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Literacy in Geosciences among Students: An In-Depth Study into Greek Secondary Education

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Literacy in Geosciences has been the topic of a number of researchers worldwide (Happs, 1985; Dove, 1997; Sharp et al, 1995; Ford, 2005; Lillo, 1994). Nevertheless, this report is incomplete as far as Greek students are concerned. Ioannidou & Vosniadou (2001) conducted a research regarding misconceptions about Earth's inner layers where they detected several incomplete or erroneous ideas on part of the students. But what exactly are misconceptions and why are they important when it comes to science teaching? The definition provided by Osborne et al. (1983) describes a misconception as a conception which differs significantly from that which is commonly agreed by the scientific community. The theory of conceptual change supports that, in order for the new knowledge to be acquired, there needs to be a reorganization of the existing knowledge (Read, 2004). This process might be impeded by the deep-rooted misconceptions and educators need to apply specific instruction for successful outcomes. According to Posner et al. (1982), the four following conditions must be met in order for conceptual change to occur:

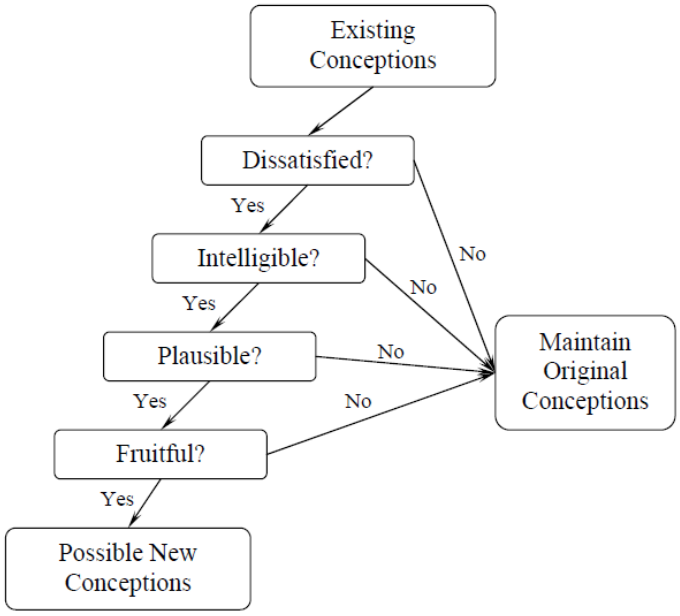

Figure 1. Posner et al.'s (1982) Conceptual Change Model – adapted from Dole & Sinatra (1998).

The position of Greece in the geodynamic model of our planet makes it unique as far as the natural phenomena are concerned, but most importantly about the natural disasters that this country has been plagued with (Nivolianitou, 2011). Greece is number one region in Europe as far as seismic activity is concerned and also ranks in the sixth position on a global scale (Tsapanos and Burton, 1991). There are 5 active volcanoes, as it is reported in the Index for Risk Management 2018 (INFORM 2018) that could possibly affect the population, and recent floods and wildfires have claimed a considerable number of lives. According to UNDRR (United Nations office for Disaster Risk Reduction) and their International Data base, the most frequently occurring disasters in Greece are floods, earthquakes, wildfires, storms, extreme temperatures, and some others, with earthquakes having the highest mortality rate. As Shaw et al. (2011) mention, "[I]t has been widely acknowledged that education takes on a pivotal role in reducing disasters and achieving human security in the attempt to achieve sustainable development" (p. 1). This is the main reason why it is of utmost importance to record the existing conceptions of schoolchildren in Greece regarding natural phenomena, their genesis, and ways to protect against them and consider revising the existing educational practices if need be.

The responses included in this paper were collected during the school years 2015-2019 from junior and senior high schools in Athens and Lamia, two densely populated cities in Greece. Students were asked to complete certain questionnaires in order to carry out an evaluation of their literacy in geological issues regarding the Earth, the genesis of volcanoes and earthquakes, the formation of mountains as well as of the different types of rocks, the importance of fossils, and water resources. The results that were obtained were rather disappointing, with students aged between 14-16 holding severe misconceptions about basic geological concepts or seriously lacking relevant knowledge. Only 13% of the students were able to identify the key components of a map, 15% could draw a fairly accurate sketch of earth's interior or name the different layers. The most common mistakes were that they drew the layers' proportions incorrectly and only 20% were

able to name “core”, “mantle”, and “crust”; and when they did, they mostly mentioned “inner and outer crust or mantle”, they described the core as being in a gas or liquid state and the mantle in a solid state. A mere 30% were correct about the way the rocks were formed and where this procedure takes place. Most of them regarded rocks as static, unchangeable elements of the Earth and only 40% recognized that rocks are comprised of minerals. Additionally, while 60% of the students knew how volcanoes are formed, only 14% were able to provide a definition of what an active volcano is, and approximately one third could recognize more than half of the volcanoes in the pictures they were shown. Less than 10% answered correctly about the formation of mountains while there was also an answer provided by a student who claimed that they are formed as a result of mountain reproduction. Only 36% actually realize that a mountain could have been formed at the bottom of an ocean. They also hold a lot of misconceptions about fossils. They do not recognize that microfossils exist or their role in forming rocks. When the students were asked to justify the existence of marine fossils on the mountains, more than half of them supported that it happened due to the receding of the sea rather than the formation of the fossiliferous rocks at the bottom of an ocean and their displacement because of plate tectonics. A vast majority of the students were not able to identify folds, stratification, foliation or to distinguish between gravels and pebbles or magma and lava. As far as the water is concerned, 60% of the students believe that the water resources are depleting - which might be the case only for fresh-water and additionally, more than half of them hold the misconception that once the water from rain enters the ground it is of no use to humans.

All in all, this research reveals the depth of students’ illiteracy regarding geological issues, even though some concepts are currently taught in secondary education in Greece. One obvious reason for this might be that the inclusion of geological units in the science curriculum is fragmented and inadequate and another that all science lessons are taught mostly as lectures in teacher-centered environments with few hands-on activities and not enough lab experiments or field trips. Geology is a science which is better understood through an experiential way and it is imperative that the education stakeholders reconsider the current teaching approaches.

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