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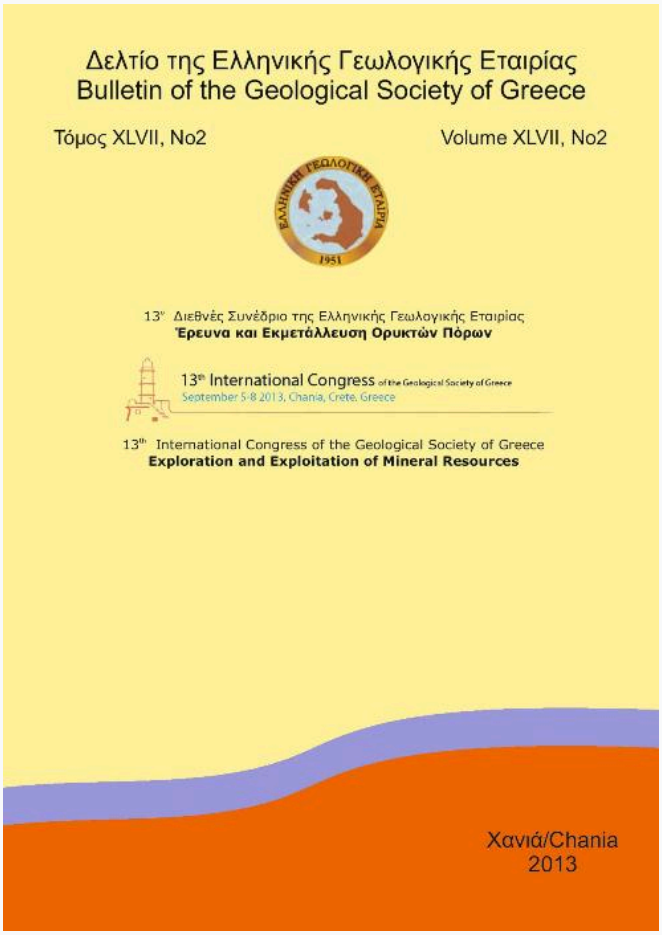

Theoretical approach of teaching lithosphere in junior high school: A critical review of the content and objectives defined by the curriculum of the Ministry of Education

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THEORETICAL APPROACH OF TEACHING LITHOSPHERE IN JUNIOR HIGH SCHOOL: A CRITICAL REVIEW OF THE CONTENT AND OBJECTIVES DEFINED BY THE CURRICULUM OF THE MINISTRY OF EDUCATION

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Abstract

The purpose of this study is an attempt to define the lithosphere concept, as described in the textbook "Geology-Geography" of the 1st Grade of junior high-school. Further we investigate whether the objectives of the corresponding chapter are being implemented according to the curriculum of the Ministry of Education. The main research hypothesis concentrates on the very limited cognitive background of the students regarding the lithosphere. It is based on the absence of a well-organized framework of proportional and gradually increased and specialized flow of knowledge, as suggest the few generalised concepts on the subject of Geography taught on the 5th and 6th grade of the Primary School. According to the Curriculum of the "Geology–Geography" of the Ministry of Education, the lithosphere chapter requires fifteen didactic hours for a sum of nine complexes, mostly cognitive objectives. However, the textbook contains only five didactic hours, an indicator of an asymmetric state of the Curriculum. Our opinion about curriculum content itself, which describes the lithosphere, compared to the strictly scientific definition, is that it represents a simplistic approach and consequently the materialization of the cognitive goals is doubtful.

Key words: *Geoscience education, Curriculum, secondary education*

Περίληψη

Σκοπός της παρούσης εργασίας είναι να μελετηθεί το περιεχόμενο της έννοιας της λιθόσφαιρας όπως περιγράφεται στο σχολικό εγχειρίδιο «Γεωλογία-Γεωγραφία» της

Α΄ Γυμνασίου και να διερευνηθεί εάν υλοποιούνται οι στόχοι της αντίστοιχης διδακτικής ενότητας με βάση το Αναλυτικό Πρόγραμμα Σπουδών του Υπουργείου Παιδείας.
Οι μαθητές της Α΄ Γυμνασίου έρχονται από το Δημοτικό με πολύ περιορισμένο γνωσιολογικό υπόβαθρο για τη λιθόσφαιρα, με ελάχιστες και πολύ γενικές έννοιες που έχουν διδαχθεί στην Ε΄ και Στ΄Δημοτικού στο μάθημα της Γεωγραφίας. Το ερώτημα επομένως που προσπαθούμε να απαντήσουμε με θεωρητικό τρόπο είναι το κατά πόσον οι μαθητές της Α΄ Γυμνασίου με δεδομένο το ενδιαφέρον τους και την ασύμμετρη ανάπτυξή της έννοιας της λιθόσφαιρας στο σχολικό εγχειρίδιο, μπορούν να την κατανοήσουν ικανοποιητικά μέσα από την αναπλαισίωση της επιστημονικής γνώσης και τις κατάλληλες διδακτικές και μεθοδολογικές προσεγγίσεις .
Λέξεις κλειδιά: *Διδακτική γεωεπιστημών, αναλυτικό πρόγραμμα, σχολικά εγχειρίδια, δευτεροβάθμια εκπαίδευση.*

