

# Science Communication in Bioengineering and Biotechnology: active and collaborative learning project

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## Abstract

In a society increasingly dependent on science and technology, the need to equip our students with the most varied digital and communication skills is crucial. Active and collaborative learning among peers is essential for the acquisition of transversal skills. Communication is one of the main tools that the Engineer uses to reach his target audience. "Science Communication in Bioengineering and Biotechnology" (CCBioTec) is a project on Innovation and Development of Teaching and Learning supported by Center IDEA-UMinho, a structure that emerges to promote and value Innovation and Development of Teaching and Learning at the University of Minho. CCBioTec is transversal to a set of Learning Units (LU) under the responsibility of the Department of Biological Engineering (DEB), including one LU of each year of the Integrated Masters in Biological Engineering and in Biomedical Engineering. The main goals of CCBioTec are: to foster the awareness of the DEB educational community on the importance of science communication, as well as to develop science communication skills, through the production of short videos (pitches) displaying the explanation, in a simple and dynamic way, of complex concepts of Bioengineering and Biotechnology related with the curricula of each LU. CCBioTec started in the second semester of 2020/21, and it will go on in the 1<sup>st</sup> semester of 2021/22. The project was designed to be implemented according to the following steps: 1 - Technical and pedagogical training of teachers; 2 - Technical training of students involved in the project - Week CCBioTEC-2021; 3 - Development of materials for "Science Communication in Bioengineering and Biotechnology"; 4 - "CCBioTec-2021" competition. In CCBioTec, teachers presenting himself as a mediator/facilitator of learning, boosting students' development of transversal skills, collaborative work, decision making and the expression of ideas, together with the acquisition of knowledge foreseen in the curricular contents of the LU.

**Keywords:** Science Communication; Active Learning; Bioengineering; Biotechnology.

## 1 Introduction

Communication is the main tool through which an Engineer conquers his target audience, which can vary from the management bodies of a company or the general society to the promotion of a product or a service. Communication is thus used to attract the attention of the interlocutor and is the key to transmit clean, clear and concise information (Kirkman and Turk, 2002).

The digital age has completely changed the communication paradigm. If a few years ago we used only PowerPoint to show results or present our work, today the general public, including the student, is more demanding, and thus more difficult to capture/involve (Kahu, 2013). So, social networks have become privileged vehicles for transmitting fundamental information, using short videos, animations and graphic images (Kolbitsch and Maurer, 2006). If, on the one hand, these advances are good for the globalization of information, on the other hand they can bring serious obstacles to those who are not prepared for this new way of communicating.

New tools appear essential to use, to teach and to motivate, namely tools for sharing documents (ex. Padlets), elaboration of animations (e.g. Animaker), infographics (e.g. Piktochart) and editing videos (e.g. Shotcut). Consequently, these are new skills that teachers and students need to acquire and/or reinforce (Lima et al., 2017).

The current pandemic conjecture has also led to the need for a very rapid adaptation of traditional and face-to-face teaching to the online model and more recently to the hybrid model, where attracting the attention of students, was and is a constant challenge to teachers (Watermeyer et al., 2020). In addition, the Society's interest in basic science concepts, namely Bioengineering and Biotechnology, also increased. Therefore, science communication emerges as a transversal competence that the Department of Biological Engineering would like to prioritize in the training of its students, contributing to their professional success in the future, as well as enabling them to become more active in society.

The teaching community of DEB has made a great effort to promote innovation in the education of quality it offers to its students. A large number of DEB teachers have participated in trainings offered by Centro-IDEA, a structure that emerges to promote and value Innovation and Development of Teaching and Learning at the University of Minho. DEB teachers are already involved in Communities of Pedagogical Practice. DEB regularly promoted "Pedagogical Innovation Workshops" for its teaching community.

The purpose of this paper is to show how DEB intends to improve the development of Scientific Communication skills in your students, through the project "Science Communication in Bioengineering and Biotechnology" (CCBioTec), that is a DEB project on Innovation and Development of Teaching and Learning supported by Center IDEA-UMinho.

