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Abstract Book

14 – 18th January 2019

Porto, Portugal

GEOETHICS SYLLABUS

AND

GEOETHICS IN GEORESOURCES AND GEOPARKS

GOAL PORTUGUESE WORKSHOP

Co-funded by the Erasmus+ Programme of the European Union

2nd GOAL WORKSHOP ABSTRACT BOOK

TITLE: Geoethics' Syllabus and Geoethics in Georesources and Geoparks

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PREFACE

To respect the Earth is an ethical responsibility in as much as a necessity, if sustainable life is to endure. Geoethics is imbued with both this concern and this principle. It recognizes that the relationship between human beings and their environment involves an ethical imperative and reflects upon different practices that may promote a sustainable balanced relation between people and nature. Now, one may even describe this as a Kant's categorical imperative, that results of logical reasoning but goes beyond reason itself; indeed, there is a circular benefit in autonomously and collectively respecting nature while autonomously and collectively being a part of it. The promotion of this balanced, sustainable relationship between people and nature is the major concern of Geoethics, the focus of the Portuguese GOAL Workshop and the main object of this manuscript.

Project GOAL offers both a Geoethics syllabus and higher education resources, based on examples that take into account geological heritage and geodiversity, that alert students to the impact of their choices and behavior, that is, that make them aware of their georesponsibility. It does so, by resorting to an interdisciplinary approach and highly qualified academic contributions related to science education, capable of informing on Geoethics cases related to georesources management, in particular Geoethics in geoparks and geotourism.

The values of Geoethics and the ethical dilemmas that are henceforth raised highlight the need to build social awareness and prepare science citizens capable of making informed choices and reduce georisks. But the scope of Geoethics is more comprehensive. Indeed, it also aims at promoting a responsible use of georesources, in alignment with both social needs and social responsibilities, thus providing for geoconservation and sustainability.

Of course, citizens used to consumerism as a way of life, do not intuitively realize the relevance of Geoethics, especially in societies that are technologically proficient. Worse still, if they do realize its relevance, reasons of economic profitability may often and wrongfully justify turning a blind eye to Geoethics dilemmas. Accordingly, social awareness must be raised and science citizens capable of making informed choices need to be formed. These are the central objectives of this manuscript and indeed they are quite successfully achieved. By reading it, you will be introduced to major Geoethics dilemmas, alternative behaviors and choices. This may effectively help you look at and to interpret geoscience practices differently, hopefully under the fundamental understanding that, ultimately, to respect planet Earth, is to respect life in itself.

M. L. Vasconcelos

University Fernando Pessoa
Portugal

WORKSHOP AIMS

The GOAL project (2017-1-PTO1-KA203-035790) aims to develop a Geoethics syllabus and related higher education resources directed at promoting awareness on the ethical and social implications of geoscience research and practice, thus enhancing the quality and relevance of students' knowledge, skills and competencies.

Therefore, the main objectives of the second GOAL workshop are:

i) To establish an educational theoretical framework and define a template for the Geoethics syllabus;
ii) To explore some Portuguese geoethical cases related to georesources management;
iii) To address the thematic of Geoethics in geoparks and geotourism – issues will be raised concerning social awareness taking into account geological heritage and geodiversity.

The interdisciplinary qualification of the participants, reflecting different overviews and approaches, constitutes an asset for this workshop.

The specific collaboration of the Israeli team will be most valuable since they have strong skills on teaching science and developing academic and practical leadership related to science education.

WORKSHOP INTELLECTUAL OUTPUTS

In the sequence of the GOAL Portuguese Workshop "Geoethics syllabus and Geoethics in Georesources and Geoparks" the following intellectual outputs will be produced:

i) One chapter for the E(hand)Book;
ii) First version of the syllabus;
iii) Educational resources for higher education based on georesources and geoparks.

WORKSHOP AGENDA

GOAL 2nd Workshop: 14th – 18th January 2019, Faculty of Sciences of University of Porto, Portugal

Schedule	Monday (14th Jan.)	Tuesday (15th Jan.)	Wednesday (16th Jan.)	Thursday (17th Jan.)	Friday (18th Jan.)
	Moderator: Clara Vasconcelos	**Moderator:** Clara Vasconcelos	**Moderator:** José Brilha	**Moderator:** Alexandre Lima	**Moderator:** Cristina Calheiros
09:00 10:30		**GEOETHICS SYLLABUS: REVISITING SOCIAL CONSTRUCTIVISM** Clara Vasconcelos (FCUP), Nir Orion (WIS), Tiago Ribeiro (FCUP), Ron Ben-Shalom (WIS) & Alexandra Cardoso (FCUP)	**GEOETHICS AND GEOLOGICAL HERITAGE** Field-Trip to Geopark Arouca José Brilha (UM/UP)	**GEOETHICS AND GEOLOGICAL RESOURCES: THE CASE OF LITHIUM FROM HARD ROCK** Alexandre Lima (FCUP) & Carlos Almeida (CS-Coelho da Silva, S.A)	**Wrap-up** Clara Vasconcelos (FCUP)
10:30 11:00		COFFEE BREAK		COFFEE BREAK	COFFEE BREAK
11:00 12:00		**GEOETHICS SYLLABUS: (IM)APLICATIONS FOR THE CLASSROOM** Clara Vasconcelos (FCUP), Nir Orion (WIS), Tiago Ribeiro (FCUP), Ron Ben-Shalom (WIS) & Alexandra Cardoso (FCUP)		**OBSERVATION OF LITHIUM HAND SPECIMEN AND LITHIUM IN MICROSCOPE** Alexandre Lima (FCUP)	**GEOETHICS AND EARTH SYSTEMS** Field-trip to Paço de Calheiros, Ponte de Lima Cristina Calheiros (CIIMAR-UP)
12:00 14:00		LUNCH	LUNCH	LUNCH	LUNCH
14:00 15:30	**WELCOME**	**GEOETHICS SYLLABUS: CONCEPTS AND TEMPLATE** Clara Vasconcelos (FCUP), Nir Orion (WIS), Tiago Ribeiro (FCUP), Ron Ben-Shalom (WIS) & Alexandra Cardoso (FCUP)	**THE ROLE OF UNESCO GLOBAL GEOPARKS ON THE PROMOTION OF GEOETHICS: THE EXAMPLE OF THE AROUCA GEOPARK (PORTUGAL)** José Brilha (UM/UP)	**GEOLOGICAL RESOURCES: SOCIAL ACCEPTANCE AND ACKNOWLEDGEMENT DEPENDENT ON EDUCATION AND CULTURAL CHANGES** John Morris Vale Perreira (Eurogeologist)	**A GEOETHICS PERSPECTIVE OF WATER CYCLE NEXUS EARTH SYSTEM** Cristina Calheiros (CIIMAR-UP) & Nir Orion (WIS)
15:30 16:00	**GEOETHICS VIDEO PILLS: ANALYSIS AND DISCUSSION** Giuseppe Di Cappua (INGV) & Silvia Peppoloni (INGV)	**GOAL TREE** FCUP Garden Cristina Calheiros (CIIMAR-UP)			
16:00 16:30	**PORTO WINE TOAST**	COFFEE BREAK		COFFEE BREAK	
16:30 18:00	**GEOETHICS SYLLABUS: ELABORATING A THEORETICAL EDUCATION FRAMEWORK** Clara Vasconcelos (FCUP), Nir Orion (WIS), Tiago Ribeiro (FCUP), Ron Ben-Shalom (WIS) & Alexandra Cardoso (FCUP)	**APP ON GEOETHICS: FOR A CORRECT PRACTICE OF OUR GEOLOGICAL AND PALEONTOLOGICAL HERITAGE** Daniel De Miguel (ZU), Guillermo Meléndez (ZU) & Beatriz Azanza (ZU)		**LITHIUM MINE IN COVAS DO BARROSO: VIDEO PRESENTATION AND GEOETHICS DISCUSSION** Alexandre Lima (FCUP), John Morris Vale Perreira (Eurogeologist) & Carlos Almeida (CS-Coelho da Silva, S.A)	

