Information and Communication Technologies and Earth Science Teaching

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Abstract: Our purpose is to build a typology of the use of ICT (Information and Communication Technologies) in the secondary classroom. In this paper we try to give an overview of the background to use ICT and then going to give some examples of this in teaching Earth science. Our typology distinguishes three categories for ICT uses: ICT as a set of instruments for disciplinary studies, ICT as a technology for education and ICT as digital environments for learning. The differences between those categories are: the roles of the teacher, the students and the technologies.

Key words: Earth science, ICT, learning, teaching

• Introduction

Didactic represent the relationships in the classroom by a triangle (fig. 1). One of the points of the triangle is occupied by the student, the second by the teacher and the third one by the school subject. The uses of ICT can be described with this triangle. Today, technologies facilitate the relationships between those points. As disciplinary instruments they allow teacher to organize school activities with his school subject. As technology for education, they play the role of medium and facilitate the relationships between teacher and his students. Finally, as digital environments for learning they can allow students to explore and to discover the concepts of the school subject.

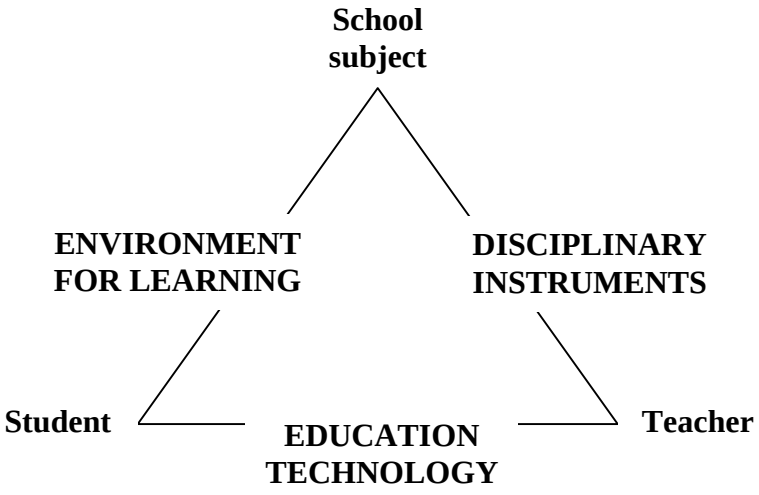

Fig. 1. The rôles of ICT in the classroom

What we aim is to describe ICT as a two sides instruments (Rabardel 1995). Artefact (software) is the technologic side and uses are the human side. By following we will try to outline the different roles of student and teacher according the place granted to the technologies in the classroom. We will focus our attention on the example of Earth science teaching.

• ICT as a set of disciplinary instruments

We start with the notion of tool for disciplinary studies. Studies of Earth planet meet difficulties because of scales of time and space that involved. A geologist has to study in a hand small objects like molecules and in the other hand mountains or planets. This means that it is necessary for him to be able to change scale of space very frequently. As a geologist, he has to measure time in milliseconds (for a earthquake) or billiards of years (for the apparition of life) so he often has also to be able to change scale of time. For those reasons, interpretation of geological

phenomena presents a wide range of difficulties.
Computers are one of the solutions to bypass those difficulties. They allow scientists to implement models to reconstruct and to simulate geological phenomena and so to accelerate or slow down process to make them more sensitive. Computers can be a substitute for the field or laboratory work. They are also used to acquire and deal with data and so allow access to complex phenomena. Hammer and computer are two main instruments for the geologist. The hammer is used for field-based work, computer is an essential laboratory tool.
In the classroom students are invited to deal with geological concept and to use geological tools. In this way, many software implemented for scientists can be adapted and used by students at school. An example is Sismolog. (Fig. 2). This software allows students to deal with data of sismicity like seismograms and learn what an earthquake is. To locate the epicentre, to distinguish the different waves of the seismogram are two of the wide range of functionalities of the software. Sismolog is a disciplinary tool created by a geological laboratory in France to study earthquakes and witch was adapted for secondary schools.

