Science Communication in Higher Education: Global Perspectives on the Teaching of Science Communication

The teaching of science communication in higher medical education in Peru in the context of the COVID-19 post-pandemic

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Abstract

The COVID-19 pandemic has underscored the importance of effective science communication skills among medical students. Developing countries, in particular, face unique challenges in assessing the adequacy of such training. To bridge this knowledge gap, we designed and administered a survey in Spanish to evaluate science communication skills among Peruvian medical students (n=69). Our preliminary study demonstrates the statistical robustness of the survey and provides valuable insights into self-reported science communication proficiency. By identifying the strengths and areas for improvement in science communication, this research represents a crucial step in addressing the communication challenges within the Peruvian healthcare system.

Keywords Popularization of science and technology; Professionalism, professional development and training in science communication; Science communication teaching

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Introduction

Effective science communication is an important component of medical education. The ability to interpret, synthesize, and convey scientific information accurately and understandably is critical to clinical practice, research, and continuing education. However, despite its importance, teaching science communication in medical education is often overlooked or underappreciated [Brownell, Price & Steinman, 2013].

Existing literature suggests that teaching science communication in medical education can be variable and often insufficient to prepare students for the challenges of science communication in clinical practice and research [Fischhoff, 2013]. In addition, the lack of reliable and specific evaluation tools makes it difficult to evaluate the teaching of science communication in medical education systematically.

Science communication was pivotal during the COVID-19 pandemic, especially in countries like Peru, where a deficient healthcare system led to elevated mortality rates. The health system in Peru is divided into several networks, including two public networks, "Sistema Integral de Salud" (SIS) and EsSalud, and private clinics, which made efficient coordination to meet demand during the pandemic difficult [Alcalde-Rabanal, Lazo-González & Nigenda, 2011]. In addition, respiratory diseases were already the leading cause of death among adults, so the pandemic faced an overloaded and under-resourced health system. In this context, reports show high consumption of pseudo-treatments in Peru and even irregular vaccination of the population with unapproved experimental vaccines against COVID-19 [Chávez, 2021; Rodriguez-Morales et al., 2020]. For example, during the pandemic, it was reported in Peru and several other countries in the region a high consumption of chlorine dioxide, a product used for the disinfection of surfaces, that presents toxicity levels when ingested. This intake was reported in Peru, Ecuador, Honduras, Bolivia, and Guatemala, countries with similar low science literacy and low freedom of expression levels [Mostajo-Radji, 2020; Soriano-Moreno, Fernandez-Guzman, Ccami-Bernal, Rojas-Miliano & Nieto-Gutierrez, 2021]. In this circumstance, the ability to convey scientific information in a clear, accurate, and accessible manner is essential to inform the public and guide public health policies and practices.

Despite the importance of developing these skills, training in science communication in medical education is often not integrated into study programs, is not a priority, or is not even considered. However, it is possible that this training is not done directly in one specific course but is carried out transversally through case analysis on different courses in medical undergraduate studies. Therefore, it is necessary to use a reliable tool that allows measuring if these skills had been learned by medical students and also that allows differentiating the abilities developed in professional training from those acquired in extracurricular courses on the subject.

Background

Effective communication skills between healthcare professionals are correlated to improvements in interpreting and conveying scientific and medical knowledge to their peers, patients, and the general public. Thus, physicians training in these competencies might affect patients positively [Bachmann et al., 2013; Bachmann, Pettit & Rosenbaum, 2022]. However, despite its importance, the teaching of science and health communication in medical schools is usually underestimated or not fully integrated into the medical curriculum, and it is usually offered transversally during the case analysis along the career [Burgess et al., 2021; Haidet et al., 2012; Brownell et al., 2013].

Several challenges with science communication training in medical education have been reported. Lack of time and resources, a shortage of qualified instructors, and a lack of in-depth curriculum evaluations are some examples. Studies have also revealed that students frequently lack confidence in their ability to use these skills and frequently feel unsupported in their learning process [Ziegler, Ronja Hedder & Fischer, 2021; Burgess et al., 2021].

Despite these challenges, these skills are needed to prepare students for their practice as physicians. According to Brownell et al. [2013] and Fischhoff [2013], preparation can positively affect professional expertise in many aspects. In medical education, this might improve clinical decision-making, facilitate collaboration between disciplines, support patient involvement in their medical care, and strengthen public understanding of science and medicine.

In this context, examining what is taught to medical students in science communication is an important step for improving the teaching and curricula [Bachmann et al., 2022]. Then, it is crucial to develop reliable and specific assessment tools to measure the progress of those skills in medical education. These tools can help identify areas of strength and weakness, provide feedback to medical educators, and guide improvements in science communication teaching and curricula.

Despite how critical the enhancement of these skills is on patient-centered care, and how this has been endorsed by several accredited organizations, there is little published literature on this area [Stone, Bazaldua & Morrow, 2021]. For instance, initiatives in Europe and the U.S. emphasize science communication within medical education to enhance public engagement. The European Association for Communication in Health Care (EACH) created the "tEACH" subcommittee to foster communication teaching in Europe, aiming to better equip future healthcare providers for effective public communication of scientific and medical information [Bachmann et al., 2013]. With similar conclusions, a group of medical specialists from Latin America, Portugal, and Spain integrated a Scientific Committee to find a consensus on the required core communication curriculum for undergraduate medical education. This committee was integrated by 15 members from Argentina, Brazil, Chile, Colombia, Spain, Mexico, and Portugal including physicians, clinical faculty, and other health and non-health related professionals, and 46 experts that participated in the survey [García de Leonardo et al., 2016].

In addition, it's pertinent to mention that there are different perspectives on what is included in the academic use of "science communication." According to Lewenstein [2022], this might refer to a field of action and also a field of study, and to other professional communications like peer review publications and conference presentations. Additionally, recognizing the science communication system is non-linear, it is necessary to establish that for this research, the definition of "science communication" approaches to the public communication of science and technology, and the "public dissemination of reliable scientific information." On the other hand, it's relevant to mention that Peru is quite behind in updating terms and concepts. For example, in Latin America, there are important efforts for promoting science communication projects to more effective models like the dialogue and contextual one, under the name of "apropiación social de la ciencia y la tecnología" (social appropriation of science and technology) [Lozano, 2005, 2008]. However, in Peru, this term is not being used and most public and private strategies are being referred to by the terms "divulgación científica" (dissemination of science) or "popularización de la ciencia" (popularization of science), according to CONCYTEC (National Council of Science, Technology and Technological Innovation) science disseminator's directory.[1]

[1] https://www.gob.pe/institucion/concytec/campañas/8133-directorio-de-divulgadores-cientificos.