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ANALYSIS AND DISCUSSION

Giuseppe Di Cappua & Silvia Peppoloni

National Institute of Geophysics and Volcanology, Rome (Italy)
International Association for Promoting Geoethics – IAPG, Rome (Italy)

Geoethics is an emerging field in geosciences (Bobrowsky, Cronin, Di Capua, Kieffer & Peppoloni, 2017; Peppoloni & Di Capua, 2017) and is defined as:

> The research and reflection on the values that underpin appropriate behaviors and practices, wherever human activities interact with the Earth system. Geoethics deals with the ethical, social and cultural implications of geoscience education, research and practice, and with the social role and responsibility of geoscientists in conducting their activities (Peppoloni & Di Capua, 2015, p.4).

The 1st Workshop of the project GOAL, entitled "Theoretical aspects of Geoethics and Geoethics in georisks" (Rome, Italy, 30th July – 3rd August 2018), gave the opportunity to take stock of situation about: (a) theoretical aspects of Geoethics and, its historical background, with the goal of creating a common conceptual background among project participants and sharing values, concepts, online resources and tools in Geoethics to be used in the project; (b) geoethical perspectives in georisks management and in geohazards and georisks mitigation policies; (c) citizen science experiences, educational aspects, sociological and risk communication perspectives in the defense against natural risks, based on Italian and international experiences.

A tangible and innovative output of the GOAL efforts to create resources for higher education courses on Geoethics consists of the preparation of a set of short videos ("video-pills") on some important aspects of Geoethics to be used as an "Introductory course on Geoethics" for geoscience students and early-career professional geoscientists, in order to make them more aware about the ethical and social implications of geoscience research and practice. The discussion about issues and contents of the video-pills started up during the workshop in Rome.

The "video-pills" will be set up in the project GOAL as strategic tools for teaching Geoethics. These videos have the aim to introduce audience to essential concepts of Geoethics, to be used as starting points for deeper discussions about ethical and social implications of geoscience knowledge, research, practice, education and communication.

The preliminary titles and short notes about the potential contents of five "video-pills", that will be discussed during the workshop that will take place in Portugal in January 2019, are the following:

What is Geoethics: Definition and meaning of Geoethics from a philosophical point of view; themes; the concept of responsibility; the four levels of responsibility in the geoethical analysis (the self, colleagues/profession, society and the Earth system); areas of application of Geoethics.

Values of Geoethics: The need to define shared values for taking ethical decisions. The three groups of values proposed for Geoethics: (a) ethical values: honesty, integrity, awareness, cooperation, inclusiveness, courtesy; (b) cultural values: geodiversity, geological landscape, geoheritage, and their practical application in geoparks and geotourism); (c) social values: sustainability, prevention, adaptation, education.

Translation into practice of those values through codes of ethics/conduct and the importance of teaching Geoethics.

Ethical issues and ethical dilemmas: The ethical issue as the problem of the choice between two alternatives: elements to be taken into account; reference system of social, scientific, economic and cultural values; the accuracy of knowledge of the problem in technical and scientific terms, and the adequate competence for its resolution. Ethical dilemmas: a choice between different options, all with inevitable, negative impacts on society and/or the environment, and with no right solution in absolute terms, but only with acceptable solutions. Acceptance of consequences and compromise choice. Geoscientists' duty and their attitude in facing geoethical dilemmas.

Geoethics in georisks management: How Geoethics can guide towards a better living with georisks. The concept of "prudence" as defined by Aristotle (384-322 B.C.) and Thomas Aquinas (1225-1274). The defense against georisks as a societal duty (Pirro Ligorio, 1513-1583). The acceptable limit of risk (Giuseppe Grandori, 1921-2011). The "defense system" against georisks: actors involved and their roles. Geoscientists as social actors. Knowledge and preparedness. Prevention, geo-education, information. Citizens: active actors in the disaster risk reduction. The concept of "citizen science".

Responsible use of geo-resources: Essential concepts: identification and engagement of all relevant stakeholders; open, inclusive and continuing dialogue with local communities; reasonable alignment of values; protection of the environment and minimization or mitigation of environmental impacts on people and communities; cooperation closely with regional and local stakeholders better to understand bio- and geodiversity and conservation issues; promotion energy savings and increase the use of renewable energy sources; preventing any

environmental contamination; conduct tailor-made and fit-to-purpose research to develop technology innovations and advanced methodologies; providing a safe and healthy work environment for all employees; educating students on the importance of effectively managing georesources as well as protecting the environment and assuming social responsibility.

Keywords: Geoethics; Georesources; Georisks; Values; Video pills.

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GEOETHICS SYLLABUS:
ELABORATING A THEORETICAL EDUCATION FRAMEWORK

Clara Vasconcelos[1], Nir Orion[2], Tiago Ribeiro[1], Ron Ben-Shalom[2] & Alexandra Cardoso[1]

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[2] Weizmann Institute of Science, Department of Science Teaching (Israel)

There is nothing more practical than a good theory.
Kurt Lewis, 1952.

