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When Teaching and Learning Microbiology Engage Societal Needs

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ABSTRACT

This article explores the integration of community-based learning into microbiology education, using as an example the Service-Learning (S-L) programme 'Movies in company for preventing diseases' implemented at the Complutense University of Madrid. The programme exemplifies how academic knowledge can be effectively applied to address societal issues focused on disadvantaged populations. The issue describes the basis and quality criteria for designing a S-L in clinical microbiology: real needs identification, student's curricular connection, social engagement and learning link, assessment of active participation of students, commitment outside university campus and recognition and assessment. The impact on university participants and community partners and the contribution to university social responsibility is also presented. The S-L programme fosters social engagement in all participants, both students and university tutors, and positively impacts community underserved members by providing crucial health information and support. The success of this programme highlights its potential as a model for integrating academic learning in microbiology with societal needs and emphasises the role of universities in addressing global challenges.

Universities are not intended to be factories of diplomas for use in a global market. With these shocking words, humanist Nuccio Ordini debates the main function of the university as gratuitously generating and transmitting knowledge as well as shaping free citizens, capable of thinking autonomous and critically, and of engaging with solidarity, tolerance and common good (Ordini 2017). As a connatural result of its activity, the acquisition of knowledge should enable university members, teachers, researchers, students and supporting personnel, to become aware of societal problems and needs and to investigate possibilities solving them. The 'third mission' of higher education refers to the active contribution made by universities to social and economic development (Laredo 2007) and the institutions might further enhance their societal impact at local, national and international levels through community engagement (Farnell 2020). Many problems facing communities can be either solved or mitigated by microbial interventions thanks to the ubiquity and metabolic diversity of microorganisms and the enormous possibilities of microbial technologies (Timmis and Hallsworth 2024). As a significant recent example, the COVID-19 crisis reinforced the active role of universities in mobilising their knowledge and resources to respond to a range of societal needs (Farnell 2020).

Community engagement includes specific knowledge exchange and the connection of teaching activities with the real-world, thereby increasing student perception of science as a tool for social good (Gordy et al. 2021). One such approach is

the Community-based-learning methodology that integrates the active participation of students, reflexive practice and social engagement (Klemencic, Pupinis, and Kirdulytë 2020). A significant example of this is Service-Learning (S-L), which is defined as 'a form of experiential education in which students engage in activities that address human, and community needs together with structured opportunities intentionally designed to promote student learning and development' (Jacoby 1996). The innovative characteristic of S-L, with respect to other active teaching methodologies, lies in the fact that students' learning activities must be focused on solving real problems outside of university classrooms, bringing the academic activity closer to the needs of society (Stewart and Wubbena 2014). S-L programmes differentiate from charities, social help or voluntarism, as those do not need to be related to student's curricula. Besides this, S-L is not only a teaching active methodology, such as laboratory or research practices, problem-solving learning, flipped class or practicum/internship, because the specific objective of these methods is just addressed to student's learning. Consequently, the activities organised to attend social needs are always linked with learning objectives in accordance with students' curricula. Within the possibilities of attending to community needs, critical S-L or S-L with social justice objectives is focused on problems of certain social groups derived from socioeconomic inequality or exclusion (Mitchell 2008).

Within scientific areas, including microbiology, SL projects are often part of Public Health actions in Nursing or Medicine courses (Stewart and Wubbena 2014; Kwok et al. 2021; Liu et al. 2023; Reeb et al. 2024) but are less extended to basic and applied sciences (Webb 2017). Specifically related to clinical microbiology, some S-L programmes are addressed mostly to the general public (Abu-Shakra 2012; Cain 2013; Cutucache et al. 2014; Townsend, Kaylor, and Johnson 2024), university companions (Potter 2021) or to undergraduate scholars (Webb 2016; Valderrama et al. 2018). However, only a few experiences dedicated to vulnerable populations have been published. Some examples are: the elaboration of educational materials about aliments for people in an underserved clinic (Larios-Sanz et al. 2011), practicing in health settings and addressing social disparities (Behar-Horenstein et al. 2015), serving in urban, rural, border and indigenous health contexts (Sabo et al. 2015) or COVID-vaccination and procuring funding to reduce HIV-infection stigma in black men who have sex with men and transgender individuals (Bernstein et al. 2024). Similarly, during the last 2 years in the Complutense University of Madrid only 7 out of 20 S-L projects in health areas included aspects of microbiology, and of these, only 2 were intended for disadvantaged people.