Literature review

Several investigations have demonstrated the importance of science communication abilities in scientists. According to Brownell et al. [2013] and Fischhoff [2013], an accurate and understandable interpretation, synthesis, and transmission of scientific information are crucial for the practice of all scientific fields, including medicine.

Despite its relevance, teaching science communication in higher education is usually neglected or devalued. Ziegler et al. [2021] underlined how the absence of reliable and focused evaluation instruments makes it challenging to properly and systematically assess how science communication is taught in higher education. Additionally, this study found that the preparation given to medical students for science communication challenges in the medical practice and research could vary and is commonly insufficient.

Brownell et al. [2013] and Burgess et al. [2021] suggest that students' attitudes and beliefs might influence the teaching of science communication. For example, science students often perceive science communication as challenging due to a lack of confidence in their communication skills, a lack of interest in science communication, and an assumption that science communication is not helpful. However, studies show that cross-curricular teaching is not only effective but also allows students to develop useful skills for science communication while staying focused on learning their profession and, in the current investigation specifically, applied to medical students [Brownell et al., 2013; Burgess et al., 2021]. Furthermore, according to Bachmann et al. [2022], the impact of communication skills training in undergraduate and postgraduate settings has been measured, and suggests several benefits for the patient. Similarly, Ruiz-Moral, Gracia de Leonardo, Caballero Martínez and Monge Martín [2019] reported that a two focus groups formed by medical students that underwent two years of communication training concluded that the emphasis should be on students developing practical communication skills within their courses. Therefore, courses of this nature should be included in the curriculum during the early stages of their curricula [Tanwani, 2017].

Given the scarcity of studies on science communication in Latin America [Massarani et al., 2017; Cortassa, 2018], particularly in Peru, there is a pressing need for an exploratory study. This study aims to investigate the perceptions of medical students and medical doctors in Peru regarding their science communication skills. Furthermore, it seeks to determine whether the teaching of science communication in universities aligns with the needs of the medical community, or if it is currently absent from the curriculum.

Methodology

We conducted a survey to assess medical students' and physicians' opinions on general information, science communication skills evaluation, perceptions of the importance and utility of science communication, and training satisfaction. This anonymous survey was distributed through a medical student association and included questions drawn from Besley, Dudo and Storksdieck [2015], Besley, Dudo, Yuan and Abi Ghannam [2016] and Dudo, Besley and Yuan [2021], Rodgers et al. [2018].

Research design

For this study, we used a mixed-method explanatory-sequential with a research process "QUAN->QUAL" according to Shorten and Smith [2017], a quantitative approach that relies on Likert-Scale surveys and a qualitative approach that analyzes the comments to gauge the perceptions of medical students and professionals regarding science communication skills and education and also the consultations with two professors with 16 and 18 years of experience in medical education. The population of interest is medical students and professional physicians. The sample of the preliminary survey consists of 61 participants from different regions of Peru reached by the digital channels provided by SOCIMEP (Scientific Medical Society of Peru) and it was obtained from a non-probabilistic approach.

Survey development

Before the utilized survey was developed, an analysis of the curricula of the five main medicine programs in Peru was carried out, along with an unstructured interview with two professors from different universities and are affiliated with a scientific medical research association. It was confirmed that there are no specific courses on science communication or related fields, and that this training is carried out transversally through the different courses. Additionally, we reviewed the curricula of private universities: (a) Cesar Vallejo University — UCV,[2] (b) Señor de Sipan University — USS,[3] (c) Peruvian University of Applied Science — UPC,[4] and public universities, (d) Toribio Rodriguez de Mendoza National University — UNTRM[5] and (d) Pedro Ruiz Gallo National University — UNPRG[6] whose curricula is public.

Based on these observations, we decided to design a survey as the tool to enable us to perform a descriptive analysis. The five objectives sought by science communication workshops, as Besley et al. [2015] proposed, were considered. These refer to the skills necessary for effective science communication, including critical analysis, synthesis and translation of scientific information, and adapting the message to the target audience. Subsequently, we used the qualitative study by Besley et al. [2016] to identify the specific skills that science communication trainers aim to promote, which could be applicable to medical students. With this information, we developed a self-reported questionnaire to measure and describe the teaching of science communication skills to medical students according to the objectives identified in the aforementioned studies.

Furthermore, we included a question to evaluate whether medical students would consider or plan to engage in science communication projects. This is interesting to measure because Besley et al. [2015] hypothesize that the interest in participating in these type of projects might be related to indicators such as willingness and

[2] https://www.ucv.edu.pe/wp-content/uploads/2020/01/MALLA_Dv2.pdf.

[3] https://www.uss.edu.pe/uss/TransparenciaDoc/PorMedicina/MallCurricular/Malla%20Curricular%20de%20Medicina%20Humana.pdf.

[4] https://pregrado.upc.edu.pe/carrera-de-medicina/malla-curricular/.

[5] https://www.untrm.edu.pe/resoluciones/2022/Consejo/R.C.U%20N174-2022.pdf.

[6] https://www.unprg.edu.pe/univ/portal/documentos_s/planes/P15.%20MEDICINA%20HUMANA.pdf.

efficacy. This could also be related to an inherent predisposition of those who choose to study medicine. For instance, this interest could be linked to predisposition to interact with patients. If this is the case, it could be evaluated whether this is something intrinsic to medical practice, or to certain medical specialties, where doctors are more often required to explain scientific concepts to patients, such as diagnoses and treatments.

We also created a section on the survey about self-perception of skills based on the work by Dudo et al. [2021] and Rodgers et al. [2018]. We selected the items we consider more applicable to medical students and medical practice, discarding those we did not consider related to medical activities. Each of these skills was evaluated through ten questions on a five-point scale. This section aimed to measure which science communication skills medical students consider most important. Finally, we introduced some open-ended questions to facilitate subsequent qualitative analysis.

Our methodology is based on the works of Besley et al. [2015] and Besley et al. [2016], Dudo et al. [2021] but considers the nature of the medical practice. It's designed to report and describe the current state of teaching science communication to medical students in Peru in a reliable way, both in terms of their current training and their perceptions and attitudes towards it.

We estimated the survey's Cronbach's alpha to measure internal consistency. Although some of these questions have been adapted from other previously validated tools, it is necessary to assess whether the internal consistency of the original surveys was affected when translated to Spanish. It is important to note that the sample used in this preliminary study does reflect the diversity in the medical population, but not in a proportional way, as we surveyed volunteer medical students who were contacted by email and a messaging app through the student channels provided by SOCIMEP.

