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The essentials of science communication in a course engaging both for students and professionals

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Abstract

On the one hand, science is increasingly entering the governance of modern society. On the other hand, society seems to be lagging behind scientific achievements, increasingly unable even to understand its language. The language gap is based on the well-known intimidating appeal of STEM programs and the unreasonable timidity of scientific degree courses to include communication skills as mandatory. An open course was experimented to provide students with the necessary tools to decode and encode the essential elements of science communication, regardless of disciplinary content. The course, which was designed following the 5W+H "golden rule" of non-academic science communication, has been offered for three consecutive years to nearly one hundred students. The students' perspective is analyzed in terms of their perception of the study effort, the achievement of their own learning expectations and the level of general satisfaction. The main result is that it is possible to involve undergraduates, graduates and professionals in rethinking their approach to communication of scientific content to the general public, with rewarding results for all players, once the focus is on the greatest common divisor instead of the lowest common multiple.

Keywords: *Science communication; soft skills; open course.*

1. Introduction

On November 27th, 2017, in the Sala Capitolare of the Senate of the Italian Republic, Pietro Greco gave a speech on the correlation between science and democracy, asserting that "scientific knowledge is no longer one of the many elements that nourish culture and reshape the individual and collective life of women and men. But it has been, for some time now, the main engine of the production system and of the social dynamics of the planet itself.", (Greco, 2018). The guiding idea of this founder of the science communication in Italy is that a society in which science is the primus movens becomes a knowledge society and the rights of citizenship must include the right to scientific citizenship.

Shortly afterwards, the SARS-Cov-2 epidemics demonstrated the importance of scientists having the necessary skills to communicate clearly with colleagues outside their discipline, with experts in nonscientific disciplines, as well as with the general public (Sandal, 2022). However, scientists traditionally have not been provided communication training in their education and the effective communication beyond their discipline tends to be a rare attribute (Stevens 2019). Science communication courses in Italy are mostly one- or two-year master's courses, now offered by many universities and scientific institutions; or they are short curricular courses in many degrees in "Communication Sciences"; or are offered as short courses accessible to PhD and graduate students (Trench, 2021). Despite the calls for science communication to be included in STEM education (Baram-Sabari, 2015; Dahm, 2019), and although training activity in various aspects of science communication have been published (Mannino, 2021), a discipline-free approach to developing an essential communication skill toolbox, like those elaborated by the QUEST EU funded project (QUEST, 2021), has not been integrated into most STEM curricula in Italian universities (Davies, 2021). Moving from these considerations, the authors devised a path to provide students with the necessary tools to decode and encode the essential elements of science communication, regardless of the disciplinary contents.

The title of the award-winning novel by Paolo Cognetti, The eight mountains, (Cognetti, 2018) originates from an ancient Nepalese myth telling that at the center of the world there is a very high mountain, Mount Sumeru, and around it there are eight seas and eight mountains. The meaning of the legend is in the question: who will have learned more, those who have gone around the eight mountains, or those who have reached the top of Mount Sumeru?

In the world of disciplinary teachings increasingly isolated from each other; in the world of countless sources of "free" (dis)information and global interconnections, a similar question arises when thinking of a valuable modality to introduce students to science communication. Without pretending to answer the question of the Nepalese legend, leveraging on their professional experiences, the authors devised a course in Communication of Science,

informed around few general principles and that also provides the essential toolbox for social media communication. The course has been running online synchronous since 2020 and has been delivered until now to about one hundred students and professionals with very different background knowledge and communication skills. The content and format of the course has been consistently refined based on participant feedback gathered at the end of each of the three editions proposed so far and on the assessment of the communication skills acquired.

In this paper, the content of the course in its latest version is illustrated in detail, also providing the reasons for the didactic choices. The effectiveness of the proposal is analyzed using a few parameters that consider the point of view of the attending students: Perceived Study Effort - PSE, Achievement of Learning Expectations - ALE and Level of General Satisfaction - LGS. The cross-reference of these parameters with the gender, knowledge base and motivation of the participants allowed to draw a synthetic and yet detailed picture of the success of the methodology adopted and of the proposed teaching contents. This 'subjective' students' perspective complements the more 'objective' assessment of the learning outcomes by homework assignments, individual and team presentations and the final production of social media content for the event LumineScienza, yearly registered in the program of the International Day of Light®, promoted by the United Nations Educational, Scientific and Cultural Organization - UNESCO (Lucente, 2023).

