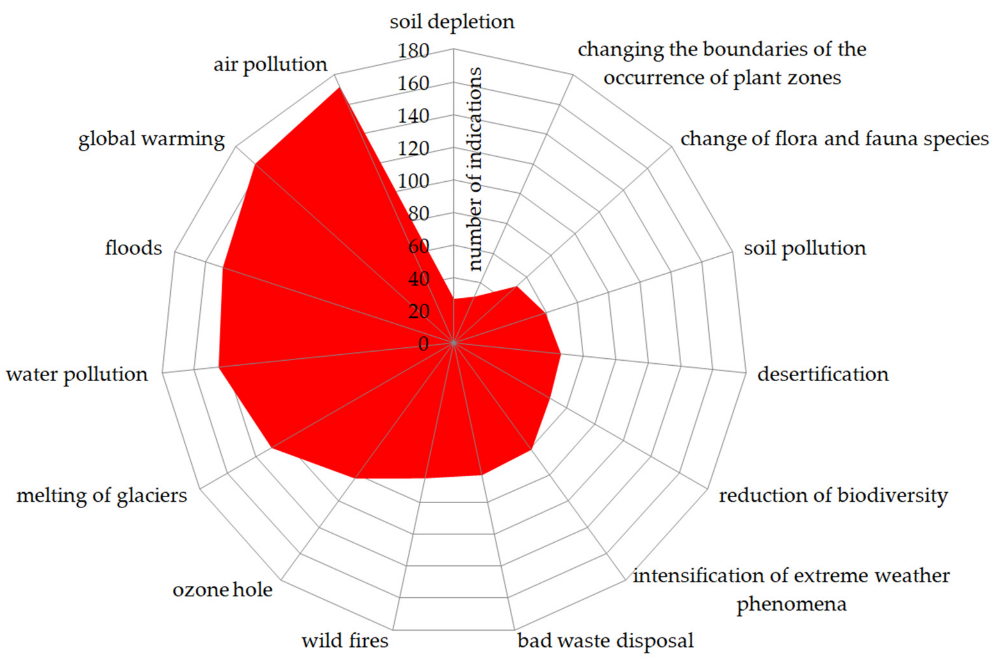

Figure 6. Students' awareness of environmental problems in teacher's opinion (N = 198).

All analyzed issues are discussed in the corresponding parts of geographical education. The list of environmental problems included the issues discussed in the implementation of the part: Atmosphere, Hydrosphere, and Soils and biosphere. For this reason, neither the Astronomy nor Cartography section was included in the analyzes below. By far the worst are the problems discussed during the introduction of the Soil and biosphere part (379 indications). It means that students' knowledge is poorest in the soil topic. Within the discussed fields of geography, ecological awareness is also diversified (Table 3). In the topic of the Atmosphere, the problems of air pollution and global warming are best known by students (27–28%), whereas extreme weather phenomena are the worst known (13%). In the topic of the Hydrosphere, floods and water pollution have the best results (29%).

The reduction of biodiversity and desertification issues are the best known by students within the topic of Soils and biosphere (17–18%). In contrast, changing the boundaries of the occurrence of plant zones and soil depletion are the most poorly understood.

Table 3. Problems in the natural environment corresponding with proper parts of geographical education (teachers indications *N* = 198).

Atmosphere	% of Indications
air pollution	28
global warming	27
ozone hole	17
wildfires	14
intensification of extreme weather phenomena	13
Hydrosphere	
floods	29
water pollution	29
melting of glaciers	25
bad waste disposal	16
Soils and biosphere	
reduction of biodiversity	18
desertification	17
soil pollution	14
change of flora and fauna species	14
changing the boundaries of the occurrence of plant zones	8
soil depletion	7

As indicated, the result of Kruskal–Wallis test the differences between some of the groups of problems discussed above are statistically significant (Table 4).

Table 4. Results of Kruskal–Wallis test for the groups of environmental threats (*N* = 15; based on [26]).

Kruskal–Wallis Test Components	Scores
H (chi2)	10.08
Hc (tie corrected)	10.11
p (same)	0.006364

Statistically significant differences are noted between the problems from the Soil and biosphere group and the problems from the Atmosphere and Hydrosphere groups. However, there are no statistically significant differences between the issues related to the Atmosphere and Hydrosphere groups (Table 5).

