



A Flipped Experience in Physics Education Using CLIL Methodology

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ABSTRACT

Physics' curricula of Italian Scientific High Schools in the last years have been enhanced by the introduction of Quantum Mechanics and Content and Language Integrated Learning (CLIL). Education monitoring reveals that last year's students are experiencing many issues in learning in their second language (L2) and advanced and counter-intuitive contents. Our experiment is aimed at understanding and then overcoming those problems using educational methodologies based on social aspects. Thanks to the Internet, a communicative style can be exploited where teachers could keep teaching, playing the role of semiotic mediators. Multimedia and simulations broadly available in MOOCs suggested a flipped classroom approach coping with the project of CLIL lessons. In our experience two classrooms of students were selected, starting from very similar performances and skills. The first one was taught with traditional lectures and tests; the second one, instead, attended to experimental lessons. Students could share their ideas and learning supports through a Facebook group, a blog, virtual classrooms and a website. Nevertheless, at the end of the experience an eTwinning exchange was planned, to spread the experiment towards foreign schools. The outcomes of the tests performed on the students were analysed and unexpected results were drawn. An extension to larger numbers of students, the introduction of different methodologies and the research about different topics in Physics could potentially develop this research.

Keywords: flipped learning, CLIL, peer learning, modern physics

INTRODUCTION

This work is the result of a teaching experimentation, through a Quantum Mechanics CLIL learning module presented to two last year's classes in an Italian Scientific High School. The rationale of our investigation is based on the fact that this topic has been introduced only recently in Physics' curricula of High Schools and it has been proven that students encounter quite a lot of problems in learning its advanced and counter-intuitive concepts (Deslauriers, L. et al., 2011; Tsapalis, G. et al., 2009; Singh, C. et al., 2006). Trying to fix these issues, we founded the choice of our educational methodology on social considerations: nowadays knowledge transmission is widely supported by digital technologies, featuring large amounts of information conveyed at high speeds and a high grade of interaction. Digital Natives, exhibiting noteworthy changes in behaviour, cognition and communication skills, need new educational approaches (Prensky, M., 2001). Current cultural models are somehow centred on the

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Contribution of this paper to the literature

- Our idea is to put together these two methodologies, because, as specified before in this paper, teachers in CLIL are mainly guides and facilitators of knowledge as in Flipped Classroom.
- Our challenge to make Quantum Mechanics more friendly recalled the basic concepts of our experiment design.
- The possibility to try these methodologies in a classroom gave us a validation of our original ideas.

concept of “collective intelligence” (Woolley, A., 2010), where no one knows everything, everyone knows something and all knowledge belongs to all of mankind. Thanks to digital devices, constantly connected to the Internet the most colossal knowledge repository ever realized, a communicative style, strongly characterized by virtual interactivity, autonomous production and sharing of individual contents, speed and communication efficiency is now emerging. In this completely new background, however, teachers still holds the role of semiotic mediators. Therefore a flipped classroom approach seemed to cope with the project of CLIL Modern Physics lessons: multimedia and simulations broadly available in MOOCs, in cloud learning environments and in social educational platforms could help teachers in their scaffolding task. The most appropriate contents, properly selected by teachers and shared with students, could be a strategic tool for students to deepen their knowledge out of the classroom independently. So the classroom comes to be a lab, where even complex ideas are discussed and higher level thinking skills are exploited in order to project and realize concrete experiments and applications to actual study cases, with the side effect of a fluid cognitive and linguistic development. In our experiment two classrooms of students were selected, starting from very similar performances and skills. The first one, A, attended to experimental lessons; the second one, B, instead, was taught with traditional lectures and tests.

ACTIVITIES

To increase the interaction level, a Facebook group and a blog were founded, where students very easily shared their ideas and materials. Besides, a website was created, as a repository of contents contributed by students but revised and selected by the teacher. Specifically, flipped activities were organized so that one subgroup collected as many information as possible about a specific part of the topic and then shared it with the entire group.

Students discussed each part of the topic developing ideas and redefining in a more precise way the key concepts. Exhibits and models were built to leave a tangible footprint of the activities.

Besides, a laboratorial activity, focused on a simplified version of the double slit experiment, was carried out by students. “...Richard Feynman famously said that interference of particles captures the essential mystery of quantum physics; at the time, this was still mostly a thought experiment, but in the intervening fifty years, the exact experiment he discussed has been done numerous times, with numerous particles.” (Orzel, C., 2015).

The double slit experiment, first performed by Thomas Young in the early nineteenth century, could be considered a key to understand the microscopic world and in particular the wave-like properties of light. In the original experiment, a point source of light illuminates two narrow adjacent slits in a screen, and the image of the light that passes through the slits is observed on a second screen. The dark and light regions that we can observe on the second screen are the interference fringes, the constructive and destructive interference of light waves. Also the matter produces interference patterns, as we can see by firing a stream of electrons instead of light.