2. The Narrative Structure of *Communication of Science* Course

Quite common in the communication realm is the 5W + H rule, and science communication directed at the general public is no different. The course content was designed in modules according to this general rule and the following definitions:

- *How* module: do it and let them know, communication strategies, technical skills of image creation and video making, the unspoken words.
- *What* module: identify the core message, be sure to know it and take your time to study it. Put in evidence, be concise, be responsible, fact checking, sniffing fakes.
- *When* module: it is not that any time is the right time, planning and delivering strategies, one more event?
- *Where* module: different public <-> different media <-> different tools, identify the best medium for delivering your message, basics on social media platforms.
- *Who* module: a different public needs a different language, follow the audience while shaping it, going out while looking in.
- *Why* module: think before say. Another drop in the ocean, is there any reason for your message to be relevant, good reasons and bad results.

The subject of the course is organized in six modules, each consisting of four hours of lectures and four hours of individual or teamwork introduced by a renowned testimonial, as a 'living example' of how to do well. After a few permutations, the modules are now ordered as follow:

Why – Who – What – Where – When – How, as detailed by the course curriculum in Table 1.

The format balances one-to-many lectures and Q&A session with testimonials, individual and team homework, intermixed with presentations and open discussions about the shaping of *LumineScienza*. A detailed discussion about choosing that specific ordering can be found in (Lucente, 2023); to the purpose of this communication is it worth to note that the first three modules set the grounds for the following three and help in building a common language and a shared horizon for the quite heterogenous group of participants, whose distribution in terms of gender, basic knowledge and motivation of the enrolled students in the three editions of the course, is given in Table 2. Enrolment is open to students from the host university as well as to people from other academic institutions and to anyone with a high school qualification. Approximately 42% of participants were not students at the host university and most of them declared professional interest in choosing the course.

On the one hand, the distribution by gender closely matches that of the student population of the hosting university, that represents 58% of the enrolled students to *Communication of Science*. On the other hand, the very same title of the course preferably attracted students from the PE group of disciplines (70%) with respect to the SH group (11.7%), in contrast to student population of the hosting institution, about 60% / 20% in the SH / PE degree courses.

3. The Students' Perspectives

During enrolment, students were asked for the main motivation for choosing the course. Table 2 shows that their response is evenly distributed among the three options, with about one third motivated by practical reasons, for example to complete the number of eligible credits needed in their degree course; personal and professional interest equally share the remaining part.

At the end of the teaching activity, students were asked to fill a feedback form consisting of three sections. The first section is meant to assess their appreciation of the course content. LS students appreciated the *What*, *Whe'*s modules more than average. SH students found less than average interest in the *How* module while appreciated most the *Why* and *Whe'*s. PE students stay on average for all modules. However, all differences are around one standard deviation, indicating that students from all background knowledge find stimulating activity that help them to decode their "natural communicative inclination" within a methodological framework and to appropriately codify the less mature aspects of their respective communication strategies. The only exception is for those who declared Professional motivation in attending the course, whose

average appreciation of all modules is one standard deviation below average. Professionals may have found too basic some content, especially of the *Why* and *Whe*'s modules.

Table 1. Course curriculum of Communication of Science.