Data collection

The instrument used to collect the data for this preliminary study was a survey that included questions designed to evaluate science communication skills, the perception of the importance of such communication, and satisfaction with training in science communication. The adaptation of the survey followed Jensen's [2015] recommendations.

Regarding ethical aspects and reliability, the survey included informed consent to ensure that participants understood the use given to the data provided in the survey, all participants were 18 years old or older, which is the age for being recognized as adults in Peru. The survey included a comment section at the end for allowing the participants to write the comments they deemed pertinent. It was administered through Google Forms and was sent to participants by email and WhatsApp groups directly related to SOCIMEP. All respondents participated voluntarily and anonymously.

Data analysis

Once the responses were collected, descriptive data analysis was carried out to determine trends and patterns in the participants' perceptions related to science communication [Besley et al., 2015]. On the other hand, the reliability of the instrument was evaluated with Cronbach's alpha because polytomous scales were used [Cronbach, 1951; Oviedo & Campo-Arias, 2005]. The Kaiser-Meyer-Olkin (KMO) test, Barlett's sphericity test, and the anti-image correlation matrix were used before performing the factorial analysis using principal components by the method of orthogonal rotation Varimax with Kaiser normalization [Ayuso-Margañón, Rodríguez-Ávila, Riera-i-Prunera & Ayuso-Margañón, 2022]. From the extracted factors, a multinomial logistic regression was performed using the SPSS 28.0.1 software to analyze how the presence or absence of the selected factors influences the probability of the event occurring [Ayuso-Margañón et al., 2022; Pando & San-Martín, 2004]. Finally, the Atlas.ti v. 23 software [Friese, 2014] was used to analyze qualitative data from comments left in the questionnaire. Each comment was coded and each code was defined, contrasting with those obtained with the OpenAI artificial intelligence tool available in that version [Lopezosa, Codina & Boté-Vericad, 2023]. The frequency of the most repeated words in the comments was determined, as well as the frequency of the codes.

Analysis of results

The results of the mixed approach are divided into two sections: quantitative results based on a Likert-scale questionnaire and qualitative results of the participants' comments and professors' interviews.

Participant demographics

The study sample comprised 58% women and 42% men, aged between 17 and 40 (Figure 1). The majority of them (94.2%9 were medical students, medical graduates (1.4%), and postgraduate doctors (4.3%) from different specialties (Figure 2), 34.43% and 65.57% from private and public universities, respectively.

Furthermore, it is worth emphasizing that 54.1% of the participants had not engaged in any extracurricular courses or workshops related to health communication or science communication (question 19). However, 65.57% expressed their intention to explore the possibility of enrolling in a health communication course (question 20). In addition to this, an impressive 90.16% of respondents expressed keen interest in actively participating in science communication initiatives, while 99.96% recognized the pivotal role of acquiring knowledge in health communication for advancing their careers (question 22) using different formats (Figure 3).

Quantitative results

It was found that the instrument used has very good reliability (Cronbach's alpha = 0.876). The KMO test (0.799), Bartlett's sphericity (p-value = 0.000), and the anti-image correlation matrix showed positive results for performing the factorial analysis. The principal component analysis divided the questions into 4 factors

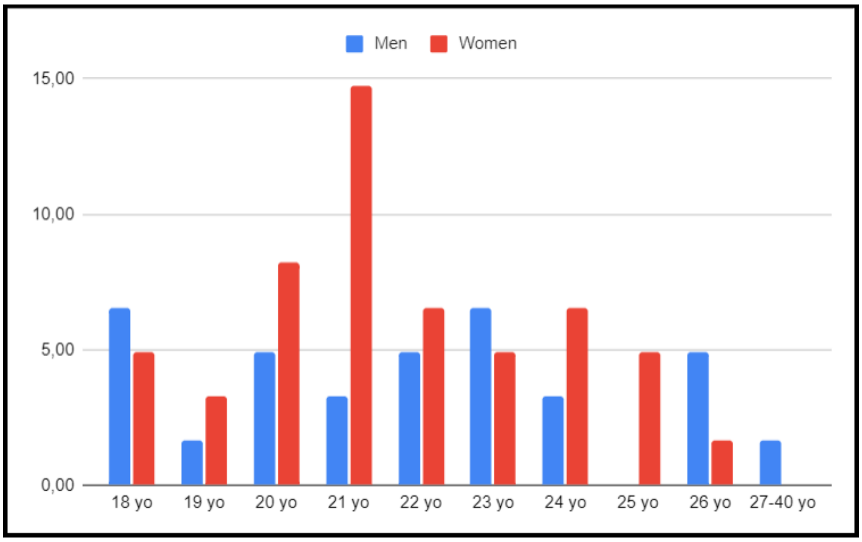

Figure 1. Pyramid of the sample studied according to their gender and age range.

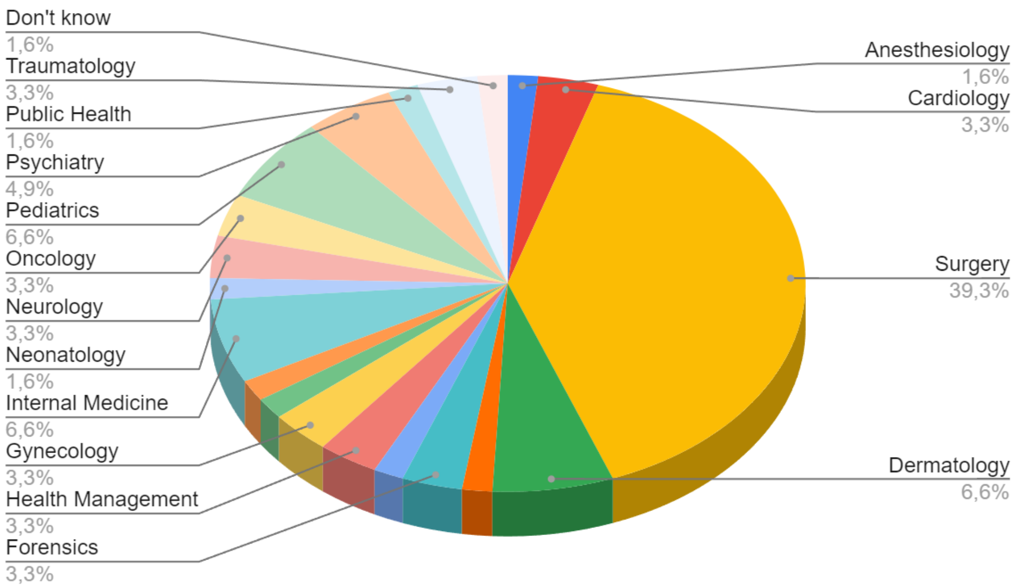

Figure 2. Medical specialties of the participants.

