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How Greek Students Perceive Concepts Related to Geoenvironment: A Semiotics Content Analysis

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Abstract: In order to design a geoeducation program in the context of the possibilities given to the Experimental Schools of Greece of Lower Secondary Education, teachers identified the need for diagnostically assess students' understanding of basic concepts of the geoenvironment and particularly the concepts of geodiversity, geoheritage, geoethics and geotourism. In addition, there was a need to apply the educational technique of creating cognitive conflicts in order to promote the scientific perceptions of these concepts. Thus, research questions were identified which led the research to assess the current latent state of students' perceptions regarding the thematic areas of the concepts and to identify concepts whose perceptions can be used in the educational process in order to achieve effective cognitive conflicts in order to promote scientific perceptions of them. The students briefly answered a four-question questionnaire, wherein each question examined their perceptions regarding the four concepts of geoenvironment: geodiversity, geoheritage, geoethics and geotourism. All 45 students of the geoeducation program that took part in the survey were aged between 12 and 15 years old. The qualitative research strategy approach was selected and specifically the hybrid technique of semiotics content analysis in combination with thematic analysis. This technique was selected due to the need to identify, code, categorize and count both obvious and latent meanings in the students' written answers; these meanings were related to the four concepts under examination. The results of the research show that the current latent state of students' perceptions regarding the thematic fields of the four concepts of the geoenvironment can be considered as particularly confused since the majority of students did not understand the concepts as they are employed in the international literature. The research also highlighted concepts that can be used by teachers in their efforts to develop students' clear or even scientifically acceptable perceptions for the concepts of geodiversity, geoheritage, geoethics and geotourism in the thematic field of the geoenvironment.

Keywords: geodiversity; geoheritage; geoethics; geotourism; geoeducation; semiotics content analysis; Greece

Citation: Georgousis, E.; Savelidi, M.; Savelides, S.; Mosios, S.; Holokolos, M.-V.; Drinia, H. How Greek Students Perceive Concepts Related to Geoenvironment: A Semiotics Content Analysis. *Geosciences* **2022**, *12*, 172. https://doi.org/10.3390/geosciences12040172

Academic Editors: Deodato Tapete, Karoly Nemeth, Jesus Martinez-Frias, Panagiotis Voudouris and Assimina Antonarakou

Received: 10 February 2022
Accepted: 11 April 2022
Published: 14 April 2022

1. Introduction

Students' education in geosciences is connected to the neglected component of the geoenvironment [1], which includes a variety of concepts. Among all these concepts, the ones that were examined in the present research were students' perceptions of the concepts of geodiversity, geoheritage, geoethics and geotourism.

Geodiversity represents multiple values (intrinsic, cultural, aesthetic, economic, educational [2]) and is perceived as the variability of abiotic nature elements (such as geomorphological, tectonic, soil, hydrological and topographical) and physical processes, both on

the surface of the Earth as well as in the sea, together with endogenous and exogenous systems which cover the diversity of places, elements and particles that are generated by either natural or human processes [3] (p. 144).

Geoheritage is an integral part of natural heritage [4] (p. 7) which presupposes the "complete perception of man for nature and the environment" [5,6] and must be preserved for the benefit of future generations [7]. The concept of geoheritage includes the valuable and important geological and geomorphological elements of the landscape [8] with significant scientific, educational, cultural, aesthetic and/or tourist value. These elements of natural geodiversity are of great value to man [9], to cultural development and sense of place. These are characterized by great importance for education and research due to their special geological characteristics, the types of rocks or minerals they contain, unusual fossils or other geological elements. Additionally, they include places that have played a role in cultural or historical events or are aesthetically appealing landscapes [10,11].

Geoethics, like geological heritage, is a relatively new topic in geosciences, so the relationships it comprises are not yet fully understood [12]. Geoethics, in addition to the awareness of geoscientists, refers to the re-examination of the relationship between humans and the Earth system [13], therefore encouraging and promoting ethical values [14] in order to raise public awareness concerning the problems related to geoenvironment [15]. As defined by the International Association for Promoting Geoethics (IAPG) "geoethics provides a reference and guidelines for behavior in addressing concrete problems of human life by trying to find socio-economic solutions compatible with respect for the environment and the protection of nature and land" [16].

Finally, geotourism reveals the economic value of geological heritage [17] (p. 147). Among the various approaches, because there is no generally accepted definition [6], geotourism focuses particularly on the geological and geomorphological aspects of the landscape [18] and refers to a new more holistic type of sustainable tourism [19] arising from two very different disciplines, namely geology and of tourism [6]. According to Newsome and Dowling, "Geotourism is a form of natural area tourism that specifically focuses on geology and landscape" [20] (p. 4); [21]. From a different standpoint, the concept of geotourism is defined as "geographical" tourism [22] and refers to tourism which contributes to the preservation or promotion of the special geographical character of a place [23] (p. 1) in terms of culture, heritage, environment, aesthetics and the well-being of its inhabitants [24]. Therefore, its goal is to "extend the principles of ecotourism" [25] (p. 21) and contribute to regional economic development [25] (p. 24).

The reason for this research is the hardly optimistic education of students in geosciences [26] in compulsory education in Greece, although the need for their education in knowledge offered by geosciences has been repeatedly pointed out. Geosciences knowledge is useful for everyday life [27] and helps to understand the natural environment and the interaction between people and the environment so that students can eventually develop a sense of responsibility for their environment and a moral code for its protection and preservation [28].

In contrast to the prevailing situation in the Greek educational system, over the last two decades, society's interest in the geoenvironment has been constantly increasing internationally. Concepts such as "geosites" [29] (p. 25); [30,31], "geodiversity" [32–35] and "geoheritage" [36] have become more widely known [7] (p. 20), while the establishment of "geoparks" and the development of "geotourism" contribute to the economic and cultural development of visited areas [6,37–39]. At the core of interest is formal or informal "geoeducation" as part of sustainable development education and the promotion of geosciences [40], because in geosciences, it is imperative to infuse the ethical way of behavior in teaching from the very first module of Earth science in primary school [41]. However, both the concept of geological heritage and the concepts associated with it are absent from the school curricula of the geology–geography course of the Greek educational system, so one way of introducing the concept and its meaning in schools is environmental education [42] (p.112); [28]—and its evolution into education for the environment and sustainability.

In the Greek educational system, the development of geological thinking is provided in primary education through a few teaching hours in the context of the course of geography [43] as well as in lower secondary education through a few hours in the course of geology–geography. Education in the field of geosciences and the geoenvironment is considered incomplete [26] (p. 74) and does not help students understand the history of the Earth and explain natural processes [44]. The lack of geological knowledge can be covered by the development of environmental education programs [27,43,45]/education for the environment and sustainability, which, however, are implemented on a voluntary basis by both teachers and students. In Greek schools, teachers of all specialties have the ability to conduct environmental education programs, but largely ignore the importance of geological formations [46], geodiversity and geoheritage, which is why the environmental groups of Greek schools that choose to develop an environmental program with a geoenvironmental theme are very limited [46,47]. Nevertheless, what contributes to the need for students' education on geosciences are the positive examples of designing and implementing environmental educational programs and educational activities in geologically protected areas which are organized for primary and lower secondary education students [38,39,48].

A recent study, one which investigated the understanding of geocultural heritage and the relative values of lower secondary school students (gymnasium) and university students, found that in contrast to the aesthetic value perceived by the participants and the importance they attach to cultural, anthropocentric, utilitarian and economic values, participants understand geological value to a moderate degree, and ecological, ecocentric and intrinsic values to a fairly low degree [47]. This is why, in the Greek school reality, the design and implementation of geoenvironmental education programs for lower secondary school (gymnasium) students is promising in the aims of empowering their geocultural values [49,50].

According to the above, it is possible to argue that the education of students in geosciences is incomplete in the curricula of the cognitive field of geology–geography of lower secondary school (gymnasium), whilst the concept of the geoenvironment as well as witnessing geological phenomena and their processes are absent from the topics of the educational programs of environmental education, thus preventing students' understanding values of the geological heritage. However, students' perceptions of basic concepts of the geoenvironment have not been explored.

The present research explores students' perceptions of the concepts of geodiversity, geoheritage, geoethics and geotourism in order to design a geoeducation program within the framework of the possibilities given to an experimental school. It is noted that this type of educational unit supports the experimentation and pilot implementation of educational innovations mainly through the creation and operation of creativity and innovation groups that concern various cognitive fields [51].