1. Introduction

In the educational practice it is followed a specific didactic guideline, certain aspects of which display a low performance to the optimization of the transmitting and assimilating information process. To that extend, in relation to the first stage of the learning process, directly associated with the main goal of this study, the codification of the cognitive data (e.g. Piaget and Inhelder, 1969; Porpodas, 1996).

In the current study we refer to the content of the geological textbook of the 1st Grade of the Greek junior high-school. We focus on the "lithosphere chapter" and its teaching adequacy. According to the geologists and geophysicists, the term lithosphere is defined as the *"strong outer shell of the earth"* (Anderson, 1995). A more sophisticated definition encloses the concept of lithosphere in the following: *"As lithosphere is defined the rocky outer layer of the Earth of medium thickness approximately 100 km, which overlie the highly viscous asthenosphere; it comprises the solid crust and a portion of the upper lithospheric mantle".*

Research results, in the framework of the European project GEOschools, have clearly shown that a high percentage of students are interested in geosciences. Concepts in reference to the "lithosphere" constitute the 5th in the row subject of interest among the fourteen equivalent proposed by the research, with "Natural disasters" and "Palaeontology" listing first among the preferences of the students (Fermeli et al., 2012).

Geoscience educational publications are reviewed by King (2008) to identify future directions for curriculum and professional development, and research. The review indicates that geoscience education will progress most effectively through: 1) extending geoscience learning to all children, 2) educating teachers in effective implementation of new curriculum initiatives, 3) evaluating the progress of the initiatives and using the results to refine them and 4) researching the whole process to demonstrate its effectiveness and to ensure wide dissemination on the basis of well-founded research findings (Chang, 2001). Furthermore, according to Trend (2007), "*the relationships between children's interest, enjoyment, learning and cognitive processing have received considerable attention in recent years, although the subject focused research has been largely restricted to mathematics, English/literacy (notably understanding texts), physical education and science (but negligible geoscience)*". In the same direction, Chang and Weng (2002) address the importance of using activities as part of geoscience teaching.
The psycho-pedagogical process of knowledge - transmitting in the didactic framework constitutes a complex condition divided into four partial stages: i) the codification of the information within various forms of material means, ii) the de-codification by the teacher, iii) the transmission (transference) of information by the teacher to the student and iv) the primarily hold and throughout the necessary rehearsal procedure consequently the assimilation of information by the student. During

the course of educational evolution, various pedagogical approaches were formulated or implemented in relation to one or more stages of the learning process. A key role to that extend have played the theory of cognitive development of the Swiss psychologist Jean Piaget, the theory of the educational process of the American psychologist Jerome Bruner and the theory of the maximum number of items that the short-term memory can contain by George Miller (e.g. Piaget and Inhelder, 1969; Bruner, 1960; Miller, 1956).
The primary goal of this study is to provide a critical review of the lithosphere concept instructed during the first grade of junior high-school. We attempt to define the concept of lithosphere, as described in the textbook "Geology-Geography" of the 1st Grade of junior high-school (Pavlopoulos & Galani, 2009), and to provide clues whether the objectives of the corresponding chapter are being implemented according to the Curriculum of the Greek Ministry of Education (Governmental Paper: 304 v. B/13-3-2003; 1196 v.B/26-8-2003). After that, we criticized from psycho-pedagogical point of view on which level the students are able to sufficiently comprehend the concept throughout the appropriate didactic and methodological approaches.

2. Methodology

In this stage we present the objectives that settled from the curriculum of the Ministry of Education regarding the Lithosphere subsection of the junior high-school textbook. According to these objectives, we attempt to find the evidences that related with their successiveness Grade. After that, we compared the objectives and specific parts of the textbook related to them. Though, the results of the comparison and recommendations, for those objectives that were not fulfilled, are presented in the table 1.