In the drive to improve standards, many educational theories are often referred to support educational curricula, teaching resources and even students' evaluative practices. Nevertheless, the use of educational terminology is most commonly neglected being the same concept used with multiple meanings. On the other hand, no educational mediation should be conducted without a previous reflection in the view of learning that supports the teacher action and the student role. Nevertheless, not many publications seemingly attempt to reorient discussion from performance to learning and teaching.

Recognizing this breadth of concerns, the elaboration of a Geoethics syllabus implies a prior discussion and definition of a theoretical educational framework that will guide the syllabus template, the implicit teaching methodologies, the complementary educational resources and the evaluation methods.

Starting with Behavioral theories of learning, where student is considering a *tabula rasa* and where tests and other forms of objectively measuring educational quality have held sway (Baysen & Baysen, 2017), the authors lead the communication toward the meaning of Cognitive and Sociocognitive theories. The last one adds to our understanding of how we learn by focusing on the type of learning that occurs even when there is no direct interaction with the environment. More specifically, Sociocognitive theory focuses on learning that is the result of observing others or observing the consequences of the behaviors of others (Moreno, 2010).

After the above learning theories, a closer look is taken at the main contributions of the Constructivism learning view to education (fig. 1). However, Constructivism is not a single unified theory either of knowledge or pedagogy (Adams, 2006).

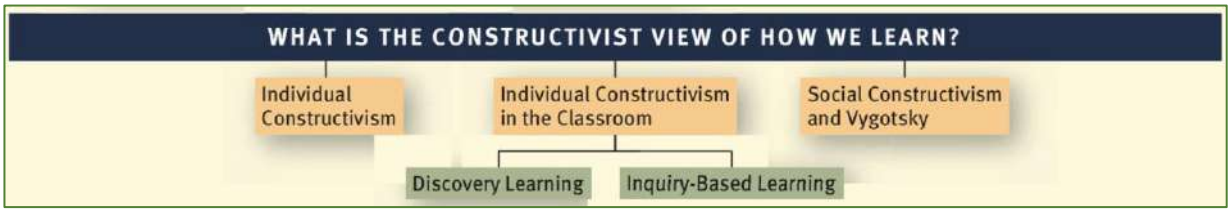

Figure 1 – Constructivist view of how we learn (Retrieved from Moreno, 2010, p. 90).

Despite the widespread appeal and influence of constructivist learning theories in education, some experts claimed that teacher-centered methods can be as effective or more effective than learner-centered methods (Rosenshine, 1986). According to Baysen & Baysen (2017), Phillips (1995) stated three approaches for the understanding of Constructivism: the good, the bad and the ugly:

> Phillips said that the good face of Constructivism was that the learner's active engagement with the learning process enhances learning. The bad side occurs when the teacher places emphasize to every effort heading knowledge but neglecting reaching the truth. The ugly approach of Constructivism is of the distrust in other methods of learning (called sectarianism by Phillips). (Baysen & Baysen, 2017, p. 167)

Finally, the authors devote the remainder of the communication to discussing the Social Constructivist theories of learning, with an emphasis on the work of Lev Vygotsky (1896-1934) and its contribution to science learning. Several educational implications can be drawn from a Social Constructivist view of learning like, for example: internalization, mediation, inner-speech and Zone of Proximal Development (fig. 2).

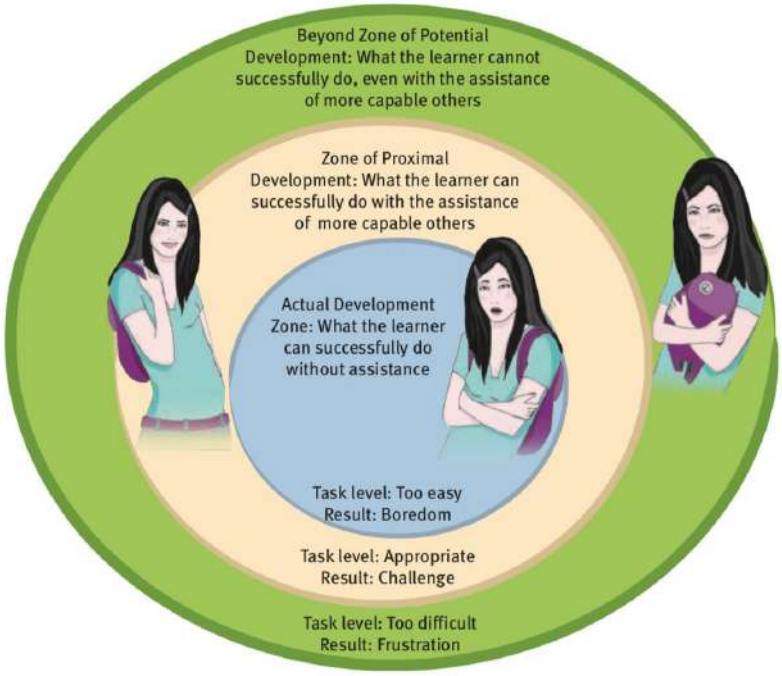

Figure 2 – Zone of Proximal Development of Vygotsky theory (Retrieved from Moreno, 2010, p. 91).

Social Constructivist learning methods are characterized by: using realistic problems emphasizing multiple perspectives and scaffolding learners through their zone of proximal development. Finally, a reference is made to teachers' role which should go beyond the examination of students' behavior and pay attention to student self-belief system as well.

Social Constructivist learning view is pointed as powerful to develop a Geoethics syllabus and complementary educational resources aligned with GOAL Erasmus Plus project (2017-1-PTO1-KA203-035790) main aims. A development of the use of Social Constructivism in the classroom will be presented and discussed in another communication.

Keywords: Educational theory; Social Constructivism; Syllabus.

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GEOETHICS SYLLABUS:
REVISITING SOCIAL CONSTRUCTIVISM IN THE CLASSROOM

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The origins of Constructivism are believed to date back to the time of Socrates, who claimed that teachers and learners should interpret and construct knowledge by asking questions (Hilav, 1990, cited in Erdem, 2001). But it is commonly referred the Piaget's theory as to have inspired Individual Constructivism. It is recognized that the focus of (Individual) constructivist learning perspective is the idea that students actively construct their knowledge from their personal experiences with others and the environment.

In contrast to Individual Constructivism, Social Constructivism is concerned with how individuals develop new knowledge and skills but emphasizing the collaborative nature of much learning. This learning perspective assumes that understanding, significance, and meaning are developed in coordination with other human beings (Amineh & Asl, 2015).