The geoeducation program was designed with the aim of broadening students' ethical concerns concerning the recognition of geodiversity's intrinsic value [9], which essentially means that people do not have the right to reduce geodiversity [52] and that students are expected to realize their personal values' framework which may signal their transition to a higher stage of ethical thinking [53]. The expected learning outcomes of the geoeducation program for the students are:

To recognize the geoenvironment as a witness to geological phenomena and its relation to socio-economic reality.
To understand geodiversity and the fact that the elements constituting geoheritage are of value to society [9], so that they understand both the geological heritage and the cultural values of geodiversity associated with mythological, historical, archaeological, spiritual and religious aspects [2,33].
To discover the geological peculiarities of an area as a geotourism product and the potential of geotourism as the basis of promoting the development of sustainable tourism [54].
To develop a moral code and a sense of responsibility for the protection and conservation of the environment [28].

As a result of exploration and empowerment in geocultural values, students will evaluate monuments of geological and cultural heritage and propose their own geotours through digital narratives on Internet maps.

The geoeducational program was undertaken by two teachers and 45 students of the experimental school who expressed the desire to participate as members of the respective Creativity and Innovation Group.

In order to design this geoeducational program, teachers realized the need for a diagnostic assessment of students regarding their perception of the basic concepts of the geoenvironment and specifically the concepts of geodiversity, geoheritage, geoethics and geotourism [55,56]. Teachers, aiming for the effective reconstruction of students' perceptions about these concepts, designed the use of the educational technique of creating cognitive conflicts [57]. This reconstruction aimed to change students' latent perceptions of these concepts, with perceptions accepted by so-called school science [58]. This signaled the need, through this diagnostic assessment, to identify those students' latent perceptions, which should be reconstructed through the educational process.

2. Materials and Method

Teachers, based on fragmented attempts to communicate with students, suspect that the cognitive structure [59] of their knowledge and perceptions of geoenvironment probably do not correspond to the corresponding scientific knowledge and perceptions, which leads them to seek a conceptual change in their students. This conceptual change leads them to the acquisition of knowledge and the formation of perceptions in the real world on the subject of the geoenvironment [60].

Therefore, they agree that an effective way for students to construct their new own models or conceptions which are in line with modern scientific conceptions of the geoenvironment is to rely on elements of knowledge and perceptions that students already have prior conceptions of [61]. Thus, using "bridging analogies" will allow students to perceive the issue of geoenvironment in the "real world" in a new way—in relation to the system of geoenvironment—based on students' conceptual understanding [61] (p. 485).

In other words, teachers want to cause a cognitive conflict in their students so that its resolution, through the implementation processes of the geoeducation program, causes the expected result of building a new conceptual construction on a scientific basis for each of them. It is noted here that the concept of cognitive conflict is understood as "the starting point to promote any change in the conceptual network . . . [leading] . . . the individual to be aware of the differences between their own beliefs, concepts or theories and the new information" [62] (p. 374).

This is how the question/concern firstly arises: Do the cognitive structures of students' knowledge and perceptions of the geoenvironment correspond to the respective scientific knowledge and perceptions of science? Additionally, if these do not correspond, what are those elements (beliefs, concepts or theories) of their cognitive structure which we should use with the technique of cognitive conflict to instigate the desired conceptual change in our students?

In order to successfully implement this geoeducation training program through the promotion of student learning and the corresponding diagnostic feedback [63] (p. 1), teachers recognize the need to collect detailed information on students' latent ability to acquire knowledge in the thematic area of the geoenvironment, i.e., in the area which includes the topic and the educational object of the program [64] (p. 1). In practice, the teachers were interested in assessing the current (latent) learning situation as students' knowledge and perception in the thematic subareas of the geoenvironment: geodiversity, geoheritage, geoethics and geotourism in the most objective way possible.

This problem identified the research questions of this survey:

Q1: What is the current latent state of students' perceptions regarding the thematic areas of the concepts of the geoenvironment, namely geodiversity, geoheritage, geoethics and geotourism?

Q2: Which concepts can be used in the educational process to achieve cognitive conflicts in order to promote scientific understanding of the concepts of geodiversity, geoheritage, geoethics and geotourism to students?

Thus, the sensitizing concepts of the survey were identified. It is noted that the similarity between the obvious or latent meanings of the students' statements with the meaning of the sensitizing concepts constitutes a measure of concordance between the teachers regarding the analysis of these statements.

Naturally, sensitizing concepts include the concepts of geodiversity, geoheritage, geoethics and geotourism:

"Geodiversity" is defined as the abiotic equivalent of biodiversity and describes the variety of geological, geomorphological, pedological and hydrological features and processes [33,34].

"Geoheritage" refers to those elements of the planet's geodiversity that are assessed as worthy of conservation [34].

The concept of "geoethics" refers to research and reflection on the values that underpin appropriate behaviors and practices, wherever human activities interact with the Earth system [65] (p. 4) [66].

"Geotourism" is a sustainable form of tourism [5] focusing on the geological and landscape component [67].

In order to answer the research question of the present survey, the qualitative approach of semiotics content analysis was followed [68] (p. 25); [64], always within the framework of the educational process of cognitive diagnostic assessments (CDAs) and with the corresponding adaptation to the objectives of this geoeducation program (Figure 1).

As mentioned above, the objectives of this educational program in addition to knowledge are oriented towards the development of perceptions and the empowerment of students in the values of geoheritage [69] (p. 32) in relation to the issue of geoenvironmental sustainability [70], especially regarding the concepts of geodiversity, geoheritage, geoethics and geotourism. This orientation in the development of perceptions and values in students showed teachers that such a diagnostic assessment technique should be followed which can deepen students' perceptions and knowledge and provide the necessary information to teachers to shape and properly implement the program in order to promote the empowerment of values in students. The latter instructed teachers to follow a similar assessment technique and process to that of Georgousis, Savelidi, Savelides, Holokolos and Drinia (2021) [50,71].

Thus, the semiotics content analysis was followed due to the interest of teachers in the search for deeper meaning in students' answers [72] (p. 716). Teachers were particularly interested in highlighting *obvious* or *latent* meanings as *conceptual patterns* and their correlation with the meaning of the characteristic key concepts which are designed to have an effect upon the actual syllabus and the educational objectives of the course [73] (p. 102). The key concepts were described as the sensitizing concepts of the present survey [72] (p. 716). This analysis used elements of thematic analysis in order to better manage and comprehend the data and to facilitate the exportation and reporting of results [74]. These elements are thematic categorization based on data and coding based on the text elements of the teachers' field of interest and the relevant reporting of the survey [75].

Four categories were identified which correspond to the four educational objectives of the syllabus of the course. These are the main sensitizing concepts of this survey, namely geodiversity, geoheritage, geoethics and geotourism.

