

## Geoscience education using virtual worlds: the Unicam Earth Island project<sup>1</sup>

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The starting point of this research is based on two problems: 1) the poor motivation in the study of geosciences in Italian schools (middle and high school, respectively 11-13 and 14-19 age ranges) which carries away the students from these topics (Forsthuber et al., 2011); 2) the constantly increasing risk for the Italian population due to natural phenomena, which requires a special attention to the territory and a better knowledge of the population about the environment they live in (Alexander, 2002).

In more recent years, the learning environment in education has diversified using virtual environments and new technologies (Biondi, 2007). In this context, immersive 3D environments have proved to be meaningful in offering an effective approach to support situated learning (Dawley 2009, Dawley and Dede, 2014), learner-centered education and increasing new generation students' motivation.

There are only few examples in the literature presenting the use of virtual worlds for geoscience education and for geo-game design (Minocha, 2013, Slator et al., 1999). For this reason, the aim of this research is to evaluate the effectiveness of use of virtual worlds in geoscience education to increase motivation in the study of geosciences. To achieve this goal, the research was guided by the following research questions:

- 1) Can a virtual world be effective to improve the scientific literacy and the skills in geosciences topics?
- 2) Can an immersive experience on the Earth sciences in virtual worlds be a resource to motivate students to learn geosciences?

To answer the research questions the following issues have been examined:

1. Use of virtual worlds (knowledge and skill on virtual worlds).
2. Student perception of the virtual path before and after the experience.
3. Teacher perception of using virtual worlds in geoscience education.
4. Effectiveness of using virtual worlds in terms of acquired knowledge and skills in geoscience topics.
5. Motivation of students to use virtual worlds for learning geoscience.
6. Motivation of teachers to use virtual worlds for teaching geoscience.

Virtual Worlds (VWs) offer alternative learning environments for geoscience education and give students a feeling of "being there" (Slater, 2009). In fact, VWs are also immersive environments that enable situated learning (Lave, Wenger, 2006) and constructivist learning in according to the Vygotsky theory (Vygotsky, 1978), because the learner is inside an "imaginary" world context. In this environment many activities and experiences can take place as scaffolding, cooperative learning, peer to peer and peer evaluation, coaching, scientific inquiry (Nelson & Ketelhut, 2007). Therefore,

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VWs can be a new technology to motivate students and provide the educational opportunities to learn in a socially interactive learning community geoscience. In the literature already some studies report experiences carried out to investigate the effectiveness of virtual worlds in science education, as ecology or biology (Dede 2009, 2014; Dickey, 2003, 2005a, 2005b) but there are no studies, up to now, about using virtual worlds for geoscience education (e.g. geo-game design, development a scientific literacy and best practices for geoscience education).

The experience takes place in a 3D virtual island, called Unicam Earth Island (Boniello & Paris, 2014a, 2014b), built for this research project on a server of the University of Camerino with the software Open Sim ([www.opensimulator.org](http://www.opensimulator.org)). The Unicam Earth Island is a virtual platform where students and teachers can study, collaborate and create scientific activities on geosciences (<http://d7.unicam.it/unicamearthisland/>). In the island, the following paths on Earth sciences have been designed and developed for the research project:

- Volcanism
- Phlegraean Fields volcanic area
- Earthquakes and Tsunami
- The trip of Darwin, the geologist

In the path volcanism and Phlegraean Fields the path can be experienced by school students of middle and high school (Boniello & Paris, 2014a, 2014b, 2014c, Boniello, 2014 and Boniello, 2015). Scheduled time is 60 minutes for one lesson. The path is divided into seven areas of investigation and students can use a ‘guided sheet’ with information on paths and guide questions for learners. In each step there are activities related to knowledges and skills about volcanism and volcanic risk.

The path Earthquakes and Tsunami can be experienced by school students of middle and high school. Scheduled time is 50 minutes or one lesson. It is divided into six areas of investigation. In each step there are information and activities to promote the knowledge and skills on earthquakes, tsunami and seismic hazard and risk. Students can use a guided sheet.

