The "INNOVAMBIENTE" Project: An Interdisciplinary Approach Integrating Natural Science, Mathematics and Computer Science

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Abstract

In scholar curriculum, the integration of contents from different learning areas has been always a challenging issue, but with very few practical experimentations. This paper reports an experimental project of teaching natural science, mathematics, and computer science (technology education) in the first level of the Italian secondary school, by means of a common integrate path based on practical experiments. We show effectiveness of the conceived interdisciplinary approach by means of a case study in a network of thirty classrooms of 11 years old scholars.

1. Introduction

Traditionally, school curriculum has been largely based on the concept that instruction should be separated into distinct subjects, for ease of understanding, and then reassembled when complex applications are required. Such a fragmented learning approach seems less appropriate in our modern society, where it is well understood that combining different disciplines, pedagogical approaches, people, and skills deeply improves scholar learning [1,2]. These reasons have been spurred overall Europe several initiatives for the promotion and integration of different teaching approaches. In Italy, this has been also done via the INNOVASCUOLA call [3] (founded by the Department for Innovation and the Ministry of Education, Universities and Research). INNOVASCUOLA intends to offer to all schools in Italy, of all order and degree, all the opportunities given by the ICT. The objectives of the initiative are:

- to facilitate the introduction of innovative didactic methods for teachers and students;
- to trigger a virtuous innovation process starting from inside the schools themselves, favoring the expressiveness of teachers and students, allowing them to develop and share digital contents.

Our project, called INNOVAMBIENTE, is aimed to experiment an innovative learning approach for the natural environment education through a combined application of mathematics and computer science (technology education) notion, in the curriculum of first level scholars of Italian secondary school, by means of real experiments. In particular, we have focused our attention on South Italy schools, due to the fact that they suffer more of the "early school leavers" problem, and because of the much lower instruction level of their scholars, as it is reported by OCSE [4]. The project has been accepted for founding in a very selective review process (it got one of the first positions, over more than 1000 projects presented in Southern Italy).

2. The INNOVAMBIENTE Project

Overview. The project is devoted to 11 years old students. It has started in September 2008 and will hold for two years. It involves a network of 30 classrooms, each one with an average of 20 students and 3 teachers. The methodological approach is mainly based on practical experiments of natural science, realized either in school or in the natural environment. The intent is to let student to learn the natural science with a lot of fun, and the accompanying mathematics and computer science concepts just "for free", while using them along with the experiments. The integration of the disciplines is thought in such a way that the base knowledge of each of them converges in a single subject without losing their own identity.

Aim. The proposed teaching approach intends to attract students much more than the classical ones. First, it helps students to become more conscious regarding the natural environment in which they live and of which they are an integrating part. Second, students take benefits from the immediate application of mathematical concepts, which are often perceived as a very abstract topic, as they do not see any immediate applicability of them. Third, the application of computer science techniques and tools to realistic problems helps students to learn and increase their abilities on multimedia and data evaluator tools.

The new approach will also help teachers understanding that their specific educational areas do not stand alone within the school curriculum and that, by combining them, students can have benefits in learning all of them.

3. A case study lesson

We have elaborated different interdisciplinary lessons. Here, for the sake of space, we only report ***"The***

Lepidoptera Biodiversity" lesson. This experiment starts in the landscape and manly considers butterflies as bio-indicators. By following a fixed path (300 meters) in Mediterranean Maquis protected natural area, students count all butterflies and repeat the counting several times. They may also catch some samples, recognize them following a book guide, and then quickly release them. Successively, students repeat the same experiment in an unprotected environment (but with similar vegetation) and compare the obtained data. As an example, assume that scholars have observed during the experiment 8 different species (see Fig. 4).

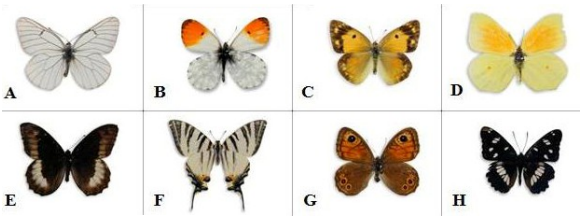

Fig 4: Butterfly species: *A) Aporia crata, B) Antocharis cardamines, C) Colias Crocea, D) Gonepteryx Cleopatra, E) Hipparchia fagi, F) Iphiclides podalirius, G) Lasiommata maera, H) Limenitis reducta*

At this stage, students are invited to create a mathematical model of the experiment for a better representation, organization, and evaluation of the achieved data. This is usually done by using the concept of *function* that, in the specific example, returns from the input data (the butterfly species) a number that corresponds to a Biodiversity index [5]. Therefore, the aim of the experiment is to simplify to scholars the Biodiversity concept and give them a real application on which test arithmetic theories. Coming back to our example, suppose that students have collected the following data in the natural (**N**) and unprotected (**U**) environment, with respect to Fig. 4:

A. (N=7, U=0) , B. (N=12, U=3), C. (N=20, U=32)
D. (N=4, U=1), E. (N=3, U=0), F (N=5, U=1)
G. (N=10, U=2), H. (N=7, U=0)

Hence, the total numbers of butterfly species observed are 68 for N and 39 for U. Let p_i, for i in {A,...,H}, be the numbers of samples recorded, for each specie and environment, with respect to the total species observed in that environment. For example, for species B, we have p_B equal to 12/68 for N and 3/39 for U. Students can then calculate the Simpson's index [5]:

$$\mathbf{D= p_A* p_A + p_B* p_B + ... + p_H* p_H.}$$

So, they obtain, respectively for N and U, the values $D_N = 0.01384$ and $D_U = 0,0254$ and, as it was expected, both numbers are between 0 and 1. Hence, students understand the biodiversity concept directly from the experiment they have performed: *"the more the obtained index is close to zero the more diverse and heterogeneous is the considered ecosystems"*. Therefore students logically conclude that the unprotected environment is, with respect to this measure, less heterogeneous than the natural one. Both the input and output data of the experiment are successively organized via databases (for the data storage) and multimedia tools. Scholars can experiment the integration of media contents and therefore the production of a digital didactic contents CDD, (one of the main goals of project). So, *what do the scholars learn from the whole interdisciplinary learning process*? They learn how to study the environment, through the Biodiversity analysis. Moreover, with such an experiment, they are "kindly forced" to use both arithmetic and computer science concepts.

4. Conclusion

This paper reports an innovative learning approach, which we have named INNOVAMBIENTE, for teaching natural science, mathematics and computer science (technology education) in the first level of the Italian secondary school. This approach extends classical ones in two different dimensions. In one, we consider real experiments in which all the disciplines are applied to solve practical problems. In the other, we integrate all the above disciplines by following a common path, in such a way that every discipline becomes complementary to each other.

We have shown benefit and feasibility of the project by means of a case study in the natural environment where students, starting with a real experiment, first collect information from tangible surrounding data, and then elaborate them by applying mathematical and computer science theory in order to get back natural science information, such as the biodiversity index.

Finally, in the full version we will report test results that will confirm a sharp learning improvement for students that have followed our teaching approach.

5. References

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