Topics	Actions	Outcomes
Get to know 2h	Self-introduction of teachers and students; description of methodology and evaluation criteria; outline of the course content; graphical illustration of the class composition; Q&A.	Respect of the time assigned - Technical issues sorted out – First time on video
Why module 8h	Spoken and unspoken communication; basic principles of communication strategies; visual identity; coordinate image; comunication campaign; examples; case history; creativity is not without boundaries; listening of professional communicators.	Elaboration of the personal pay-off – Tips for reading behind the surface – Main mistakes to be avoided
Who module 8h	In the land of lies, truth is a disease (G. Rodari); know the subject, the context, the public, the goal you want to achieve; know yourself; the narrative techniques: objects, slides, posters; verbal, paraverbal and non-verbal language; two RSVP working methods: Respect, Stimulate, Valuate and Present.	Short sensory experience on perceptions – team working – brain storming – focus groups.
What module 8h	What is scientific?; the reliable and unreliable source; read and write a scientific text; the jargon; what is the red thread with society; tell the uncertainties of science; errors, inaccuracies, oversights; the inner balancing of scientific method and also the dark side of science.	Serching the databases – Google trends – cut a long story short – the 5W+H golden rule
Where module 4h	Attention is a rare commodity; content marketing strategies; language experimentations; the publics of social media.	Main features of popular social media – content creations for Insta and fb
When module 4h	Social media manager: basic principles, tips and tricks; the editorial plan; copy it; stay away from; monitoring in real time; post analysis.	Schedule delivering media content – benchmark analysis
How module 8h	Framing; basic principle and social media adaptation; objects, people, background; screenplay; timing; editing.	Personal video: 3' – video editing software
Am I sure? 2h	The only certainty of science is uncertainty; the rigour of the method instead of the method of rigour; one question has many answers; unbias yourself.	Question and Answer game – graphical abstracts – hidden CV
Let's face it 2h	What do we think about the course; what do you think; feedback	Self-evalaution – identify priorities

Table 2. Distribution of the total population of students over three years.

Gender		Basic Knowledge			Motivation		
Male	**Female**	**Life Science**	**Physical & Engineering**	**Social & Humanities**	**Practical**	**Personal**	**Professional**
36.7%	63.3%	18.3%	70%	11.7%	36.7%	31.6%	31.7%
100%			100%			100%	

Basic Knowledge is classified according to the European Research Council index. Practical motivation refers to those whose attendance was instrumental to completing their eligible ETCS; Personal motivation refers to those who chose to attend because of personal interest; idem for Professional. 100% = 60 compiled feedback forms.

The second section of the feedback module is meant to assess to what extent students achieved their own learning expectations (ALE), their level of general satisfaction (LGS) regarding the whole experience and the perceived study effort (PSE), compared to their initial outlooks. The responses were collected over a five-grade scale and translated in integers from –2 to +2: + indicating fulfillment and satisfaction, – indicating disappointment and discontent. The averaged response is reported in Table 3 together with the distribution across the gender, knowledge and motivation categories. Almost all students are aligned in deeming the learning objectives substantially achieved, with the SH group being more satisfied than the average, positively correlated to a PSE significantly higher than the average. The reported LGS is positive for all, with the notable exception of the LS group, probably because all teachers have PE or SH background and are somewhat biased in the examples and analogies proposed. An essential and specific feature of *Communication of Science* is the direct and regular involvement of students in the production of media content (video, poster, text, tweet, slideshow) working in small groups, along with the creation and management of the web event *LumineScienza* at the end of the course (on fb and Insta). The content realized and posted for *LumineScienza* (graphics, videos, texts, ads) is evaluated by the teachers and contributes 50% to the final grade. The groups are formed by teachers to be as much heterogeneous as possible. A great deal of time is devoted to team building: at least two sessions each year are dedicated to introducing the methodologies of brainstorming and focus group. Students are constantly invited to step out the comfort zone and face new challenges.

The third section of the final feedback form is meant to assess how students would qualify their experience in the acquisition of new technical skills, teamwork, work planning and in identifying their own biases and preconceived opinions. Instead of using a numerical index, options were proposed using an "emotional" scale from disappointing to exciting. At first glance, Figure 1 shows an overall "positive" evaluation highlighted by the dominance of the bluish area in all rows, corresponding to a *Surprising* and *Exciting* evaluation of the activity. The categorized analysis is then focused on the other side of the colored spectrum (green, red and orange), considering only values exceeding the corresponding Global averages by more than one standard deviation. Gender category does not show significant difference, except for