(Table 1) which explain 73.28% of the variability (Table 2) (See appendix B). Figures 4 to 7 show the axes, and the details of the questions can be found in appendix A.

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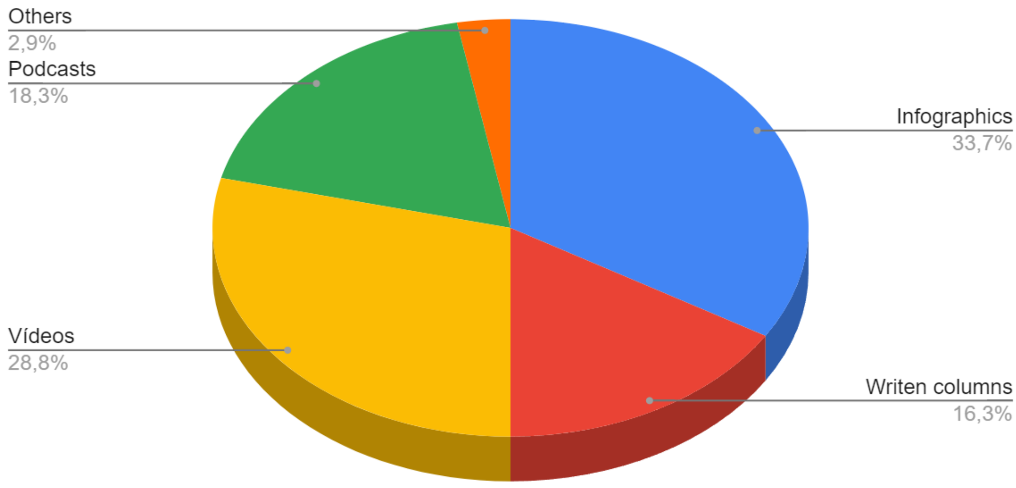

Figure 3. Different Science Communication formats that participants would consider participating.

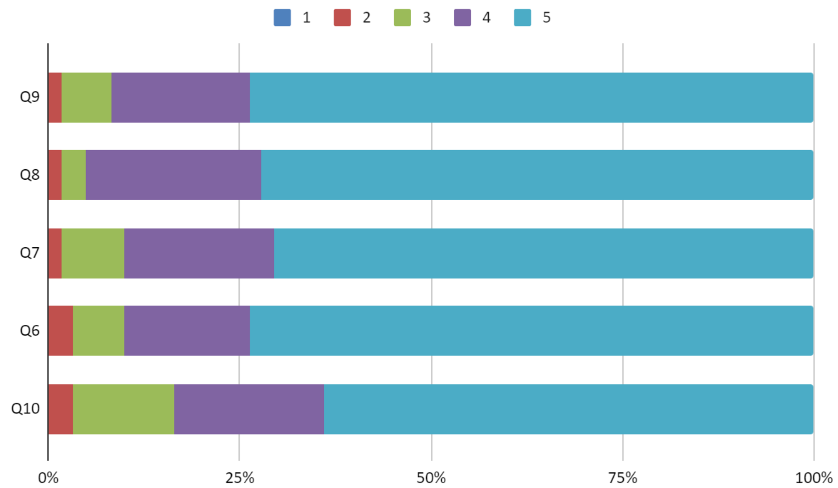

Figure 4. Percentage who responded to questions Q6-Q10, corresponding to factor 1 (available in appendix A) regarding their beliefs on the importance of learning to communicate about health. The colors in the figure represent Likert scale numbers ranging from 1 to 5, reflecting varying degrees of agreement, where 1 signifies complete disagreement and 5 signifies complete agreement.

The multinomial logistic regression analysis suggests several results that we proceed to detail:

(a) The perceived capability to make a presentation with slides to explain a treatment or diagnosis is a significant factor in predicting patient contact predisposition (question 6, p-value=0.000). This result is likely due to

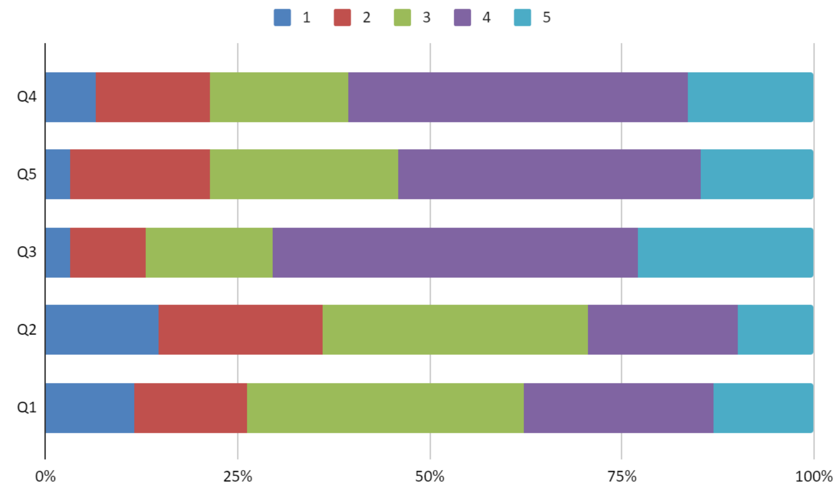

Figure 5. Percentage who responded to questions Q1-Q4, corresponding to factor 2 (available in appendix A) related to the perception of their ability to communicate science. The colors represent Likert scale numbers from 1 to 5, from lowest to highest degree of ability where 1 means "I do not feel capable" and 5 means "I feel totally capable".

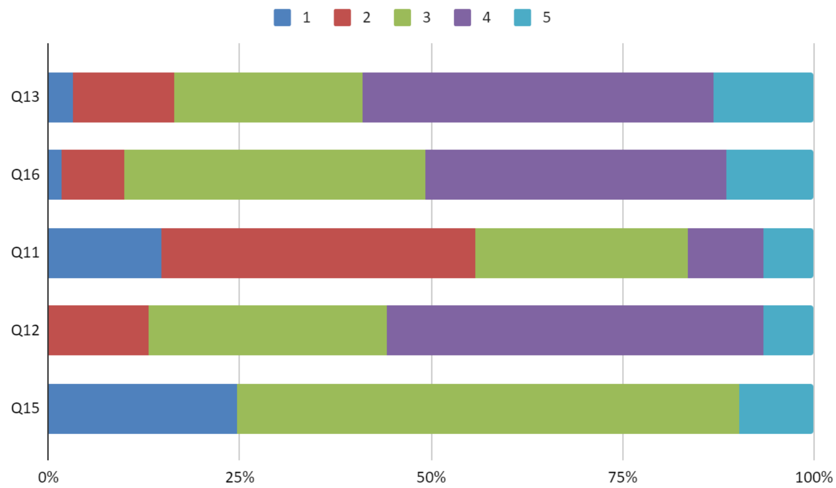

Figure 6. Percentage who answered the questions corresponding to factor 3 (available in appendix A). Q11-Q13 related to how they describe their ability to communicate science, Q15 on whether their training in communication is sufficient and Q16 referring to the teacher's ability to teach communication. The Likert scale used was 1 to 5, from lowest to highest.

individuals who feel capable of making a presentation with slides considering it important and being predisposed to use this tool to explain treatments and diagnosis to patients (question 3).