This perspective was developed by Lev Vygotsky, a cognitivist that rejected the idea that it was possible to separate learning from its social context:

> "While Piaget believes that development precedes learning, Vygotsky believes the opposite. On the topic of the development of speech, Piaget said that the children's egocentric speech goes away with maturity and is the transformed in to social speech. On the contrary, Vygotsky stated that the child's mind is inherently social in nature and so speech moves from communicative social to inner egocentric. Therefore, since the development of thought follows the development of speech, Vygotsky claims that thought develops from society to the individual and not the other way." (Amineh & Asl, 2015, p.10).

According to this learning theory, also called *distributed cognition*, individuals share their ideas with others and enhance their understanding because they are encouraged to clarify and organize their own ideas, elaborate on what they know, discover flaws in their reasoning, and entertain alternative perspectives that may be as valid as their own (Moreno, 2010). The role of the teacher is being a facilitator on the mediation process. Students required an assisted

learning and need peer or other tutors to help them to construct knowledge. Vygotsky's theory of social learning has been expanded upon by numerous later theorists and researchers.

Social Constructivist learning methods are characterized by using realistic problems, emphasizing multiple perspectives, and scaffolding learners through their zone of proximal development. Other Social Constructivist learning methods are mainly involved with: cooperative learning, tutoring, reciprocal teaching, communities of learners, problem/dilemmas/case-based learning, and structured classroom discussions.

Problem-Based Learning (PBL) and Case-Based Learning (CBL) use problems, dilemmas or cases as the teaching starting point. In these methodologies, the student assumes a central role in his/her learning process. On the other hand, the teacher adopts the role of facilitator. In this sense, the teacher has to be able to promote assisted development (scaffolding), through the promotion of questioning, the definition of learning needs and objectives, the provision of resources and the stimulation of students' research capacities (Moreno, 2010; Vasconcelos & Faria, 2017). PBL emerged in 1969 at the McMaster University in Canada. This methodology resulted from the rejection of the expositive practices in a medicine master's degree class (Lambros, 2004; Vasconcelos & Almeida, 2012). This methodology starts from a real problem (scenario) of everyday life, that must be relevant to the students. To solve it, the class is divided into groups (generally 4 elements in science classes). From the scenario (fig. 1), the students gather facts, introduce questions, formulate hypotheses, investigate, collect evidences, propose solutions and communicate their results (Lambros, 2004; Vasconcelos & Almeida, 2012). The construction of new knowledge takes place during the research process to solve the initial problem. As this process occurs, students need to learn certain concepts because without them, they will not be able to construct a workable solution to the problem (Vasconcelos & Almeida, 2012).

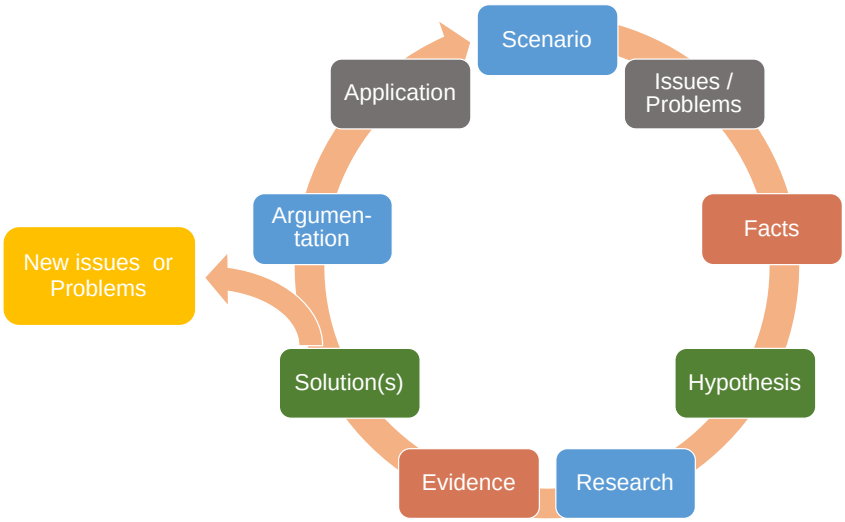

Figure 1 – The cyclic process of PBL (Adapted from Vasconcelos & Almeida, 2012, p. 22).

CBL methodology appeared in 1870 in Law and Business Harvard Schools in the United States of America and was developed by Christopher Langdell (1826-1906). He started to refer real cases in his classes, breaking away from decades of transmissive teaching. In this approach, cooperative learning is emphasized, but it can also be individual. The CBL methodology starts from cases (a dilemma is taken from real life and laid in the form of a case) and students are generally asked to work in groups, so they are exposed to several viewpoints and ideas (fig. 2). Students are also asked to evaluate each other's opinions. The exploration of a case usually finishes with a plenum discussion. This approach develops students' collaborative competences and their communication competencies (Vasconcelos & Faria, 2017; Vasconcelos, Faria & Cardoso, 2017).

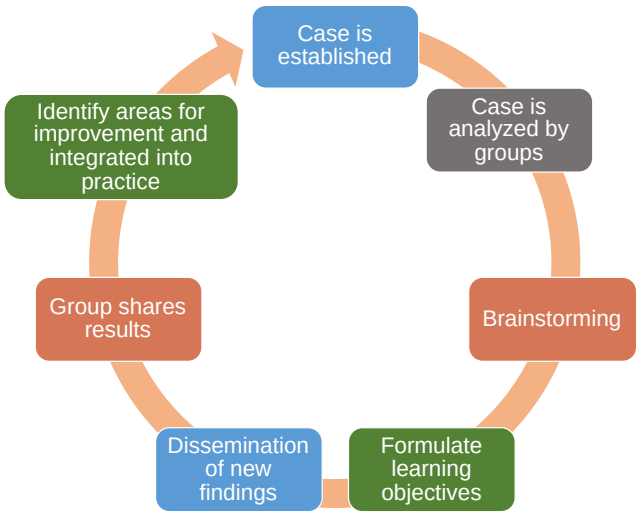

Figure 2 – The cyclic process of CBL (Adapted from Williams, 2005, p. 578).

These two methodologies are often confused because they share common goals, as enabling students to solve real world problems. Nevertheless, each methodology holds specific characteristics. CBL requires to recall previous knowledge to solve the cases. In contrast, in PBL methodology the problem drives the learning process. Since CBL requires a prior knowledge, it provides to students the opportunity to effectively relate their previous knowledge with the new (Vasconcelos & Faria, 2017; Vasconcelos, Faria & Cardoso, 2017).

However, learning is an idiosyncratic process and moreover, learning is a natural process - it is an instinct. Like any instinct, the urge to learn is only called into play by a stimulus or need. The stimuli that initiate learning are emotional (for example interest, curiosity, relevancy). Thus, any teaching process should start with establishing a learning environment and learning sequence that will stimulates the student's interest and curiosity and ignite the learning instinct. Only then could the above powerful Constructivism models be used in their full capacity (Orion, 2017).

