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Development of a "Fossilis" tutorial on the concepts of fossils and fossilization

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Abstract

Our study is meant to address the steps of designing a "Fossilis" tutorial with a general aim of facilitating the assimilation of students' knowledge of the notion of fossil, the understanding of the process of fossilization in time and space and then self-evaluation. It is an interactive software that targets students of Sciences of the Earth and the Universe (STU). Developing the idea of such teaching device is based on the results of a questionnaire survey that was administered to university students at the Faculty of Science, Dhar El Mahraz, Fez, Morocco. This investigation tool has allowed detecting the main difficulties expressed as well as the suggestions of the involved students. Indeed, the majority of them approved the integration of ICT as an alternative solution to alleviate their difficulties in assimilating the concepts of fossil and fossilization.

Keywords: Tutorial; students; fossils; time; space.

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1. Introduction

Over the past two decades, Information and Communication Technologies (ICTs) have transformed the educational world by capturing and stimulating the learner's attention. Pedagogically speaking, these new technologies made the student more autonomous thanks to the interactive modalities of access to the information, the knowledge by the various multimedia resources. In this context, several authors have stressed the need for development of tutorials and to adapted effective learning environments as well (Caelen, 2004; Tricotetal, 2003).

1.1. Integration and use of ICT in higher education in Morocco.

Being aware of the contribution of ICTs to the improvement of teaching and learning, the Moroccan Ministry of Education, in the National Charter of Education and Training, has recommended the use of ICT since 1999. In this context, the State has heavily invested in developing ICTs in teaching and learning through a series of programs and actions (Kaddouri et al., 2012): the emergency program (2009- 2012), the "MARWAN" network, the Moroccan Virtual Campus (CVM), etc. Despite all these efforts, the integration of ICT in the Moroccan university still faces multiple problems. Indeed, Kaddouri (2012) reported that students of Moroccan universities are in an non use situation of ICT, mainly due to and for a majority of the inaccessibility of technological tools at home and on university campuses. It should also be noted that some teachers resist the use of ICTs by stating that this would undermine the status of the university teacher and that the medialization of the pedagogical act could negatively affect the human relational dimension that underpins the pedagogical act.

1.2 Difficulties in assimilating fossil and fossilization concepts.

Fossils are considered as precise markers of time, as tools of relative dating. They are also indicators of facies of the paleo-environments. And finally, they constitute one of the arguments in favor of the synthetic theory of the evolution of the species (Crepin-Obert, 2010). However, numerous research conducted on teaching-learning geology have highlighted the difficulty student's encounter in addressing the concepts of fossil and fossilization. On the one hand, Laperriere (2002) emphasized that the concept of fossil constitutes a knot of obstacles converging: epistemological obstacles linked to the construction of the time concepts, space and material transformation On the other hand, Triquet and Laperriere (1999) asserted that determining the origin of fossils also constitutes a crossroads of obstacles, notably "artificialism", "phenomenism" and "reasoning by notional couples".

2. Issues and objectives

It is true that assimilating the fossils and fossilization concepts faces a series of obstacles. So, what are the students difficulties vis-à-vis these concepts and what are some of the pedagogical solutions or actions that may be suggested to overcome such difficulties?. In order to answer these questions, initially a questionnaire survey was administered to STU students. Then as an alternative solution the tutorial "*Fossilis*" was suggested. This tutorial is an interactive software meant to STU students with a general aim of facilitating the understanding and allowing self-evaluation of the students knowledge concerning the notion of fossil and the unfolding of the phenomenon of the fossilization in time and in space. Our study can be considered as a variant of action research, namely "research and development" (Guichon, 2006). This type of research focuses on improving teaching-learning practices, through creating tools or new applications (Frascati-Manual, 2002). In this regard, our project undertakes the development of an instrument adapted to our students since it is designed taking into account their difficulties and the Moroccan pedagogical context where It can be used.

3. Methodology

To answer the need for developing a tutorial for the teaching of Earth Sciences, in this case the part on the concepts of fossil and fossilization, a questionnaire survey consisting of two closed questions was submitted to 78 bachelor and master students of the STU. The first question was about:"what obstacles do hinder your understanding of the fossilization phenomenon?. While the second question was about"

what are your suggestions to overcome these obstacles?".

A simple random sampling was adopted. Indeed, our population represents a sub-population of all students in the STU stream of Moroccan universities. This available subpopulation may fulfill the requirements of a random population. Thus, it is valid because there is a relationship between our sub-population and the total population of Morocco. Indeed, these two groups of students have undergone the same training with the same didactic and pedagogical means and similar socio-cultural conditions.

