FEMS Microbiology Letters, 368, 2021, fnab016

doi: 10.1093/femsle/fnab016
Advance Access Publication Date: 17 February 2021
Commentary

COMMENTARY – Professional Development

MicroMundo@UPorto: an experimental microbiology project fostering student's antimicrobial resistance awareness and personal and social development

Patrícia Antunes[1,2,†,‡], Carla Novais[2,3,†,‡], Ângela Novais[2,‡], Filipa Grosso[2,‡], Teresa G. Ribeiro[2,‡], Joana Mourão[2,‡], Svetlana Ugarcina Perovic[2,‡], Andreia Rebelo[2,‡], Magdalena Ksiezarek[2,‡], Ana R. Freitas[2,†,‡] and Luísa Peixe[2,3,*,†,‡,§]

[1]Faculty of Nutrition and Food Sciences, University of Porto. Rua do Campo Alegre, 823 / 4150-180 Porto Portugal, [2]UCIBIO/REQUIMTE, University of Porto, Portugal and [3]Faculty of Pharmacy, University of Porto. Rua de Jorge Viterbo Ferreira n°. 228, 4050–313 Porto, Portugal

*Corresponding author: Faculdade de Farmácia da Universidade do Porto, Rua de Jorge Viterbo Ferreira n°. 228, 4050–313 Porto, Portugal. Tel: +351 220428580; Fax: +351 226093390; E-mail: lpeixe@ff.up.pt

One sentence summary: A brief description of a microbiology service-learning experimental project, MicroMundo@UPorto, as an approach for integrating students' antimicrobial resistance awareness with personal and social development.

Editor: Beatrix Fahnert

†These authors co-coordinated the initial implementation of MicroMundo project in Portugal through the University of Porto.
‡All authors actively participated in the tutoring of University students or in the organizational part of the project.
§Luísa Peixe, http://orcid.org/0000-0001-5810-8215

ABSTRACT

Antimicrobial resistance (AMR) is a global societal challenge requiring the contribution of professionals along with general community citizens for their containment. Portugal is one of the European countries where a lack of knowledge on the correct use of antimicrobials and AMR problematic is preeminent. Moreover, youth demotivation to pursue science careers is emerging. To address these problems an innovative experimental service-learning pedagogical strategy, MicroMundo@UPorto, was implemented in Portugal during 2018 through University of Porto as a partner of the global Citizen Science project 'Tiny Earth' responding to the AMR crisis. In this first edition of MicroMundo@UPorto, university students ($n = 41$; Pharmaceutical Sciences and Nutrition Sciences) organized in eight teams tutored by university professors/researchers ($n = 13$) on Microbiology and AMR theoretical and practical aspects as well on communication skills to enable their guidance of younger school students ($n = 140/3$ schools) in experiments to discover antimicrobial-producing microorganisms while exploring the soil microbial diversity. Post-survey-based evaluation revealed that this project allowed university students to acquire diverse personal, social and scientific skills while increasing AMR awareness, in the One-Health perspective, and interest for science in school students. This University to Society approach can be successfully extended across Portugal and for education in Microbiology in general, with benefits for the future generations contributing to socially responsible and scientifically-literate citizens.

Received: 8 January 2021; **Accepted:** 13 February 2021

Keywords: active learning; education; microbiology; service-learning; antimicrobial resistance; public engagement

INTRODUCTION

Antimicrobial Resistance (AMR) is one of the most important global public health challenges of the 21st century. Being a cross-cutting problem in clinical, food and environmental areas-'One Health' (McEwen and Collignon 2018; WHO/FAO/OIE 2016) it justifies the simultaneous commitment of different professionals (research, health and education) along with community citizens for their containment. Education and training on AMR is among WHO priority areas, in line with the goals of 2030 Agenda for Sustainable Development (United Nations 2015), to globally tackle AMR (World Health Organization 2015), as deficient knowledge in this topic is widespread in many countries. In fact, according to data from the Eurobarometer (2020), Portugal is one of the European countries where the lack of knowledge about the correct use of antimicrobials and awareness about AMR is preeminent. Moreover, pre-graduated students are globally showing demotivation to pursue science careers compared to other professional areas (Kearney 2016). To address these two problems with an integrated approach, novel pedagogical strategies for engaging young students and their relatives on AMR global crisis have recently been developed in different countries worldwide (Valderrama *et al.* 2018). Among such strategies is 'Micro-Mundo' (common designation in Portugal and Spain) integrated in a global Citizen Science project (Tiny Earth-https://tinyearth.wisc.edu/) in AMR (originally implemented in the USA with Small World Initiative designation in 2012—http://www.smallworldinitiative.org/).