Keywords: Classroom; Methods; Social Constructivism**.**

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GEOETHICS SYLLABUS:
CONCEPTS AND TEMPLATE

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Geoethics is an extremely relevant and timely curricular and scientific area since it takes into account the negative human impacts on geology and ecosystems, which have gained prominence in the Anthropocene, and elects sustainable development and life on planet Earth as an ethical imperative.

Parallel to this, one must recognize that excellence in teaching demands (also) for thorough planning. Thus, whenever a new disciplinary subject emerges, the greater is the need to provide for both the design of its syllabus and the development of educational resources that will promote a competent and qualified conceptualization of its knowledge.

Accordingly, the international partnership named Erasmus Plus GOAL project (2017-1-PTO1-KA203-035790) explores expertise in overlapping interdisciplinary areas and offers both a Geoethics syllabus and suggestions for educational resources that can be used in higher education so as to enhance the knowledge, skills and competencies of students, as well as arise the awareness of citizens in relation to Geoethics. Moreover, the proposal for a Geoethics syllabus template integrates contents that are related to georisks, geoheritage, water management and georesources exploitation and exploration.

Note that a syllabus is defined as the descriptive document consisting of topics covering a particular subject, or contents of a course or study, that serve as a guide both for students and the teacher. Teachers usually provide it to students for a specific period of time, so as to help them learn the subject in detail. The form and the content of a syllabus changes quite a lot, depending on the discipline, department, course and instructor (UNESCO, 2016; Wallace, 2015). Nonetheless, a syllabus is fundamentally a document which outlines the following: the aims of the curricular unit, the selection and sequence of contents that are to be covered, the teaching methodologies (including the mode of delivery, materials to be used, learning tasks and activities), the expected learning objectives or outcomes, the proposed assessment/evaluation schemes for that specific course, unit of study or teaching subject, and the proposed reading (UNESCO, 2016; Wallace, 2015). That being said, the term curricular syllabus is often misused as an equivalent of the term "curriculum". However, curriculum is the

overall content, taught in an educational system or a course. A single curriculum may encompass several syllabuses for each subject area, for example (UNESCO, 2016; Wallace, 2015).

The present communication aims to promote the debate regarding the items that should integrate a Geoethics syllabus, clarifying its meaning and fostering a coherent approach amongst the participants of the GOAL project. To this end, several syllabus template proposals, originating from different universities and countries, will be presented and discussed. We are striving for an open debate from which to emerge the design of a consensual template that may serve as the base structure for the on-going process of developing a Geoethics syllabus.

Keywords: Concepts**;** Geoethics; Template.

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THE ROLE OF UNESCO GLOBAL GEOPARKS ON THE PROMOTION OF GEOETHICS:
THE EXAMPLE OF THE AROUCA GEOPARK (PORTUGAL)

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A UNESCO Global Geopark is a territory with a strategic management planning supported on three main pillars: geoconservation, education and geotourism (McKeever & Zouros, 2005; Henriques & Brilha, 2017). A geopark seeks to create the conditions to promote the sustainable development of the territory, with clear benefits to local communities. At present, 140 geoparks in 38 countries around the world are recognized by UNESCO. Due to the aims and methods applied in geoparks, these territories are excellent case-studies to discuss different Geoethics-related topics (Giardino, Lucchesi, Magagna, Dellarole & Bagnati, 2017; Poch, 2018; Sá & Silva, 2016; Sá, Silva & Vasconcelos, 2015; Silva & Sá, 2017).

The Arouca UNESCO Global Geopark was the second geopark to be established in Portugal in 2009. With an area of 328 sq. km and about 22 500 inhabitants, the boundaries of the geopark match with the limits of the Arouca municipality. In the Arouca Geopark there are 41 geosites with different types of values and relevance. At least two of them have international scientific importance and will be visited during the fieldtrip: the giant trilobites of Canelas (fig. 1) and the "birthing stones" of Castanheira (fig. 2).

Trilobites are fossils of marine animals (arthropods) that were very abundant in the Paleozoic oceans. The trilobites of Canelas have a remarkable characteristic: they are the largest trilobites in the world, with same exemplars reaching 50 cm long. These trilobites were found during the exploitation of slates in a quarry owned by a local family. One of the owners is fascinated by these fossils and for many years he collected and kept them in a warehouse near the quarry. Subsequent studies done by paleontologists have revealed the high international scientific value of these fossils. The owner has decided to build a museum near the quarry where some of the fossils are exhibited to thousands of visitors each year. This geosite provides an interesting discussion about the relation between exploration of geological resources and nature conservation, which is normally seen as two incompatible activities.

Figure 1 – A. Geological Interpretative Centre of Canelas; B. Trilobite fossils.

The geosite "birthing stones" of Castanheira is a very peculiar geological phenomena and very rare worldwide. Centimetric biotite nodules are released from the granitic rock due to normal weathering and erosion. As this process never ends, nodules are always appearing in the fields and this is why the local population has called them "birthing stones". In order to avoid the illegal collecting of these nodules by visitors, the geopark managers have decided to build a small interpretative center in the nearby village. In 2017, 31 000 visitors were registered in this center which is a remarkable number taking into account its location in a mountain remote area. The educational activities in the center raise the awareness of visitors about the relevance of this rock and explain them why nodules should not be collected. Replicas of the nodules are available to sell at the interpretative center.

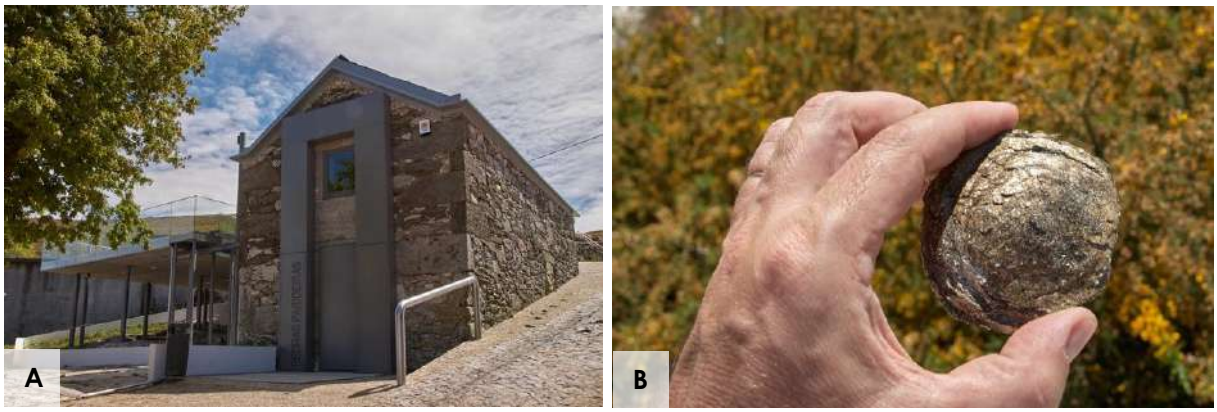

Figure 2 – A. "Birthing Stones" Interpretative Centre; B. Nodule.