Males that found Team Work slightly more *Tiring* than average (25% against 20.7(2.6)%). 20% of the SH group found Team Work *Pointless* and Work Planning *Tiring* or even *Disappointing*, as compared to averages around 3.5(5)%. This is consistent with the below-average level of LGS (see Table 3) expressed by the same group and compares negatively with the above-average values of PSE and ALE. The apparent inconsistency finds a possible explanation in the fact that teamwork and the use of planning tools are widespread practices in the disciplines belonging to the SH group. A similar picture emerges for the Professionally motivated category, that also generally appreciated less than average the content of some modules. Work planning was Tiring for 35(8.2)% of all students, distributed in all categories, with peaks of 45% for Practically motivated, a category representing students mainly interested to securing the ECTS in their career. It is worth pointing out that Team Work, which is based on comparison and collaboration among different points of view, allows everyone to "look in the mirror", in front of their own preconceptions (Bias Identification), and this experience was unanimously reported either as *Surprising* or *Exciting*. It is always difficult to recognize and accept your own cognitive biases, so it is encouraging to note that this was the most valued skill across all categories. Professionals, PE and SH students stand out in well above average surprise and excitement, surprise and hype shared by the authors as well.

Table 3. Student perspective of the learning outcome.

Student perception	Gender		Basic Knowledge			Motivation			Average (St.Dev.)
	M	**F**	**LS**	**PE**	**SH**	**PRAC**	**PERS**	**PROF**	
ALE	0.9	1.0	0.9	1.0	1.4	1.1	0.8	1.0	**1.0 (0.2)**
LGS	1.2	1.3	0.7	1.5	0.9	1.1	1.3	1.4	**1.3 (0.3)**
PSE	-0.3	-0.4	0	-0.5	1.5	0	-0.4	-0.5	**-0.3 (0.7)**

ALE: Achievement of Learning Expectation; LGS: Level of General Satisfaction; PSE: Perceived Study Effort. LS: Life Science; PE: Physics & Engineering; SH: Social & Humanities. PRAC: Practical; PERS: Personal; PROF: Professional motivations, as defined in the caption of Table 2.

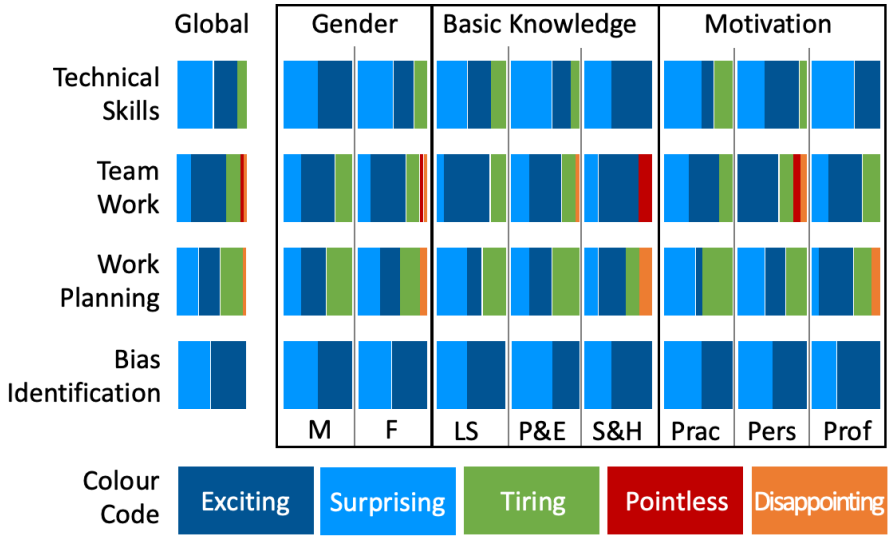

Figure 1. Synthetic graphical representation of the students' appreciation of being engaged in laboratory activity. Options are expressed on the 'emotional' scale illustrated by the color code. Relative percentage is proportional to colored area. The area of each colored square corresponds to 100%.

4. Conclusions

Climbing Mount Sumeru on the straight track, ascending it along gentle spiraling paths or wandering the eight mountains is a matter of personal choice. However, scientific literacy cannot be guaranteed until all scientists have learned the basic skills necessary to communicate with clarity and empathy. *Communication of Science* claims to provide such basic skills in a format compatible with any academic degree program. The syllabus focuses on common principles with respect to specialized languages and communication strategies. The greatest common divisor of the communication of scientific contents of any discipline to a non-specialized public on social media is preferred to the least common multiple of STEM languages and disciplinary communication.

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