In this commentary, we present and discuss our experience with MicroMundo@UPorto project, while describing practical issues and the benefits for student's learning pathway. We believe that our experience constituted an opportunity to join active learning of U.Porto's students with different backgrounds through a social commitment, seeking to have future good professionals and socially responsible and scientifically-literate citizens, extendable to other Portuguese Universities.

PROJECT DESIGN

MicroMundo@UPorto started in Portugal in 2018 with the main aims to increase awareness about 'Antimicrobial Resistance' in our community and to stimulate the interest in science and research of students from various educational levels. Through the application of an innovative Service-Learning teaching strategy outside the university context (Webb 2017), students from two curricular units (Bacteriology-Faculty of Pharmacy-FFUP and Microbiology-Faculty of Nutrition and Food Sciences-FCNAUP) from University of Porto (MicroMundo@UPorto) were trained on Microbiology and AMR theoretical and practical aspects. Simultaneously, this project aimed also to contribute to an improvement of university students' academic performance through the acquisition of diverse personal, social and scientific skills as well as approximating the University to the Society. By involving two educational levels, the experimental challenges allowed university students to motivate and teach younger school students while promoting their own development. The following sections explain in detail the project structure, the sessions involving knowledge transfer and the interaction between the University and schools.

Planning and preparation of university students for school sessions

The MicroMundo@UPorto methodology is centered on promoting university students active-learning by acquisition of new knowledge in Microbiology and AMR and soft skills through a strong component of social commitment and science literacy. The four-session course is prepared with great involvement of university students (named MICRI**TA**s as Teacher Assistants), supervised by a university professor or researcher (MICRI**PI**s as Professor/Investigators), to be taught to third cycle (ninth year—14 years old) and high-school (10th year—15 years old) students (MICRI**CE**s as school scientists; Fig. 1). Each team is constituted by 1–2 MICRIPIs, 4–7 MICRITAs and a class of 20–25 MICRICEs plus their Natural Sciences school teacher (MICRI**PE**, as School Professor). The experimental challenge to engage students for the AMR problem is the discovery of antimicrobial-producing microorganisms while exploring the microbial diversity of Portugal's natural soil habitats. The first stage was the recruitment of community partners (three Porto schools, eight Natural Sciences classes ministered by six school Professors and 140 students) and university students from FFUP and FCNAUP (41 volunteered). The students' theoretical training (2 h session) consisted on the presentation of the AMR problem in the One Health perspective, a detailed explanation of the project goals and tasks, and a workshop entitled 'How to Communicate Science?', supported by the Portuguese Program 'Ciência Viva'. This session was held during the World 'Antibiotic Awareness Week' and included public awareness campaigns through paper posters and social networks advertisement (Facebook—'MicroMundo@UPorto'; Twitter—https://twitter.com/MicroMundoUP and Instagram—https://www.instagram.com/micromundo_uporto/) by students/other stakeholders. This was followed by two laboratory sessions (2 h each) for explaining and debating Microbiology methodological issues (e.g. biosafety, soil collection, material preparation and recording/interpretation of results) and mimicking the work developed by the students in the school sessions preparing them to face different levels of responsibility and difficulty. Before school visits, students were organized in teams and tutored by each MICRIPI for school' sessions preparation. Each team was free to organize the teaching material (e.g. PowerPoint slides, videos, games and quizzes) for the schools sessions (2 h each; four consecutive weeks), using the pedagogical strategies that they consider most favorable to teach Microbiology concepts, to communicate the AMR problem and the measures for its containment. Since this project involved teams of Pharmaceutical and Nutrition Sciences students/tutors, diverse strategies to teach the AMR problem were used, namely AMR awareness-learning videos in the One-Health perspective (e.g. https://www.youtube.com/watch?v=DlQUbWlV5SU). The team tasks also included the organization and preparation of laboratory material (70 EUR were estimated for the acquisition of consumables' for each school class-10 soil samples and 20 school students). The Basic Laboratory Guide, adapted from the original SWI-Spain (Valderrama *et al.* 2018), was provided to support student's work at both levels of education. In the last years, improvements to the proposed microbiological protocols and/or pedagogical strategies were performed by Spanish nodes of MicroMundo (De Groot *et al.* 2019; Alvarado *et al.* 2020; Bueso-Bordils *et al.* 2020; Maicas *et al.*

