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Science popularization on Facebook: statistical analysis of posts from a Brazilian university

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Abstract

This study performed a statistical analysis of the repercussions of a project concerning science popularization (SP) during the first 14 months of execution in a Brazilian public university. The metrics used were the results achieved from posts of 95 videos disseminating scientific research on the institution's Facebook page. The objective was to verify the dialogical potential of the project while considering that social media increase the possibilities for public participation. Analyses included general descriptive data (means, minima, maxima, and standard deviations), Pearson's correlation coefficients, and clusters' formation. Among the main results, we verified that the published videos can be divided into five clusters, which differ by the level of interaction/reach. The research themes, text,

and video strategies used in the posts modulate the potential for interaction with the public. The results are helpful for the future planning of SP actions.
Keywords: Science popularization. Facebook. Public mobilization. Public university. Scientific research.

Introduction

Various contemporary perspectives in the field of social sciences, with different intensities and perspectives, emphasize the importance of public engagement and prioritize the role of citizens in political decisions. Whether through the lens of governance (RYAN, 2015; MEJLGAARD *et al.*, 2012; GUSTON, 2014) or the proposal of "dialogic managerial action" (CANÇADO; PEREIRA; TENÓRIO, 2013), the idea of active citizen participation in public discourse is strongly present. In this context, a significant challenge is for civil society to access technical and scientific knowledge that enhances their argumentation potential in discussions. The flow of information about Science and Technology (S&T) becomes essential for the public sphere, as they directly affect society, encompassing health policies, education, public security, social inclusion, economic development, sustainability, and more (OLIVEIRA, 2010). The outcomes of S&T efforts also permeate the citizen's daily life directly and concretely, influencing, for example, product choices during consumption.

As generators of scientific production, universities have a role in this process known as Science Popularization (SP). Supported by public investments, Brazilian federal universities have commitments to society regarding quality education, research development in various knowledge areas, and knowledge exchange between the university and society. The practice of science popularization in the communication departments of these institutions, aiming to use language that is understandable to the public in order to share scientific and technological knowledge, can offer a significant contribution to the circulation of information about science and technology in society.

Recognizing the importance of science popularization, we conducted a case study on the initial stage of the project "Creation of the Science Communication Center at the Federal University of Lavras (UFLA): Bridging the ivory tower." We submitted the project to the Minas Gerais State Research Support Foundation (Fapemig) through a call for proposals released in 2015 to support the establishment of science communication structures in federal higher education institutions in Minas Gerais, Brazil. At UFLA, this project was the first coordinated effort to disseminate science popularization content through organizational communication systematically.

The project began with regular production in November 2017, and research findings were disseminated twice a week on the institution's official website, as well as on social media platforms and in a science journalism magazine created for this purpose. For this case study, we selected a sample of video publications on the Facebook page between November 2017 and December 2018, including all videos from the project's central editorial department (95

publications composed of the database). We used the SPSS software to process the information extracted from the metrics provided by Facebook to the page administrators.

This article aims to statistically analyze the engagement generated by different science-related publications on a social network that allows interaction. The aim is to reflect on the project's dialogic potential and practical results in engaging society with scientific information.

When we talk about science popularization, we refer to the transposition of ideas from scientific texts to popular communications (MUELLER, 2002), the task of making scientific knowledge comprehensible and accessible to the lay public for interaction (SCHARRER *et al*., 2017). By proposing the cycle of scientific information, Lievrouw (1992) defines the popularization stage as the one in which communication activities begin to break the boundaries of the scientific field and spread throughout society through mass media and other channels.

There is an extensive discussion in the literature about the models or perspectives adopted over time for public science communication, ranging from those that consider the public as passive, ignorant, mere recipients of information, to those that advocate dialogism and the consideration of widespread knowledge and values in the science communication process (KATO-NITTA *et al*., 2018; MYERS, 2003; BAEUR, 2007; GREGORY *et al*., 2002; STILGOE *et al*., 2014; MAKAROVS; ACHTERBERG, 2018; JASANOFF, 2014; NISBET; SCHEUFELE, 2009; BURNS; O'CONNOR; STOCKLMAYER, 2003; FRIESIKE *et al*., 2016; DIETZ, 2013).

