



## Can we Dare Say Modern Society Doesn't Need Raw Material? Reflecting about the Increasing Demand for Teaching Geoethics

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### Abstract

*In today's society, there are many raw materials employed in our daily lives. Without them, our quality of life would be seriously compromised. Besides, the exploitation of these resources is crucial for leveraging their own scientific and technological development and thus enabling social and economic advancement. Differently, the world's population is growing, and complex societal issues are rising, creating a greater need for the consumption of mineral resources and the demand for its exploitation. To mediate these dimensions – scientific, technological, social and economic –, geoethics, as an interdisciplinary field of study, can contribute to a better relationship between the humans and the Earth. To reflect on the need to teach geoethics, the educational resource “Can we dare say modern society does not need mineral raw materials?” – developed by the GOAL Erasmus+ Project – was applied to 12 graduate students divided into five groups. Students were asked to identify competencies expected to be developed during the application of the educational resource. A content analysis was done after gathering the data. Data showed the development of system-thinking and interpersonal competencies in all groups. Strategic competency was addressed by three groups and anticipation competency was also mentioned only by one group. When asked what the consequences of incorrect dissemination of mining procedures by all actors involving in the process, the students stated that nontransparent communication potentially perpetuates the ignorance within the population (n=10). Concerning how important is the mining process dissemination given by the media to inhabitants, the responders (n=10) consider that media plays a crucial role in dissemination, which has to be imparted impartially and on a scientific basis so citizens can form grounded opinions. The students also advocated ways to minimize the impacts in the environment and local communities as environmental (n=8) and socio-economic impact studies (n=5). The educational resource asked students to suggest a plan of rehabilitation, based on environmentally and socially sustainable standard elements and management systems in a mining site and the answers included: landscape requalification (n=10), exploitation for geoeeducational (n=5) and geotourism initiatives (n=8).*

**Keywords:** Geoethics; Georesources; Higher education; Society.

### 1. Introduction

The human species, like any other, depends on the Earth to survive. It is from the materials present on the planet's crust, and from the conditions that it provides, that life could develop and complexify [1]. In the human case, from the Stone Age, the applicability of raw materials in everyday life becomes more evident. According to Chatterjee (2009), in this period, a quarzitic shaped stone – today is known as "flint" – turns out an important element for our species' early economy. With this stone, human beings could start to defend themselves, hunt for food, and search or construct their own shelters [1,2]. The human dependence on Earth has intensified in recent centuries [1]. The growing and complex needs, inherent in human civilizational development, have led us to a constant search for other raw materials and minerals. Prove of this Earth dependency is that, since the beginning of this millennium, more than 3000 minerals have been reported and named, of which 1800-2000 have been totally studied and described [3]. Today, in addition to referred previously, humanity has extended the application of rocks and minerals to other and diverse areas such as, for example, medicine or food industry [3]. However, the exacerbated or incorrect exploitation of these georesources is co-responsible for the existence of a possible new geological epoch - the Anthropocene, which underlines the beginning of a geological time heavily characterized by human activity on the planet [4]. Since every action triggers a consequence, modern society faces serious dilemmas related to our relationship with the planet. Any action of our quotidian requires, in a directly or indirectly way, materials extracted from Earth. Without



these materials, our quality of life could be seriously compromised and, consequently, our prosperity on the planet and itself [5].

The world's population is growing, and at the same time, complex societal issues are rising, creating a greater need for the consumption of georesources and, consequently, the demand for new/or other resources that can be exploited [2]. Moreover, being unable to reduce, reuse, and recycle all materials extracted from the Earth, it is impossible to live without mining activity. From another perspective, the exploitation of these resources is critical for leveraging our scientific and technological development and thus also enabling social and economic development. This fact is substantially important since the exploitation activity and georesources must be considered as economic and politic strategical elements for a country, especially for the developing ones.

Universities and Schools – as institutions devoted to personal, academic, and professional development – cannot be alienated regarding citizens' life-long education. These must prepare them for informed, full, and democratic participation in society [6], especially in the opinion-forming process about relevant topics, like mining activity, its value, and impacts on the environment, people and country's strategic socio-economic development [2]. To mediate the dimensions presented – scientific, technological, social and economic –, geoethics, as an interdisciplinary approach and emergent scientific field, could contribute to a better, integrated, and ethical relationship between the humans and the Earth, bringing a more holistic view of the societal issues discussed [7]. According to the International Association for Promoting Geoethics (IAPG), geoethics “*consists of research and reflection on those values upon which to base appropriate behavior and practice where human activities intersect the geosphere*” (p.1) [8]. The integration of geoethics on education institutions and public debate may help to a better understanding of mining activities, underling its ethical, social and cultural geoethical values [7].

## 2. Methodology

### 2.1 Sample

The convenience sample was comprised of 12 graduate students (n=12) of the master's course in science teaching, from a northern Portuguese university. Concerning gender, the sample comprised nine female students (n=9) and three male students (n=3). The participants' academic background included biology (n=8), geology (n=1), chemistry (n=1), physics (n=1), and environmental sciences (n=1).

### 2.2 Procedure

To reflect on the need to teach geoethics, particularly in higher education, the educational resource “Can we dare say modern society does not need mineral raw materials?” (accessible in [https://goal-erasmus.eu/educational\\_resource](https://goal-erasmus.eu/educational_resource)) – developed by members of the GOAL (Geoethics Outcomes and Awareness Learning) Erasmus+ Project – was applied to a convenience sample. Following a case-based teaching methodology the students were distributed into five groups and were asked to identify some key competencies needed to answer some questions. Answers obtained were the target of a content analysis.

## 3. Results

After analysis, and considering the competencies developed when solving the educational resource, all groups considered that improved their system-thinking and interpersonal competencies. Moreover, strategic competency was addressed by three groups and anticipation competency was also mentioned by one group.

When asked what the consequences of an incorrect dissemination of mining procedures by all actors involving in the mining process, the students stated that nontransparent communication potentially perpetuates the ignorance within the population (n=10).

In relation to how important is the mining process dissemination given by the mass media to inhabitants, the respondents (n=12) consider that the media play a crucial role in the dissemination of information, which has to be imparted impartially and on a scientific basis so that citizens can form grounded opinions

The students also advocate ways of how to minimize and mitigate the negative impacts in environment and local communities as environmental (n=8) and socioeconomical impact studies (n=5).



A list with a plan of rehabilitation based on environmentally and socially sustainable standard elements and management systems in a mining site was written by the students and included: landscape requalification (n=10), exploitation for geoeeducational purposes (n=5) and geotourism initiatives (n=8).

#### 4. Conclusions

The results of this investigation show us that students recognized the importance and relevance of maintaining a geoethical perspective when taking decisions about Earth problems. For the resolution of the complex problems that society faces on a daily basis, it is essential to underpin the procedures to take under a geoethical perspective. Students involved also point out that the lack of transparency between the actors engaged in the mining exploitation process is one of the biggest problems faced when new exploitation is being formalized. The need to improve this communication should be one of the first steps assured on the process, as well as plans to minimize and mitigate the negative exploitation impacts and to benefit from the positive ones.

The implementation of educational resources based on a geoethical perspective was efficient in reaching the initial aim and the application on other samples and contexts can reinforce its quality and importance for the needed change of perspective, concerning both ethical decision-making on Earth-related problems and on science education itself. Students must be challenged to develop new competencies. Following the reality of nowadays society Students must be challenged to develop new competencies and to follow the reality of nowadays society and science education is the best way to do it.

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