

**DEEP TIME: FROM THE COMPLEXITY OF THE CONCEPT,  
TO THE IMPLEMENTATION AND ASSESSMENT OF CURRICULUM MATERIALS,  
TOWARDS THE DEVELOPMENT OF CITIZENSHIP**

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This paper, with its roots from an earth science education research project, is divided in three parts: (i) guidelines of the project and a short reflection about the nature of time with educational implications; (ii) results of the implementation and assessment of new curriculum materials for 12/13 and 17/18 year olds; (iii) final considerations, mainly related to citizenship.

## **Introduction**

*Geology at School and University: Geology and Civilization* the name given to this scientific event. The authors assume that:

- . geology is related to a certain understanding of the totality of the Earth and this can be achieved by examining the history of the way ideas on the subject have been developed - mostly all the short analysis, with an occasional big synthesis. So, citizens need historical records to know, whether or not, our Planet is becoming healthier or is in mortal decline;
- . civilization is an advanced state of intellectual, cultural, and material development in human society, marked by progress in the arts and sciences, the extensive use of record-keeping, including writing, and the appearance of complex political and social institutions;
- . school and university must help the development of independent thinkers, effective communicators and multifaceted citizens.

There's no doubt about the potential of complex concept of time both for the achievement of a holistic perspective and for the development of attitudes and values by the learners.

### **Guidelines of the project and short reflection about the nature of time with educational implications**

This project in quest for factors which influence the understanding of the complex curricular concept of time by students and the consequences of this concept for both the design of science curricular materials and the development of a cultural dimension responsible for the development of citizenship.

The ontological statute of time, its relation with space and its cognoscibility is, undoubtedly, one of core philosophical problems. Scientific speech also reveals deep concerns with a reflection about time, which results in a connection between philosophical and scientific thoughts.

To Aristotle, platonic eternity is expressed with time succession – *number of movement according to the before and the after* (Klein, 2007).

With the scientific revolution dawns a time conception substantially different (Coveney & Highfield, 1992), defended by Galileo Galilei in an abstract perspective, seen as a parameter that is valid to all kinds of movement and not only for the rigid one as Aristotle thought. For Newton, time loses this transcendence, flowing without any relation with the exterior. With Einstein, time will be affected by matter and energy, and susceptible of being manipulated.

Geologists treat all kinds of geological processes and most of them are slow reflecting the pace at which the heat engine works. James Hutton was the first scientist to understand the profound significance of relative time in Geology and Charles Lyell realized that the slowness of processes like

erosion implied that relative geological time must equate to truly vast and amounts of absolute time.

These routes – relative and absolute time - strongly influence the geological reasoning, geologists' procedures, teachers' strategies and students' learning. Citizens' beliefs, attitudes and values development are also close to these temporal relations.

### **Results of the implementation and assessment of new curriculum materials for 12/13 and 17/18 year olds**

The approach of the concept of Geological Time, based on new educational material, was initiated on a diagnosis of ideas and conceptions of 12-13 years old students, through a questionnaire. The analysis and interpretation of information gathered in the questionnaires, the reflection developed by the staff of the project and some bibliographic data resulted in the conceptualization phase of curriculum materials that seek to diminish difficulties found and the identified needs.

New educational materials represent a diverse set of learning situations with problematizing issues, conducting to a holistic share of knowledge and experiences on various geological events, commencing the main question: *How does the interpretation of Earth history may help to understand the concept of geological time?*

Curriculum materials, detailed at the presentation of the paper, covered five themes: Your story; The story of man; Earth and life history; Man and evolution of planet Earth; Time of consciousness on evolution. A guideline sub-question was defined for each theme, which intended to look for responses through the proposed set of activities (eg, information analysis, data interpretation, debate/discussion/reflection, among others).

New curriculum materials were implemented with students of 12-13 years old, by three Natural Sciences teachers in the same school. Later the same materials were applied in 17/18 years old students by another teacher.

The implementation of these materials took about 10 hours for 12/13 years old and about 6 hours for 17/18 years old students. The adopted strategies have been mainly designed within a teaching inquiry framework. It was requested to the students a final work where they should tell the history of the planet. About this, the authors can say that there was some difficulty in younger students to get into a relationship of Earth's history, compared to the older students. However, the most important events, as those that serve as a dividing line between the different geological eras, have always been appointed. Through this scenario, in which students realized that the most significant events were used to organize and divide such a large time span, we can say that student's mindset suffered a qualitative leap. That is, the students were aware of the significant events that occurred through Earth's history, which include extinctions and the emergence of new forms of life and have developed a consciousness that they have an important role as a citizen responsible for preservation of our planet, and may thus indelibly mark the scale of geological time.

Later, both students group recognized that the curricular materials have been diversified and motivating, which has contributed to a better understanding of Earth history, and the concept of geological time - *These materials gave another idea of Geological Time, not only factual but also interesting and easy to analyze critically some related issues* (St8). They also considered that these new materials have enabled the articulated and integrated use of concepts from various disciplines, thus meaning that the strategies implemented have contributed to an improvement of the teaching/learning process.

17/18 years old students, after the implementation of new curricular materials, devised an exhibition entitled *Dialogues with Earth*. With this activity, they caught the educational community attention to the main geological, climatic and biological processes that occurred throughout Earth's history and aroused the need to assume a more active role in preserving the Planet. Students boosted the exhibition and school opened doors to all the educational community. Those hundreds of citizens that visited their work were confronted with questions like: Will we be able to inhabit the Earth wisely? How we fulfil the duty of preserving our planet? We believe that each visitor reflected on those questions, giving them the will to be more active and interventionist in the preservation of our Planet.

### **Final considerations**

Looking out the work we developed, beginning at the construction, and following to the implementation and evaluation of these materials, we can say that beyond the central theme, geological time, it was its holistic dynamics, the rationale of this project. We intend, form a basic issue of Geology, to give students a perspective not only of scientific knowledge, but also of citizenship. We believe this approach to the subject of Geology, by geological time issue, quite difficult to the comprehension, summoned students to new challenges, once they reflected on their own conduct as citizens of a Planet with about 4600 million years.

The implementation of the materials we worked on, to a set of students from 12/13 and 17/18 years old, demonstrates that the curricular approach of complex concepts, such as the geological time, does not fall into a reductive perspective of education. These complexities inherent to some concepts need to develop a multidimensional and multidisciplinary approach, where innovative curricular materials can act as a facilitator of a more holistic thinking and culturally enriching. It is expectable that

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adequate approaches inherent to time, help to structure the best geological reasoning, thus contributing to the development of a more critical citizenship.

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