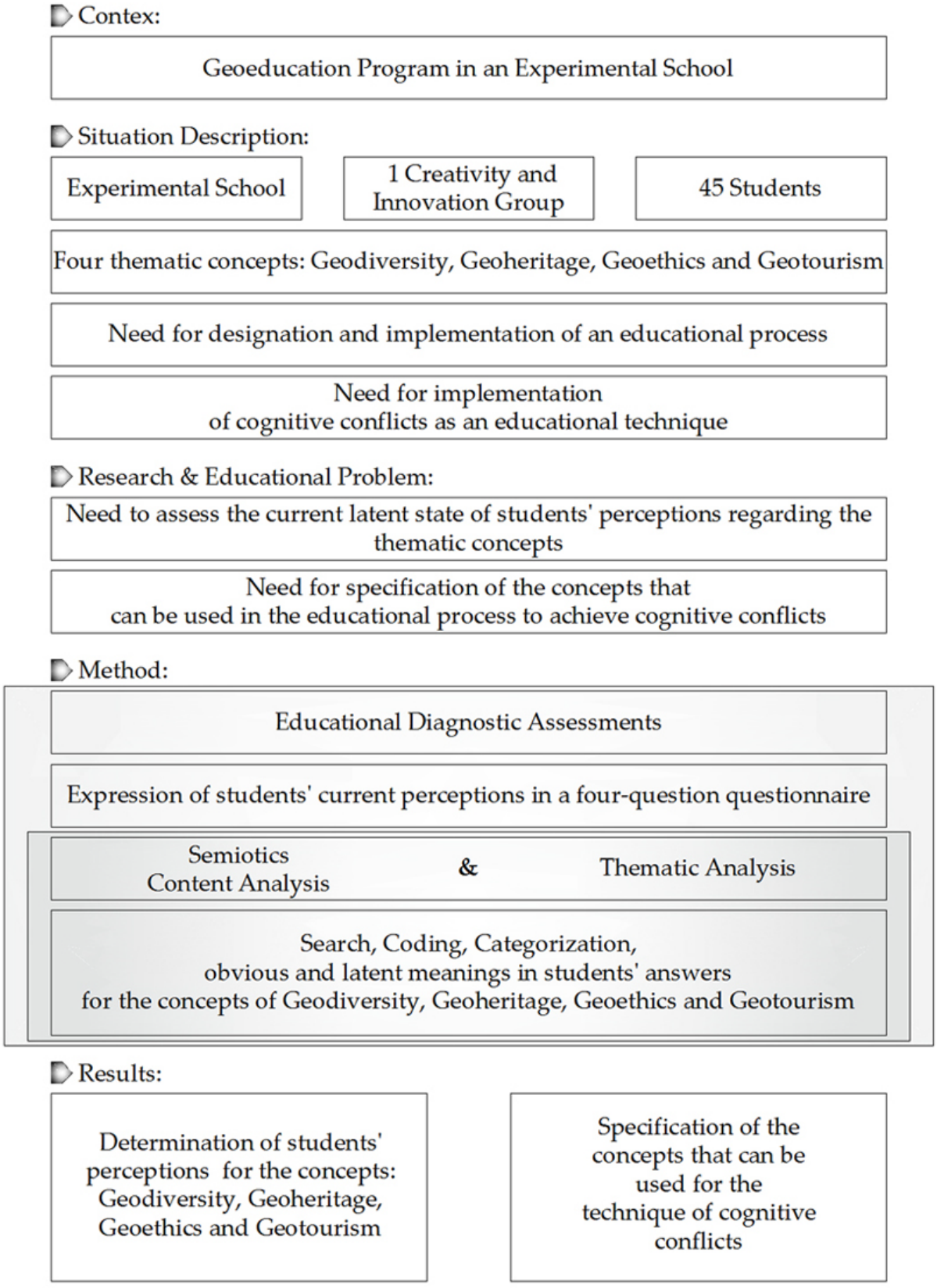


Figure 1. Context and methodology for answering the research questions.

The teachers estimated that the knowledge and perceptions of all participating students should be explored as we are interested in "mining" data that will help in the

education and pedagogical empowerment of all students with no exceptions. In addition, a thorough qualitative examination of these data (as opposed to a quantitative one) may have given teachers the opportunity to draw interesting "internally generalized" conclusions, even if the source of the data was the knowledge and perceptions of a small minority of students [76] (p. 6). For these reasons, it was decided that the diagnostic assessments of students should be addressed to all students. Thus, an inventory survey was carried out [77] (p. 020023-2) with a sample of all 45 students of the geoeducation program of the Experimental School of Volos, who were aged between 12 and 15 years old.

A questionnaire of four questions was typed which can be answered openly. The questionnaire was addressed to students who are encouraged to use a small number of words to express their understanding of what the concepts of geodiversity, geoheritage, geoethics and geotourism mean to them. Specifically, the urge to express their perception of what these concepts mean to them refers to what "comes to mind" when they read these words. The questionnaire was in the format of a digital form and it was filled in optionally.

Students' answers were examined on the basis of the linguistic unit of the sentence [78] (p. 50). The sentence of each answer was approached semiotically, i.e., it was semantically analyzed in order to highlight obvious concepts and reveal latent concepts, which are found in it and are related to the identified sensitizing concepts [72] (p. 559, 716); [73] (p. 102). In their answers seeking to express their perception of the general meaning of one of the four concepts, the students instilled points of meaning which reflected this perception. Thus, the search for these instilled points was sought which referred to the students' perception of the meaning of these four concepts, the examination of which is of interest to the teachers. These points are defined as conceptual patterns and are grouped—and coded—according to their relevance to each other in the codes of analysis [72] (p. 599).

An "a priori" code [79] was identified in each category which was expected to include those conceptual patterns (students' answers) that are consistent with the concept (general meaning) of the category as described—based on the selected bibliography—in the corresponding sensitizing concept. The four (4) a priori codes, in their name, were characterized by the word consciousness. The a priori codes are geodiversity consciousness, geoheritage consciousness, geoethics consciousness and geotourism consciousness.

The following is a thorough semiotic examination of the concepts in the students' answers simultaneously and collaboratively conducted by the two teachers of the course.

Related conceptual patterns were grouped and integrated "in processus" codes (corresponding to the term "a priori"). Conceptual patterns which were not consistent with the concept (general meaning) of a category were included in a code named *Uncategorized*.

The examination of the linguistic unit (sentences) of the answers was carried out with the following systematization:

- Words were sought to convey the meaning identified in the description of the corresponding sensitizing concept in an obvious or latent way [72] (p. 559, 716); [73] (p. 102). The explanation of the meaning was also examined with regard to the meaning of the definition which was mentioned in the corresponding sensitizing concept and always according to the teachers' assessment.
- It was examined whether the words in correlation with the corresponding context of the text unit give the meaning of the respective sensitizing concept in an obvious or latent way [80] (p. 204).

The genre of the sentence was examined in order to determine the semantic "intensity" of the morpheme [78] (p. 10, 13). The genre was examined, as a school textual genre, according to the categorization: the genre of describing, the genre of instructing, the genre of explaining, the genre of arguing and the genre of narrating [81] (p. 13). On an intensity scale, according to the teachers' assessment, linguistic unit with an arguing character is considered to be of high semantic intensity, while a linguistic unit with a describing character is considered as low [82].

What followed was a quantitative drawing of the results and conclusions. The results were reported in quantitative form using tables and reports, and documented using Sankey diagrams and verbally according to linguistic scales [83].

The claim that the survey can be characterized as descriptive, interpretive and theoretical in its environment validity could be supported. This is inferred as the data were consistently recorded by the participants themselves under the supervision of the teachers. Additionally, the sensitizing concepts, as the foundation of the survey, are based on modern theoretical perceptions of academic and research bodies and the aim of this survey was intertwined with daily practice [84] (pp. 284-285); [72] in the club of an experimental school in Greece. It can also be argued that the research was characterized by credibility, since the research design, consistent data collection and documentation of the results extraction process led to findings which, as considered by the authors, can be trusted by the reader [85] (p. 1057).

The survey was conducted in compliance with the basic ethical principles of research [86]. The questionnaires were anonymous and were submitted in digital form, thus ensuring the required respect, confidentiality, data protection and students' personality protection. Of course, the whole process was aimed at the students' benefit (it was aimed at improving the educational and pedagogical processes with them as recipients). The latter was perceived by them and it emerged with their informed consent as there was no student who did not submit the questionnaire, despite it being optional for them to complete it. Finally, the whole process was not motivated by any self-centered interest since—as mentioned above—it aimed to optimize the educational work for the benefit of the students only.

The method was implemented as follows.

The classification of the conceptual patterns of the linguistic units into codes and corresponding categories, as well as the extraction of results, was performed via relevant software computer assisted qualitative data analysis (CAQDAS), namely Atlas.ti 9 [87].

Thematic analysis techniques were applied and upon their basis, one (1) theme was identified, namely "geoenvironmental concepts and perceptions" and four (4) categories were identified: geodiversity, geoheritage, geoethics and geotourism. In addition, four (4) "a priori" codes were also identified with the names geodiversity consciousness, geoheritage consciousness, geoethics consciousness and geotourism consciousness.

The followed process sought to be understood by the reader through the following examples:

- Linguistic units are examined in the students' answers to some of the questions, for example, that referring to geodiversity. The examination was performed according to the above in order to identify conceptual patterns with a meaning related to that of geodiversity, as mentioned in the description of the respective sensitizing concept (of geodiversity). Related concepts were classified in codes, which were either created for this purpose ("a priori" codes) or when the need to create a code was present ("in processus" codes). It was noted that, during the coding through QACDAS software, the linguistic unit receives a characteristic numeric code (e.g., 1: 6 p 1 in 01_Geodiversity), which in the present study is used for the exact reference to the linguistic unit only.
- For example, the linguistic unit: 1: 6 p 1 in 01_Geodiversity was mentioned, to which the student answers: "It is the many species of flora and fauna". Here, we observe that the student's expressed perception of the concept of geodiversity is a conceptual pattern, which according to the teachers, was neither identified as obvious nor as latent (with the concept of geodiversity). It is a descriptive text, whose obvious meaning basically derives from the words "many species", "flora" and "fauna", according to the teachers, and that can be identified with the concept of biodiversity. Thus, another code was added to the thematic analysis map, in the category geodiversity, namely that of biodiversity. Of course, the conceptual pattern of the linguistic unit 1:6 p 1 in 01_Geodiversity was coded in code biodiversity, of the category geodiversity.