Table 5. Dunn's post hoc test results for groups of environmental threats (*N* = 15; *p* = 0.05; based on [26]).

	Atmosphere	Hydrosphere	Soils and Biosphere
Atmosphere	x	0.9812	0.006428
Hydrosphere	0.9812	x	0.01014
Soils and biosphere	0.006428	0.01014	x

As mentioned before, this part of geographical education is one of the most problematic for implementation: too little time for presenting the geographical concepts, difficult content and terminology, lack of tools for the proper transfer of information, and the lack of adequate activating methods. It takes a long time to understand the relationships between the components of the environment and to become aware of the interdependence between them. Students should discover these cause–effect relationships for themselves and think about and predict the consequences of their own actions. The above-mentioned difficulties probably contribute to the low attractiveness of these concepts for students in the teachers' opinion (Figure 7).

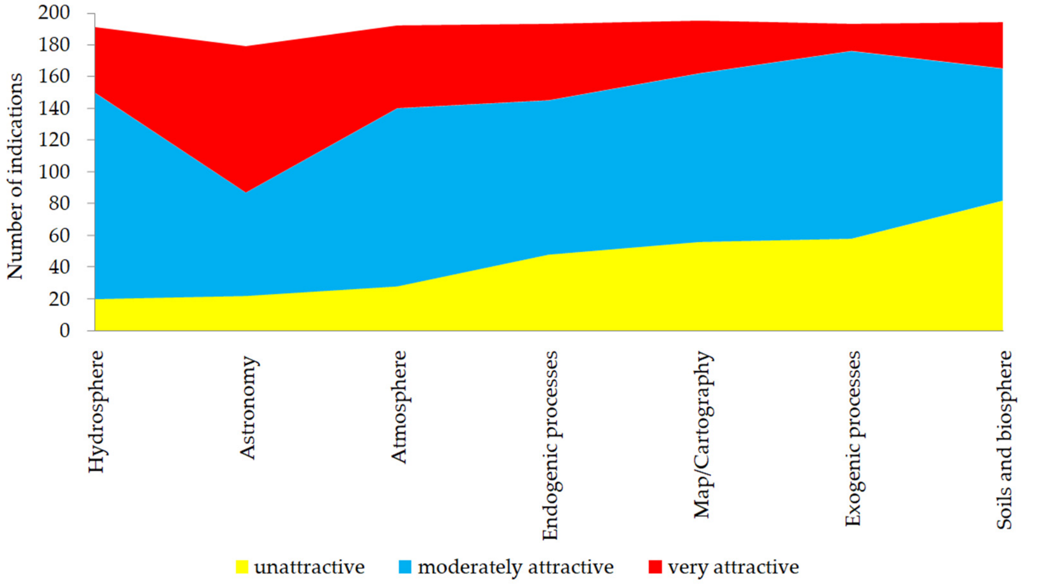

Figure 7. Attractiveness of individual geographical parts for students in teachers' opinion (N = 198).

Students' indications on environmental problems known before their school education confirm previous conclusions (Figure 8). A a total of 100% of the respondents indicated knowledge of the issues discussed in the sections: Atmosphere and Hydrosphere (floods, water pollution, air pollution, bad waste disposal). The least known threats concern the topic Soils and biosphere: changing the boundaries of the occurrence of plant zones (9%, 19 indications), reduction of biodiversity (11%, 22 indications), soil depletion (11%, 23 indications), soil pollution (19%, 38 indications), change in flora and fauna species in relation to extreme events (26%, 53 indications), and desertification (50%, 101 indications). Altogether, this is 256 out of 1974 indications. This fact is very disturbing because soils have a very important role in our life and in the management of the human environment. They are one of the most valuable elements of terrestrial ecosystems and perform many ecological functions [27–29], that is why they can be a testimony of human activity.