(b) The dependent variable on how they would describe their skills in science communication before starting medical school (question 12) is significantly associated with three independent variables: the belief of having sufficient training in science communication (question 15, p-value=0.000), whether they study at a public or private university (p-value=0.000), and whether they have participated in any extracurricular course on science communication (question

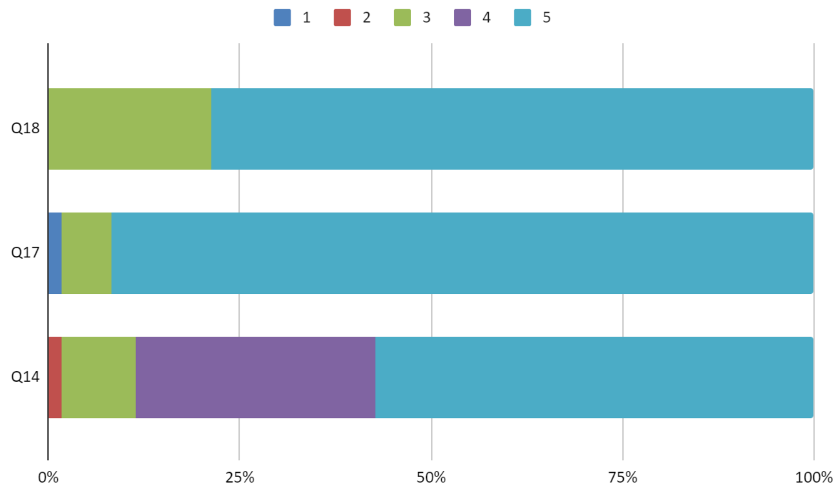

Figure 7. Percentage who answered the questions corresponding to factor 4 (available in appendix A). Q14 related to whether it is important for professors to learn about science communication, Q17 whether learning science communication helps in their careers and Q18 whether they consider it is important for physicians to report on health. The Likert scale used was 1 to 5, from lowest to highest.

19, p-value=0.000). It was found that participants coming from national universities perceived a lower ability to communicate science before starting university than those from private universities. On a 1–5 Likert scale, the percentages were as follows: 1–2 (69.57% for public vs. 47.73% for private), 3 (26.09% for public vs. 27.27% for private), and 4–5 (4.35% for public vs. 25.00% for private). However, it is important to bear in mind that logistic regression does not establish a causal relationship between variables, but only a significant association. Therefore, additional research is needed to determine the exact nature of these relationships and to better understand how science communication skills can be improved in university students.

(c) Self-assessment of knowledge about science communication throughout their career (question 13, p-value=0.016), specialization (Figure 2, p-value=0.000), and consideration of taking a science communication course (question 20, p-value=0.000) are significant variables to predict students' opinion that learning science communication influences patients' trust in their doctor. These findings suggest that education and training in these topics can have a positive impact on student's perception of how their learning influences patients' trust in doctors.

(d) Students' opinion of the importance of physicians being dedicated to communicating scientific information to the public (question 18, p-value=0.033) is correlated to the perception that patients need doctors who are capable of effectively explaining diagnoses and treatments. These findings suggest that students who value the importance of science communication also recognize the importance of doctors' ability to communicate complex information clearly and effectively to patients.

(e) The results indicate that specialization (Figure 2, p-value=0.000) is significantly associated with students' ratings of professors' ability to teach science communication (question 14, p-value=0.000). In other words, different specializations may have different perceptions about professionals' ability to teach skills in scientific communication.

Qualitative results

The analysis using Atlas.ti of participant comments revealed key themes. The most frequent words used were "communication," "health," and "important." The primary codes centered on the need for studies in this field (25%), the demand for scientific communication training (21.43%), and recognition of its importance (21.43%). Less commonly, comments touched on simplifying patient communication (14.29%), the perception that some doctors undervalue scientific communication (7.14%), self-assessment of communication skills (7.14%), and the reduction of communication to clinical knowledge (3.57%). While the results suggest that participants recognize the significance of science and health communication, a review of the curricula at the five leading universities revealed a notable absence of relevant courses aimed at honing this skill. This absence was corroborated during interviews with professors, one of whom expressed that health communication "is best cultivated through practical experience, rather than classroom instruction."

Discussion

Survey reliability

The study aims to describe the science communication skills developed by medical students based on a preliminary perception study carried out with students from different universities in Peru. One of the main challenges is to design a reliable tool that allows for this measurement. This is due to the fact that several studies that use questions that had to be filtered and translated into Spanish have been used as a reference. Another challenge was the diversity of the terms that the science communication has in Spanish. For example, it is very common to use "divulgación científica" [science dissemination], "science popularization" (popularization of science), "comunicación científica" (science communication), among others. There are also various definitions for science dissemination, which could refer to science communication among specialists. Finally, considering the use of these terms among health professionals, and seeking the most appropriate, science communication was chosen. This was done considering that even when it strictly does not directly refer to science communication, it does so in the population studied.

Regarding the structure of the survey, statistical tests proved that it is reliable (Cronbach's alpha = 0.876) [Cronbach, 1951; Oviedo & Campo-Arias, 2005]. However, at the time of conducting the study, there were substantial constraints that demanded addressing to carry out more in-depth studies. For instance, while the data discovered provides a certain homogeneity that allows for a basic description, and there is diversity in the sample, we must also consider that it is not proportionately representative of some crucial characteristics that should be taken into account.

Findings of the survey

This is the first study of this type carried out in Peru, so we have characterized the study sample by age and sex (Figure 1). We also observed that most of the students expressed a preference for being surgeons (39.3%) compared to other medical specialties (Figure 2).