With the transition from the deficit model (passive public) to the dialogue model, we enter the realm of democratic citizenship and egalitarian pluralism. Scientific rationality makes room for other types of reasoning. Moreover, the way to manage this is through dialogue, in which actors are communication partners, requiring a change in traditional hierarchies of knowledge. Pieczka and Escobar (2012) found genuine attempts to engage in deliberative dialogues but also identified indications that dialogue has been used as a sophisticated tool to manage public perceptions. They conclude that the scientific community operates based on a limited understanding of public comprehension, although they employ rhetorical resources of dialogue.

An essential theoretical focus closely related to engagement and dialogue models is citizen participation in science to ensure legitimacy in public policy formulation processes and address democratic deficits (RYAN, 2015). The ways of giving voice to citizens may vary, but the conception is that political decisions are more effective when there is participation. The notion of citizen participation is linked to the idea of governance, a prominent term in the field, which refers to the participation of a range of actors, including civil society, in public decisions, which become collective. The author argues that issues of scientific governance have the potential to challenge prevailing passive models of democracy, suggesting new possibilities for democratic revitalization.

The dialogic perspectives align well with Santos' (1988) propositions regarding the second epistemological rupture in science, in which a dialogue between science and common sense would establish the production of enlightened practical knowledge or even with his proposal of an "ecology of knowledge" where scientific knowledge is considered one among many. They also

resonate with Habermas' communicative action (2012). We can infer that scientific knowledge becoming a new common sense cannot occur without science communication practices and, therefore, without the support of reflections from the humanities and social sciences.

Considering the dialogic perspective as the contemporary trend for thinking about science communication, this article examines the popularization actions practiced on Facebook, one of the social media platforms in use today, which, like others, enables interaction and dialogue. Hargittai, Füchslin, and Schäfer (2018) state that, despite many studies focusing on digital social media, there is a research gap regarding the specific potential for sharing science-related content. The authors argue that engagement with science and research content on social media should be integrated into the concerns of those studying science communication. Social media platforms have the advantage of allowing direct engagement of individuals in various conversations. They also transform the possibilities for scientists and research institutions, providing them with direct communication channels with the public.

Citing a study by the National Science Board in 2018, Hargittai, Füchslin, and Schäfer (2018) mentioned that 81% of young people aged 18 to 24 used the Internet as their primary source of scientific and technological information. Social media also emerged as the primary source of information on these topics for this audience (83%). In a survey of Swiss youth, the authors found that 95.6% sought science information on the Internet, with 62.9% doing so weekly. This topic ranked only lower than seeking information about current events, which engaged 99.5% of respondents. In the sample of young adults, 81.3% stated that they had clicked or commented on science-related information, a percentage similar to engagement with current events. However, the latter elicited more sustained involvement (weekly). The data also revealed that young adults used Twitter less than Facebook to interact with science content, leading the authors, at that point in the study, to consider Facebook more relevant for studying the interactions between science and society.

Furthermore, Facebook was one of the leading social media platforms to implement the UFLA's SP project. At the time of data collection (between 2017 and 2018), despite already experiencing a decline in popularity, especially among young people, it was considered the largest social network in the world regarding monthly active users. The trend of declining numbers of Brazilians with Facebook accounts was highlighted in a Datafolha survey in 2019. However, it still maintained 56% of respondents reported having an account on this social network. There were 127 million monthly active users (NEGRÃO, 2019).

Lee and VanDyke (2015) argue that the dialogue facilitated by social media can contribute to the reputation of research institutions and allow them to identify disagreements or misunderstandings regarding their content. However, their study conducted with 252 posts from US government organizations related to science supports research showing that government agencies do not fully utilize the dialogic potential of social media, emphasizing the one-way dissemination of scientific content. The authors found that posts rarely asked users questions or solicited feedback. Another strategy not employed was to encourage offline behaviors by

explaining how users could utilize the information available in the post. The response rate to user comments by organizations was also meager.

Procedures and methods

We adopted a sample of 95 video publications on research and scientific content from the official UFLA Facebook page between November 2017 and December 2018, corresponding to the first editorial created in the project under analysis, "Minuto do Câmpus" (Campus Minute). The institutional practices of SP at the institution were selected for this analysis, considering that the University was in the process of implementing the project "Creation of the Scientific Outreach Center: Bridging the Ivory Tower," approved in a call for proposals by the funding agency Fundação de Amparo à Pesquisa de Minas Gerais (Fapemig) and specifically motivated by the objective of encouraging institutions in Minas Gerais to structure their communication areas in order to engage in SP. Despite being in operation for over a century, having been founded in 1908 as the Agricultural School of Lavras, and being recognized in national and international rankings and assessments for the quality of its teaching and research, its institutional science popularization efforts were sporadic until the implementation of the project (SILVA; PEREIRA, 2021).

