STIMULATING REFLECTION AND CATALYSING CHANGE IN CHEMISTRY EDUCATION

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Stimulating Reflection and Catalysing Change in Chemistry Education

Società Chimica Italiana
Coordinated by its
Didactics Division

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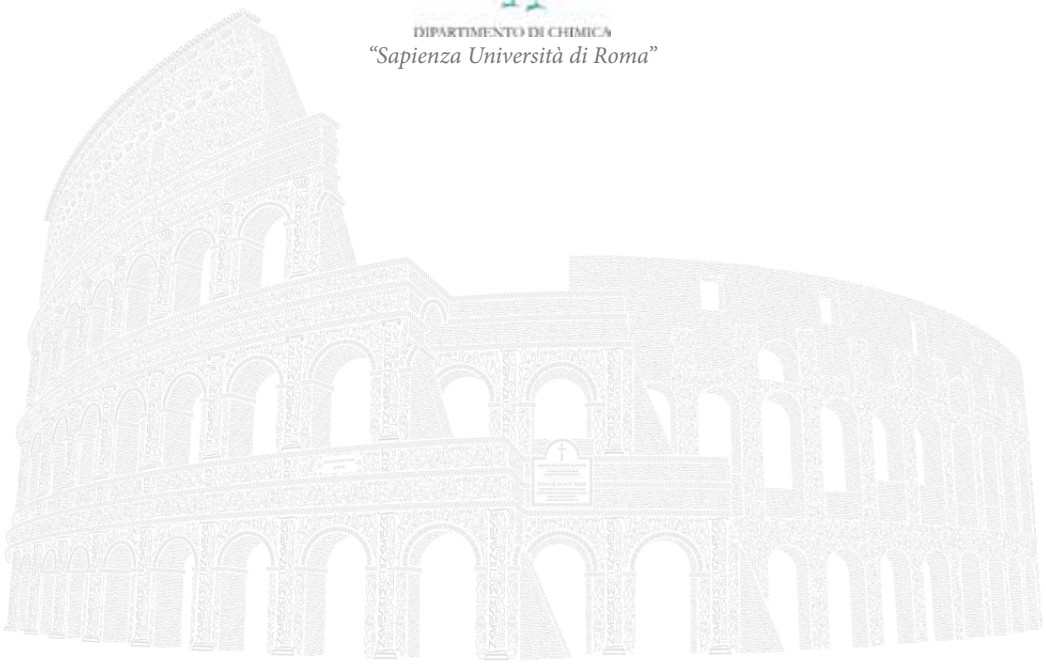

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CHEMISTRY ... WHAT A PIZZA!!!

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With the aim of improving education, a group of teachers in our school are participating in a European project called PROFILES. As a component of the project, we have received training in the use of cooperative learning method, to include a scenario and to introduce concept maps in our teaching to help students to be aware of their learning and to utilise problem solving methods. Because we are convinced of the necessity to increase interest and active student involvement in the processes of learning and studying, we have developed a didactic module suitable for learning important concepts in Biology and Chemistry. Our idea was to develop a teaching module focussing on increasing the intrinsic motivation of students[1,2], thus overcoming students' hostility towards science which often makes it difficult for students to learn complex concepts. Through the module, we wanted to introduce our students to the study of chemistry by means of daily life phenomena.

Pizza is a food, very popular among teenagers and featuring strongly, together with pasta dishes, in Italian gastronomy. The module starts from a well-known food and seeks to analyse, from a scientific standpoint, the main chemical changes, physical and organoleptic characteristics that occur during its preparation by reflecting on the parameters that can affect the success of the final product. This activity also stimulates observation and reflection skills of students through requiring them to face a practical problem (how to make a good pizza) using a scientific method of investigation and an experimental approach.

Scientifically, this grade 10 (second year of secondary school) science (biology and chemistry) module is about fermentation and chemical reactions, while the educational goals are to increase student motivation, self-esteem and social abilities through group work and experimental work. At the end of the module, our students will present their work, improving, in this way, their communication skills. We are also developing a suitable assessment approach to positively evaluate the engagement and efforts of all of our students.

Acknowledgments: EC-FP7, Grant agreement no.: 266589.

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MOTIVATIONAL SECONDARY SCIENCE EDUCATION: PROFILES IN ITALY

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The PROFILES (Professional Reflection-Oriented Focus on Inquiry-based Learning and Education through Science, www.profiles-project.eu)[1] project has been initiated in Italy in several schools in the Marche region. The project promotes motivational inquiry-based science education (IBSE) by supporting science teachers to develop more effective ways to teach students, involving them in their learning. Because of the relation between a teacher's sense of efficacy and their commitment to teaching[2], it is important to sustain a long-term professional development programmes, based on the challenges of implementing student relevance in the learning of scientific subjects.

The programme for professional development includes coverage of active learning methods such as cooperative learning, the use of concept maps, scientific problem-solving plus support in the development of specially designed didactic modules for use in the classroom. The goal of the professional development is to develop teacher self-efficacy in motivational IBSE with an ultimate goal of transforming teachers into leaders, able to take ownership of the use of a socio-scientific learning environment for motivating their students in relevant science learning. The demanding task is to guide and support teachers in being able to scaffold students towards self-directed learning.

The PROFILES programme for professional development has started in seven schools, with teachers teaching a range of scientific topics. Although examples of modules developed according to the PROFILES' philosophy are available for every scientific subject, the teachers have preferred to enact their learning to develop their own teaching modules. Even though the programme started only a few months ago, one module is almost complete and others are at an advanced development stage. This demonstrates the potential importance of teacher motivation. The almost complete module 'Chemistry ... What a Pizza!!!' has been developed in collaboration between a chemistry and a biology teacher; this collaboration leading to very positive outcomes for the students. This is aided by a further goal of the programme for professional development which is to develop a professional friendship between teachers, so they can use the same teaching methods, can share the same standard for the assessment, and support each other where there are difficulties.

