

An innovative learning ecosystem for educational success and orientation.

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Abstract. This work presents an innovative teaching practice implemented in the "Physics for Biologists" course of the Bachelor Degree in Biology at the University of Calabria. The methodological innovation was motivated by the reduced fraction of students, enrolled in the course during last few years, who passed the exam on schedule. Setting up an original learning ecosystem, based on the Just-in-Time-Teaching (JiTT) practice, allowed a great improvement of the educational outcomes as regards both the fraction of students earning the physics credits on time and the average mark of the passed exams. Its possible extension to high schools will surely foster students' orientation towards an effective learning method, suitable for STEM studies.

1 The context

This work presents an educational innovation experience, currently being tested since the academic year 2014/15, introduced in the course of "Physics for Biologists" at the University of Calabria. The need for innovation started from the observation of the critical problems encountered by students in the acquisition of Physics learning credits, scheduled for the first year of course. An accurate analysis about the origins of this criticality identified the lack of students' class attendance as one of its main causes. Further insights suggested that this reduced attendance was just a proximate cause, as in turn determined by a series of factors rooted in the previous school experience of freshmen. These factors included:

- a) The habitude to a content-based study, with reduced or no conceptual understanding, very often based on the simple and acritical memorization of formulas;
- b) The lack of perception of the role of the assessment and of the peer comparison, as fundamental elements of the learning experience;
- c) The need to be constantly guided by the teacher;
- d) A student's overestimation of their own skills, also caused by the reduced culture of standardized assessment, characterizing many schools in Italy.

In particular, regarding point c), a significant fraction of the students showed to need (often unknowingly) the continuous presence/supervision of their teacher in order to keep high and constant the due commitment. The combination of these factors (worsened by the discontinuity in the organizational model in the school/university transition) confirmed the widespread commonplace, in the students' subjective perception, picturing Physics as an inaccessible and abstract discipline. In this context, the freshmen got soon discouraged, abandoned the attendance at lectures, postponing the physics exam at an indefinite later time. As a final effect, at the end of the first year, only 20% of students succeeded in the physics examination, while their success in remaining courses were attested around 60%.

2 The educational innovation

In this context, starting from the a.y. 2014/15, we have completely redesigned the "Physics for Biologists" course, based on the Just-in-Time-Teaching (JiTT) methodology [1, 2]. The new teaching approach is built up and grounded on an original active learning ecosystem, enriched by highly innovative teaching services. Classroom activity is only one component of the ecosystem and the role of students is not limited to passive information receptors. The implementation of the learning environment is made possible by the employ of the latest interactive teaching technologies, based on the use of students' personal devices (smartphone, tablet, notebook), following the BYOD paradigm (Bring Your Own Device) whose validity is widely recognized. A key tool in this ecosystem is represented by an e-learning platform based on the *Moodle* Course Management System. Besides didactic interaction among students and students and teacher, the platform allows learners to get trained with the relevant conceptual physics topics through multiple choice quizzes, giving (as an immediate feedback) an exhaustive explanation either for erroneous or for correct answers (Fig. 1).



Fig. 1 Example of a multiple choice item giving students a formative feedback for erroneous answers.

The implementation of the outlined teaching method has led in the last three years to a progressive improvement in the students' performance in the "Physics for Biologists" course, whose rate of success has first reached (a.y. 2014/15) and then have overtaken the average students' performance in the other first year courses. Furthermore, we found that this improvement is closely related to the noticeable increase in the steadily high attendance rate to the class activities (around 90% in the 2017/18 academic year).

We believe that our experience may be useful for facing and solving important orientation issues, characterizing students' transition from high school to STEM university degree courses.

[1] G. Novak, E.T. Patterson, A.D. Gavrin and W. Christian, *Just-In-Time Teaching: Blending Active Learning with Web Technology*, Prentice Hall, Upper Saddle River, NJ, 1999.

[2] K.A. Marrs and G. Novak, Just-in-Time Teaching in Biology: Creating an Active Learner Classroom Using the Internet, *Cell Biology Education* 3 (2004) 49-61.