A potential contradiction arises between questions 11 and 12 (Figure 6), which aim to quantify individuals' perceived change in their science communication skills. Initially, most students described their skills as "limited" before starting their university education, an expected observation. However, after their university courses, the majority began rating their skills as "proficient." This contrast raises questions because earlier, they had expressed skepticism about the quality of their science communication training. One plausible explanation is that students might assume their science communication skills improved along with their medical studies. This assumption aligns with their belief in the importance of these skills for doctors. Moreover, it's essential to consider the bias explored by Besley and Nisbet [2011], in which scientists tend to equate science communication skills with those needed for enhancing science literacy using the deficit model. This is consistent with our findings; participants favored formats like infographics (33.7%), podcasts (18.35%), and writing columns (16.3%), associated with the deficit model, over in-person discussions (0%) or other formats (2.9%), which are more related to a participative model (Figure 3). In other words, if students believe that they have increased their knowledge about the medical field (science), it is logical for them to believe that they have also improved their skills in science communication. In order to verify and contrast this hypothesis, more research is needed.

Another potential inconsistency emerges between questions 15 and 16 (Figure 6). Initially, most respondents express that their science communication training was somewhat sufficient. However, they later rate their instructors' science communication skills as good or excellent, implying sufficiency. This raises questions about trusting their professors' expertise while simultaneously doubting their training. One explanation could be that students believe their training is somewhat sufficient, but other factors may affect their learning, such as course content, university logistics, or instructional approaches. This might suggest challenges in knowledge transfer rather than instructor competence. Alternatively, students might not yet feel they have acquired all necessary science communication skills at their career stage. Exploring this question in future studies may enhance our understanding of factors impacting science communication training and students' perceptions at different career stages.

We observed that students have almost unanimously stated that it is important that doctors know about science communication, especially considering that it is not their major activity. This finding allows us to propose a few hypotheses that could help explain this phenomenon: (a) They may view patients as the target audience, knowing that in their interaction, effective communication is vital to deliver medical information clearly and understandably and to create a relationship of trust. (b) Students may perceive that science communication and the ability to communicate effectively have a strong connection to their competency in the field of medicine. Therefore, they recognize the need to gain communication skills to complement their medical expertise and be more effective and thorough professionals.

Notwithstanding the above, a few studies have previously shown that there can be a gap between self-perception and external measurement of medical students' communication skills [Graf et al., 2020]. Therefore, while students might attribute having high communication skills, it would not be unusual for these indicators to be lower in an external evaluation.

Limitations and future research

This study has limitations due to the size of the sample taken. The statistical analysis of Cronbach's alpha and the multinomial logistic regression analysis and the qualitative analysis of students' comments using Atlas.ti have shown positive results, but these will be reviewed in subsequent tests with more representative samples. However, it is clear that the results show some interesting trends that highlight a few correlations, so broader studies are needed to corroborate these findings.

In future work, we plan to conduct a broader study with a larger statistical sample in the same population to assess the validity of the proposed instrument. Our preliminary results suggest we should seek to maintain or increase the diversity of the participants, considering the proportions between students from public and private universities, in a larger demographic sample. This might provide more robust results that could allow us to propose recommendations to improve the higher education system and systematize the teaching of science communication in medical curricula.

Conclusions

This study conducted among medical students in Peru sheds light on their perceptions of their science communication skills and the importance of communication skills for their profession. This research suggests the need to include science communication training early in medical curricula, as students appear to have a growing awareness of the importance of effective communication in their future roles as healthcare professionals. Moreover, it suggest the need to emphasize the advantages of more efficient communication approaches, for instance, participative over deficit models.

Declaration of conflicting interests. The authors declared no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

Appendix A. Questionnaire

Q1: **"Soy capaz de explicar mediante una narración (o solo "narrar") cómo evoluciona un diagnóstico o cómo se desarrolla un tratamiento"** [*"I am able to explain through a narrative (or just "narrate") how a diagnosis evolves or how a treatment develops"*].

Q2: **"Soy capaz de explicar un diagnóstico o tratamiento sencillo en 30 segundos o menos"** [*"I am able to explain a simple diagnosis or treatment in 30 seconds or less"*].

Q3: **"Soy capaz de hacer una presentación con diapositivas para exponer sobre un tratamiento o diagnóstico"** [*"I am able to make a slide presentation to explain a treatment or diagnosis"*].

Q4: **"Soy capaz de crear contenido escrito o visual explicando un diagnóstico o tratamiento"** [*"I am able to create written or visual content explaining a diagnosis or treatment"*].

Q5: **"Tengo las habilidades suficientes para explicar temas médicos de forma sencilla para un público no médico (o no especializado)"** [*"I have sufficient skills to explain medical topics in a simple way to a non-medical (or non-specialized) audience"*].

- **No me siento capaz** [*I do not feel capable*].
- **Me siento un poco capaz** [*I feel a little capable*].
- **Me siento medianamente capaz** [*I feel moderately capable*].
- **Me siento muy capaz** [*I feel very capable*].
- **Me siento totalmente capaz** [*I feel totally capable*].

Q6: **¿Consideras que es importante aprender a comunicar sobre salud en un lenguaje sencillo?** [*Do you think it is important to learn to communicate about health in simple language?*].

Q7: **¿Consideras que aprender a comunicar sobre salud es útil para los médicos?** [*Do you think that learning to communicate about health is useful for doctors?*].

Q8: **¿Consideras que aprender a comunicar sobre salud influye en la confianza de los pacientes hacia su médico tratante?** [*Do you think that learning to communicate about health influences patients' trust in their treating doctor?*].

Q9: **¿Consideras que los pacientes necesitan que los médicos sean capaces de explicar los diagnósticos y tratamientos de forma sencilla?** [*Do you think that patients need doctors to be able to explain diagnoses and treatments in a simple way?*].

Q10: **¿Consideras que la medicina requiere que los médicos se especialicen en que las personas entiendan lo que ellos explican?** [*Do you think that medicine requires that doctors specialize in ensuring that people understand what they explain?*].

- **Nada de acuerdo** [*Totally disagree*].
- **Un poco de acuerdo** [*Strongly disagree*].
- **Medianamente de acuerdo** [*Moderately agree*].
- **Muy de acuerdo** [*Strongly agree*].
- **Totalmente de acuerdo** [*Totally agree*].

Q11: **¿Cómo describirías tus habilidades de comunicación científica antes de empezar la universidad?** [*How would you describe your science communication skills before starting university?*].

Q12: **¿Cómo describirías tus habilidades de comunicación científica actualmente?** [*How would you describe your science communication skills currently?*].