The visit to some other geosites will also provide interesting discussions about the role of geoparks in the promotion of Geoethics.

Keywords: Education; Geoethics; Geoparks; UNESCO.

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GEOETHICS AND GEOLOGICAL RESOURCES:
THE CASE OF LITHIUM FROM HARD ROCK

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Lithium is a strategic metal for the 21st century. Its current application ranges from the use in ceramic and glassware pulps to the most advanced technology in terms of generation or storage of energy, through the manufacture of lubricants, pharmaceutical production, air conditioned, and also in the production of light alloys for use in aerospace industry.

But there is an application that will increase in a special way in the near future, as the replacement of the current internal combustion engine (ICE) car park by hybrid and electric cars (not to mention the growing market for electric bicycles/motorbikes in Asia), together with the growing energy storage in giant batteries for solving various problems of power supply continuity, all them will cause an extreme demand for Lithium (Fig. 1).

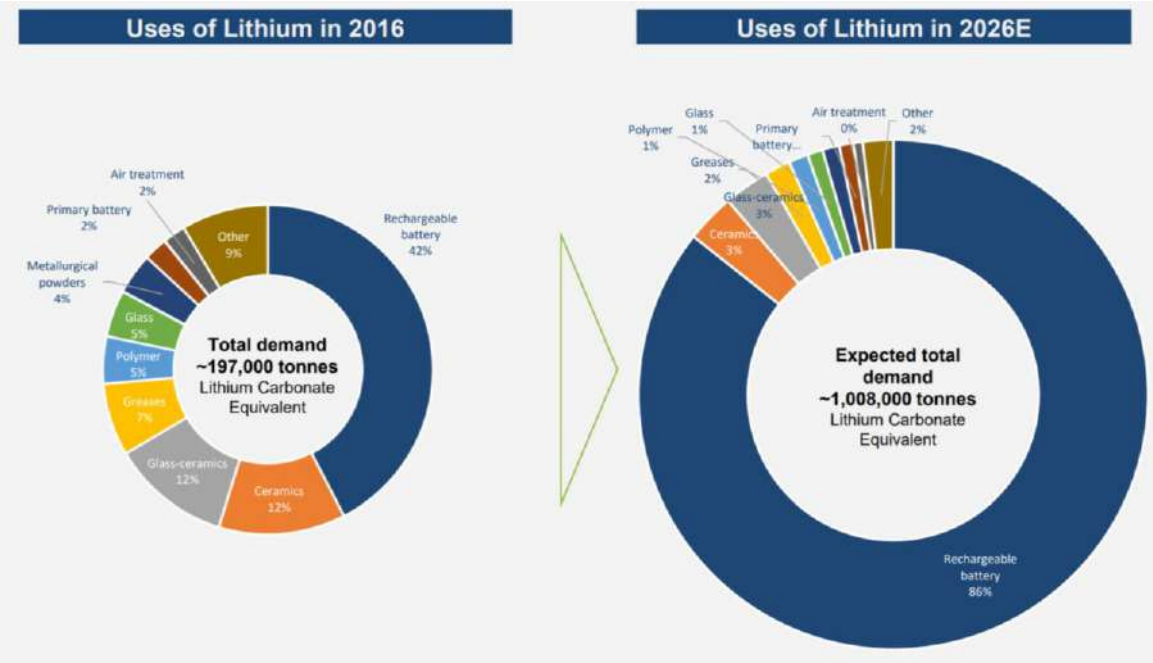

Figure 1 – Uses of Lithium in 2016 and previewed in 2026 (Retrieved from Lithium, 2018, p. 11).

At present, about a third of the world's Lithium source is in lithiniferous pegmatites. The most common lithium minerals in these pegmatites are silicates such as spodumene, petalite and

lepidolite. But also, lithium phosphates as montebrasite-amblygonite are possible to be used as the previous referred silicates to transform in lithium components of batteries.

These numbers are indicative of the value of the pegmatites with Lithium, but mainly of those in which the ore is the spodumene, because this mineral is easier to transform in Li hydroxide. Until recently lithium carbonate — used in everything from pharmaceuticals to cement and batteries — dominated the global trade in the metal. But battery manufacturers are increasingly using lithium hydroxide, a material with a higher percentage of the metal than its carbonate equivalent. Hard rock mining can make lithium hydroxide products more competitive, leading analysts to predict a more rapid growth in the use of hydroxides than carbonates in coming years.

Currently in Portugal there are already exploitations of Lithium pegmatites for the Ceramics and Glass Industry, in areas where lepidolite, spodumene and petalite are dominant (Fig. 2). However, the use of certain reserves with a content of more than 1% Li_2O in the spodumene-rich veins in the Barroso-Alvão region should already be treated as lithium ores (Fig. 3). Although there are already significant reserves within the mining concessions already awarded, it is necessary to carry out exploration work in areas of all the regions mentioned, as is currently happening the construction of other industries as Hydroelectric that can sterilize these important geological resources.

Figure 2 – Exploitation of Li pegmatite to Ceramic and Glass Industry in Barroso (2018).

In fact, at the present time in the World market, although the main sources of Lithium are lithiniferous brines, the spodumene is an important lithium ore namely in China, Australia and

Brazil and will come very soon to production in the USA, Canada, and Russia. In Europe (whose European Community in July 2010 concerned about the external dependence of its raw materials industries has published the study "Critical raw materials for the EU" where Lithium is widely mentioned), Finland claims that will be the first Lithium mine to obtain the metal from the spodumene. It should be noted that the contents of Lithium and resources are equivalent to those already identified in Portugal at the Barroso-Alvão region.

Figure 3 – Example of spodumene ore from Barroso.

This open pit mining industry, besides being practically non-polluting when compared to the old Mining Industry of the past in Portugal, will have the characteristic of being limited in the physical and temporal space and if being associated to an industry of lithium batteries to develop in the same inlands regions (of the poorest in the country and in Europe) may even be considered as one of the solutions to help stop the desertification of the population and industry in these regions.

Keywords: Exploitation; Lithium; Mining.