- Another example refers to the latent conceptual pattern of a linguistic unit. Specifically, in linguistic unit: 2:17 p 1 in 02_Geoheritage, the student, expressing his perception of Geoheritage, answers: "It is what people have inherited from the land, forests and plains". Here, first of all, it seems that the meaning of the conceptual pattern does not refer to the meaning of the concept of geoheritage, as it was defined in the corresponding sensitizing concept. On the contrary, the teachers assessed that the latent meaning of the linguistic unit was consistent with that of natural heritage. This was deduced both from the identification of words that refer to heritage concerning "land, forests and plains" and more generally from the examination of their context, things which—according to the teachers—refer to the concept of natural heritage. Thus, linguistic unit 2:17 p 1 in 02_Geoheritage was classified in code natural heritage of the category geoheritage.
- An example of a linguistic unit, coded as uncategorized, is 4:18 p 1 in 04_Geoetourism. The student, expressing his understanding of the concept meaning of geotourism, stated: "It refers to young people working as farmers". Here, the teachers considered that the meaning of the answer was not in line with the topic of geoenvironment, nor even with any of the examined concepts and for this reason, it was coded as uncategorized.

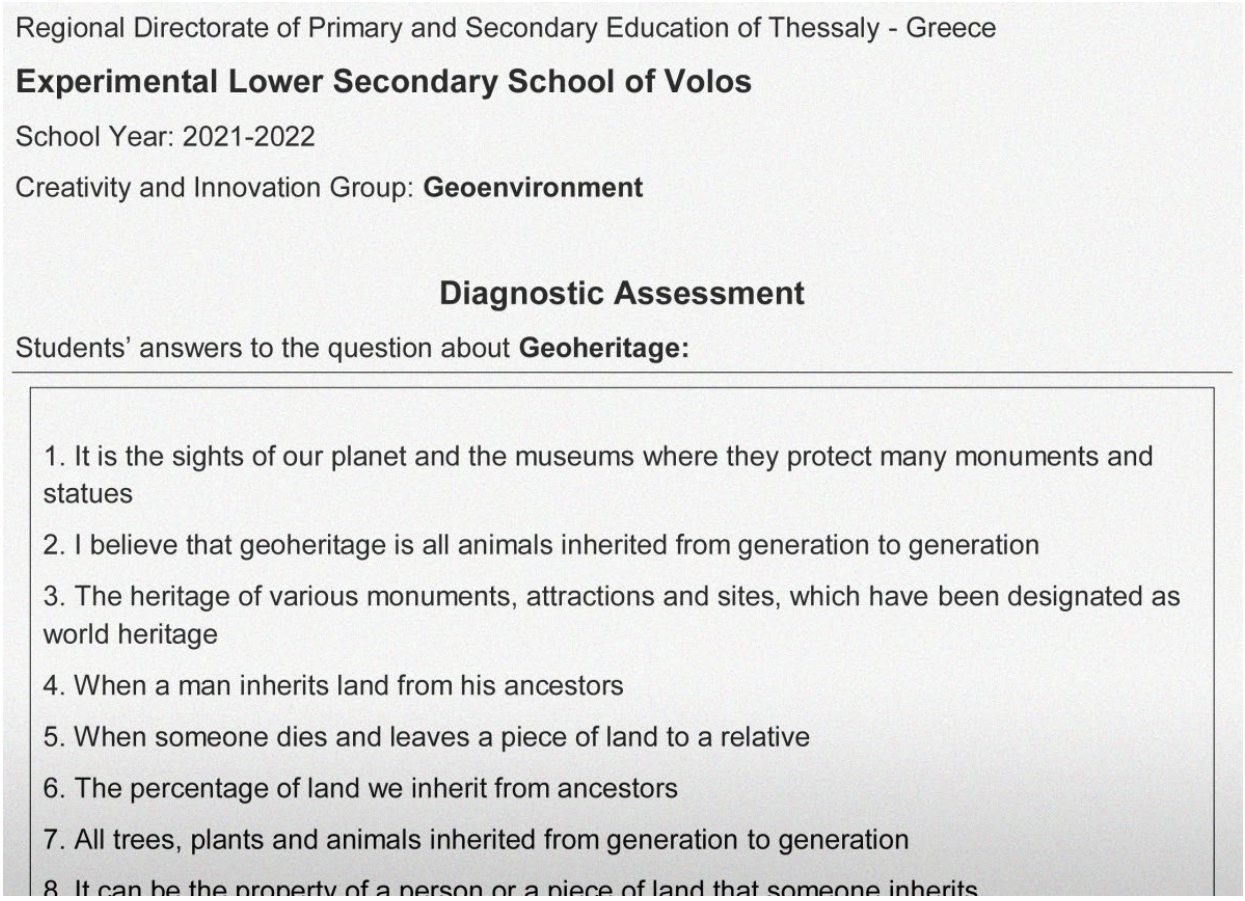
Finally, it was noted that the linguistic scale [81] was used which characterizes the number of students who answered about the meaning of a concept as many (percentage $\geq$ 25%), several (percentage > 25% and $\geq$10%), some (percentage > 10% and $\geq$5%), few (percentage > 5% and $\geq$2%) and minimal (percentage > 2%).

3. Results and Discussion

In the application of the procedures of the aforementioned methodology, the course teachers received 45 answered digital questionnaires from an equal number of students. Thus, 180 answers were received (45 questionnaires $\times$ 4 answers per questionnaire) which means that the linguistic units were also identical at the same number (n = 180). The 180 students' answers were redistributed into four documents according to the concept which the question explored and which each answer dealt with. Thus, the answers were redistributed in documents: 01_Geodiversity.pdf, 02_Geoheritage.pdf, 03_Geoethics.pdf and 04_Geotourism.pdf. Naturally, their redistribution yielded 45 responses in each document, distributed by negotiated concept, which is also evident in the names of the documents. These four (4) documents were input in the CAQDAS software, Atlas.ti [87], for the purpose of categorization, coding and further drawing of conclusions. A part of document 02_Geoheritage.pdf and some of the students' relevant answers are shown in Figure 2.

In this way, the semiotics content analysis of the linguistic units of the students' answers highlighted 170 conceptual patterns which were estimated to be related to the theme. These patterns were included in the 4 a priori and another 15 "in processus" codes (codes that arose during the analysis process). Conceptual patterns which were judged as unrelated to the theme (23 conceptual patterns) were included in a (twentieth) code named uncategorized.

Figure 3 depicts the thematic map of analysis (theme, categories, codes and link routing).


Regional Directorate of Primary and Secondary Education of Thessaly - Greece

Experimental Lower Secondary School of Volos

School Year: 2021-2022

Creativity and Innovation Group: **Geoenvironment**

Diagnostic Assessment

Students' answers to the question about **Geoheritage:**

1. It is the sights of our planet and the museums where they protect many monuments and statues
2. I believe that geoheritage is all animals inherited from generation to generation
3. The heritage of various monuments, attractions and sites, which have been designated as world heritage
4. When a man inherits land from his ancestors
5. When someone dies and leaves a piece of land to a relative
6. The percentage of land we inherit from ancestors
7. All trees, plants and animals inherited from generation to generation
8. It can be the property of a person or a piece of land that someone inherits

Figure 2. Part of the document with students' answers (on the concept of geoheritage).