3. Results and Discussion

3.1. The Comparison Case

A thorough cross-examination of the relation between the standard objectives set by the Curriculum (Governmental Paper: 304v.B/13-3-2003) and the information enclosed in the textbook, with reference point to the three psycho-cognitive theories, came of with the following deductions:

- The first didactic objective (D.O.), according to which the student should be able to identify the position of the lithospheric plates, is insufficiently served in the framework of the textbook (Tab. 1). The identification of each lithospheric plate requires a map with the drawing of the plates in relation to the position of the continents and oceans. Since the standard, set by the curriculum, indicates the efficient completion of a task upon visual/optical graphic means, the successful information imprinting principle presupposes the transmission of the cognitive data in the same manner as it is required to be assimilated by the student. In order for the student to be able to perform in a visual task, which presupposes the acquisition of the information asked through the learning process, that specific kind of information is necessary that it would be transmitted accordingly – that is, via a visually assumed stimulus. The ability of the student to modify-decode the written and verbal information into optical, it could be examined in the framework of a distinctively different objective (an intelligence quota test, a creativity task, assimilation and understanding level of an information taught thoroughly and for a long period of time task, etc.). The novelty of the cognitive data taught to the student and the narrow and specific didactic purpose advocates for the conclusion that the ability measured requires the equivalence between the form of the means through which the information is transmitted and examined throughout a task procedure.
- The second didactic objective aims to enable the student, after the completion of the didactic chapter, to correlate the relative movement of the lithospheric plate with certain

connected phenomena. The textbook includes in two pages a sufficient and adjusted to the cognitive background of the student didactic material. Therefore, as shown to the main section of the discussion, the goal is adequately achieved.

- The third objective is not achieved, in reference to the textbook's organizing of information. Though the curriculum set as standard that the student should be in a position to identify the factors that play a key role to the shaping of the surface of the Earth, not only the textbook is confined to a mere imputation of the concept of those geological factors, but also includes the suggestion that the student should retrieve the relevant information from the previous textbooks of the sixth and fifth Grade of Primary School. This approach reduces the possibility of efficient completion of the curriculum objective, due to two reasons: Firstly, in a practical level, is obliging the student to extract information from a material means that could be as well be damaged or disposed. Secondly, the guideline of the textbook makes the functional assimilation of a certain kind of information considerably difficult, as it does not permit the uninterrupted and ease access to the necessary information and thus constitutes the rehearsal process insufficient. Since the imprinting of data to the long term memory requires the systematic rehearsal of this information. It can be deducted that no such procedure can be adequately completed, unless the curriculum either includes the didactic material of the previous years' textbooks in the current one or restructure and enrich the content of the existing relative chapter.
- The fourth goal, regarding the correlation of the action of geological forces with certain manifestations in the surface of the planet is satisfyingly achieved.
- The recognition of the effects of geological forces, such as the earthquakes and the volcanic eruptions, on people's life presupposes an analysis, followed by examples, case scenarios and photographic material. None of those conditions is filled / accomplished, even though Greece is a country with intense earthquake activity. Therefore, the specific goal cannot be considered adequately accomplished.
- The definition selected to describe basic geological terms (e.g. fossil or lithosphere) demonstrate a high degree of difficulty, due to their immediate reference to strictly scientific terminology. By the term 'difficult' is indicated an inconsistency between the current cognitive status of the student of the 1st degree of junior high-school and the complexity of the information transmitted. In this specific case, there is an abruption of the proportional, gradually increased and specialized flow of cognitive information. The limited, until this certain educational stage, offered and assimilated knowledge – as it was shown on the main part of the discussion – does not constitute an adequate and sufficient cognitive background, in order for the student to correlate the incoming information with the already existing and therefore to proceed to sufficient and functional imprints in the long-term memory.
- The seventh didactic goal, according to which a certain ability to correlate the action of a variety of external forces with specific manifestation of their action should be accomplished, cannot be considered achieved.
- In relation to the identification of the shape of the continents by the student, this specific objective can adequately be achieved as the textbook indicates the necessary visual / optical means. On the contrary, the prerequisite regarding the readiness of the student to describe and to cite basic features of the continents is less possible to be obtained as the information given is limited. In order for the student to become familiarized with the main aspects and characteristics of the surface of the Earth, a suggestion would indicate the offer of audiovisual means attached to the main textbook. In that way the specific educational purpose would be accomplished in a greater extent and the assimilation of the information would be achieved in less time. The combination of audio and visual stimuli would sharpen

the interest of the student for the interaction of various people with and in relation to the environment they inhabit.

- Similarly, the textbook, in reference to the ninth objective, is divided into two distinctive objectives; recognition on the map of basic terrestrial morphological characteristics and additionally, description, by the use of examples, of the impact of those phenomena on man's activities. The textbook does not indicate a relevant map; therefore the first objective is not accomplished. In relation to the second objective, the argumentative form in which the textbook attempts to demonstrate the habitual differences among people living in plain and mountainous areas respectively, aims in sharpening the interest of the student and rendering the cognitive in a more immediate way. That certain approach accomplishes in combining information about the surface elements of the Earth and opinions about living on such places. However, there is no provision for an exercise, which will enable the mnemonic rehearsal and thus help the student to assimilate that information.