4. Results

4.1. Questionnaire Results

The questionnaire results allowed us to detect many difficulties in assimilating the concepts of fossil and fossilization (Figure1). In this case, difficulties in mobilizing time and space factors. To these are added others that we have qualified as pedagogical. To overcome these difficulties, students made proposals, including the integration of ICT with a majority of citations from (56%). These results are represented in the form of graphs in the figures below: Figure 1 and Figure 2.

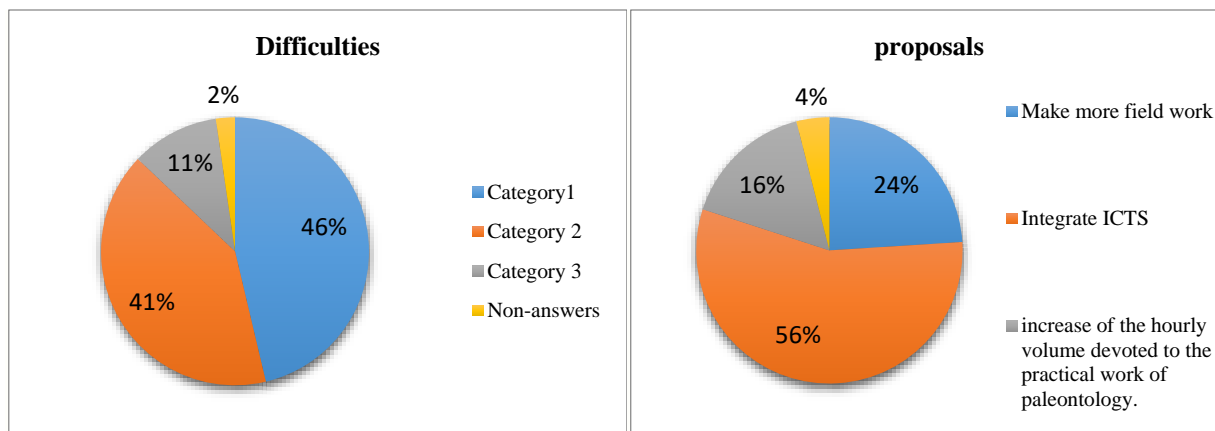


Figure1. Classification of the categories of difficulties encountered by students

Figure2. Classification of student proposals

4.2. Discussion of results

We categorized the difficulties of students as follows (Figure.1)

- Category 1: it represents 46.30% of the obtained answers that revealed difficulties in mobilizing time and space factors. Indeed, these students stressed the fact that they find it difficult to imagine the phenomenon of fossilization in time and space and to understand the geological time scale;
- Category 2: it gathers 40.80% of the collected answers which have been pedagogically qualified by the lack of field work, absence or insufficiency of practical sessions, non-adapted teaching methods And the complexity of paleontological terms;
- Category 3: it covers 10.60% of all the responses that mentioned difficulties in identifying fossils.

For the suggestions (Figure. 2) it is clear that students are aware of the importance of field and practical work to understand fossil and fossil concepts. In this context, as a solution, 24% of the students suggested the programming of the field work, while 16% rather favorable for the increase of the hourly volume devoted to the practical work of paleontology. However, the research carried out in this field (Lamarti et al., 2009) and the difficulties approved by our population have shown that in our universities the field work is not always programmed, due to administrative problems, lack of logistical and material

resources and civil responsibility. To compensate for such educational deficiencies, a large proportion of the questioned students (56%) proposed ICT as a support to understand these concepts. This high rate of students demonstrating a profound interest in ICT has prompted us to design and develop an innovative tutorial to help facilitating the assimilation of fossil and fossilization concepts. It is obvious that this technological tool cannot fulfill all the pedagogical act of practical field work.

4.3. Development of the "Fossilis" tutorial

4.3.1. Design Phase

The design phase is about the didactic structuring of the contents of the tutorial or the Pedagogical scripting of activities. It is the work of transforming "learned knowledge" into "knowing how to teach". In the case of our tutorial "Fossilis", this phase is carried out by teachers of the specialized subject. Moreover, with in the teaching and learning approaches cited in the literature, the question is what is the preferred model? We used the constructivist approach. It is based on the Swiss biologist Jean Piaget work (1977). For this author, learning is no longer a passive process. The person must be actively involved in the problem at hand in order to learn the necessary mechanisms of problem solving. As far as we are concerned, this approach choice aims at enabling the student to construct his own knowledge and to test his own hypotheses. This is done via a set of activities that will enable to develop the ability to mobilize time and space factors in order to be able to solve the propose problem: reconstructing the spatio-temporal evolution of a paleo-environment.