We classified each analyzed publication according to the knowledge areas organized by the Brazilian National Council for Scientific and Technological Development (CNPq) (Table 3). For categorization, we considered the department of the University where the research was produced. Since there are many interdisciplinary studies, it is expected, for example, for the Department of Administration to have research involving the business of "coffee" relating to the Social Sciences and Agricultural areas. However, we opted to define the classification according to the academic area of origin of the study.

Next, we collected the metrics assigned to each post based on Facebook's records, available to page administrators. The following indicators, all on a ratio scale, were considered:

Table 1 - Metric Variables (Ratio) Included in the Analysis

Indicator	Relevance
Number of people reached	It reveals the number of people for whom the publication appeared in their timeline. In other words, the number of people who likely saw the publication. This reach increases due to different factors determined by Facebook itself, but the more interest and engagement the publication generates, the greater the reach.
Number of video views per person	It counts the number of times the video was viewed by different profiles, taking into account that a person may view the video multiple times.

Indicator	Relevance
Average video viewing time	It measures the duration of time that the viewer stayed watching the video. The higher the average duration, the greater the likelihood that it generated interest.
Number of positive reactions	It tallies the clicks on “like,” “love,” and other positive reactions.
Number of negative reactions	It tallies the clicks on “sad” and “angry” reactions (expressing irritation).
Number of shares	It counts the number of times users shared the publication on their own profiles. This action is significant because it indicates a higher willingness to interact and a willingness to become a propagator of that content to a wider audience.
Number of comments (divided into tags, criticism, praise, and questions)	This counting was done manually by reading all the comments and categorizing them. Comments, compared to the act of liking or clicking on another reaction, indicate an additional step taken by the user in relation to the post: if they take the trouble to engage in dialogue and express themselves, it means they have been mobilized to a greater extent by some factor. “Tagging” refers to those comments in which the user simply mentions the name of another person they want to see the publication. They are significant because they denote that the audience wants to establish a more private communication based on that post (KAPLAN; HAENLEIN, 2010, p. 60), unlike sharing, which occurs when they want multiple people to see it.
% of male audience participation	It allows evaluating audience profiles.
% of female audience participation	It allows evaluating audience profiles.
% of audience aged 13-17	They allow evaluating audience profiles. Age groups are a specification provided by Facebook itself.
% of audience aged 18-24	
% of audience aged 25-34	
% of audience aged 35-44	
% of audience aged 45-54	
% of audience aged 55-64	
% of audience aged 65 and above	
% of accesses in Minas Gerais (MG)	They allow evaluating audience profiles.
% of accesses in other states	
% of accesses in other countries	

Source: Professional dashboard of UFLA’s Facebook profile.

We organized the database containing these indicators using the SPSS Statistics software (version 17.0). In the statistical analysis, we opted to use general descriptive data (mean, minimum, maximum, standard deviation), frequency of knowledge areas, Pearson correlation analysis, cluster analysis using Ward's Method/Squared Euclidean Distance, and determination of cluster frequencies.

Results and analysis

The results were valuable in revealing details that can assist in planning science popularization (SP) on social media through organizational communication.

General descriptive data

A great amplitude is observed in variables such as reach of posts (publications), number of video views, positive reactions, shares, and tags. These variables indicate engagement, and therefore, the significant variation shows that the audience receives and reacts differently to different science topics and content. In the comments – divided into tags, criticisms, compliments, and questions – the average is only more significant in tags and compliments. The audience asks questions and criticizes relatively less, regardless of the topic. Only in one of the posts, which we will discuss in the cluster analysis, the number of criticisms reached 32, while the average for this variable is 0.51.

Regarding variables related to demographic profiles, we see that gender participation (men and women according to the profile available in the platform statistics) in science content is generally balanced across the posts. However, in the post about breastfeeding, female participation reached 80%. On the other hand, in the content about constructing an agroecological filter, the peak was from the male audience – 70%. These data show that some science topics have different mobilization potentials according to gender.

