We want news about Pingu: An explanatory action research case study in undergraduate service mathematics

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MATH IS SCARY

Math is scary. For life science students, math is even scarier (Bishop & Eley, 2001). Students' failure in mathematics is usually attributed to their negative attitudes towards the subject (Goldin & al., 2016), or to the rupture of the self-regulation cycle of engagement, reflection, and anticipation (Schunk & Zimmerman, 1998). What is even worse, is that students "after taking Calculus showed a reduction in positive attitude about mathematics" (Rickard & Mills, 2018) and that "[b]etween the start and the end of the students' college calculus class, their confidence and enjoyment of mathematics dropped sharply, with confidence falling by half a standard deviation and enjoyment of mathematics by a third" (Bressoud, 2015).

I have been teaching for six years the Calculus class in the "Natural Sciences" programme, a BSc degree in Italian universities which, integrating life & earth sciences, focuses on the correlation between organisms, substrate, environment. Its students are often amongst the *weakest* STEM students with respect to mathematics competences that should have been acquired in high school (Rizzo, 2020).

What to do? Bressoud (2015) shows that *ambitious teaching*, i.e. active learning approaches, can be a solution.

WHAT IS GOING ON?

Pandemic at-distance teaching (Fall term 2020) brought the creation of short ad-hoc videos on all the *theoretical* contents in the syllabus. This made possible to devote most class time to active teaching, thanks to the capability of at-distance software to effectively implement rapid quizzes and the subdivision of students in small groups.

The Fall term 2021 was, in Milan, back in presence—but with the possibility for students to attend at-distance. The availability of the videos created for the previous term allowed a flipped approach, with most 2-hours slots devoted to a cycle of formative assessment (45') and to an explorative group activity (60') where students were called to apply the assigned concepts to the solution of a problem relevant to Natural scientists. E.g., using vector sums to compute the position of a dolphin given daily movements as detected with a GPS device; or using derivatives to study the weight of a nesting penguin and his chances of survival before the return of his companion.

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THE THEORETICAL FRAMEWORKS

Classes were designed using the formative assessment cycle theory (Black & Wiliam, 2009) and Engeström's (1999) Activity Theory. Specific examples of the design will be shown in the poster.

THE RESEARCH QUESTION

Do we have an effective active learning approach? What does *effective* mean, in this context? It has been shown (Rizzo, 2020), that the chance of success—defined as passing the exam within the Academic Year—is closely related to the score in the national standardised entrance tests; for *effective* we will henceforth mean not dropping out, passing the exam and later passing Statistics.

We do not yet have a quantitative answer to the first question, since students are still sitting exams. Although data will be definitive only in February 2023, partial results suggest a positive answer; moreover, we already have some quantitative results:

— Students have been observed talking about the problems outside of the classroom, on their way to the cafeteria.
— Students have reacted negatively to the news of the episodical *traditional* face-to-face lecture: "We want news about Pingu!" was notably a student's reaction.
— Attendance to lectures decreased to 40% rather than 25-30% at the end of term.

REFERENCES

Bishop, R., Eley, A (2001). Microbiologists and maths. *Microbiol. Today*. 28, 62–63

Bressoud, D. (2015). Insights from the MAA National Study of College Calculus. *Math. Teach*. 109, 179–185.

Engeström Y. (1999), "Activity theory and individual and social transformation", in Y. Engeström, & al. (eds.), *Perspectives on activity theory*. Cambridge : CUP.

Goldin, G. A., Hannula, M. S., … (2016). *Attitudes, Beliefs, Motivation, and Identity in Mathematics Education*. Springer Open.

Rickard, B.; Mills, M. (2018). The effect of attending tutoring on course grades in Calculus I. *Int. J. Math. Educ. Sci. Technol*. 49, 341–354.

Rizzo, O. G. (2020). Online remedial courses for missing mathematics credits in scientific degree programmes *Quaderni Di Ricerca in Didattica*, NS 8, 79–86.

Rizzo, O. G. (2021). Making Good of a Pandemic: A Long-Distance Remedial Summer Course in Calculus. *Education Sciences*, *11*(7), 327.

Schunk, D.H.; Zimmerman, B.J. (Eds.). (1998) *Self-Regulated Learning: From Teaching to Self-Reflective Practice*. New York : Guilford Press.

Black, P.; Wiliam, D. (2009). Developing the theory of formative assessment. Educ. Assess. Eval. Account. 21, 5–31.