DOCENDO DISCIMUS: THREE GENERATIONS OF STUDENTS AS PROMOTERS OF SCIENCE DISSEMINATION SHARE THEIR DEEP-ROOTED PASSION FOR BIOLOGY

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Abstract

Here I present results and my ongoing activity of a new Science Teaching and Dissemination project conceived, started and realized in the framework of "FUTURO REMOTO", the Italian Convention aimed to Dissemination of Scientific and Technological Culture. The aim of this work started almost five years ago is to improve student engagement and participation to University Molecular Biology course their preparation and exams performance. In the frame of XXXII edition high school students ("budding" biologists) and three generations of biologists (researchers, high school teachers, graduate students and undergraduates in Life Sciences) were also enrolled spontaneously and freely teamed up to propose and involve the public of all age groups (including younger) in interesting activities deriving from their school-work experience at the Department of Biology of the Federico II University of Naples, Italy. Passion, competence, creativity and determination have supported the success of their Science Communication activities on the RI-GENERATION theme also documented by the results of satisfaction tests designed and prepared for this purpose and administered to visitors of all age at the end of the visit at the stand of XXXII Edition of FUTURO REMOTO last November.

Different activities, designed for visitors of all age groups, have been proposed, all seasoned with simple experiments and serious games to discover and have fun with the numbers and themes of molecular and/or cellular biology.

Keywords: Stem cells, Science Communication, by teaching we Learn, Docendo Discimus, peer-led team learning.

1 INTRODUCTION

Scientific research is considering a fascinating activity but is often disseminated using a language that is fully understood almost exclusively by expert.

In order to overcome the gap between Society and Science, The Docendo Discimus project is a teaching strategy that encourages students to engage in independent self-directed investigations and exploration by developing a range of specific skills in Molecular Biology and Life Sciences in the last three years [1], [2], [3]. Docendo Discimus is a teaching model that organizes teaching and learning around a learning theme. According to the definition found in the literature for the Based Learning project, the Docendo Discimus projects provide for complex tasks, based on challenging topics that involve students in the design, resolution of problems, decisions or investigative activities and dissemination to an audience of any age group of non-experts. The students selected to be part of the Docendo Discimus team are given the opportunity to work relatively independently for a long period of time (from one to three months), their activities culminate in products (posters, games, models) and concrete public presentations [4], [5]. For the continuity of the scientific-educational project, in order to encourage talented students, and empower effect of leadership roles [6] last year I selected 4 of the 12 members of the Docendo discimus team from undergraduate or graduated students who did well in the previous edition of Futuro Remoto. I trained them for leadership roles and entrusted each of the undergraduate students to the new team.

This experience added a contribute to a growing body of research [7], [8], [9], [10], [11] by analyzing how students engage in conversation and work together to solve problems in a peer-led small-group setting.

2 METHODOLOGY

All activities and many of the products have been documented with digital pictures taken by the author of this paper and by students involved during or at the end of their activities. For the assessment and
the evaluation of achievement level of training and skills objectives, structured tests for the evaluation of the progression of learning and a semi-structured test for the final evaluation of the objectives achieved have been prepared.

3 RESULTS

This project derives direction and ideas from my experience derived from innovative educational projects, funded under the Italian Ministry of University and Scientific Research, aimed at bringing the students of High School to Work. Some of my ongoing projects have been realized and advanced, as part of the planned activities that have been targeted in order to enhance Biology learning of a class of 20-25 High School students (16-17 years old). One of the key elements to reach enhanced education at the level of University courses such as those in Molecular Biology or biotechnology, is the need of time and expertise to allow the High School student to familiarize with regular theory in par with laboratory techniques. Experiencing in a personal way has been useful to gain confidence both with the scientific method and with scientific research world. In Fig.1 (panel A-C) and Fig.2 (panel A-E) some digital shots are given as an example of the activities carried out with high school students who have participated in simplified wet-lab activities, if compared to those directed to University students and with me, have been recruited to become peer-leaders. The integration of the molecular approach (wet-lab: DNA extraction, DNA spectrophotometer analysis, agarose gel electrophoretic analysis, restriction enzymes hydrolysis, PCR introduction), and bioinformatics (in silico lab) are the educational and training peculiarities of Integrated Learning Project that I've designed and reported before [12], [13].

Moreover, as promoters of Science dissemination, all students involved were also equipped with paper, pencil, ruler and fantasy to build 3D DNA origami (Fig 3, panel A) also customized and 3D edible DNA models (Fig.3, panel B and C) realized using fruit and or vegetable were proposed and/or build in order to reinforce the pleasure of discovering and learning through teamwork.