Regarding age, there is a low presence of young people between 13 and 17 years old. This audience would predominantly be in high school and could be more engaged with the University's page. The 18 to 24-year-old audience, which includes the most influential age group among undergraduate students at UFLA, has an average participation of 30%. However, it reaches over 50% in some posts and is absent in others (9.2% for 18-24 years in the minimum record). This latter case occurred with the video asking whether hibiscus tea helps with weight loss. The second-lowest participation of this audience (11.6%) was with the video about the difference between free-range and industrial eggs – precisely the content with the highest engagement and reach (outlier). On the contrary, when the topic was the judicialization of public policies, a subject capable of mobilizing people from a specific area, there was record participation (54.1%) in this age group. However, this was a topic with low performance in the general context, as seen in the cluster analysis. When the disclosure was about a new vehicle developed by a UFLA team (The Chaos car), this audience had its second-highest participation (51.4%).

Another audience with similar numbers is the age group of 25-34 years, which has an average of 34.43% and records minimum and maximum presence peaks similar to the previous age group. It is an audience that can encompass a significant portion of postgraduate students, as well as recent graduates, without disregarding the external audience of the institution. The publication that engaged them the least (16.7%) was about the difference between free-range and factory-farmed eggs, and the one that engaged them the most (51.8%) was about local productive arrangements in the coffee industry. With these younger audiences, greater mobilization occurs with topics related to their field of study since the two most interactive discussions, in both age groups, are more specific discussions within certain fields of knowledge.

In the age group of 35-44 years, the audience is less present (average of 16%), less interested in specific topics within certain fields, and more interested in topics of general repercussion such as health, nutrition, and education. The three publications that mobilized this audience the most were about blindness and education (35%), neglected diseases (30.1%), and the one discussing the potential weight-loss effects of hibiscus tea (30%). On the other hand, the ones that mobilized them the least were the use of infrared thermography technology (6.6%), new species of cave isopods (9.4%), and the development of a holographic device (9.5%).

The following age groups, starting from 45 years old, have a smaller average – together, they account for 16%. Within these age groups, the publication with the highest repercussion gains a proportionally more significant audience percentage. Technology-related topics are less attractive, followed by those dealing with politics and social issues. Publications that flirt with everyday life, food, and topics circulating in the media stand out as those of greater interest.

Regarding the geographical location of access, the largest general audience is from Minas Gerais (average of 76.09%). Other states represent 20.9%, with São Paulo having the highest predominance. Access from other states, as well as from other countries, is less significant. When we observe the topics with the highest and lowest impact in other states, they coincide with those that mark the age groups from 45 years old onwards. The Pearson correlation confirms this relationship, as it shows that the positive relationship between this age group and the representation of other states is highly significant, meaning that the audience from other states that follows the publications is predominantly from older age groups.

Table 2 summarizes the descriptive statistics. It allows tracking the minimum and maximum results of the set of publications, as well as the mean and standard deviation, indicating the dispersion of the results.

Table 2 – Key descriptive data of the sample

Indicator	Minimum	Maximum	Mean Standard	Deviation
Number of people reached	1,840	501,058	19,847	54,506
Number of video views per person	298	138,999	4,679	14,469
Average video viewing time (seconds)	3	19	9	3,14

Indicator	Minimum	Maximum	Mean Standard	Deviation
Positive reactions	10	8,424	389.97	928.78
Negative reactions	0	24	0.56	2.55
Shares	0	2,957	74.21	303.98
Mentions	0	323	13.22	41.59
Critiques	0	32	0.51	3.33
Compliments/Praises	0	117	5.38	13.44
Questions	0	9	0.24	1.10
% of Men	20	70	48.40	11.23
% of Women	30	80	51.45	11.14
% of Audience aged 13-17	0.20	7.50	1.05	1.04
% of Audience aged 18-24	9.20	54.10	30.76	9.47
% of Audience aged 25-34	16.70	51.80	34.43	6.46
% of Audience aged 35-44	6.60	35	16.59	5.10
% of Audience aged 45-54	1.8	18.10	8.89	3.31
% of Audience aged 55-64	0.90	13.90	5.10	2.82
% of Audience aged 65 and older	0.50	7.60	2.17	1.21
% of Audience from MG	35.50	93.70	76.09	11.43
% of Audience from other states	6.30	63.80	20.90	10,05
% of Audience from other countries	0.00	45.30	0.84	4.71

Source: Authors' compilation based on data processing extracted from the SPSS software.

In general, these data already allow the identification of a strong differentiation in the participation of audiences in different science topics. Regarding the frequency of publications by field of knowledge (Table 3), there was a predominance of Agricultural Sciences (33.7%), which is understandable considering the UFLA's historical tradition in this field. However, other statistics and cross-analyses conducted during the process did not reveal differentiation in audience mobilization based on fields of knowledge. The differentiation occurs more based on the specific topics than the fields.