They also are a reservoir of artefacts—a historical trace of human existence and management [30]—so people should realize that soil problems (e.g., pollution and depletion) are equally important for humankind as global warming and the ozone hole. Despite the importance of soil cover, there is still a limited understanding of the role of soils in human life among the general public [31–33]. Unfortunately, people frequently overlook soils as components of the physical and biological landscape and do not perceive soil management as essential for sustainability. According to The International Union of Soil Sciences [34] the key to achieve the Sustainable Development Goals (SDGs) is to protect soil resources and educate for its conservation [35]. Geography, as a school subject, is defined as the study of the landforms, features, inhabitants, as well as soils and phenomena of the Earth and touches all aspects of sustainability thinking [36–39]. In physical geography, sustainability-related concepts should include an understanding of geomorphological processes, resource distribution, landforms, weather, and soil cover, as well as the close interdependencies between them. The impact of thoughtless behavior (inconsistent with the principles of sustainable development) on human beings should be particularly emphasized. Nevertheless, geography lessons have much unused potential when it comes to sustainability [37,40]. According to Agenda 21 [41] and the 2030 Agenda for Sustainable Development [42], the following environmental issues can be identified: soil/land degradation, desertification, biodiversity loss, climate change, water, health and food, etc. It can be stated that suitable teaching topics for education in geography include issues relevant to Earth sciences. However, it should be noticed that sustainable development concerns not only natural elements but also socio-economic ones. The knowledge and understanding of the major natural Earth' s systems (landforms, soils, water climate, vegetation), and the interactions within and between ecosystems and the major socio-economic systems (agriculture, settlement, transport, industry, trade, energy, population) should be considered as a cooperating one [43]. Geographical education could be a key strategy for sustainability development. The environmental problems identify the need for the proper education and promotion of citizens' commitment to the environment and 'ecological literacy' [44–46]. This is essential for understanding the natural systems that make life on Earth possible. There are many examples of how the overexploitation of the Earth's resources has changed the direction of development of societies, often forcing people to leave inhabited areas. People whose homes and communities have been destroyed by environmental disasters are called environmental refugees. Scattered throughout the developing world are 135 million people threatened by severe desertification and 550 million people subject to chronic water shortages [47–50]. Soil loss contributed to the demise of societies from the ancient Greeks and Romans to European colonialists and the American pioneers [51]. Due to the imprecision of the concept of environmental migration, it is difficult to estimate the scale of the problem. According to statistics from the United Nations Development Program as a result of natural disasters an average of 21 million people are displaced every year [52]. In 2019, the number of displacements due to natural disasters (disaster displacement) totaled 24.9 million on all continents, of which 96% was the result of weather events such as storms, floods, droughts, extreme temperatures, and fires [53]. The World Bank experts predict that 143 million migrants will be forced to escape their countries by 2050 from Latin America and Sub-Saharan Africa and Southeast Asia [54]. A significant increase in the total number of migrants in the last two decades (from 173 million in 2000 to 258 million in 2017) was noticed [55].

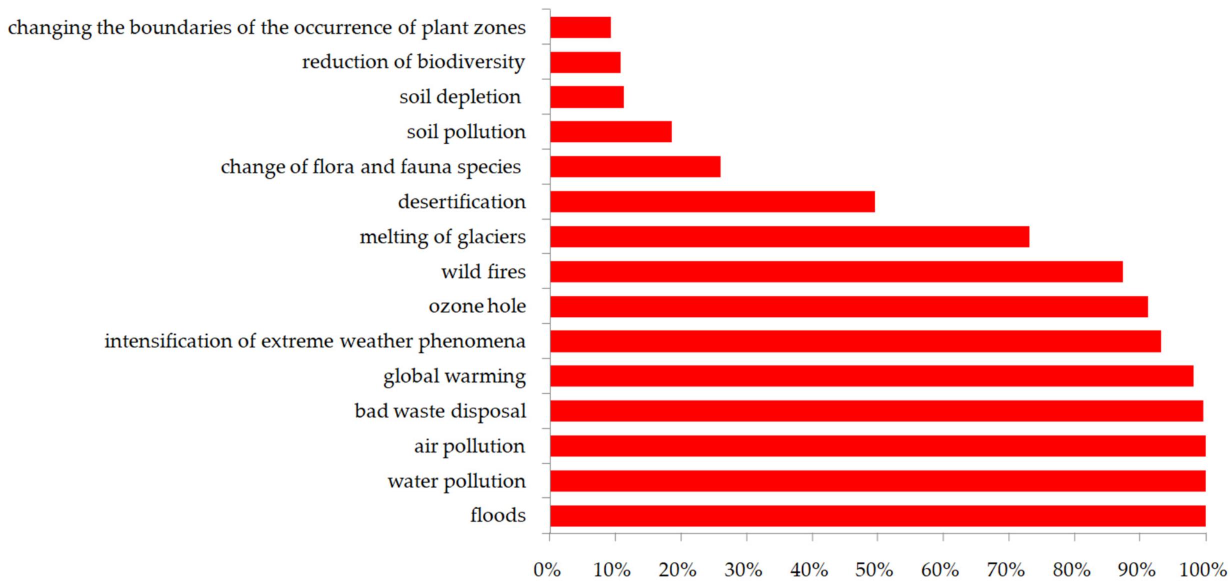

Figure 8. Students' indications on environmental problems they were aware of prior to school education(N = 204).