The initiative 'Movies in company for preventing diseases' is an S-L programme implemented in Complutense University of Madrid in 2017 which addresses disadvantaged or at risk of exclusion persons. Initially focused on infectious diseases, we have already published the first experience, then called 'Movies and infectious diseases', that included a detailed description of the activities and results of the first two editions (Linares et al. 2021). Since then, the project has grown in terms of participants and scientific areas, and now it includes other health topics such as metabolic, nutritional or mental illnesses because many of the attended persons suffer from several health problems at the same time, that need to be addressed jointly. The aim of the present contribution was to introduce the design basis of the afore-mentioned S-L project and to analyse its adaptation to university resources, student curricula and to specific societal needs.

1 | 'Movies in Company for Preventing Diseases': Designing A S-L Programme and Adaptation to University Resources and Community Needs

Prior to designing the programme 'Movies and company', several key aspects were considered (Figure 1). In the first place, the social sector to be addressed, disadvantaged populations, with the objective of bringing microbiological knowledge out of the university to persons who have no possibilities of accessing it. And secondly, formation in S-L methodology through specific university courses and reviews of other S-L projects, which is necessary for an adequate initial approach.

Some other topics were analysed to adapt the initiative to university resources and the characteristics of the selected social groups. First, it was essential to map the social entities that work in the geographical area close to the university (such as Non-Governmental Organisations, NGO, that collaborate with the university or others that attend disadvantaged persons) and to contact public institutions, for example, the City Council, that can play a mediating role. Additionally, it was considered the teaching or research experience of lecturers in infectious and other diseases, as well as their available time, number and curricula of potential students that would participate, university resources, including funding, infrastructure and consumable materials needed, possibilities of adaptation to specific requirements of social centres and characteristics of attended people and, finally, bioethical and insurance aspects and the necessity of obtaining authorisation by university committees.

In order to ensure effective learning combined with significant community service, S-L programmes must meet several Quality Criteria (Figure 2): (1) Real needs identification, (2) Curricular connection, (3) Social engagement and learning link, (4) Active participation of students, (5) Commitment outside university campus and (6) Assessment and recognition (Seifert, Zentner, and Nagy 2012; Koslowsky et al. 2023). In the next subsection, the application of these quality criteria to 'Movies in company for preventing diseases' will be discussed.

1.1 | Real Needs Identification

A good assessment of real needs in health areas of disadvantaged collectives requires a detailed bibliographic search about illnesses and mortality suffered by such groups, including data provided by Epidemiology Institutes (CNE n.d.) and documents from heath organisations, such as World Health Organisation (WHO 2024) or European Centre for Disease Control and Prevention (ECDC n.d.). Additionally, information as well as reports from NGOs and Madrid City Council are also useful (Díaz et al. 2023).