The main goals of CCBioTEc are: to foster the awareness of the DEB educational community on the importance of science communication, as well as to develop science communication skills, through the production of short videos (pitches) displaying the explanation, in a simple and dynamic way, of complex concepts of Bioengineering and Biotechnology related with the curricula of each LU.

At the same time, the intention is to introduce changes in conventional pedagogical practices, namely in terms of content and competence assessment, which is intended to be more diversified and phased, emphasizing the importance of feedback by peers and teachers (Lima et al., 2007). Finally, the ambition is to leverage the creation of a Pedagogical Innovation Community in the area of Engineering, which is intended to be transversal to other areas, in addition to Biological and Biomedical Engineering, while promoting research on the value of new applied pedagogical practices.

## 2 Implementation process

The Project "Communicate Science in Bioengineering and Biotechnology" (CCBioTec), is transversal to a set of Learning Units under the responsibility of the Department of Biological Engineering (DEB), including at least one LU each year of the Integrated Masters in Biological Engineering (IMBioE) and Biomedical Engineering (IMBioE). The selected LU (theoretical, theoretical-practical or laboratory) have in common learning objectives that imply the acquisition of engineering concepts, as well as the understanding of Chemical and Biological Processes.

Thus, the present Project intends to foster, in the educational community of DEB, the awareness of the importance of science communication, in a society increasingly dependent on science and technology, and arises from the need to equip our students with the most varied digital and communicational skills, while promoting active and collaborative learning among peers. CCBioTEc also intends to promote the interaction, involvement, participation and collaboration of students, in the development of contents, through the elaboration of short videos - pitches with the explanation, in a simple and dynamic way, of complex concepts of Bioengineering and Biotechnology, concepts related to the learning objectives of the LU involved in the project, also contributing to the improvement and quality of learning.

Within the scope of the Project CCBioTec, it is intended to develop transversal skills that will improve future professional performance of Biological and Biomedical Engineering students, including socio-emotional and behavioural skills, such as assertiveness, team work, planning, time management, initiative, as well as communication skills, such as clarity, oral fluency, objectivity, non-verbal communication, empathy, conviction, among others (Lima et al., 2017).

Simultaneously, it is intended to create an active learning scenario that leads students to understand, in an integrated and contextualized way, complex engineering concepts, predicted as learning outcomes of the various LU involved, contributing to the educational success of students and to the creation of a legacy of resources that can be voluntarily made available.

The project implementation started in the 2<sup>nd</sup> half of 2020/21 and it will continue in the 1<sup>st</sup> semester of 2021/22. In the first stage of implementation, as stated above, only one LU for each year of the both Courses was covered (Table 1). However, it is intended to replicate in other LU of the same courses and in other study cycles, thus contributing, to increase the development of transversal skills in our educational community.

Table 1. Courses units per year of the Integrated Masters in Biological Engineering and Biomedical Engineering.

Course/Year	1st	2nd	3rd	4 <sup>th</sup>
IMBioE	Introduction to Process Engineering	Transfer Phenomena II	Bioprocess Laboratories	Process Control and Instrumentation
IMBiomE	Introduction to Biomedical Engineering	Heat and Mass Transfer	Clinical Support Services	Treatment of Hospital Waste and Effluents

The project has several steps, implemented in different stages, and that are going to be described below.

## 2.1 Technical and pedagogical training of teachers involved in the project

To achieve the proposed objectives, the project started with a technical-pedagogical training of teachers, to allow the insertion, in the teaching practice, of competences in digital literacy. This training, was entitled “hands-on digital tools”, and took place on March 17<sup>th</sup>, with 51 participants including career teachers and researchers who collaborate in the teaching activity of DEB. This training, complementing the one that Centro-IDEA has already promoted to University of Minho teachers. During this training, the teaching team had the opportunity to explore the pedagogical potential of the different technological tools (e.g. for creating mind maps, animated videos and online questionnaires).

## 2.2 Technical training of students involved in the project - Week CCBioTEC-2021

In order to promote the technical training of the students involved in the project, an initiative entitled “CCBioTEC-2021 Week” was organized. Around 300 students signed up for the actions promoted, which took place between April 12<sup>th</sup> and 16<sup>th</sup>, using digital platforms, and which included Lectures and Workshops on Science Communication, as well as the presentation of Success Cases in Science Communication.