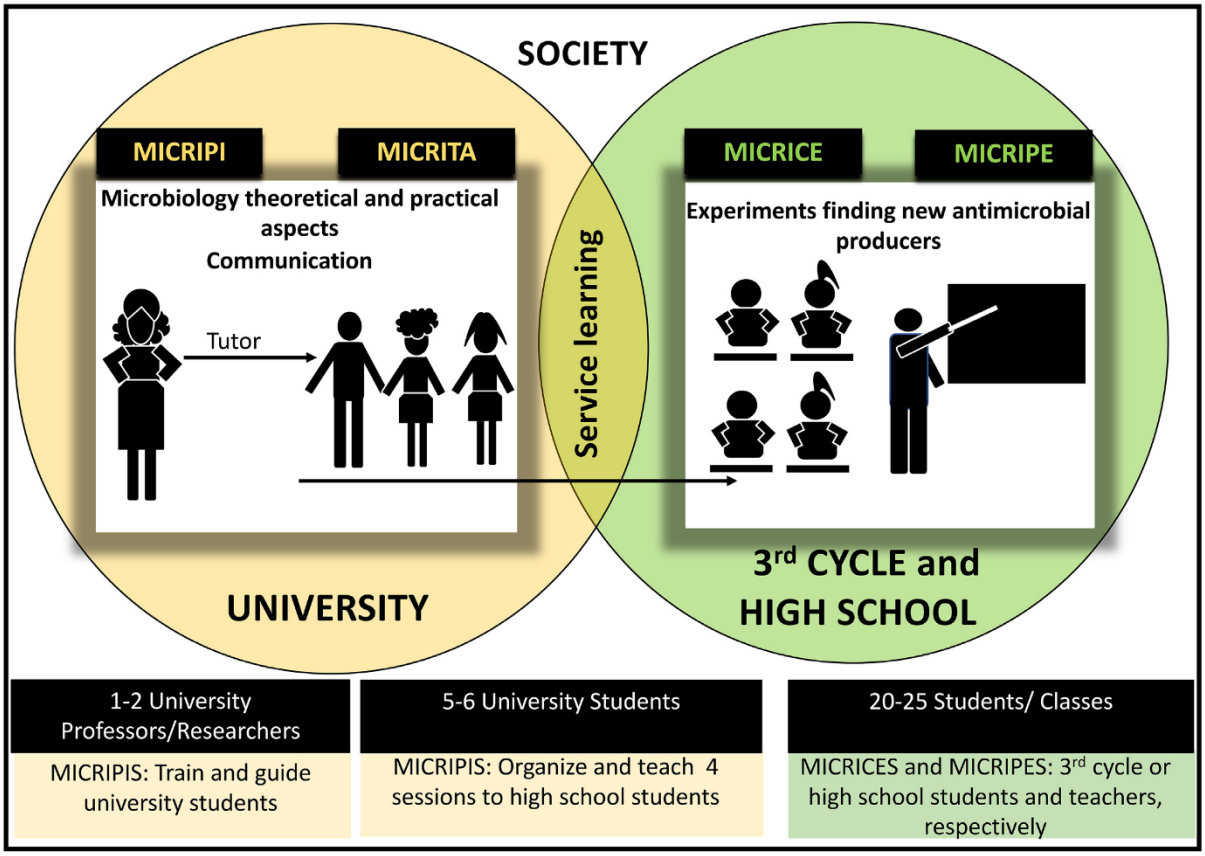


Figure 1. Organization of the MicroMundo@UPorto team.

2020) and in the USA towards education on genomics and bioinformatics (Basalla *et al.* 2020).

From the university to schools: *in loco* activities during the four sessions

An overview of the MicroMundo@UPorto project school sessions is provided in Fig. 2, highlighting the diverse opportunities for acquiring new knowledge, soft skills and competences, critical for their personal and professional development. Briefly, MICRITAs started with a general presentation about the project, Microbiology concepts and AMR challenge and distributed a kit for soil sampling explaining correct procedures for collection (session-1). The soil samples were processed (session-2) and representative colonies selected for antibiosis assays against safe relatives of clinically-relevant species (*Staphylococcus epidermidis* and *Escherichia coli*; session-3). In the session 4, the results were registered and discussed followed by variable quizzes, games, videos or other creative ways to conclude the project. All biological material returned to the University and identification of soil isolates with inhibitory activity was performed by VITEK® MS (bioMérieux, Marcy l'Etoile) or genotypic markers, and stored for further analysis. In this first year, eighty soil samples were collected in eight different Portuguese regions and eight hundred isolates were selected for antibiosis assays. Presumptive positive results were detected among 50 isolates recovered from 20/80 samples (25%), which belonged to different species mainly from Gram-positive genera (e.g. *Bacillus*, *Kocuria*, *Micrococcus*, *Paenibacillus*, *Rhodococcus*, *Staphylococcus*, *Streptococcus* and *Streptomyces*). All isolates showed antagonistic activity against the tested Gram-positive *S. epidermidis*, whereas no growth-inhibiting activity was detected against the Gram-negative *E. coli*. In this laboratory-based experiments, students investigated their own and their classmates' soil samples to address the proposed research questions: I-What is the microbial diversity present in our soil samples?; II-How to distinguish the different microorganisms from each other?: III-Are bacteria from different environments distinct?; IV-Can we detect antimicrobial activity? and V-Are environmental microorganisms capable of inhibiting the most feared 'superbugs' that cause human infections? According to our first year experience, different student´s backgrounds led to the development of diverse strategies to approach the same problem along the four sessions, contributing to their personal and scientific enrichment.