Students performed this experiment using a piece of smoked glass scratched using a pin, drawing different couples of very thin lines, the slits (about 0.1 mm, 0.2 mm and 0.05 mm), to detect different interference patterns. After that, they illuminated the slits using a coherent light source, such as a laser beam from a laser pointer. So different Fraunhofer diffraction pattern appeared on a screen, placed 4 meters away (see [Figure 1](#)). The measurements should be taken in a darkened room or in constant natural light. If this is not possible, a longish tube about 4 cm in diameter and blackened on the inside (such as a card-board tube used to protect postal packages) can be used.

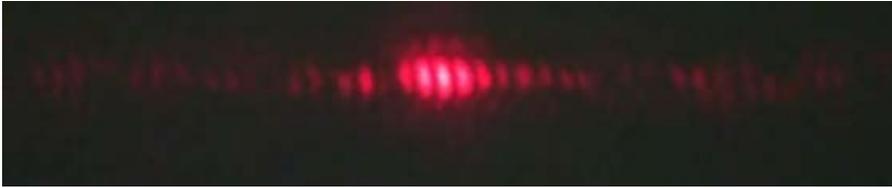


Figure 1. Interference pattern

Using the same experimental setup but with a single slit, they also proved the uncertainty principle: the thinner is the slit, the wider is the position of the photons on the screen.

TESTING AND OUTCOMES

At the end of the module, both the classes A (flipped classroom) and B (traditional education) were tested using a similar online form. Two sets of 30 items were selected with the aim of detecting the skills obtained by the students. Besides, in order to limit cheating and other kinds of mutual influences, the testing system scrambles the multiple questions and answers and ask different questions to different students.

Testing procedure also included the production of a report of the experiments: the sharpness and the quantity of information of group A was largely higher than the one of the group B.

Finally, testing procedure also included the verification of the results after a month.

Also in this case, students were tested by an online form with 30 multiple choice questions and the results confirmed that the flipped classroom group A obtained a more persistent knowledge as in the next diagram.

The histograms depicted in **Figure 2a, 2b** and **2c** show a synthetic version of the results.

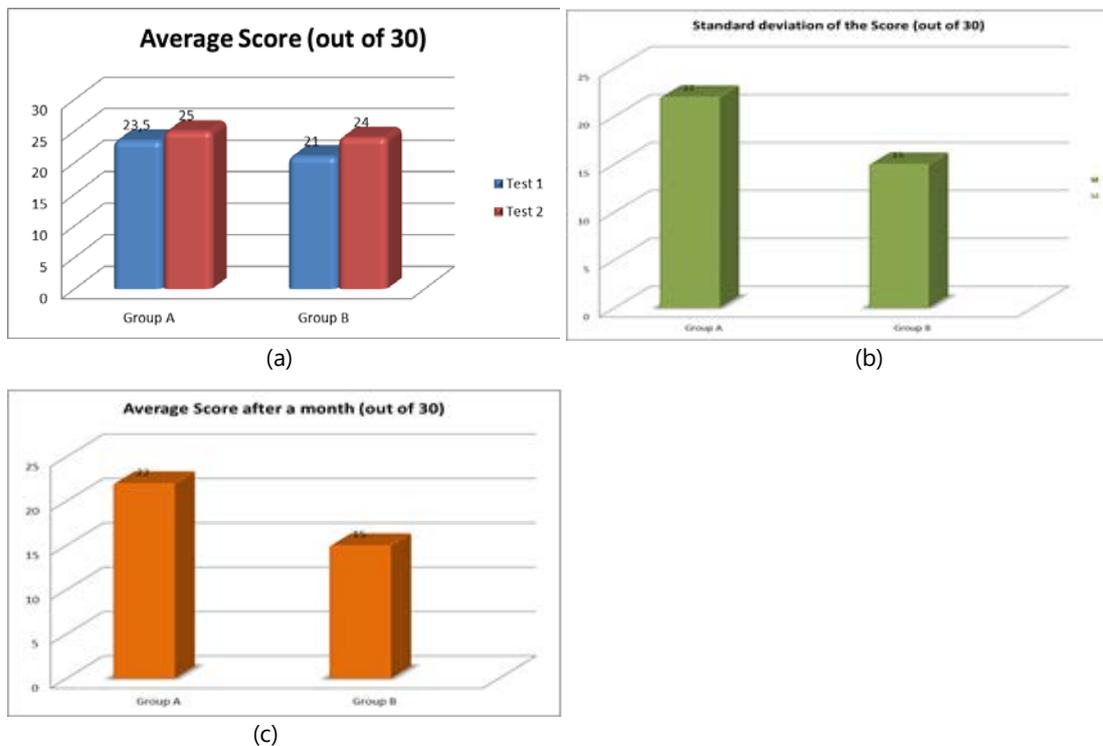


Figure 2. Testing outcomes: a) average scores of a multiple choice test; b) standard deviation; c) persistence of the results

CONCLUSIONS AND FUTURE DEVELOPMENTS

This experiment has shown that performance of secondary school students can benefit of flipped classroom strategy in learning difficult topics, such as quantum mechanics in CLIL methodology. These outcomes, very persistent in time, were gathered by a multiple choice questionnaire and reports.

Potential future developments of this experience are the extension to larger numbers of students, the introduction of different methodologies and the research of the similarity of the issues encountered in quantum mechanics with the ones encountered in other similar topics.

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