In the path ‘trip of Darwin, the geologist’ the aim is to improve motivation in the students to learn about the journey of Darwin as a geologist and improve knowledge and skills in geoscience using a role-play game (Boniello et al., 2014). Among the places described by Darwin, were chosen to be reported in the path, those of greatest geological interest and in which the Avatar-Darwin could interact with the environment in an educationally effective way. In this context, it was omitted a part of the journey (that of the Galapagos), which will be added in a later stage of the project with all the biological aspects.

To share and disseminating this approach among science teachers, an online course on ‘Virtual Worlds in geosciences education: the example of Unicam Earth island’ was organized. The aim of the course was to introduce the science teachers to the practice of this new technology and make them aware of the potentials in the field of geoscience education.

This research is based on quantitative and qualitative approaches (Corbetta, 2003 and 2005; Trincherò 2004; Cohen et al., 2001) and therefore it can be defined as a mixed-methods research. The necessity of using this approach arises from the difficulty to collect heterogeneous data and connect them to the experimentation in geoscience education.

The main instrument used for this approach is a questionnaire that has been used with an experimental protocol exploring the effect of one variable on another. The main variable was the learning environment, i.e. the virtual worlds, to verify its effects on other variables: motivation, perception, knowledge and skills. The experimental protocol was organized with an experimental and a control group (Oppenheim, 2000).

Data were collected using three instruments: questionnaires, observation and interviews. This research doesn't claim that virtual learning environments can replace traditional teaching but they represent an excellent integration. In this perspective virtual worlds have strong potentials to reproduce real situations into virtual environment. This is especially interesting to model a situation or a phenomenon in time or space, with good applications in geosciences education topics. The teaching/learning activities take place in a virtual island, called Unicam Earth Island (Boniello & Paris, 2014a, 2014b, 2014c), built for this experience on a server of the University of Camerino with the software Open Sim ([www.opensimulator.org](http://www.opensimulator.org)) and available online. For building the virtual island a model of instructional design has been tested with school students, university students and science teachers. In the island several paths on geosciences have been designed and developed especially focusing on topics related to the natural hazards.

To share this approach among science teachers, an online course in the island has been organized, under the name '*Virtual Worlds in geosciences education: the example of Unicam Earth island*' (from november 2014 to march 2015, lasting 20 hours). To collect the experimental data for this research, many tools have been used, like surveys, observations and interviews in according to both a quantitative and a qualitative approach, using also a mixed approach (Trincherio, 2004; Santoianni, 2010).

The results obtained from this research suggest that virtual worlds are potentially effective in science education to enhance learning outcomes in Earth science.

The results obtained on the student's evidence that this immersive environment 1) is motivating and involving, 2) increases the learning outcomes about knowledge and skills acquisition, 3) increases the students' interaction with peers and teachers and their appreciation for collaborative work, 4) improve their interest to study Earth science topics. The science teachers participating the research, also noted the effectiveness of this methodology on motivation and learning of students, more of a traditional mode. In particular, the teachers noted that this approach: 1) increases attention and motivation, 2) increases problem solving and development of creativity, collaboration and cooperation, 3) allows simulation of a scientific context and situated learning, 4) can be an environment to create IBSE activities, E-Activities and authentic assessment.

Whereas all the previous aspects have been very well received by the teachers, some problems have been also detected, like 1) the digital divide between teachers and students, 2) the still scarce access to technologies by schools, 3) the limited time to dedicate to new experiences, 4) the necessary training of teachers. Most of these issues can be resolved with solutions based on a good planning of the experience and an active involvement of the Principal and the instrumental figures in the school. On the other side, this approach contributes effectively to decrease the digital divide and effectively connect teachers and students. These results can be used to new experimentations in the future on other virtual paths on Earth sciences and on the development of expertise of science teachers in the use of virtual worlds in science education.

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