4.3.1.1. Preliminary analysis

One of the first motivations behind choosing the content of our tutorial is the unavailability and non-adaptability of existing software on the market to the educational needs of our population. In fact, the production of computerized resources requires that this technology take into account the educational, socio-cultural and economic reality of the target population. In our case, the existing software on the Internet (Erasme, BrainPoP-fossil, ammonite fossil, etc.) and dealing with the concepts of fossil and fossilization are concentrated in most of the time on the vulgarized modeling of the phenomenon of fossilization, In the form of simulations, schematizing the main phases of fossilization, without, however, introducing in a relevant way the notion of evolution in time and space. Yet these factors are two key parameters for understanding fossil and fossil concepts.

4.3.1.2. Pedagogical architecture of content

The content of our tutorial is formed the following way:

The reception, which allows access to the application. This access requires authentication and a password for the user that is of two types:

- The administrator is the teacher who can manage (add or delete) the institutions, the pedagogical levels, as well as the accounts of the students to give them the right of access;
- The student must fill in the username and password provided by the administrator, his institution, and his pedagogical level.

Screen-page 1: from which students have access to three learning modules, in the form of icons to identify and define a fossil, assimilate the progress of the fossilization and then reconstruct the spatio-temporal evolution of a paleo-environment (Figure. 3). The user can not directly choose the icon that interests him, he must pass, with a single click, the first module to access the second and then the third. This successive strategy has been chosen to ensure the progressivity of the integration of acquired knowledge and to prevent the student from dispersing in the various proposed activities.

Module 1: This is the first pedagogical sequence where the student is shown a video of a field trip. This allows him to relive the experience of a paleontologist, in this case, the identification of fossils, their

spatial arrangement in strata and methods of extraction of fossil samples. The second activity is about a museum of fossils, in which, the student confronts a diverse collection of fossils. This sequence ends with two interactive exercises. In the first exercise, the student is asked to choose from a list of given propositions, those representing fossils, determining their characteristics (origin, mode of fossilization, interest). In the second exercise, the student must formulate a definition of a fossil.

Module 2: We proposed to the student two innovative simulations, allowing to better assimilate the phenomenon of the fossilization in this pedagogical sequence. The first simulation is an interactive experiment, where he consults, in a lively way, all the steps of the manufacture of the internal and external castings of a fossil. The second represents an animation tracing the evolution of the different stages of fossilization in a spatio-temporal framework. The evolution over time is schematized by the durations representation of the fossilization processes on the geological time scale. Moreover, these times are converted, thanks to a chronometer, of units on a geological scale (thousands to millions of years) to units on a human scale (hour, minute, second). For space, a scale of references always appears, in the case of bathymetry variation; the thickness of the accumulated sediments and finally the diameter of the fossilized organism. At the end of the pedagogical sequence, the student independently evaluates these achievements through the exercise of closed-ended questions of multiple choices.