4. Summary and Conclusions

There are two types of environmental driving factors influencing migration of people: sudden onset events, i.e., various types of natural disasters, and long-term, slow onset events, such as droughts, desertification, increasing the salinity level, ocean acidification, and the lifting the level of the seas and oceans. Sub-Saharan Africa, South Asia, and Latin

America together represent 55 percent of the developing world's population. Current research finds that climate change will force millions of people to migrate by 2050 [54]. These people could be pushed to move their countries to escape the slow-onset impacts of climate change. Soil depletion, soil erosion or desertification are definitely less spectacular processes than floods or typhoons, but they are equally dangerous for human beings. Threats that change the nature of the soil develop insidiously because they are invisible to the eyes, buried under the surface of the Earth [56]. People will migrate from places with lower water availability and crop productivity, but there will be less and less areas with good and healthy soil conditions. Despite the currently dominant socio-economic nature of migration [57], it should be noted that this process is also directly influenced by soil depletion, water availability, and the quality of the ecosystem.

Education is the most effective method to prevent or at least minimalize many environmental problems before they appear. One of the aims of education is to make people aware of necessity of protecting the Earth and our environment by making positive changes in human behavior and by ensuring that people actively participate in finding solutions to emerging problems. Geographical education plays a special and important role in this process. Unfortunately, geographical education is not always able to meet the demands of sustainability. There are many obstacles to teachers being unable to implement sufficient knowledge and skills (e.g., improper educational methods, too little time for implementation, difficult terminology, lack of proper educational tools). However, not all parts of physical geography are equally familiar to students before they enter high school.

The conducted research allows for the following conclusions:

- Students have the least information about issues related to the pedosphere (soil depletion and pollution, reduction of biodiversity). This topic—Soils and biosphere—is perceived as the most unattractive for them to study, even during and after implementation.
- Students are not aware of the role that soil plays in human life and in the functioning of the environment. Without such awareness, they will not be able to fully understand the principles of sustainable development and properly solve environmental problems.
- Universities and media, as well as authorities and scientists, should be involved in the better promotion of soil science issues so that the level of their awareness is equal to other problems of the natural and anthropogenic environments.
- Active questioning of social and environmental decisions should be promoted.
- Teachers should make students aware of how problems over space or sustainability can be resolved.

Only such a balance can shape a young world citizen who will be able to stop the existing threats being caused by careless exploitation of the Earth's resources and face emerging environmental problems.

To save the world, we should take care of sustainable geographical education, and soil science ought to be a highly important component. How much soil it takes to support a human society depends on the size of the population, but people should realize that soil conservation is essential for the longevity of any civilization as history shows civilizations failed due to improper management of pedosphere resources [58–62].

"Many factors may contribute to ending a civilization, but an adequate supply of fertile soil is necessary to sustain one" [51]. However, not every part of sustainable development measures addresses the particular problem of environment and environmental refugees. Especially important, for example, would be the Anti-Desertification Action Plan as applied to the Sahel and arid sectors of Africa, as well as the Indian subcontinent.

Soils provide us with an insight into changes over time in our natural surroundings from ancient civilizations to the modern digital world. This history makes it certain that sustaining an industrialized civilization will rely as much on soil conservation as on technological innovation [51].

Students are aware of many risks and problems such as global warming and air pollution, but they are not sufficiently informed about soil resources and soil protection as being equally important for their existence. Soil science issues are unattractive for them. This is unacceptable. Soil is a treasure of the Earth deeply hidden from human eyes. It does not mean that soils do not exist. On the contrary, they accompany us from the first days of our existence. It would be worth treating it with due respect. School education based on the principles of sustainable development including soils concepts can help people to make their life as well the Earth's life better.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The document shares access to various materials and data from the study.

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