During “CCBioTEC-2021 Week” specialists in Science Communication, either from the University of Minho (Institute of Social Sciences), and other Higher Education institutions were invited as speakers, thus fostering inter- and intra-institutional collaboration. Three 60-minute lectures occurred on consecutive days at 6 PM (after classes), which include themes as: “Science Communication for an Audience”, “Help, I have to speak in public. What now?” and “Science Communication Success Cases”. The other two days, were dedicated to Workshops that intend to teach the participants to use some digital tools, software and/or techniques useful in Science Communication. Oral communications and workshops were open to the entire DEB community, with online transmission with streaming on YouTube, and it had an average daily participation of 110 participants.

## 2.3 Development of materials for “Science Communication in Bioengineering and Biotechnology”

Active and collaborative learning were promoted, where communication materials for scientific concepts of Bioengineering and Biotechnology were developed, comprised in the learning objectives of the different CU. The concepts selected by the students were adapted to the pedagogical context of the specific CU and validated by the respective teachers. The final aim was to create a one-minute pitch, using a video / graphic

animation, which were made available voluntarily to the entire DEB educational community, through the institutional website.

In a pedagogical project like this, based on the principles of active and collaborative learning, in which students are at the centre of the process, the skills of research, selection and structuring of information were reinforced by the teaching team. It is also important to emphasize that the use of technological tools for the production of communications of scientific concepts guided the students' activity towards the final objective, the apprehension/appropriation of certain scientific concepts of Engineering and Biotechnology, as well as, aroused curiosity and the interest of colleagues in similar concepts, through the creative and effective creation of content that was integrated in the final product - pitch.

The video editing and/or create animations software were chosen by the students according to their relevance and applicability, but they were encouraged to use licenses free of charge. Regardless of the methodological adaptations implemented by each teacher, it was important to carefully guide each group of students through the content design process so that the curriculum content was not lost sight of.

## 2.4 CCBioTec – 2021 competition

At the end of the second semester (June), it is foreseen to organize a Science Communication in Bioengineering and Biotechnology competition, which was already announced in the week CCBioTEC-2021, on the Department's institutional page and on social networks. The aim of this contest is to give visibility to the pedagogical practice developed, share experiences and naturally motivate other teaching colleagues to implement these methodologies in their LU. Students were encouraged to compete with the materials produced in the LU, with the attribution of symbolic prizes per year for each course and the selection of 3 grand prizes.

The general rules of the contest were:

- Each video will have to expose in a simple way, a concept of Bioengineering and or Biotechnology, preferably answering a key question;
- The length of the video is a maximum of 60 seconds;
- The video can contain animations, characters or actors;
- The images used in the videos must be from the authors or from a non-copyrighted image bank;
- Only 2 pitches per LU, that integrate the CCBioTec project, were considered for the competition (a selection of which will be at the expense of the teacher responsible for the LU);
- Students/groups of students from the 2<sup>nd</sup> and 3<sup>rd</sup> cycles under the responsibility of Centre of Biological Engineering (CEB) were also eligible to the competition, and must comply with the first 4 clauses;
- The remaining videos of each course will be made available voluntarily on a link already placed in the CCBioTEC padlet and will integrate a future platform with the various videos produced;
- The Jury's vote is worth 70%, the public vote is worth 30%;
- Public voting (likes on Facebook and Instagram platforms) period will last one week.

The team of juries is composed by several teachers involved in the project, by the DEB/CEB direction and by invited experts.

## 3 Learning Assessment and project monitoring

The teachers of each LU are responsible for the identification of the topics/concepts of Bioengineering and Biotechnology contemplated in the learning objectives of each LU, as well as for the delivery dates of the respective digital content – pitches – produced by each group of students, and for the assessments.

The assessment of the quality of the content produced by the students, will be based on assessment grids built by the team of teachers included in the project and will be transversal to all LU (table 2). The evaluation/feedback of the peers, expressed during the presentation/availability to the class will also be empathized. This exercise will be an integral part of the LU assessment component, corresponding to 10% to 20% of the final classification.