Q13: **¿Cómo calificarías el conocimiento que obtuviste sobre la comunicación científica a lo largo de la carrera?** [*How would you rate the knowledge you obtained about science communication throughout your degree?*]

- **Nulas** [*None*].
- **Escasas** [*Poor*].
- **Intermedias** [*Intermediate*].
- **Buenas** [*Good*].
- **Excelentes** [*Excellent*].

Q14: **¿Crees que para los profesores es importante aprender de comunicación científica?** [*Do you think it is important for teachers to learn about science communication?*].

- **Nada importante** [*Not at all important*].
- **Poco importante** [*Little important*].
- **Medianamente importante** [*Moderately important*].
- **Bastante importante** [*Fairly important*].
- **Totalmente importante** [*Completely important*].

Q15: **¿Crees que tu formación en comunicación científica fue suficiente?** [*Do you think your training in science communication was enough?*]

- **Sí** [*Yes*].
- **Parcialmente** [*Partially*].
- **No** [*No*].

Q16: **¿Cómo calificarías las habilidades de los profesores de medicina para enseñarte a comunicar temas de ciencia o medicina?** [*How would you rate the abilities of medical teachers to teach you how to communicate science or medicine topics?*]

- **Nulas** [*None*].
- **Escasas** [*Poor*].
- **Intermedias** [*Intermediate*].
- **Buenas** [*Good*].
- **Excelentes** [*Excellent*].
- **No aplica** [*Does not apply*].

Q17: **¿Crees que aprender comunicación de la salud te ayudará en tu carrera?** [*Do you think learning health communication will help you in your career?*]

– **Sí** [*Yes*].
– **Parcialmente** [*Partially*].
– **No** [*No*].

Q18: **¿Consideras importante que los médicos se dediquen a divulgar sobre salud?** [*Do you consider it important that doctors dedicate themselves to disseminate information about health?*].

– **Sí, todos** [*Yes, all*].
– **Sí, algunos** [*Yes, some*].
– **No** [*No*].

Q19: **¿Ha participado en algún curso o taller extracurricular sobre comunicación de la salud o comunicación científica?** [Have you ever participated in any extracurricular courses or workshops on health communication or science communication?]

Q20: **¿Has considerado llevar un curso de comunicación de la salud?** [Have you considered taking a health communication course or workshop?]

Q21: **¿Considerarías participar en una iniciativa de comunicación de la ciencia?** [Would you consider participating in a science communication initiative?]

– **Sí, todos** [*Yes*].
– **No** [*No*].

Q22: **¿Crees que aprender comunicación de la salud te ayudará en tu carrera?** [Do you think learning health communication will help you in your career?]

– **Sí, todos** [*Yes*].
– **No** [*No*].
– Parcialmente

Appendix B. Tables for the principal component analysis

Table 1. Rotated component matrix. The rotated component matrix resulting from the statistical analysis groups the questionnaire questions (Q) into four factors (clusters) that exhibit shared characteristics. The rectangles represent the questions grouped into the different factors.

	Factor 1	Factor 2	Factor 3	Factor 4
Q9	0.91	0.153	-0.004	-0.008
Q8	0.896	0.195	0.1	-0.018
Q7	0.882	0.233	0.072	0.187
Q6	0.868	0.152	0.104	0.17
Q10	0.741	0.106	0.048	0.395
Q4	0.249	0.846	0.035	-0.142
Q5	0.135	0.838	0.133	-0.024
Q3	0.303	0.838	0.143	-0.087
Q2	0.053	0.838	0.324	0.028
Q1	0.144	0.831	0.229	0.029
Q13	0.137	0.31	0.811	0.127
Q16	0.213	0.034	0.794	-0.114
Q11	-0.197	0.328	0.701	0.201
Q12	0.186	0.526	0.674	0.19
Q15	-0.005	-0.05	-0.565	0.358
Q18	0.082	-0.1	0.111	0.815
Q17	0.178	-0.092	-0.162	0.716
Q14	0.43	0.145	0.111	0.493

Table 2. Sums of squared extraction charges. The multinomial factor analysis shows the percentage of variance contributed by each factor, and the total variability (rectangle) represents 73.28%.

Total	Variance (%)	Accumulated (%)
6.685	37.140	37.140
3.318	18.433	55.573
1.817	10.095	65.668
1.370	7.609	73.277

References

Alcalde-Rabanal, J. E., Lazo-González, O. & Nigenda, G. (2011). Sistema de salud de Perú. *Salud Pública de México 53* (Supplement 2), s243–s254. Retrieved from https://www.scielo.org.mx/scielo.php?pid=S0036-36342011000800019&script=sci_abstract

Ayuso-Margañón, S., Rodríguez-Ávila, N., Riera-i-Prunera, M. C. & Ayuso-Margañón, R. (2022). Análisis factorial y regresión logística multinomial del cuestionario de evaluación de sobrecarga del cuidador. *Gerokomos 33* (2), 68–75. Retrieved from https://scielo.isciii.es/scielo.php?script=sci_arttext&pid=S1134-928X2022000200002

Bachmann, C., Abramovitch, H., Barbu, C. G., Cavaco, A. M., Elorza, R. D., Haak, R., . . . Rosenbaum, M. (2013). A European consensus on learning objectives for a core communication curriculum in health care professions. *Patient Education and Counseling 93* (1), 18–26. doi:10.1016/j.pec.2012.10.016

Bachmann, C., Pettit, J. & Rosenbaum, M. (2022). Developing communication curricula in healthcare education: an evidence-based guide. *Patient Education and Counseling 105* (7), 2320–2327. doi:10.1016/j.pec.2021.11.016

Besley, J. C., Dudo, A. & Storksdieck, M. (2015). Scientists' views about communication training. *Journal of Research in Science Teaching 52* (2), 199–220. doi:10.1002/tea.21186

Besley, J. C., Dudo, A. D., Yuan, S. & Abi Ghannam, N. (2016). Qualitative interviews with science communication trainers about communication objectives and goals. *Science Communication 38* (3), 356–381. doi:10.1177/1075547016645640

Besley, J. C. & Nisbet, M. (2011). How scientists view the public, the media and the political process. *Public Understanding of Science 22* (6), 644–659. doi:10.1177/0963662511418743

Brownell, S. E., Price, J. V. & Steinman, L. (2013). Science communication to the general public: why we need to teach undergraduate and graduate students this skill as part of their formal scientific training. *Journal of Undergraduate Neuroscience Education 12* (1), E6–E10. PMID: 24319399

Burgess, A., Matar, E., Roberts, C., Haq, I., Wynter, L., Singer, J., . . . Bleasel, J. (2021). Scaffolding medical student knowledge and skills: team-based learning (TBL) and case-based learning (CBL). *BMC Medical Education 21* (1), 238. doi:10.1186/s12909-021-02638-3