Table 3 – Frequency of publications by field of knowledge, according to CNPq.

Field of knowledge frequency	
Areas	**%**
Exact and Earth Sciences	14.7
Biological Sciences	10.5
Engineering	9.5

Field of knowledge frequency	
Areas	**%**
Health Sciences	20
Agricultural Sciences	33.7
Applied Social Sciences	6.3
Humanities	5.3

Source: Authors' elaboration, based on data processing extracted from SPSS software.

Correlation between variables

To statistically determine the variables that behave in a coordinated but independent manner, we opted to examine the Pearson correlation using SPSS. In our analysis, we considered all metric variables from the study. Out of the 22 variables examined, over 100 results were highly significant (at 1%), and 30 were significant (at 5%). Due to space limitations in this article, we will only comment on some results that provide new and helpful information for communication planning within the scientific community.

Shares are a relevant and representative variable of interaction, as when the audience shares content, it indicates that they attribute such importance to it that they want many others to see it. Internet users become new transmitters of that content. This action has a negative correlation with the 18-24 age group (-0.254, significant at 5%) and the 25-34 age group (-0.264, significant at 1%). However, the relationship for all audiences over 45 is highly significant (at 1%) and positive: 0.303 for the 45-54 age group, 0.378 for the 55-64 age group, and 0.412 for those over 65. Therefore, even though the audience in these older age groups is less frequent on the page, they are the ones who engage the most through sharing. There is also a negative relationship between the audience from the state of Minas Gerais and shares (-0.443, significant at 1%). This lower interaction of young people through sharing is an important finding when analyzing the studies by Hargittai, Füchslin, and Schäfer (2018), which suggested that Facebook would be a promising medium for science communication among young people.

Regarding criticisms and questions, the participation of older age groups is also more representative. In the 55-64 age group, there is a highly significant (1%) positive correlation between criticisms (0.311) and questions (0.384). The situation is similar with those over 65 (0.401 for criticisms and 0.424 for questions, both at 1%). We also highlight the cross-referencing of age groups among the audience. The correlations between the audiences indicate a tendency for similar behavior among audiences starting from the 35-44 age group: there is a highly significant (1%) correlation between this age group and the 45-55 age group (0.434) and the 55-64 age group (0.362). The correlation with the audience over 65 is significant (5%) with a coefficient of 0.229.

In the 45-54 age group, we begin to observe a positive and highly significant (1%) relationship with access from other states (0.290) and a negative relationship with Minas Gerais (-0.367). Similar results are repeated in the following age groups, showing that the audience in the

older age groups is primarily located outside Minas Gerais. As we mentioned before, according to Facebook data, the state most present after Minas Gerais is São Paulo. Considering other sources, such as the Enade 2017 questionnaire (PRESS KIT..., 2018), it is possible to speculate about the identity of this audience. In the profile of UFLA students, after Minas Gerais, São Paulo is the second central origin of this audience. Thus, the accesses from other states (predominantly São Paulo) involving an older age group may be from the students' families.

As for positive reactions, their cross-references show that when they increase, negative reactions also tend to increase (0.924, with a significance level of 1%), revealing that the more information circulates, the more diverse the reactions will be. This finding supports arguments against the deficit perspective, which sees the audience as a blank slate vulnerable to accepting scientific knowledge without questioning it.

Formation of clusters

Using hierarchical classification with SPSS (Ward's Method/Squared Euclidean Distance), we generated clusters considering the predictor variables that explain the phenomena: number of people reached, video views, positive and negative reactions, shares, tags, criticisms, compliments, and questions. We analyzed the possibilities of having two to five clusters. Based on the frequency of cases assigned to each cluster, we opted for 5 clusters as it generated more fragmented groups, allowing for more detailed analysis. Among the five options, one cluster consisted of only one case, which can be considered an outlier as it had a significantly different impact than the others: it reached over 500,000 users and set a record for interactions.

With 5 clusters, we had the opportunity to analyze the differences between two larger groups (38 and 46 cases) and three smaller groups (one, four, and six cases) (Table 4).