Table 2. CCBioTec Assessment Grid

Contents			Narrative						Inovation				Global Assessment				Grade			
<b>Relationship with the theme</b> (Subject focused, ability to synthesize)			<b>Approach to the theme</b> (Ideas organization and interrelation, information clarity, particularities)			<b>Acoustic and audio-perceptual evaluation</b> (Voice tone, speech speed, diction, fluency, musical background)			<b>Graphic Interface</b> (Animation, video editing, filming)			<b>Resources</b> (Attractiveness, impact, dynamics)				<b>Message effectiveness for Science Communication</b>				<b>0 to 20</b>
Poor relationship	Average relationship	Good relationship	Inadequate approach	Reasonable approach	Good approach	Not suitable	Suitable	Very Suitable	Not suitable	Suitable	Very Suitable	Without innovation	Few differentiating elements	Various differentiating elements	Very innovative	Ineffective	Effective	Very effective	Excelent	
1	2	3	1	2	3	0,5	1	2	0,5	1	2	1	2	3	4	1	2	4	6	
Team		x			x			x			x				x				x	20

At the end of the semester, a new survey was made to the students involved to validate whether they have acquired transversal skills and whether initial perceptions regarding Science communication have changed.

Monitoring the success of the project will be decisive in deciding on its extension to the 1<sup>st</sup> semester of 2021/2022. It is also expected in this second period of implementation the involvement of LU teachers initially selected in the team of trainers, as well as some groups of students to share their experiences and showcase their pitches.

#### 4 Preliminary results

Prior to the technical and pedagogical training of teachers, they were asked about their willingness to be part of the CCBioTEC project, and 29.8% answered affirmatively, which included 17% that were already part of it, but 53.2% did not express interest. These results reveal that there are still teachers in DEB community who need to be motivated for pedagogical themes, however it is not a discouraging result.

Before the students training week, a survey was sent to all enrolled students (only 152 students responded), which aimed to assess the students' initial knowledge of Science Communication. Initially, we asked students if they knew what Science Communication is, and 59.9% answered that they have a vague idea and only 16.4% revealed to know perfectly what Science Communication is. It should be noticed that although 23.7% said that they do not know what Science Communication is, they demonstrated an interest in knowing it. The vast majority, 94,1%, emphasized that Science Communication is important for society in general, however a small number of respondents said it is only important for researchers (2%) and 3,9% said it is important for the student audience. When we questioned how Science Communication is mostly done, 91,3% answered that it was through the publication of scientific papers, however other forms of Science Communication were also evidenced, namely the elaboration of didactic videos about scientific concepts (76%). Questioned about how they feel if they have to make a science communication, 45.7% said that they do not know how to plan a





## 5 Conclusion

In conclusion, this project essentially aimed at a redefinition of the role of the teacher who presents himself as a mediator/facilitator of learning, promoting in students the development of transversal skills, collaborative work, decision making and the expression of ideas. Simultaneously it intends to facilitate the acquisition of knowledge foreseen in the curricular content of the LU that were included in the project. The CCBioTec project is being a challenge for both students and teachers. The challenge of accurately and effectively built and present for a diverse audience the mean of engineering concepts in shorts videos stimulated and speed up the development of synthesis capacity skills, as well as of thinking methods and the problem-solving capability of students. This endeavour of creating videos to communicate science, although hard and time consuming, was considered successful. This believe was grounded on the positive students' opinion as most of them recognized that this project helped them to develop communication skills. Furthermore, students' willingness of, in the next semester, preferring to make videos instead of other forms of communication in science is also an evidence of the CCBioTec project's pedagogical value.

For the success of this initiative, the previous technical training of students and teachers involved in the project in the scope of previous CCBioTec week was fundamental as the launching ramp. As the number of the effective participants was lower than the expected, in the next semester a wider dissemination effort of this training week will be made, exploring the social networks that are, at the moment, essential, to reach the student audience. In addition, it is also intentioned to improve the program of the 2<sup>nd</sup> edition of the CCBiotec week, refining the less well achieved aspects, to meet the suggestions disclosed by the participants in the intermediate survey, namely increase the time to explore and acquire experience into the software to create videos and graphical animations.

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