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GEOLOGICAL RESOURCES EXPLOITATION: SOCIAL ACCEPTANCE AND ACKNOWLEDGEMENT DEPENDENT ON EDUCATION AND CULTURAL CHANGES

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Current informed society has a distorted image of the Geological Resources and most of the time it is just necessary to put it into perspective and show the path that advanced humans look for the Mining Industry of the Future.

According to United Nations and several other sources the World Population has changed dramatically as the way of living. Population has doubled in the last 50 years moving fast to the 10 000 000 000, and that most look for a way of life based on goods that are made almost entirely of Geological Resources, from a house to the food they eat, Geological Resources are present. And that during those 50 years it was necessary to increase dramatically the use of Geological Resources, and that expansion was not well thought, in many cases was opportunist and surrounded by ignorance, not only related to lack of knowledge (fig. 1).

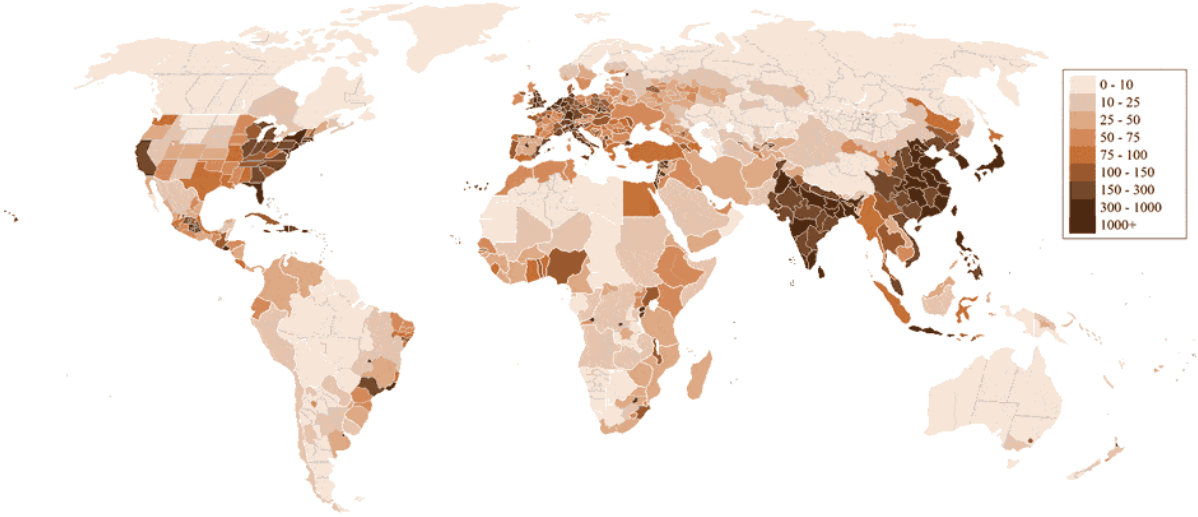

Figure 1 – World Population distribution (Retrieved from http://www.worldometers.info/world-population/).

In the last 10 years the global awareness has changed significantly, but that change is often ignored or not recognized for numerous reasons. It is clear that as in any big change, it has to be gradual and there are no perfect solutions, just by following and promoting the best

practices and strategies to higher sustainability and the use of much efficient tools to promote Safety to People and Environment, will make change the global image of the "Miners" (fig. 2).

Figure 2 – Changes in Mining Operations – Safety and Awareness (Retrieved from https://www.conflictmineralslaw.com).

Education and advertising of actions of the New Geological Resources Operations has to become a tool to increase Social awareness and acceptance of this much needed Industry.

Refusal of this Industry in "Our Own Backyard" will maintain poor practices in Countries of Lower GDP, promoting the Human Slavery, the use of Under Age (children) workers in the Mining operations and the Environmental catastrophes that hit the news almost every day (fig. 3).

Figure 3 – Current Problems in Low GDP Countries, which keep supporting supply off Geological Resources (Retrieved from https://www.globalwitness.org/en/campaigns/conflict-minerals/).

And the realization that High GDP Countries that are Mining Friendly (such as Finland, Norway, Canada, US, UK and Australia) have invested in solid laws and regulations that protect the Geological Resources and the Environment at the same level (fig. 4).

These Countries have seen their economy to grow and be able to sustain World Wide Economic Crisis, and at the same time becoming less dependent on resources that come from high risk and conflict regions of the World. Other like France and Germany have decided to base all its production in Geological Resources from these low GPD Countries. Portugal, Spain and UK are in a transition stage and have to make that Political decision in a very short break time.

Figure 4 - New way of Mining with environmental respect and return to the Society (Retrieved from https://www.conflictmineralslaw.com.)

It is capital to change the way that Geological Resources Industry is seen by the Society and it is necessary to educate and inform people at different levels about the Industry and the Processes, so they can take informed decisions rather than supported in fundamentalists propaganda.

It must be clear that Geological Resources Industry is changing but it is nonsense to think that it can be done in one day, but that is good to have ambitious goals. Assume once and for all that Geological Resources are finite and that we all must work to find ways to reuse and recycle to be able to keep up with the growing and demanding population, without even think that it is possible to ban it. Informed Society make better judgments and supported decisions, lets promote the HOW instead of the NO!

Keywords: Geological resources; Mining industry; Public awareness.

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A GEOETHICS PERSPECTIVE OF WATER CYCLE NEXUS EARTH SYSTEM

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All human activities have impact on the Earth systems, but in different extents. The Geoethics' perspective as these activities are foresee will dictate the way humans can interact with earth systems.

At Paço de Calheiros, a farm where the main activities are the wine production and tourism, four projects were implemented:

- a multifunctional constructed wetland (polyculture) followed by a pond for wastewater treatment coming from the unit of tourism with reuse of water for gardens (Fig. 1A);
- a pilot constructed wetland (with a substrate of used cork stoppers) for the winery wastewater treatment and reuse (Fig. 1B);
- a pilot floating wetland island, cork based, for water quality improvement and biodiversity promotion in a pond that act as strategic water reservoir (Fig. 1C);
- recovery of an old mill where was installed a mini-hydric for energy production (Fig. 1D).

Figure 1 – Projects implemented at Paço de Calheiros related to water cycle (A) constructed wetland, (B) constructed wetland pilot, (C) Floating wetland island, (D) Mini-hydric.

All the projects implemented at Paço de Calheiros were related to an integrated water cycle management. The aims of these projects were to promote productive efficiency, system circularity and assure a positive impact on the community within an approach of *nature-based solutions*. According to UNESCO, *nature-based solutions* are inspired and supported by nature and use, or mimic, natural processes to contribute to the improved management of water (UNESCO, 2018).