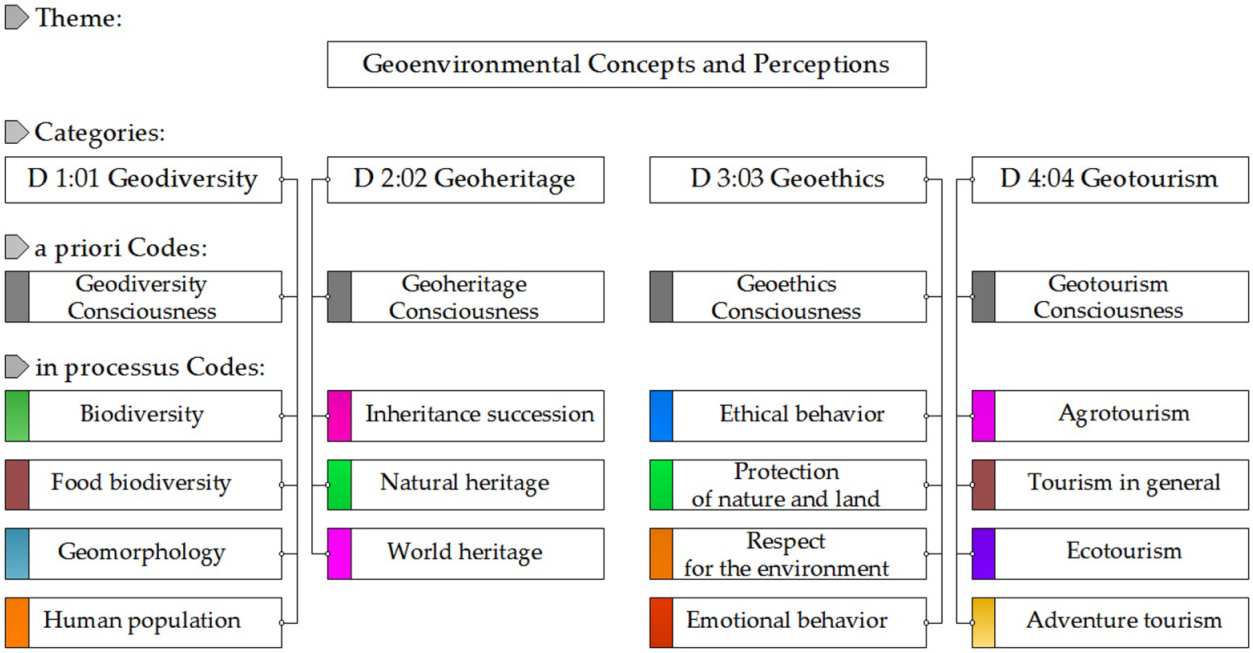


Figure 3. Thematic map: theme, categories, codes and coding color index.

In Table 1, the number of conceptual patterns was presented, which were identified per document, category and code. What was also presented was the marking color index of the codes in the CAQDAS software [87].

Table 1. Semiotics content analysis/thematic analysis: number of conceptual patterns per document/category and code. Coding color index.

Code		Document:	01_G [1]	02_G [1]	03_G [1]	04_G [1]	Totals
s/n	Category	Code					
1	Geodiversity	●—Geodiversity consciousness	0				0
2		●—Biodiversity	19				19
3		●—Geomorphology	12				12
4		●—Food biodiversity	12				12
5		●—Human population	3				3
6	Geoheritage	●—Geoheritage consciousness		1			1
7		●—World heritage		3			3
8		●—Inheritance succession		21			21
9		●—Natural heritage		15			15
10	Geoethics	●—Geoethics consciousness			4		4
11		●—Respect for the environment			10		10
12		●—Protection of nature and land			11		11
13		●—Ethical behavior			13		13
14		●—Emotional behavior			2		2
15	Geotourism	●—Geotourism consciousness				4	4
16		●—Ecotourism				7	7
17		●—Agrotourism				16	16
18		●—Adventure tourism				6	6
19		●—Tourism in general				11	11
20	Uncategorized	●—Uncategorized	5	7	9	2	23
		Totals (minus uncategorized quantities):	46	40	40	44	170
		Totals:	51	47	49	46	193

[1] 01_G: 01_Geodiversity.pdf (Gr = 45), 02_G: 02_Geoheritage.pdf (Gr = 45), 03_G: 03_Geoethics (Gr = 45), 04_G: 04_Geoetourism.pdf (Gr = 45).

The results of the examination of all the students' answers per category (which exactly corresponds to the corresponding document) are presented below, per category. Here, we must note that the absolute number of total frequencies of the codes is higher than the number of students' answers (45 × 4), since in any one answer, more than one different conceptual patterns may have been identified, which were naturally coded in more than one corresponding codes.

3.1. Category Geodiversity

Based on the examination of the respective linguistic units of their conceptual patterns answers, it was found that the students did not understand the concept of geodiversity, as was found in the international literature and was described in the corresponding sensitizing concept (Table 2).

It seems that many students (37.26%) confused it with the concept of biodiversity, that is "that part of nature which includes the variety and richness of all the plant and animal species at different scales" [88]. For example, the linguistic unit 1:25 p 2 in 01_Geodiversity was mentioned: "Geodiversity is the variety of products of the earth, such as fruit and vegetables and especially the organic products produced by the land", which was evaluated as a descriptive text with latent meaning, which resembles the concept of biodiversity and not geodiversity.

Many students (23.53%) perceived it as food biodiversity, that is, as "the diversity of plants, animals and other organisms used for food" [89] and also many (23.53%) perceived it as geomorphology, that is, they referred to features found on Earth, such as mountains, hills, plains and rivers. [90].

Table 2. Frequencies/distribution of codes (students' perceptions) in the category geodiversity.

	01_Geodiversity (n = 45)	Frequencies		
	Code	Absolute	Relative (in Category)	Relative (Within All Codings)
1	—Biodiversity	19	37.26%	9.84%
2	—Food biodiversity	12	23.53%	6.22%
3	—Geomorphology	12	23.53%	6.22%
4	—Uncategorized	5	9.80%	2.59%
5	—Human population	3	5.88%	1.55%
6	—Geodiversity consciousness	0	0.00%	0.00%
	Totals:	51	100.00%	26.42%

For example, linguistic unit 1:21 p 1 in 01_Geodiversity "It is the variety in various plants and animals used for food" seems to suggest that the student's perception that the concept of geodiversity referred to food biodiversity. Additionally, linguistic unit 1:20 p 1 in 01_Geodiversity "The morphology of the soil" rather refers to the meaning of geomorphology, perhaps because in Greek, the word "soil" is also called "Earth" ("Gi" from the ancient Greek word "Γαία", "Gea").

Some students (5.88%) understood the meaning of geodiversity as *Human population*. For example, in linguistic unit 1:31 p 2 in 01_Geodiversity, the student answers: "Geodiversity refers to the population of the earth", which refers to the concept of human population, where it was codified. This perception seems to derive from the fact that in the Greek language, the word "Earth" is called—this one too—"Γή" ("Gi" from the ancient Greek word "Γαία", "Gea") and associatively, the student understood it as the prefix of the word "*(Geo)poikilotita*", which is the word (Geo)diversity in Greek.

It appears remarkable that no student (0.00%) understood the concept of geodiversity (code: geodiversity consciousness), as it was found in the international literature, even approximately. It is also noteworthy that several students (9.80%) gave answers which did not even refer to the topic of geoenvironment and which were coded in code uncategorized.

Finally, it seems that the concepts that represented the cognitive structure of the students' knowledge and perceptions about the concept of geodiversity were basically biodiversity, food biodiversity and geomorphology, and secondarily, the concept of human population (Figure 4).