Chávez, C. (2021). Proyecto de vacuna de Farvet: autoridades no asumen responsabilidad en fiscalización. *Ojo Público*. Retrieved from https://ojo-publico.com/derechos-humanos/salud/autoridades-no-asumen-responsabilidad-fiscalizacion-farvet

Cortassa, C. (2018). La identidad del campo de Comunicación de las Ciencias en América Latina. *JCOM — América Latina 01* (01), Y01. doi:10.22323/3.01010401

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika 16* (3), 297–334. doi:10.1007/bf02310555

Dudo, A., Besley, J. C. & Yuan, S. (2021). Science communication training in North America: preparing whom to do what with what effect? *Science Communication 43* (1), 33–63. doi:10.1177/1075547020960138

Fischhoff, B. (2013). The sciences of science communication. *Proceedings of the National Academy of Sciences 110* (Supplement 3), 14033–14039. doi:10.1073/pnas.1213273110

Friese, S. (2014). *Qualitative data analysis with ATLAS.ti* (2nd ed.). Sage Publications.

García de Leonardo, C., Ruiz-Moral, R., Caballero, F., Cavaco, A., Moore, P., Dupuy, L. P., . . . Jovell, A. (2016). A Latin American, Portuguese and Spanish consensus on a core communication curriculum for undergraduate medical education. *BMC Medical Education 16* (1), 1–16. doi:10.1186/s12909-016-0610-8

Graf, J., Loda, T., Zipfel, S., Wosnik, A., Mohr, D. & Herrmann-Werner, A. (2020). Communication skills of medical students: survey of self- and external perception in a longitudinally based trend study. *BMC Medical Education 20* (1), 1–10. doi:10.1186/s12909-020-02049-w

Haidet, P., Levine, R. E., Parmelee, D. X., Crow, S., Kennedy, F., Kelly, P. A., . . . Richards, B. F. (2012). Perspective: guidelines for reporting team based learning activities in the medical and health sciences education literature. *Academic Medicine 87* (3), 292–299. doi:10.1097/acm.0b013e318244759e

Jensen, E. (2015). Evaluating impact and quality of experience in the 21st century: using technology to narrow the gap between science communication research and practice. *JCOM 14* (03), C05. doi:10.22323/2.14030305

Lewenstein, B. (2022). What is "science communication"? *JCOM 21* (07), C02. doi:10.22323/2.21070302
Lopezosa, C., Codina, L. & Boté-Vericad, J. J. (2023). *Testeando ATLAS.ti con OpenAI: hacia un nuevo paradigma para el análisis cualitativo de entrevistas con inteligencia artificial*. Barcelona, Spain: Departament de Comunicació. Universitat Pompeu Fabra. Retrieved from http://hdl.handle.net/10230/56449
Lozano, M. (2005). *Programas y experiencias en popularización de la ciencia y la tecnología. Panorámica desde los países del Convenio Andrés Bello*. Bogotá, Colombia: Convenio Andrés Bello.
Lozano, M. (2008). El nuevo contrato social sobre la ciencia: retos para la comunicación de la ciencia en América Latina. *Razón y Palabra 65*. Retrieved from http://www.razonypalabra.org.mx/N/n65/actual/mlozano.html
Massarani, L., Rocha, M., Pedersoli, C., Almeida, C., Amorim, L., Cambre, M., . . . Ferreira, F. B. (Eds.) (2017). *Aproximaciones a la investigación en divulgación de la ciencia en América Latina a partir de sus artículos académicos* (1st ed.). Rio de Janeiro, Brazil: Fiocruz, Casa de Oswaldo Cruz.
Mostajo-Radji, M. A. (2020). Pseudoscience in the times of crisis: how and why chlorine dioxide consumption became popular in Latin America during the COVID-19 pandemic. doi:10.31235/osf.io/u9ehf
Oviedo, H. C. & Campo-Arias, A. (2005). Aproximación al uso del coeficiente alfa de Cronbach. *Revista Colombiana de Psiquiatría 34* (4), 572–580. Retrieved May 30, 2023, from http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S0034-74502005000400009&lng=en&tlng=es
Pando, V. & San-Martín, R. (2004). Regresión logística multinomial. *Cuadernos de la Sociedad Española de Ciencias Forestales 18*, 323–327. Retrieved from http://secforestales.org/publicaciones/index.php/cuadernos_secf/article/view/9478
Rodgers, S., Wang, Z., Maras, M. A., Burgoyne, S., Balakrishnan, B., Stemmle, J. & Schultz, J. C. (2018). Decoding science: development and evaluation of a science communication training program using a triangulated framework. *Science Communication 40* (1), 3–32. doi:10.1177/1075547017747285
Rodriguez-Morales, A. J., Gallego, V., Escalera-Antezana, J. P., Méndez, C. A., Zambrano, L. I., Franco-Paredes, C., . . . Cimerman, S. (2020). COVID-19 in Latin America: the implications of the first confirmed case in Brazil. *Travel Medicine and Infectious Disease 35*, 101613. doi:10.1016/j.tmaid.2020.101613
Ruiz-Moral, R., Gracia de Leonardo, C., Caballero Martínez, F. & Monge Martín, D. (2019). Medical students' perceptions towards learning communication skills: a qualitative study following the 2-year training programme. *International Journal of Medical Education 10*, 90–97. doi:10.5116/ijme.5cbd.7e96
Shorten, A. & Smith, J. (2017). Mixed methods research: expanding the evidence base. *Evidence Based Nursing 20* (3), 74–75. doi:10.1136/eb-2017-102699
Soriano-Moreno, D. R., Fernandez-Guzman, D., Ccami-Bernal, F., Rojas-Miliano, C. & Nieto-Gutierrez, W. (2021). Factors associated with the consumption of chlorine dioxide to prevent and treat COVID-19 in the Peruvian population: a cross-sectional study. *BMC Public Health 21* (1), 2109. doi:10.1186/s12889-021-12191-9
Stone, M., Bazaldua, O. & Morrow, J. (2021). Developing health literacy communication practices for medical students. *MedEdPORTAL 17*, 11091. doi:10.15766/mep_2374-8265.11091

Tanwani, R. (2017). Perception and attitude of medical students towards communication skills lab and teaching module. *Journal of clinical and diagnostic research 11* (6), JC12–JC14. doi:10.7860/jcdr/2017/24858.10120

Ziegler, R., Ronja Hedder, I. & Fischer, L. (2021). Evaluation of science communication: current practices, challenges and future implications. *Frontiers in Communication 6*, 669744. doi:10.3389/fcomm.2021.669744

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