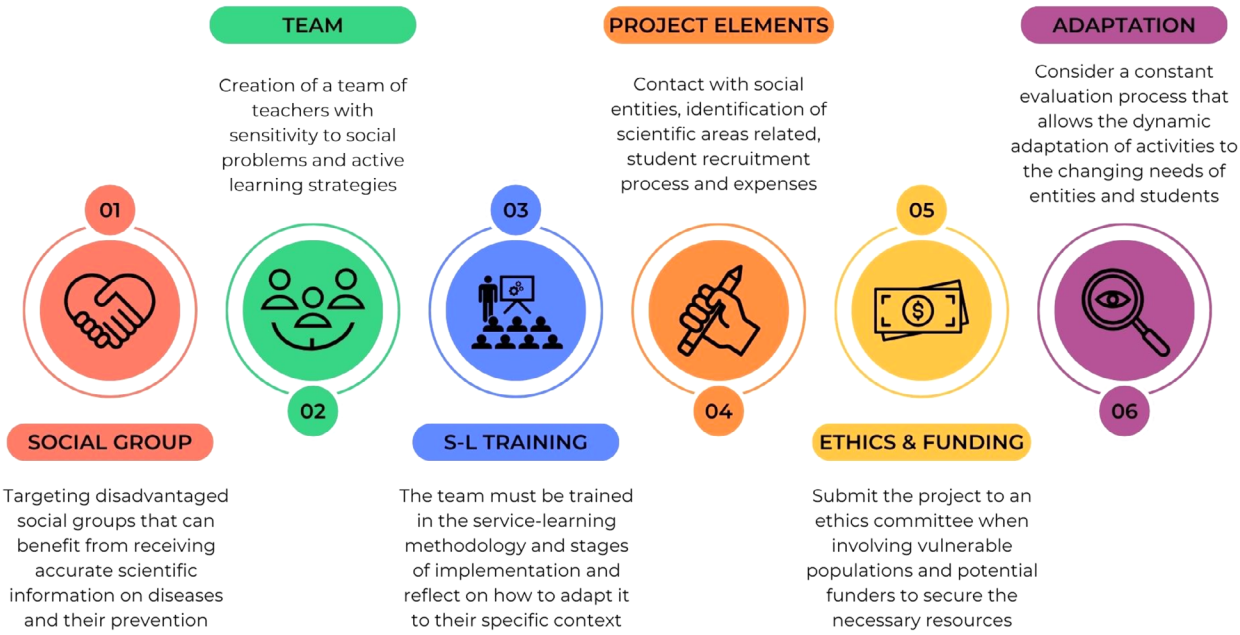

FIGURE 1 | Key aspects evaluated prior to the design and development of the Service-Learning project 'Movies in company for preventing diseases'.

FIGURE 2 | Quality criteria for the design and implementation of a Service-Learning programme.

The next paragraph illustrates the results of this search. The concept of 'social inequality in health' refers to differences in opportunities and resources related to health that people have depending on their social class, sex, territory or ethnicity, which translates into poorer health among socially less-favoured groups (Solar and Irwin 2007). In such groups, the incidence of various diseases is higher than in the rest of the population, with a 20% higher mortality rate (Díaz et al. 2023). Many of them suffer from several pathologies at any time, the most prevalent being infectious diseases (e.g., sexually transmitted diseases, tuberculosis and hepatitis), cardiovascular, respiratory and mental illnesses, or those derived from the consumption of drugs and alcohol or malnutrition (Wenzel et al. 2017; Asgary 2018; Swash and Probasco 2019; Wadhera et al. 2020; Baggaley et al. 2022; Nöstlinger et al. 2022). Furthermore, most of them have limited possibilities to access adequate information on how to prevent those diseases, their treatment or hygienic practices, due to, among other causes, low levels of education, lack of knowledge of the local language, discrimination or difficulty of access to social or health care settings. The situation of loneliness and isolation in homeless people, immigrants, prisoners, women or the LGBTI (lesbian, gay, bisexual, transgender and intersex) population introduces an additional lack of company, attention and possibility of socialisation (NASEM 2020).

On this base, the identified needs of the targeted population of our project (homeless individuals, prisoners, drug/alcohol users, migrants, women at social risk, disabled and elderly persons) comprised of a lack of information about the illnesses they suffer as well as difficulties for social relationships, company and advise.

1.2 | Curricular Connection. Planning Learning Objectives

The integration of the project into specific courses ensures that the learning objectives are directly linked to students' curricula and, ideally, S-L programmes should be included in formal classes. Nevertheless, the implementation of 'Movies and company' or other S-L initiatives in microbiology as an obligatory activity would require modifications to academic programmes,

a task that is not easily feasible in the university (Valderrama et al. 2018). On the other hand, it is not clear if S-L activities should be mandatory as a lack of motivation could be counterproductive for the intended objectives (Cloyd 2017). As an alternative, participation of students in this project is voluntary, although they can earn optional academic credits. Related courses include microbiology, biochemistry, nutrition and anthropology, within different degrees and masters (Biology, Biochemistry, Medicine, Microbiology and Parasitology, Pharmacy, Veterinary and Virology). Accordingly, the learning objectives of the project include acquiring (a) specific knowledge about different illnesses and (b) academic skills, such as searching for information, critical analysis, preparation of divulgation materials or oral communication to non-specialised public. The students work in multidisciplinary groups comprising of three to five members from different courses and levels to promote teamwork, organisation and collaboration. Based on this, selecting appropriate specific teaching methods is important to achieve each of the learning objectives (Van Beek et al. 2024).