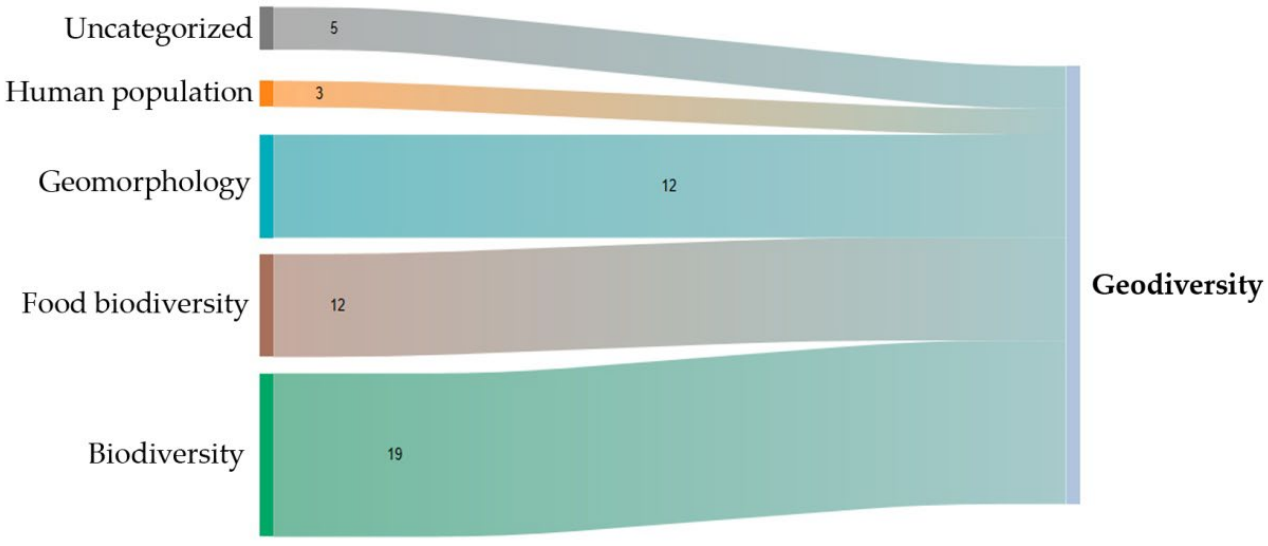


Figure 4. Graph of students' perceptions (codes) on the concept of geodiversity (Sankey diagram).

3.2. Category Geoheritage

Here, the students' answers are examined in relation with the concept of geoheritage. Here, as well, the students appeared to fail to understand the concept of geoheritage, as it is found in the literature, but on the contrary, they confused it with other concepts. Examining the answers' conceptual patterns, as linguistic units, displayed perceptions which were coded by the teachers in five different codes of category geoheritage (Table 3).

Table 3. Frequencies/distribution of codes (students' perceptions) in the category geoheritage.

02_Geoheritage (n = 45)		Frequencies		
	Code	Absolute	Relative (In Category)	Relative (Within All Codings)
1	•—Inheritance succession	21	44.68%	10.88%
2	•—Natural heritage	15	31.92%	7.77%
3	•—Uncategorized	7	14.89%	3.63%
4	•—World heritage	3	6.38%	1.55%
5	•—Geoheritage consciousness	1	2.13%	0.52%
	Totals:	47	100.00%	24.35%

It was found that many students (44.68%) understood the concept of geoheritage as *Inheritance succession*. For example, linguistic unit 2:19 p 1 in 02_Geoheritage was mentioned. Here, the student expressed his perception of geoheritage by answering: "It is the heritage of estates located in towns or villages". In this descriptive text of the answer, it was estimated that there is a latent meaning, which refers to inheritance succession, that is, the transfer of assets, rights and obligations by reason of death [91], as well as in many other answers by his classmates (more than 20). Thus, the conceptual pattern of linguistic unit 2:19 p 1 in 02_Geoheritage led to its codification in the code inheritance succession of the category geoheritage.

Additionally, many students (31.92%) seemed to understand the concept of geoheritage as natural heritage [92]. This was also found in linguistic unit 2:29 p 2 in 02_Geoheritage, as the student replied: "Geoheritage is everything beautiful that exists on earth, rivers, waterfalls, lakes, animals and fishes". Here, it was estimated that the student's perception of geoheritage was more in line with the meaning of the concept natural heritage. Some students (6.38%) perceived the concept of geoheritage as world heritage, i.e., places on Earth that are of outstanding universal value to humanity [93]. What is particularly interesting is that several students expressed completely "irrelevant" perceptions to the meaning of theme and category. For instance, in linguistic *unit 2:10 p 1 in 02_Geoheritage*, the student's answer "I believe that it is the wealth that animals and plants offer us. Some animals offer meat and others milk, while plants offer us beauty and serenity" was considered "irrelevant" to the meaning of the concept geoheritage and was coded as uncategorized.

A characteristic feature of the differentiation of students' perceptions from the accepted bibliographic perception of geoheritage was the assessment that only 1 in 45 students understood—albeit approximately—its meaning. The laconic but comprehensive answer of linguistic unit 2:11 p 1 in 02_Geoheritage was mentioned, for which it was estimated that its latent meaning was in line with the meaning of geoheritage: "It is the geographical heritage".

Hence, it seems that the concepts that can be used for the conceptual change of students regarding the concept of geoheritage are inheritance succession and natural heritage, while, secondarily, world heritage can be used as well, which is visually presented in Figure 5.

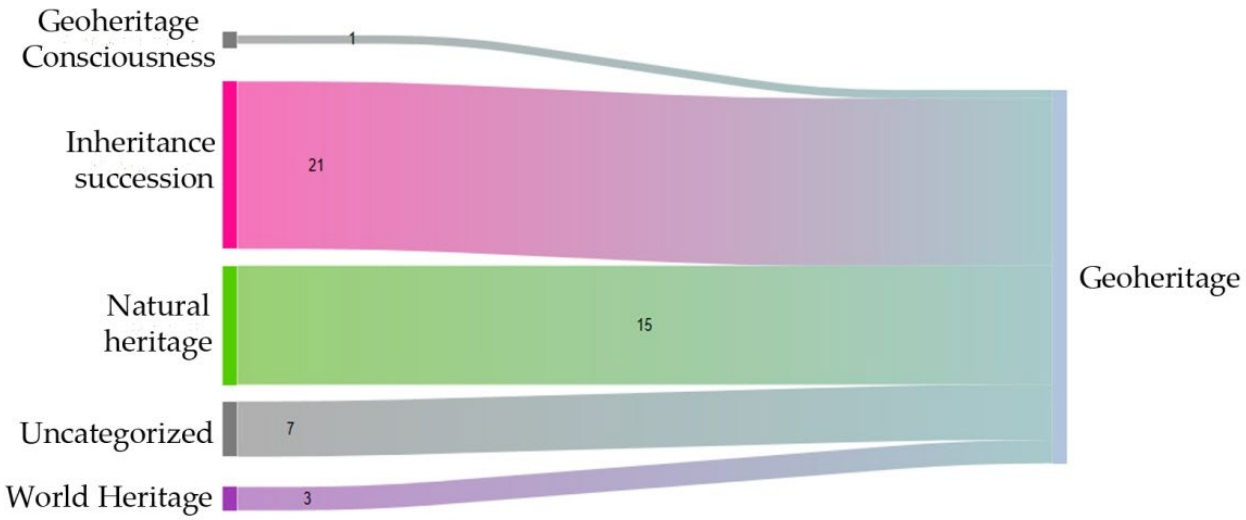


Figure 5. Graph of students' perceptions (codes) on the concept of geoheritage (Sankey diagram).

3.3. Category Geoethics

Unlike the previous two categories, the results in the category geoethics present a different image. Specifically, based on the examination of the respective linguistic units of the students' answers' conceptual patterns, it seems that on the one hand, their perceptions bears greater resemblance—more than the two previous concepts—to the concept of geoethics as it is expressed in the literature (Table 4). On the other hand, there were a significant number of "irrelevant" answers, which seems to indicate two different groups of students in relation to their perception of the subject of geoethics (Table 4).

Table 4. Frequencies/distribution of codes (students' perceptions) in category geoethics.

03_Geoethics (*n* = 45)		Frequencies		
	Code	**Absolute**	**Relative (In Category)**	**Relative (Within All Codings)**
1	●—Ethical behavior	13	26.53%	6.74%
2	●—Protection of nature and land	11	22.45%	5.70%
3	●—Respect for the environment	10	20.41%	5.18%
4	●—Uncategorized	9	18.37%	4.66%
5	●—Geoethics consciousness	4	8.16%	2.07%
6	●—Emotional behavior	2	4.08%	1.04%
	Totals:	49	100.00%	25.39%

A large number of students (26.53%) was identified as perceiving geoethics as ethical behavior, which shows that their perception can be easily formed in order to provoke the planned conceptual change for them with regard to the concept of geoethics. The conceptual patterns of their answers seem to show an increased sense of morality towards the Earth and the environment. For example, in linguistic unit 3:10 p 1 in 03_Geoethics, the student stated that "[Geoethics is the] . . . Ethical behavior for the variety that exists on earth".

In a similar (latent) spirit of ethics thinking and sustainability promotion, in linguistic unit 3:27 p 2 in 03_Geoethics, another student stated that geoethics " . . . means that people protect the earth so that future generations will have what we have today". These linguistic units were included in the code ethical behavior.