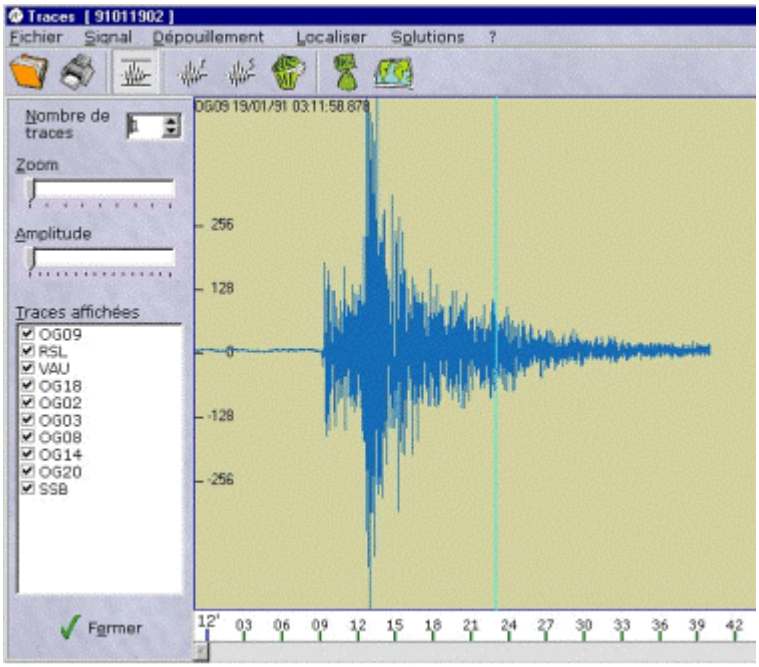

Fig. 2. Sismolog

We now like to turn attention to the roles of teacher, students and technology when ICT are used as disciplinary tools (Baron & Bruillard 2003). Teacher identifies and selects the tools of his field. He adapts them to allow students to use those tools. Students use the tools in the classroom as geologists use them in the science laboratory. Technology is an artefact used to acquire and deal with data.
In this case the purpose by using ICT is to reconstruct, in the classroom, the laboratory activities of the scientist. Many other example could be describe: Computer Assisted Experimentation (CAEx), Geographic Information System (GIS) are some of them.

- **ICT as technology for education**

At the beginning ICT were created in a context witch was not a school context but teachers and educators has been aware of their interest very early. So ICT are actually used as a technology for education. For example, video projectors, interactive whiteboard are more and more frequently used in the classroom. Email, forums and collaborative plate-forms allow students to keep contact with their teacher after the classroom. Internet is a powerful access medium to information. But one of the most interests of those technologies is their capacity to allow multimedia and multi-modal presentations.

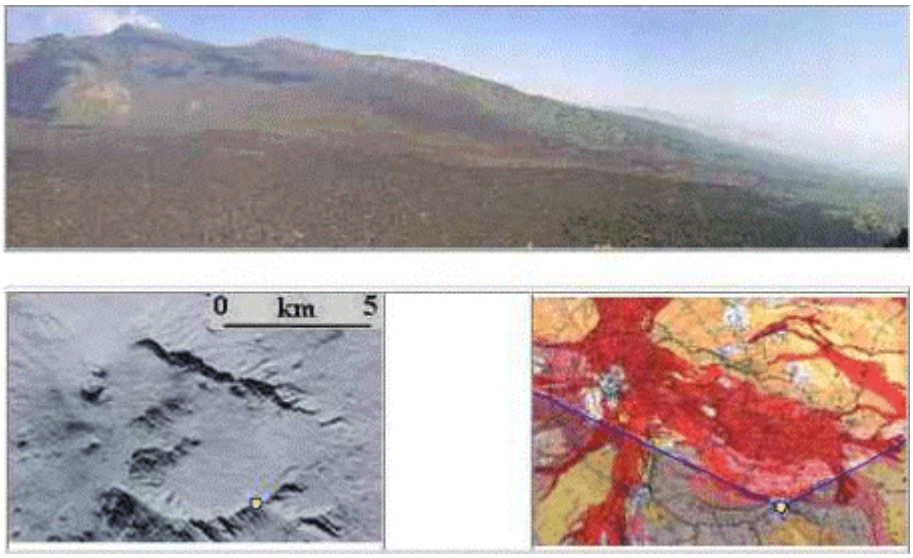

Fig. 3. Hyper-landscape of Etna (Sicily)