1.3 | Social Engagement and Learning Link. Defining Service Objectives and Strategy

Serving objectives should be related to the identified needs, and they should be accurately defined and reachable during the academic period. In this case, service objectives include providing (a) company and (b) information about infectious and non-infectious diseases. To reach these serving objectives, the strategy to be selected needs to be adequate and adapted to the target population (De Lorenzo 2024). Considering that most of the social groups to be attended in the project would have low educational level or the immigrants a poor Spanish language knowledge and that some people suffer some kind of mental disorder, rather than giving talks on different diseases, entertaining activities and colloquia would be used. For this, the project incorporates commercial films as a novel approach within the context of S-L experiences following the practice of using cinema as a teaching tool on health science and microbiology (Darbyshire and Baker 2012; Sánchez-Angulo 2023). For election of suitable multimedia, for example, films in our project, it is necessary to take into account the available resources in the university, and the digital infrastructure in the social centres, such as computers, TV or internet connection (Van Beek et al. 2024). As a result of a previous innovative teaching initiative, the faculty library has a good collection of films related with infectious and non-infectious illnesses useful for this S-L project.

In brief, the strategy for the service activities was designed as follows: each university team visits one social centre on three occasions, the first one to identify the specific needs or interests of the attended group about illnesses they may suffer; the second one to watch a film related with a selected illness; and the third one, a colloquium and celebration (Linares et al. 2021).

1.4 | Active Participation of Students

A salient characteristic of S-L programmes is that the students are actively responsible for the development of all the phases. Within each working team, individual roles are assigned for coordination of each task and assessment that all the team members participate, that is, general group coordination and communication with social centres, preparation or selection scientific and divulgation/entertaining materials, analysis and selection of films, survey design and analysis and activities memory. This organisation has the objective of promoting responsibility, active participation, collaboration and adaptation to the specific group of people to be attended in the social centre. Students are accompanied and supervised by one or two tutors, who should be behind, supporting their academic progress (Bringle and Hatcher 1995).

1.5 | Commitment Outside University Campus and Executing the Activities

Collaboration with community partners is fundamental for the project as they host the service activities and coordinate the people who attend (Bringle and Hatcher 1996). The teams visit social centres (daycare centres, shelter houses, social insertion centres for prisoners, centres for elderly people, residencies for disabled persons or with addictions), deal with authentic situations and necessities, and share their scientific knowledge with people from different background and social situations.

First meetings are challenging, as the students need to 'break the ice' and introduce some microbiological and other scientific topics to find out the type of illnesses of interest. For doing so, they prepare entertaining activities about infectious or non-infectious diseases, such as bingo, Kahoot, true/false or memory games, and finally select one disease of common interest. Next step is watching a movie, drinks and popcorn included, and a colloquium about the presented illness or related subjects, focusing on prevention and hygienic and healthy habits. Adequate design of these activities is important in order to attain the attention of the group and engage them as participants rather than passive spectators (De Lorenzo 2024).

Selecting an adequate film (short films and chapter TV series are also useful) implies adaptation to the different situations of attended persons and requires careful critical analysis. Some recommendations are connection with the selected illness (clear and simple to identify), running time and plot (not too long and easy to follow), genre (avoiding hard dramas or sensitive topics such as drugs or alcohol). Examples of adequate films are provided as S1.

1.6 | Assessment and Recognition

This last quality criterion is one of the pillars of all S-L projects. The engagement and performance of students and the utility of the service for attending needs of the social groups needs to be evaluated and recognised through feedback and final conclusions (Koslowsky et al. 2023). Lecturers design a post-survey for students, covering reasons to participate in the project and social consciousness acquisition or improvement, and the students propose a few questions for community participants and centre coordinators to evaluate the usefulness and enjoyment of the activities and overall satisfaction. Additionally, students write a reflection memoire to express their experience during the project.