Additionally, several students (22.45%) understood the meaning of geoethics as having the meaning of the protection of nature and land. For example, the student's answer to

linguistic unit 3:27 p 2 in 03_Geoethics was "It means that people protect the earth so that future generations will have what we have today". Here too, there is the concept of the protection of nature and land and of sustainability promotion. Thus, linguistic unit 3:27 p 2 in 03_Geoethics was included (codified) in the code protection of nature and land of category geoethics.

Students' perceptions of the meaning of the concept of geoethics is consistent with that of the concept of respect for the environment which appears at a similar number (20.41%). To illustrate this, the answer 3: 5 p 1 in 03_Geoethics is noted: "It means that we must have respect for the environment, that is, not to throw away garbage and not to pollute the environment".

Few students (4.08%) responded emotionally (they used the word *love*). It should be noted that "love" constitutes one of the principal emotions [94] (p. 366). These linguistic units were included in the code of emotional behavior.

As mentioned above, a characteristic element of coding in the geoethics category was the increased number of perceptions which are in line with the sensitizing concept to which it corresponds and is examined. It was found, therefore, that four students (8.16%) perceived the concept of geoethics as expressed in the literature. For example, a student (Linguistic *Unit 3:25 p 2 in 03_Geoethics*) stated "It is the morals that people must have towards the earth, towards the environment". This unit is one of 4, which were coded in code geoethics consciousness.

Another characteristic element of the geoethics category is the large number of uncategorized linguistic units (18.37%). Indeed, several linguistic units were assessed whose conceptual patterns are rather "irrelevant" to the spirit of the geoethics concept. For example, linguistic unit 3:22 p 2 in 03_Geoethics "Respect for foreign land ownership" was mentioned. The conceptual pattern of this linguistic unit was deemed unrelated to the spirit of the theme and was coded as uncategorized.

Thus, it can be argued that the concepts that can serve to provoke a cognitive conflict, which will lead to the development of values in the field of geoethics, are essentially ethical behavior, protection of nature and land and respect for the environment and, secondarily, emotional behavior (Figure 6).

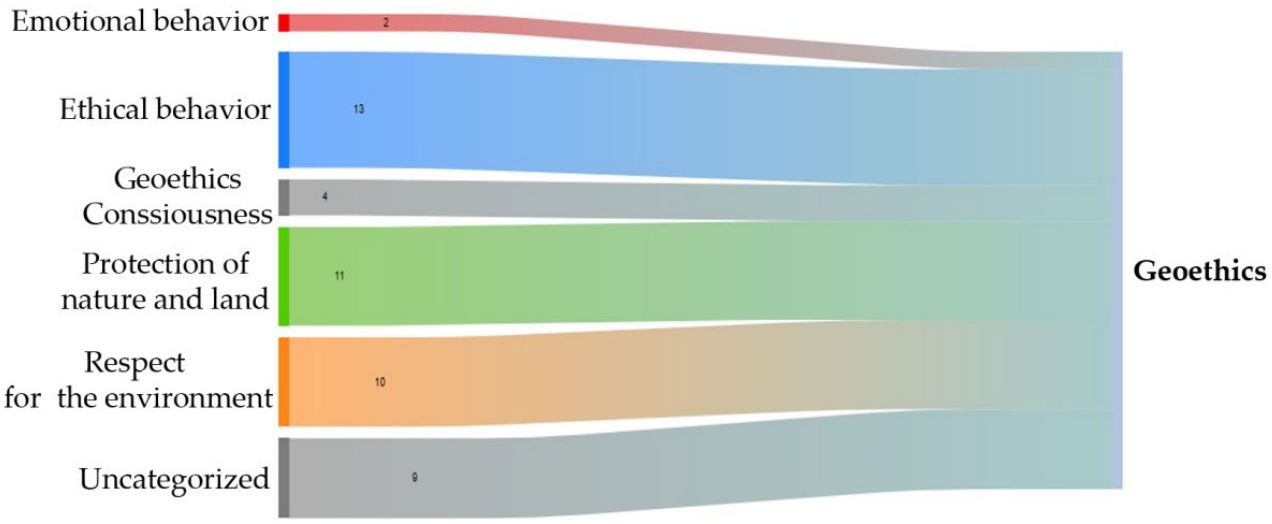


Figure 6. Graph of students' perceptions (codes) on the concept of geoethics (Sankey diagram).

3.4. Category Geotourism

In the category of geotourism, it seems that students' perceptions resemble this concept (of geotourism) in a similar way to that of the concept of geoethics. This means that they refer to concepts related to the word tourism and its various manifestations and sometimes their perceptions typically "approach" the spirit of the concept of geotourism (as it appears

in the literature). In general, it should be noted that Greek students are familiar with many concepts of tourism since they live in a country which can be characterized as a tourist destination and in which tourism can be defined as an agent of development [95]. The conceptual patterns' examination of the students' answers led the teachers to the codification of the linguistic units of these conceptual patterns in the category geotourism. The occurrence frequencies of these conceptual patterns per code are shown in Table 5.

Table 5. Frequencies/distribution of codes (students' perceptions) in the category geotourism.

04_ Geotourism (n = 45)		Frequencies		
	Code	Absolute	Relative (In Category)	Relative (Within All Codings)
1	●—Agrotourism	16	34.78%	8.29%
2	●—Tourism in general	11	23.91%	5.70%
3	●—Ecotourism	7	15.22%	3.63%
4	●—Adventure tourism	6	13.04%	3.11%
5	●—Geotourism consciousness	4	8.70%	2.07%
6	●—Uncategorized	2	4.35%	1.04%
	Totals:	46	100.00%	23.83%

Hence, it seems that many students (34.78%) perceived the meaning of geotourism as agrotourism, meaning tourism wherein the main motivation is recreation in rural areas [96]. This is probably due to them hearing about this type of tourism which seems to be developing in their area [97] (p. 1472), but it may also be due to the fact that the first part of the compound word "agrotourism" ("Agro-") derives from the Greek word "αγρός" ("Agros"), which means "field" and "field" in Greece, and is often called "Γή" (Earth) ("Gi" from the ancient Greek word "Γαία", "Gea"), whence the international prefix "Geo-". Thus, this may mean that they confused the prefix "Agro-" with the prefix "Geo-" in the words agrotourism and geotourism. An example of categorization of such a conceptual pattern is the linguistic unit (answer) 4: 8 p 1 in 04_Geoetourism "When a tourist rents a small field for some short time".

Several students (23.91%) perceived geotourism as a general form of tourism. For example, in linguistic unit 4: 5 p 1 in 04_Geotourism, the student expressed his perception by answering: "It is tourism in a beautiful landscape visited by many tourists". Based on the assessment of the latent meaning of this linguistic unit, it was codified in code Tourism in general.

Lower percentages of students seem to perceive the concept as Ecotourism (15.22%), that is, as a form of "tourism that attempts to minimize its impact upon the environment" [98] *or Adventure tourism* (13.04%), which entails travelling to an unusual, exotic, remote or wild destination [99] (p. 28). An illustration of linguistic unit coding in code ecotourism is 4:27 p 1 in 04_Geotourism, "It is tourism in nature that requires proper behavior towards the environment" and an illustration of codification in the code adventure tourism is 4:34 p 2 in 04_Geoetourism, "It refers to the tourism of an unusual place" (as assessed by its latent meaning).

What appears to be characteristic of the examination of the Geotourism concept is that four (4) students (8.70%) perceived it even approximately (according to the teachers). An example of such an answer is the answer 4:26 p 1 in 04_Geoetourism, "Tourism related to visits to wonderful landscapes". The concept pattern of this linguistic unit based on its latent meaning was codified by the teachers as geotourism consciousness.

In conclusion, it seems that the concepts that can be used in the construction of "bridging analogies" [61] (p. 485) of a cognitive conflict [62] (p. 374) for the development of perceptions on the subject of geotourism are agrotourism, tourism in general, and secondarily, those of ecotourism and adventure tourism (Figure 7).