Acknowledgments: EC-FP7, Grant agreement no.: 266589.

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HOW MUCH ARE YOU COSTING ME!

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With the aim of improving interest and motivation in mathematics, several teachers from different schools in the Marche region are developing didactic modules to convey important concepts of the curriculum. The idea of the module "How much are you costing me!" is to involve the students in a topic vital for them: the cost of phone calls. The students work in cooperative groups, with different roles, to collect the tariff plan and the many offers from the multitude of providers. Students are involved in a modeling activity, with the objective to learn the Cartesian plan, the straight line, and the concept of function in a meaningful way. We wish to develop competences, knowledge and abilities, according to the curriculum, in a way that student find motivational and in this way be attracted to the learning of mathematics.

As it is often difficult to interest students in mathematics, we have followed the philosophy of the European project called PROFILES[1], to find ways of increasing the intrinsic motivation of students[2,3]. The idea is also to educate the students through this activity to be more aware of the use of the cell phone.

With this module, several important learning goals can be attained: comparing and selecting variables; developing mathematical models of real-world situations; making graphs of elementary functions; formalizing relationships between variables; strengthening the capacity for teamwork; using mathematics for the development of argumentation skills.

An example of work in progress. Together the students' worked on the parabola: in this experience, after minimal explanation, students were requested to develop meaningful applications of this geometric figure. Each cooperative group presented their work to the class and even the less interested students worked actively with their peers.

Acknowledgments: EC-FP7, Grant agreement no.: 266589.

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COUNTING THE CHEMICAL CONCEPTS

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Elementary calculation operations are verbalised, imitated and rehearsed until both conscious and automatic abilities are achieved in calculating masses and chemical amounts of substance in elementary stoichiometric problems. A new intermediary concept has been introduced with the purpose to lead or prepare to the *mole* as an intuitive concept.

Difficulty of students in choosing the proper way to divide or multiply chemical quantities in solving stoichiometric problems has been described and studied. Every teacher has experimented a strong frustrating and discouraging sense of inadequacy of the efforts to teach thoughtful (non-mechanical) strategies and/or the scarce reliability of automatisms based on the substitution of numbers in formulas or by means of Factor-Label like methods.

Several reasonable hypotheses have been carried out to make this issue explainable and several corresponding teaching strategies to overcome the lack of formal and proportional reasoning, as well as teaching materials have been developed. Models of particulate matter as nuts and bolts, magnets, symbolic drawings, etc. have been unsuccessfully exploited.

The hypotheses behind this experiment is that children build up spontaneous concepts as the number of apples in one kilogram neither by logics nor by arithmetic, but as the result of immersion in the implicit rules of a sort of linguistic game. Furthermore these concepts remain at the intuitive and unconscious level until the development of the systemic concept (true, scientific) structure of generalisation arises. It is important, anyway, to *prepare* the imitable "preconcepts" in such a way that they won't obstacle the subsumption, conscious, process.

Dividing the mass of a substance sample by the formula weight you get something similar to a *number* of formulas. We call this the –proportional- *number* of formulas, (molecules, atoms etc.), remaining indifferent to the lacking of measuring units. What matters is that this is psychologically a countable *number*. Moles haven't got the same sense. Too often they don't make *any* sense. The second step is comparing and verbalising similar calculations using this temporary concept. In the third step these numbers of formulas-particles of substance A are related (as equal, the double, one third and so on) to the corresponding number of formulas-particles of substance B. Finally, the easiest step is to multiplying number of B by the FW of B to get the mass of B. Verbalisations are made in every step to fix the rules of the implicit proportional reasoning.

BEGINNERS APPROACH TO CHEMISTRY IN A "MILD" INQUIRY BASED LEARNING LABORATORY CONTEXT

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The recent halving of laboratory time in the secondary State Technical Institutes in Italy has apparently impaired the possibility to exploit this resource in basic chemical education. Anyway, after one year and half of adaption to this new system, we have been compelled to re-think some aspects of laboratory as a resource, and some conditions for its effectiveness that had been overlooked in the past, because of the "abundance" of this resource.

In this abstract we can summarize the most important criteria for an effective IBSE lab program, according to the philosophy of the PROFILES project[1]. 1. Any important chemical concept should be referable to experimental evidence. 2. A few meaningful experiments should act as milestones in the path of the adapted and progressing syllabus. 3. The materials, instrumentation and context of each experiment should be presented in advance, with a preview of a certain phenomena, to illustrate the task, to elicit a focus question or investigation, and to give enough time for preparing a plan by the students, discussing vocabulary and theoretical background, and comparing the plans before of going in the laboratory. 4. Even if the laboratory is a firm anchoring reference in the development of the course, language development is more important, so it is better to defer a lab session and use time to fix and share chemical words and meanings, to rise the interest and understanding of students. Sometimes a demonstration can be done instead of a hands-on laboratory in groups. 5. Time demanding preparation activities should be avoided or pre-arranged in advance for the students by the teachers, and planning should be focused on time optimization in such a way to maximize the cognitive outcomes of the experiment. 6. Reporting and discussing after-lab should be supported by a ICT environment permitting a continuity of interactions and scaffolding tasks in school and out of school. 7. Every activity should be scaffolded and followed by imitation and practicing in the use of concepts, because of the age: the beginner students will never be able to master a complete inquiry activity and autonomous choice and use of concepts.

We mean to *prepare* the scientific-concepts construction, and not to expect straightway a mastery learning. This is the sense of adjective "mild" in front of Inquiry in the title.

Acknowledgments: EC-FP7, Grant agreement no.: 266589.

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