At the end of the activities, a join-together party at the university to which all participants are invited, tutors, students, social organisations, people attended, City Council representatives and academic authority. The celebration, with diplomas for the students and snacks, provides the opportunity for mutual thanks and recognition of the commitment.

Finally, an additional step to assess the achievement of quality criteria of 'Movies and company' is the evaluation of the project itself and the degree of adaptation to the real needs initially detected. The application of an evaluation chart can serve as a guideline of indicators, including, among other aspects, S-L formation received by tutors, learning and service objectives definitions, social justice orientation or link to specific microbiology and biochemistry academic courses (López-de-Arana, Aramburuzabala, and Opazo 2020).

2 | Impact of Microbiology S-L Programmes on Academia and Society

The 'Movies in company for preventing diseases' S-L programme successfully combines academic learning with meaningful community service. It provides students with a deeper understanding of infectious and other diseases, enhances their practical skills, and fosters a sense of social responsibility. The use of mixed academic levels, commercial films as an educational tool, and the strategy of applying acquired knowledge to real societal needs are particularly effective, offering a novel approach to learn and communicate complex scientific concepts to underserved society.

2.1 | Collaborative Teaching and Learning Clinical Microbiology and Related Health Sciences in Real Contexts

All the participants in the project form a single team and collaborate horizontally at the same level. The team includes faculty lecturers and technicians, hospital personnel, postdoctoral and predoctoral researchers, university students of different degrees or masters, Madrid City Council and several NGOs as community partners, and various underserved population groups. The interdisciplinary character of the project links to the One Heath approach and characteristically with Sustainable Development Goals (SDG) launched by the United Nations (UN 2024). Additionally, the project offers an opportunity to explore a professional future in clinical microbiology and related disciplines through a Public Heath objective (Larios-Sanz et al. 2011).

The students are motivated by the opportunity to apply their scientific knowledge in real-world situations. This aspect is one of the most rewarding ones of the experience, as also highlighted in many S-L programmes, including microbiology ones (Cain 2013). Moreover, the project facilitates the development of general skills such as teamwork, communication, problem-solving, leadership and critical analysis, which are not always incorporated in conventional classes in the university. These skills are particularly important when explaining scientific concepts to non-experts in the community and are included as one of the general competencies of the curricula. The process of teaching others is an efficient learning methodology that reinforces the students' understanding and confidence in their knowledge (Rutherford 2015; Webb 2016, 2017). The non-hierarchical, collaborative nature of the project is particularly useful for learning and preparation for future professional work, and the strategy of working in heterogeneous teams (formed by students from different years, degrees or master) is beneficial, as junior students receive guidance from their more experienced peers, and such collaborative learning environments enhance understanding and retention of complex concepts (Hou et al. 2018).

2.2 | Social Awareness and Engagement of University Members

A salient outcome of 'Movies in company for preventing diseases', as in some other S-L microbiology projects (Valderrama et al. 2018), is the opportunity for social involvement and introduces an emotional component derived from physical interaction with the recipient subjects of the actions carried out.

The students find the experience to be enriching beyond its academic aspect. They appreciate this project as an opportunity to use their privileged situation for good, and to interact with realities different from their own. Because of this exchange of varied lived experiences, many students feel like they have learnt more from the disadvantaged people with whom they shared their time than from those who have taught them. This experience helped them value life and opened their minds. Participating in this project illustrates the necessity of listening to those affected by the subject of study, infectious diseases or other health problems, as they often have practical knowledge that would be impossible to learn in a classroom setting. They discover the diseases that are the most worrying for society and this allows them to deepen their understanding of them. In this experience, the combination of providing a service to disadvantaged individuals and learning about microbiology became more than the sum of its parts. It shines light on the role of science as a bridge that has the capacity of bringing people together through knowledge.

Tutors participating in the S-L project (university teachers, young researchers and hospital members) have a precious opportunity to expand the usual activity beyond the university campus, enhancing their compromise with teaching quality. It allows effective transmission of knowledge by making students participate actively in their own learning process, accompanying them through an experiential activity and projecting them to society in need. Somehow, S-L methodologies help to broaden the professional focus, and to discover a new, wider and highly satisfactory projection of daily duties. In the same way as the students, lecturers might approach unknown or ignored social situations for the first time, and by participating in these projects they become engaged with societal needs.