The United Nations settled the water management as one of the biggest challenges of the XXI century. "Water is at the core of sustainable development. Water resources, and the range of services they provide, underpin poverty reduction, economic growth and environmental sustainability" (UNESCO, 2015, p. 2).

In a rural context the management of water cycles is of upmost importance since it is necessary to assure not just the freshwater supply to the community (for farming and other agricultural activities), but also the water quality after its use. The availability of water needed to meet the demand for food, energy, human uses and ecosystem support is associated to the uncertainties of the impact of climate change (WWAP, 2015). Part of the solution lays down on rethinking the water cycle which increases the importance of understanding the origin of the water.

The spring found in this site is the heart of Paço de Calheiros farm. This hydrosphere phenomenon is a result of the interaction of the geosphere and the atmosphere. The topographic height of this area, a geosphere outcome, influences the temperature of the atmosphere and therefore the amount of precipitation (rain water) in this granitic area.

The uplifting of granites by geological forces formed granites joints allowing the rain water to enter in the unconfined aquifer and to cross its unsaturated area. As the water table is at a higher level than the unconfined aquifer, and also due to the slope's inclination, the underground water appears at the surface of the farm as a spring.

The type and the quality of the wine – *vinho verde* (the name literally means "green wine" but is translated as "young wine" because the wine is produced in 3-6 months after the harvest) of this farm is also directly related to the interrelationship of earth systems. The water (hydrosphere), the soil (geosphere) and the climate of this area (atmosphere and its narrow interrelation with geosphere) potentiated the characterization of this farm as part of a region that produces vines of a light and fresh wine. Farmers of this region used to train their vines high off the ground (up trees, fences, telephone poles and even walls) so as to develop vegetable crops below the vines, which could serve as a food source to their families and farm animals. Thus, the farm is part of the socio-cultural heritage of this region and preserves its geological heritage (landscape).

Nevertheless, and based in all that has been mentioned, if a road or a house is built above the granites' joints that feed the spring, it would probably dry the water system and end the wine production. As such, a Geoethics perspective of this farm is within the scope of public awareness and geo-heritage.

The visit to this site will provide the work-base for the reflection about interactions between human activity and the earth systems. The understanding of this interrelationship will enable to recognize a Geoethics perspective of this site.

Keywords: Earth systems; Geo-heritage; Geoethics; Public awareness; Water cycle.

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APP ON GEOETHICS:
FOR A CORRECT PRACTICE OF OUR GEOLOGICAL AND PALEONTOLOGICAL HERITAGE

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In the last decades, the geosciences have experimented the urgent necessity to count on practitioners who possess an ethical conscience and the desire to act responsibly (Bobrowsky, Cronin, Di Capua, Kieffer & Peppoloni, 2018). This is especially necessary for an adequate valuation and evaluation of our paleontological heritage (and geoheritage) and for a correct practice of its management and paleontological research (Morales, Azanza & Gómez, 1999; Meléndez, 2018; Meléndez & Peñalver, 2002). Fossils connect us with our natural environments, but also with our origins and past. The paleontological heritage is therefore strongly linked with both our natural and social/cultural heritage (despite ongoing debate among Spanish georesearchers) and cannot be interpreted or studied without this synergetic perspective.

Today, i) the increasing use of technological advances and an ambitious development of infrastructures (e.g., mining activities and exploitation of georesources, railroad, highway and residential projects, etc.) often initiated, funded, and influenced by government agencies or powerful public or private organizations; ii) individual actions to collect the most spectacular, relevant fossils related to both commercial or collecting, or simple vandalism; and iii) the increasing use of fossils in paleontological research, didactic and touristic activities and exhibitions, have a profound impact on paleontological sites and fossils, which raise key ethical concerns related to this heritage. Identifying and considering ethical issues and dilemmas in paleontology is important for both moral (adhering to ethical principles or cultural conceptions of what is right and wrong) and practical reasons.

Here, we propose the development of an application for electronic devices with Android and Mac OS operating systems based on Augmented Reality and informative screens as an educational output for disseminating Geoethics messages that arise from geosciences. The App guides the user through different geographical points or itineraries (either in Geoparks, field, or museums/exhibitions) which pose interesting ethical issues and dilemmas related to our geological and paleontological heritage.

Given that nearly half of the applications downloaded today are games, a didactic application of this nature, with a well-worked graphic interface and a cutting-edge design, is very attractive for users and one of the best ways to reach different audience. First, and because the youngest sector of the society has an almost innate familiarity with newest technologies, children and students from secondary and higher education are our first target groups. In addition, a more general audience with specific interest in geology and paleontology can also benefit from it.

The application includes view in Augmented Reality of a particular point (based on GPS location) and icons of interest for Geoethics and a "Time Bubble" (Fig. 1) option that allows the user to enjoy a 360° panoramic view of the current state of the point and its reconstructed appearance in the past.

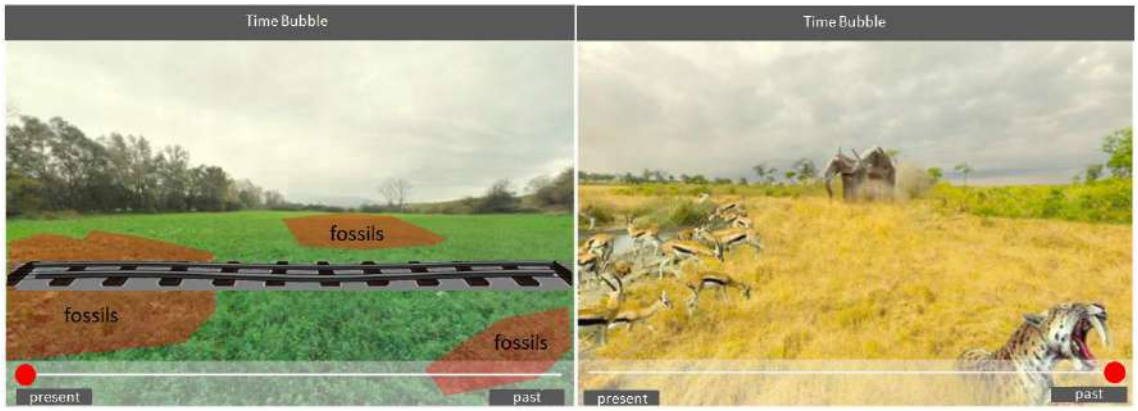

Figure 1 – Example of the "Time Bubble" function in the prototype. Image showing fossil deposits of the current state of a Pleistocene fossil site with a constructed railroad track (left) and reconstructed appearance of the ecosystem in the past (2 millions of years ago).

Keywords: Conservation; Cultural/scientific value; Paleontological heritage.

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