ICT AND MULTIMEDIA IN PHYSICS LEARNING AND TEACHING

EXPERIMENTAL ACTIVITIES AND INTERDISCIPLINARY EDUCATION SUPPORTED BY MULTIMEDIA

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1 INTRODUCTION

Many assessments on cultural level of secondary school students have reported not exciting results for the Italian instruction system and these outcomes are worrying especially in scientific sectors. Furthermore, results for Italian southern regions are even worse. It is well known that an insufficient educational grooming, together with a big gap of knowledge and know-how, sets up a great barricade on the way of the current socio-economical development. Consequently, it is mandatory to face this strategic problem without further delays; also by undertaking all those initiatives helpful to raise a consciousness on the critical size of this trouble in more local contexts as well.

In this paper we present a didactic action devoted to demonstrate how different disciplines (as chemistry, biology, physics and obviously mathematics) ought to integrate each other for a complete comprehension of a most common phenomenon as the water transport in plants.

2 FCI INVESTIGATIONS

In the described context, we have performed a Force Concept Inventory (FCI) test [1, 2] addressed to freshmen of Science and Engineering at the University of Calabria (in the South of Italy). FCI is a multiple-choice test designed to monitor students' conceptual understanding of force and related kinematics. Hestenes et al. [1] conclude that an FCI score of 60% can be regarded as the 'entry threshold' to Newtonian physics and a score of 85% as being the Newtonian 'mastery threshold'. Our investigation has been carried out just at the beginning of first year university courses (first days of October), respecting all recommended advices in order that students respect test duration and answer sequentially to the supplied questions. In this paper, also in order to give reason for our proposed didactic action discussed in the following, we start by briefly presenting one interesting result concerning the comparison between two samples of 340 and of 270 students of Science and Engineering faculties, respectively (a complete and exhaustive discussion of the obtained results will be done in a next publication).

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In Fig. 1 we represent the mean normalized score relative to the FCI first 15, to the first 20 and to all the 30 questions. The represented score, for each range of items, is expressed as a percentage of the maximum obtainable score in that range. The decrease of the observed score, as the number of evaluated items increases, is due to the fixed amount of time for test performing. From Fig. 1 is evident that Engineering students get to a score surely better if compared with that achieved by Science students, but in both cases they are widely below the threshold of 60%.

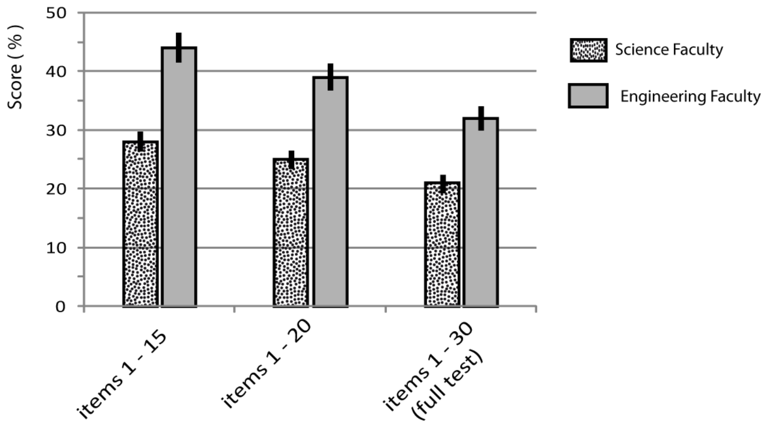

Figure 1 FCI score for Science and Engineering freshmen at the University of Calabria. Score is expressed as percentage of the maximum obtainable score, for each group of test items. 'Entry threshold' to Newtonian physics is considered to be 60% for full test [1].

3 THE LEARNING PATH

In the last decade many ideas, initiatives and teaching strategies have been set to handle the described problem, all addressed to affect attitudinal change in students and to make physics an attractive subject [3]. To attain this purpose, teachers, teaching methods and syllabi play a crucial role. Physics education research has well assessed that students emerging from physics education without adequate laboratory activities lack proper appreciation of physics and capacity in understanding its applications. Furthermore, the use of a constructivist and interdisciplinary approach [4, 5] has shown to enhance teaching and learning mainly because breaks usual barriers between knowledge fields and rebuilds the unitary cognition. In this contest a judicious use of new media can give a valid support in reaching formative and motivational goals.

Starting from these considerations, we have built a formative path, with several and impressive laboratorial activities performed using low cost materials, in order to allow their repetition at home. A wide spectrum of arguments (from pressure in fluids, to liquid surface tension in soap bubbles, to capillarity) are presented in the experiments, linked and matched together, to lead learners to the comprehension of water transport in plants. The proposed experimental activities are supported by multimedia tools freely available in internet, but suitably integrated to achieving the formative goals. As well, this designed path is devoted to emphasize the role of interdisciplinary character of learning, in order to obtain an improvement in observation and understanding abilities towards everyday natural phenomena.

Fig. 2 shows the conceptual map of the learning path. The proposed experimental activities lead the learner to explore the properties of water molecules in various contexts, and from different points of view. In particular, the learning path starts with the theme of pressure in fluids, and especially in gases, by proposing some classical simple experiments on pressure. The next step considers the everyday phenomenology of water surface tension, such as soap bubbles and films, and capillarity. Subsequently, water phase transitions are considered. Finally, the acquired knowledge's are integrated in describing the mechanism of water transport in plants.

To support the experimental activities and to promote student learning, we have produced an interactive multimedia tool, freely accessible on line at the URL: (http://www.fis.unical.it/didattica/water_transport_in_plants).

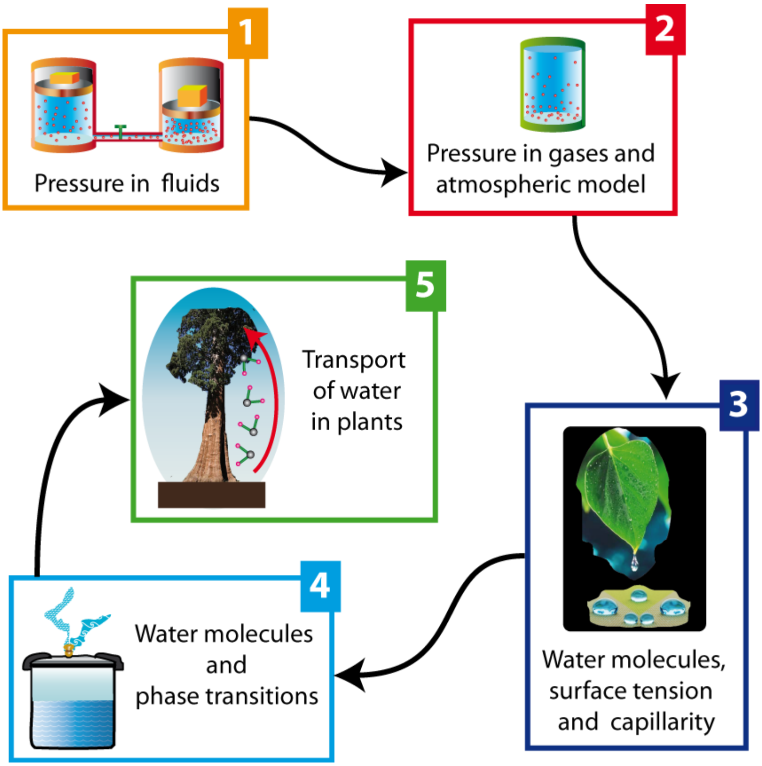

Figure 2 Conceptual map of the proposed learning path.

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