University undergraduates, conceiving and creating posters, written both Italian and English languages, models of cells and viruses (Fig.4) purposely constructed with "poor" and/or recycled materials, have allowed visitors to discover "the numbers" and the functions of the generations and re-generation of cells while they are kept under a microscope.

A strategy to increase public interest in Life Sciences was to design serious games and make "live games" by interpreting and implementing the theme re-generations of the XXXII edition of FUTURO REMOTO. In particular, "live games" were prepared almost seven weeks before generating plants from seeds (Fig.5, panel C and D) and pictures of animals from egg cells (Fig.5 panel B).

A further playful activity, which was very successful, was one in which visitors had to "connect" images of larvae to their respective adult insect (Fig.5 panel C) and crosswords, memory games and some simple experiments in line with the RE-GENERATION theme.

Dissemination activities integrated with those carried out in the Molecular Biology laboratory (wet-lab) and also in Bioinformatics (in silico lab) have constituted and will constitute the thesis project of three-year degree in Life Sciences of some team members (http://www.dipartimentodibiologia.unina.it/progetto-docendo-discimus).

For the continuity of the scientific-educational project, in order to encourage talented students, last year I selected 4 of the 12 members of the Docendo discimus team from undergraduate or graduated students who did well in the previous edition of Futuro Remoto. I trained them for leadership roles and entrusted each of the undergraduate students to the new team.

This experience added a contribute to a growing body of research by analyzing how students engage in conversation and work together to solve problems in a peer-led small-group setting and to elaborate different satisfaction test for the audience.
Figure 1. High School students, dressed in official personal protective equipment, were able to learn from researchers and University students, to explore the molecular biology lab and experience first-hand a range of scientific wet lab activities at Biology Department of University of Naples Federico II.

Figure 2. In silico lab: high school students familiarize with regular theory in par with laboratory techniques. Among first lab virtualized there are those on general laboratory techniques (panel B) those on informational macromolecules starting with nucleic acids (DNA) or proteins, and in particular on their electrophoretic separation on agarose (panel A, C and D) and polyacrylamide gels from Science Education section of Basic Biology of the Journal of Visualized Experiments (styled JoVE).
Figure 3. Examples of 3D DNA models realized folding paper (Origami) (panel A) or edible DNA using familiar object as some fruits (panel B) and vegetables as a lemon (panel C) in order to reinforce the pleasure of discovering and learning through teamwork.

Figure 4. Models of viruses purposely constructed with “poor” and/or recycled materials to allow visitors to discover the size and function of viral invisible structures even if observed under an optical microscope. The picture also shows the original “BIO-TRIS” game designed to correlate the number of chromosomes to picture of animals or vegetable specimens and their genetic complexity.
Figure 5. Examples of "live games" generating shoots or plants (in the pots) from seeds (on the wheel, panel D) and pictures of animals from egg cells (panel A). Particularly all exhibition visitors have been involved in recognizing and correlate seeds and plants, eggs and/or animals, larvae and adult insects.

Figure 6. Example of Satisfaction Test elaborated also to transmit further knowledge

4 CONCLUSIONS

Docendo Discimus project is going to be also an opportunity to improve the knowledge of the English language and scientific writing skills of undergraduate students using scientific text and webinar with the goal to realize a multidisciplinary approach teaching aimed at different aspects and applications of biotechnology technique DNA based. It is an example of multidisciplinary Integrated Problem Based Learning (PBL) for Soft Skill improvement and High Order Thinking of Vocational Students applying and modifying also in Cyberspace the well-known Peer-Led Team Learning pedagogical strategy. When we think about the high school of the future, it is natural to take into consideration the huge role
of technology. Our future will be plenty of spaces, where physical and digital won’t be told apart and classrooms are probably one of the first environments in which this synergy is already coming true and will come true more and more and will have an impact on every aspect of the learning experience: on teachers, students and learning methods. However, the risk is still that of focusing on a choice between physical and digital solutions, embracing this point of view when we really must accept the fact that we will always be moving between these two dimensions and increasingly never leaving either realm. Through all this, the aim is to offer a global and introductory vision of possible educational scenarios of the future. We will take into consideration the fact that society and technologies are forever advancing and that, due precisely to this uncertainty, we should train teachers and prepare our students who will be the future teachers.

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REFERENCES