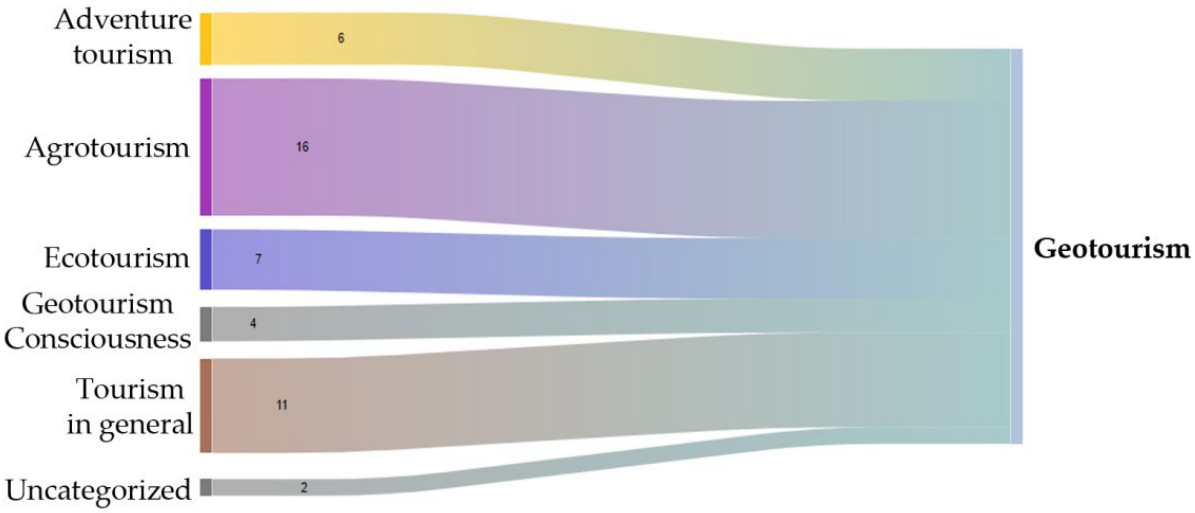


Figure 7. Graph of students' perceptions (codes) on the concept of geotourism (Sankey diagram).

3.5. Answers to the Research Questions

Regarding the first Research Question (Q1), summarizing the above results, we found that the current latent state of students' perceptions in the thematic fields of geoenvironment—namely the concepts of geodiversity, geoheritage, geoethics and geotourism—can be considered as very confused. This is reminiscent of the research results of Vasconcelos, Torres, Vasconcelos and Moutinho (2016), in a related subject, which found a "low level of knowledge on the three pillars of Sustainable Development" in 187 Portuguese citizens which was attributed to the lack of relevant education of these citizens [100] (p. 514). Similar conclusions were reached by Almeida and Vasconcelos (2015) in a study of 36 higher education students pursuing a Master's of Geology [101] (p. 904). Additionally, Georgousis, Savelidi, Savelides, Holokolos and Drinia (2021) came to similar conclusions about the lack of education in related subjects in approximately 600 Greek pupils and students [47]. We also noted the conclusion of Comănescu and Nedelea (2020) that there is a need to intensify public awareness and education at all levels regarding geoenvironmental factors [102].

More specifically, the vast majority of students did not seem to have a clear understanding—especially regarding a perception that is consistent with the literature—of any of the concepts of the theme "geoenvironmental concepts and perceptions". They attribute meaning to the concept of geodiversity which was considered to be in line with the concepts of biodiversity, food biodiversity, geomorphology and human population. Similarly, concerning the concept of geoheritage, students attribute meaning which can be considered to be in line with the concepts of inheritance succession, natural heritage and world heritage. In essence, the same is true with the concept of geoethics to which they attribute meaning that seems to correspond to the concepts of ethical behavior, protection of nature and land, respect for the environment and emotional behavior. However, it should be noted, especially with regard to the students' perceptions of this concept, that perceptions were observed which either very closely resembled the bibliographic perceptions of geoethics or only "approached" them.

The same was observed with the concept of geotourism. Here too, there are students' perceptions which for the most part "revolve" around the international bibliographic perceptions of geotourism or closely resemble them. However, it seems that the majority of students perceived the concept of geotourism as agrotourism, tourism in general, and secondarily, as ecotourism and adventure tourism.

Regarding the second Research Question (Q2) about which concepts' perceptions can be used in the educational process, in order to achieve cognitive conflicts aiming to promote scientific perceptions about the concepts of geodiversity, geoheritage, geoethics and geotourism among students, it seems that teachers, in order to create cognitive conflicts in the process of their educational program on aspects of geoenvironment, have the

opportunity to utilize concepts which students perceive more or less as the concepts of geodiversity, geoheritage, geoethics and geotourism. The present research has shown that some concepts can be utilized, and by implementing the appropriate educational strategy, these can provide students with opportunities to clarify their ideas and then to challenge, develop or replace them by approaching acceptable scientific perceptions of these concepts in the field of geoenvironment [61] (p. 485). These concepts can be:

Biodiversity, food biodiversity and geomorphology, and secondarily, the concept of the human population, in order to develop perceptions of the concept of geodiversity.
Inheritance succession and natural heritage, and secondarily, world heritage, in order to develop scientific insights into the concept of geoheritage.
Ethical behavior, protection of nature and land, respect for the environment, and secondarily, emotional behavior, in order to promote scientifically substantiated perceptions of the concept of geoethics.
Agrotourism and tourism in general, and secondarily, those of ecotourism and adventure tourism, in order to promote perceptions of the concept of geotourism.

4. Conclusions

In order to design a geoeducation educational program in the context of the creation and operation of an experimental junior high school club (Creativity and Innovation Group), the need to gather detailed information on the current latent state of knowledge and perceptions of students was recognized on basic geoenvironment concepts. Essentially, the need for diagnostic assessments of the 45 students of the program was identified regarding their perception of the basic concepts of the geoenvironment and specifically the concepts of geodiversity, geoheritage, geoethics and geotourism. The main goal of the educational process was the replacement of students' latent perceptions of these concepts with modern scientific perceptions of these concepts. To achieve this goal, we chose to apply the educational technique of creating cognitive conflicts (based on this technique, the teacher seeks the conflict of students' latent—and usually incorrect—knowledge and perceptions of some concepts with modern scientific knowledge and perceptions of the same concepts). Thus, research questions were identified which led the research to assess the current latent state of students' perceptions regarding the thematic areas of the concepts and to identify concepts whose perceptions can be used in the educational process with a view to achieve effective cognitive conflicts aiming to promote scientific insights into them.

The results of the research showed that the majority of the participating students confused perceptions about the concepts of geodiversity, geoheritage, geoethics and geotourism in the thematic field of the geoenvironment. This confusion was attributed to the lack of knowledge and therefore to the lack of students' education on the subject which has been found in previous research as well and not only in Greek students.

Concepts have also emerged which can be used by teachers in their efforts to develop students' clear or even scientifically acceptable perceptions of the concepts of geodiversity, geoheritage, geoethics and geotourism in the field of the geoenvironment. Students' current latent perceptions, as expressed by the concepts that emerged, can be put to good use by teachers to develop "targeted" educational techniques. These can be based on the creation of cognitive conflicts in students, resulting in the reconstruction of perceptions and the development of scientific concepts in them. Thus, a problem which is attributed to educational deficiencies can be transformed into an educational opportunity.

The authors of the article consider that the research method followed herein yielded useful and reliable results for the design and implementation of the educational process in this geoeducation program. Combined with its simplicity and ease of implementation, this leads the authors to recommend method and techniques, as used in this research, as a process for educators and designers of environmental education syllabi and curricula, and especially of geoenvironmental education.

Finally, the authors support the opinion that if any educational policy aims to promote education for sustainability and especially holistic environmental education, it should also

promote geoenvironmental education since students do not understand the aspects of the geoenvironment and this is a rather major shortcoming of the desired modern holistic environmental education. Our proposal is therefore the creation and operation of educational programs or entire curricula which, through holistic approaches and interdisciplinary connections, can play an important role in the enhancement of environmental education with geoenvironmental education, with the objective of enhancing understandings of the geoenvironment as a system of multiple components that directly affect the existence and development of human societies.

Author Contributions: Conceptualization, E.G., S.S. and H.D.; methodology, E.G., M.S. and S.S.; software, M.S.; validation, M.S.; formal analysis, M.S.; investigation, E.G. and S.S.; resources, E.G., M.S., S.S., S.M. and M.-V.H.; data curation, E.G. and S.S.; writing—original draft preparation, E.G., S.S., S.M. and M.-V.H.; writing—review and editing, E.G., S.S., S.M. and M.-V.H.; project administration, H.D. and S.S.; supervision, H.D. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Acknowledgments: The authors gratefully thank the journal academic editor and the three reviewers for their thorough consideration of this paper.

Conflicts of Interest: The authors declare no conflict of interest.

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