Table 1 - Comparison of the objectives that settled from the curriculum of the Ministry of Education regarding the Lithosphere subsection of the junior high-school textbook and recommendations for those targets that were not fulfilled.

Objectives	Attainment	Recommendations
D.O.1	No	Draw a map with the lithospheric plates in relation to the position of the continents and oceans.
D.O.2	Yes	---
D.O.3	No	Give the meaning of the basic terms that influence the shape of the earth`s surface (e.g. erosion) with respective examples.
D.O.4	Yes	---
D.O.5	No	One to two paragraphs of the effects of geological forces on people's life (with examples, case scenarios and photographic material).
D.O.6	No	This objective should be omitted from the textbook of the 1st degree of junior high-school
D.O.7	No	This didactic objective should be merged with D.O.3
D.O.8	No	Incorporation of audiovisual means within the main textbook.
D.O.9	No	Draw a geomorphological map.

3.2. A Criticized Review of the Phycho-Pedagogical Theories

The theoretical psycho-pedagogical approach which is followed based upon the three theories (by Bruner, Piaget, Miller), already addressed in the introduction. According to the first theory, the biological and cognitive development of the person passes through certain pre-defined temporal stages. Those stages are; Sensorimotor (birth – 18/24 months), pre-operational (ages 2 – 6), concrete operational (ages 6 – 12), formal operational (through adolescence to adulthood). During the last stage, which coincides, from an educational point of view, with the 1st Grade of junior high-school, the development of the rational thought is integrated and at the same time is signifying the development of the abstract thought. The contribution of the cognitive developmental theory, despite the various weak points, can be characterized as substantial, as Piaget, by formulating a structural interpretation of human cognitive evolution, has set a more

standard and general ground for the didactic procedure by abridging the theoretical deflections due to intercultural, interracial, inter-social and inter-sex variances (Piaget and Inhelder, 1969).

In the second theory, Bruner (1960, 1986), while having accepted certain parameters of the developmental theory of Piaget (i.e., the cognitive structures of children develop by time, children have a tendency towards learning, children are active participants in the learning process), diversified his approach in several crucial points. According to Bruner's cognitive model, development is a continuous process, rather than a series of predefined stages, while, at the same time, the participation of the adults to that very process constitutes a crucial factor. A major contribution of Bruner's theory is the suggestion that the main objective of education should be the creation of self-reliant, autonomously thinking students, of individuals that would be able to evaluate any given cognitive information and pursue by themselves to upgrade their cognitive capacity. As Bruner underpinned, "*We teach a subject not to produce little living libraries on that subject, but rather….. to take part in the process of knowledge-getting. "Knowledge is a process, not a product"* (Bruner, 1986). Additionally, "*Ideally, interest in the material to be learned is the best stimulus to learning, rather than such external goals as grades or later, competitive advantage*" (Bruner, 1960).

Finally, in the third theory, Miller (1956), after having conducted experiments, (i.e., by asking a person to repeat a set of digits presented), has ascertained that the short-term memory – the function of the immediate and brief storage of data, with a duration between 0-20 seconds (Atkinson & Shiffrin, 1968) before those data are imprinted in the long-term memory - has a capacity limit of 7, minus-plus 2, items. As item is defined every bit of information, which is entrained primarily as acoustic stimulus, such as every particular digit of a number. According to multi-store model and working model a rehearsal process it is required, in order for the new information to be stored in the long-term memory and be available for retrieval at any time. "Working memory is the term used to refer to a system responsible for temporarily storing and manipulating information" (Alloway et al., 2006).

Despite the substantial differences between the above mentioned models regarding the structure and function of the short-term memory, it is suggested that the more systematic and well-organized the procedure of repeating information in short-term scale, the more increased are the possibilities for the student to hold the given cognitive data. Furthermore, the more frequent the rehearsal in long-term scale, the better the chances for the student to absorb the taught information.

4. Conclusions

In this study we address that the following: a) the term "lithosphere" is not covered adequately as described in the textbook of the 1st Grade of junior high-school, b) The majority of the didactic objectives settled by the Curriculum of the Ministry of Education were only partially achieved and c) the considerable knowledge gap in the meaning of the lithosphere between the students of the 1st Grade of junior high-school and previous years' textbooks i. The above conclusions are solely based on a theoretical approach of the topic addressed in the introduction. A more comprehensive study, with analytical questionnaire is ready to be given and the results will be presented in a forthcoming paper. The challenge for the future would be to combine a well balanced structural and conceptual teaching of Earth Sciences with permanent links to attractive interesting topics, i.e. making Earth Sciences something present and related to daily life.

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