For example, in a previous work (Sanchez & Urgelli 2004) we showed that *hyperpaysages* – a translation of this French word could be hyper-landscape - are tools to help students to build themselves a 3D representation of the field where they have to work (fig. 3). Hyper-landscape is a panoramic photograph of a landscape where the student can zoom, go to the left or to the right and click to access to related information like text or videos. Added to the panoramic view, a map allows locating the point where the photograph is taken and the piece of the map visible in panoramic view. Both are coordinated.
So what is the role of each one when ICT are used as a technology for education? Teacher shapes disciplinary knowledge and uses communication tools. Students exchange with their teacher or look at the tools realised by him. Technology is used to communicate and to give access to information by connecting students and teachers.

- **ICT as digital environments for learning**

Today, individualization of learning is a great challenge. The constructivist theory of learning seems to be widely accepted and the job of teacher changes. Instead of information providers for students, teachers seem to become more and more team managers instead of knowledge providers. Students are lead to be active to learn by being engaged in problems solving and teacher controls the learning process. In this context, ICT provides a wide range of software

applications to engage students in learning activities.
Chonocoupe (fig. 4) is an example among a large choice of software for Earth science teaching (Sanchez 2003). With Chronocoupe students simulate geologic phenomena like the sedimentary process, a volcanic eruption or the tectonic process. The results can be seen on a picture, which represent an outcrop and can be compared to a picture created by the teacher. Students are supposed to identify the geological events and find their chronology to reproduce a correct picture. The aim is to teach the rules of relative chronology.

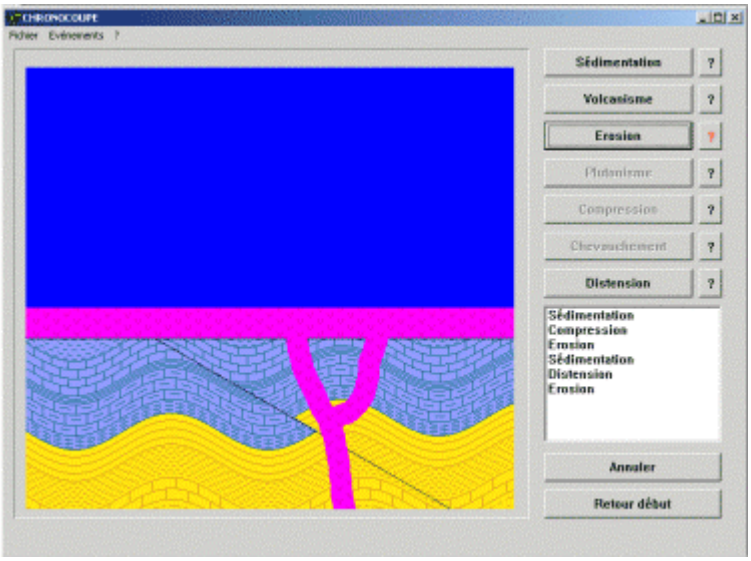

Fig. 5. Chronocoupe

With the increasing of distant learning more and more learning environments are implemented. When ICT are used as digital environments for learning, the teacher elaborates situations for learning by choosing software applications and help students as a tutor. Technologies allow creating micro-worlds which properties and behaviours are the properties and behaviours of the reality. They are a link between the student and the disciplinary studies. The students explore, experiment and simulate by using software application and learn by themselves.

- ## Future?

The basic message we are trying to get across here is simple. ICT can be used in classrooms in different ways to help students to learn Earth science. For the future we have to create new tools to help students to learn Earth science. Augmented reality could be a way to follow. Augmented Reality is a system of tools that allows a person to view – and sometimes manipulate - one or more virtual 3D objects in the real-world environment. Shelton & Hedley (2002) show that the manipulation by students of a virtual solar system helps them to understand such phenomena as seasonal variations or Earth-Sun relationships. But the question of ICT using in the classroom is not only a matter of technology or artefact. We have to identify the roles of teacher and students to take care of their needs and wishes and to find creative and innovative way to integrate ICT across the curriculum.

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