Post-survey-based evaluation

The impact of the MicroMundo@UPorto service-learning project on MICRITAs and MICRICEs was assessed by an anonymous online survey using Enalyzer (https://www.enalyzer.com) with response scale questions (Figure S1, Supporting Information). A high level of achievement by MICRITAs towards the acquisition of research abilities, soft skills and competencies, as well as the usefulness of the service-learning approach for their personal and professional development was revealed. Concerning the impact of the project in their future career or academic decisions, more than half of the students agreed that they were positively inspired for orienting their curriculum towards research (Figure S1-A, Supporting Information). Concerning schools, most MICRICEs considered that the project encouraged their interests and competencies for science, as well as increased their

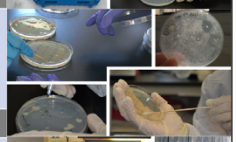
Overview of the MicroMundo@UPorto experimental module		
Outline of the experiment sessions	**Specific activities performed by University students**	**Illustrations of school activities**
S1-Introductory lesson: project explanation, introduction to the "real problem" - Antimicrobial Resistance (AMR), biodiversity exploration and soil collection.	-Literature search about AMR challenge, soil biodiversity and laboratory biosafety measures. -Planification of the pedagogic approach to communicate concepts described in the previous point. -Presentation on the composition of soil collection kit and explanation of soil collection method.	
S2-Soil analysis: weighing, dilution, and plating of soil samples (10-12 per class; total=80 from 8 districts).	-Literature search about culture media, dilutions and incubation conditions. -Planification of the pedagogic approach to communicate the concepts described in the previous point. -Practical advices about soil weighing, dilution and plating and monitoring of students during experimental activities.	
S3-Antibiosis assays: colonies selection and antibiosis assay (100-200 colonies per class; total-n=800 isolates).	-Literature search about colonies identification, ESKAPE bacteria and antibiosis concepts. -Planification of the pedagogic approach to communicate the concepts described in the previous point. -Practical advices about colonies selection and antibiosis assay and monitoring of students during experimental activities.	
S4-Data analysis: results interpretation and discussion (at least 1 positive antibiosis assay per class; total-n=50 positives).	-Selection of the strategy to assess school students knowledge on AMR topic resulting from MicroMundo. -Monitoring school students during data interpretation and data discussion.	

Figure 2. Summary of the four school sessions of MicroMundo@UPorto project.

awareness for the AMR problem. Moreover, 90% of the students evaluated their participation in the project positively (Figure S1-B, Supporting Information) and MICRIPEs were also particularly enthusiastic and strongly recommended it to other schools.

CONCLUSION

Experimental educational projects involving university students and the community represent an excellent opportunity to increase the scientific knowledge about relevant issues such as AMR in countries with high illiteracy rates in the field. MicroMundo@UPorto experience allowed university students to develop diverse strategies to communicate to younger school students about Microbiology and the AMR problem in the One-Health perspective, increasing their own personal, social and scientific enrichment. We could also observe an improvement in the perception of university students related to the effects of Microbiology subject in professional practice and in their autonomy, responsibility/commitment, planning, public communication, teamwork, improvization and empathy, essential skills for well-prepared health professionals. Concerning school students the participation in the project increased their awareness for the AMR problem as well as encouraged their interests for science, including Microbiology. We believe that MicroMundo project model can be successfully extended across Portugal and for education in Microbiology in general, with benefits for the future generations creating socially responsible and scientifically-literate citizens.

ACKNOWLEDGMENTS

We greatly acknowledge the initial support from Victor Cid (SWI/MicroMundo-Spain) and J. Handelsman and N. Broderick (Tiny Earth- USA) to MicroMundo@UPorto. We also are in debt to the Faculty of Pharmacy and Faculty of Nutrition and Food Sciences for their project support, to teachers at the two Porto schools who hosted MicroMundo@UPorto, to Raquel Branquinho (Programa Ciência Viva), Liliana Rodrigues and Bárbara Duarte for technical support.

SUPPLEMENTARY DATA

Supplementary data are available at *FEMSLE* online.

FUNDING

This work was supported by Porto University through the 'Projetos de Inovação Pedagógica 2019' award and by the Applied Molecular Biosciences Unit—UCIBIO which is financed by national funds from FCT (UIDP/04 378/2020 and UIDB/04 378/2020). We are also grateful to BioMérieux Portugal, Frilabo, NZYTech and Auchan for generously providing material.

Conflicts of interest. None declared.

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