On the other hand, the service aspect of the project is equally significant. Community participants express high satisfaction with such activities, highlighting the utility of the information provided about diseases they are interested in, and the respectful and engaged attitude of the students. They acknowledge the clear explanations given by them and the advises on prevention of infectious diseases, but overall, they thank the opportunity to

talk about their illnesses and doubts, to receive attention, and to be visited by young university students who treat them as equals and who share with them all what they know about microbiology as well as refreshments, popcorn or homemade cakes. Social partners confirm the programme's effectiveness in addressing real community needs, underlining the high knowledge of students when answering questions and their excellent dedication and commitment.

Along the five editions of 'Movies in company for preventing diseases' programme, more than 250 university students and 30 instructors have participated by bringing knowledge about microbiology and other related scientific areas to c.a. 800 disadvantaged or at risk of exclusion persons, in close collaboration with seven NGO and Madrid City Council. Beyond the numbers, in an integrative way, the great advantage of S-L is that all those involved in the activities benefit from their implementation (Kaye 2004).

2.3 | University Social Responsibility and SDG

Nowadays, society demands a higher social responsibility from universities, particularly public ones, as a significative function, together with education and research (Klemencic, Pupinis, and Kirdulytë 2020). Based on this, S-L has gained recognition as an innovative teaching methodology to respond to these challenges while at the same time strengthening investigation, transmitting knowledge and learning. The European Observatory of Service-Learning in Higher Education (EOSLHE) recognises S-L as an adequate strategy to address University Social Responsibility and sustainability and many European universities now have departments to impulse S-L projects (Cayuela, Aramburuzabala, and Ballesteros 2020). Also, dissemination of S-L experiences, through publications, conferences, divulgation media or social networks could inspire and animate other initiatives in universities. Nevertheless, as the initial organisation of S-L programmes and the establishment of community contacts takes a considerable time and effort on the part of teachers (Larios-Sanz et al. 2011), it would be necessary to implement ways to maintain the projects through specific funding and support (Cayuela, Aramburuzabala, and Ballesteros 2020). Although the level of institutionalisation of S-L is not homogeneous among countries, the need of creating national and supranational networks to share experiences is taken as a challenge by many universities (Ribeiro, Aramburuzabala, and Paz-Lourido 2021).

Along with the initiative of the Complutense University of Madrid of introducing academic activities for the achievement of SDG, S-L 'Movies in company for preventing diseases' contributes actively to several objectives and goals, that is, no. 3. Good health and well-being, by providing information and advice on infectious diseases and their prevention 4. Quality education, by offering significative and active learning to the students, 10. Reduced inequalities, by drawing university members to disadvantaged populations and 17. Partnerships for the goals, by stablishing links among universities, City Councils, NGOs and social entities.

Given the central role of microbial science, microbiology teachers are convinced of the importance of bringing their knowledge to university students in a captivating and active manner as well as to society outside the campus. In the last years, several initiatives on extending literacy in microbiology to all levels of society, from international projects such as The International Microbiology Literacy Initiative (IMiLI) (Timmis et al. 2024) or open courses via social networks like #microMOOCSEM Initiative (López-Goñi et al. 2016), to an ample range of divulgation activities held in most universities and research institutes. But, alongside this, we might wonder, who is benefiting from these teaching objectives and who are we losing? (Schaechter, Kolter, and Buckley 2004). Adhering to the United Nations commitment 'Leave No One Behind' (UN 2017), the microbiological community is well-placed to contribute to SDG targets and to respond to societal needs through research and education (Fagunwa and Olanbiwoninu 2020). S-L programmes in microbiology, like the initiative focused on underserved communities around the university here described, are effective and meaningful strategies, replicable in different educational settings, to successfully reach these challenges.

Author Contributions

María-José Valderrama: conceptualization, writing – original draft. **Etna Nebreda:** visualization, writing – review and editing. **Noemí López-Ejeda:** writing – review and editing, conceptualization, visualization. **María Linares:** writing – review and editing, conceptualization.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.