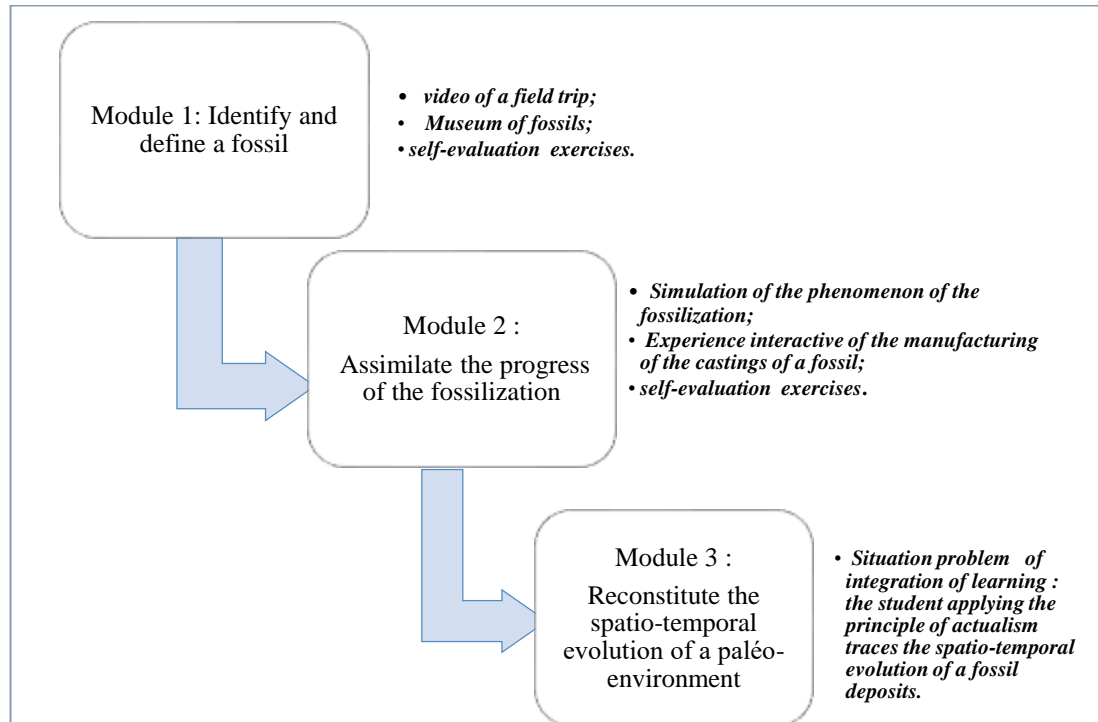


Figure 3. Pedagogical diagram of the "Fossilis" tutorial

Module 3: This pedagogical sequence is about a problem of integration of learning. On the basis of a statement, the student must start and rely on the principle of actualism, and of the proposed documents (geological map, bio-stratigraphic log, photographs of Ostreidae samples and others) as a basis to solve the problem of reconstructing spatial and temporal evolution of fossil deposits.

Moreover, for each module, the student can consult interactive course elements in the form of texts, images or media (videos and simulations), he can also evaluate his knowledge, at the end of each module using interactive exercises that are of two types:

- Multiple-choice questions for which the student's answers are compared with the correct predefined answers at the database level to make an automatic correction and give the correct answers;
- Direct questions to which the student must provide answers, automatic correction is carried out at the basis of keywords already stored in the database.

Finally, our tutorial provides students with possible Access, via hyperlinks, to fossil record cards throughout the learning process. These records include the origin of the fossil (animal or plant), its systematic classification, its spatio-temporal distribution, its mode of fossilization (remains of organism, molding, ichnofossile) and finally its interest (facies fossil or stratigraphic fossil). In addition, the student was provided with an available glossary explaining the difficult words of the discipline paleontology, in the form of a hyperlink.

4.3.2. Production phase

After defining our objectives, developing the didactic structuring of scientific contents and the pedagogical scripting of the activities; PHP software is used as a programming tool to transform the pre-constructed pedagogical scenario into computer language. PHP (Personal Home Page) is a set of authoring software designed to assist in the creation of web application that can be deployed on an intranet network of an educational institution. It is a free and open source technology, considered as the world leader in creating websites, among the more famous ones, such as Facebook, Wikipedia, Yahoo, etc. The accessibility to our platform has become very easy thanks to this technology that does not require any specific installation on the computer, it is enough to have a web browser (Internet explorer, Google Chrome, etc.) It is compatible with all operating systems such as Windows, Linux and Mac OS, adding to that, it can be used on mobile terminals (Tablet, iPad, Smartphone, etc.) This system of software authors has indeed given access to three essential characteristics:

- Interactivity, where the student can always access hypertext links and hypermedia (images, videos, simulations);
- The diversity of learning channels, where the student has the opportunity to integrate knowledge, according to his needs, through different channels: texts, images, videos and simulations;
- The possibility of a self-assessment, the student can always access his answers thanks to a renewable answer sheet, in a PDF format, elaborated by the software, in order to analyze them throughout the learning process and to have feedback to rectify them in an autonomous manner;
- The administrator system that allows the teacher to follow the learner's path.

5. Conclusion

Our research aims at developing a "Fossilis" tutorial to STU students. This tool is of a pedagogical support, to better understand the concepts of fossil and the process of fossilization in a spatio-temporal framework. The development of such a teaching-learning device was made following a questionnaire survey.

The research tool targeted STU students from Dhare El Mahraz Faculty of Science in Fes, Morocco, it allowed us to raise the difficulties that the respondents confront when learning these geological concepts particularly, the mobilization of time and space factors. These difficulties are due to their inability to imagine the course of the fossilization phenomenon in a spatio-temporal framework, as well as to their inability to assimilate the geological time scale. In addition to that, the students mentioned difficulties that have been described as pedagogical issues and have been referred to as the lack of fieldwork, the absence of inadequacy of practical sessions, or inappropriate teaching methods. To overcome these difficulties, our students have suggested the use of ICT as an alternative teaching

means, to understand the concepts of fossil and fossilization, from which the development of our tutorial has emerged.

Time and space are two key factors to understand geological concepts. Consequently, our interactive tutorial focuses on introducing students to the notion of evolution in time and space, through the case of fossil and fossilization concepts. This through the assimilation and then the application of the actualism principle. To achieve the objective, a pedagogical content has been developed based on various types of scientific resources and learning channels such as interactive course elements in the form of texts, images or media. Finally, this innovative system offers students self-evaluation opportunity through which they can have access to their answers via a renewable answer sheet, in a PDF format, so that they can rectify it in an autonomous way.

The reported working this article represents a part of our project. Initially, the focus was on the design and implementation of the tutorial to consider later on an evaluation approach. This last part will make the tutorial more efficient with the ultimate goal of meeting the students 'needs.

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