Table 4 – Possibilities of cluster generation and classification assigned to the option of five clusters

Number of Cases According to Cluster Generation Possibilities					
Clusters	**2 clusters**	**3 clusters**	**4 clusters**	**5 clusters**	**Label**
1	94	90	84	38	Reasonable performance
2	1	1	6	46	Low performance
3		4	1	6	High performance by interaction
4			4	1	Record repercussion
5				4	High performance by reach

Source: Authors' own elaboration, based on data processing extracted from SPSS software.

What sets clusters apart is reach and interaction. In view of this, they were named as specified below:

(i) *Low performance*: Among the 46 publications that comprise this cluster, 23 share a common characteristic: they address research topics of particular interest to specific audiences

and areas, such as coffee farming, moringa cultivation, wooden panels, MDP production, bull breeds, complex networks, tree cutting, treatment of oily waste, infrared thermography technology, judicialization of public policies, and studies from Einstein to Hawking.

We reflected on several hypotheses regarding the limited impact of the other 23 topics within this low-performance situation. Initially, these subjects should generate general interest, such as information about diseases, roadkill, drowsy driving, games, music, dog diet, mental health, and suicide. We argue that these publications need to be analyzed on a case-by-case basis, as the explanations for their performance can be diverse, including factors such as posting date and time, type of text used in the post's caption, the attractiveness of the first 10 seconds of the videos, among others. The observation that the explanation is not necessarily related to the post's theme is possible by comparing two posts with the same theme - the "Urubu Expedition on the Road," related to animal roadkill. One post had low performance, while the other had reasonable performance, with almost three times more reach. A qualitative study would be necessary to identify the explanations.

(ii) *Reasonable performance*: This cluster consists of publications related to deaf education, soapbox cart racing, cachaça preservation, sodium reduction in food, dragon fruit (pitaya), seafood, low-cost roofing tiles, acerola residues, "urubu expedition," Mangalarga Marchador horses, smartphones and nutrition, Mariana dam disaster, light cereal bars, breaded pequi (souari nut), breastfeeding, flaxseed and cancer, end-of-year poultry, blindness and education, impacts of aluminum waste, mycotoxins affecting human health, among others. These topics are closer to people's daily lives and interest a broader range of citizens. Many topics (the majority) related to food are in this group. Others, like indigenous constellations, the Chaos car, low-cost drones, and soapbox carts, spark curiosity. Some themes are always on the media agenda, such as issues related to special needs (deaf and blind individuals), environmental concerns (Mariana dam disaster, Amazon climate, livestock, and the environment, meteorology, aluminum waste), and topics related to health and aesthetics (essential oils, mycotoxins, anti-vaccine movement).

Only a few contents (4) that had *reasonable performance* do not fit the most common parameters in this category. For example, the post "Uepam is a reference in Biomaterials research" does not include terms related to daily life, the post's text does not stimulate interaction, and there is nothing unusual in the initial images of the video; nonetheless, it remained in this cluster with *reasonable performance*. This good achievement could be due to the research team's mobilization, which may have actively engaged in interaction. The same happened with the video about the electron microscopy laboratory, silage and corn cob/cattle nutrition, and the Brazilian Center for Subterranean Biology.

(iii) *High performance by interaction*: This cluster comprises six articles that achieved significantly higher performance than the *reasonable group*, with an average reach of 45,000. Although this number is much lower than *the cluster of high performance by reach*, the interaction within this cluster was comparatively higher (considering shares, praises, questions, video views, reactions, and tags). While these topics may not have the same level of widespread

potential as those in the *record interaction cluster*, specific characteristics of the posts may have contributed to their boosted engagement and positive outcomes. One of the posts focuses on the creation of a hexapod robot, which inherently sparks curiosity. In addition to that, the composition of images and sound in the video creates a fun atmosphere, as reflected in the comments, which differ from those in the record interaction cluster, expressing how enjoyable the video is: "adorable," "cute," "funny," "so lovely," "so sweet," and others. The post's text also begins with a question, encouraging audience participation.

Another highly successful post revolves around the exotic fruit pitaya. Published in January, the first line of the text presents pitaya as the fruit of summer. This connection with the current season alone can enhance audience interest. The comments reveal significant interest in cultivation, as they request seedlings and ask about planting methods.

This cluster also includes topics such as the benefits of milk, myths about pork, clarifications about vaccines, and differences between the main types of coffee. In the latter two cases, the researchers' popularity (as perceived through the comments) plays a significant role. Both researchers appear in the first image of the video. Regarding the pork and milk cases, besides falling within the food category, which maintains significant interest among the general public, they aim to address "myths." This discursive approach may have been the attractive factor for these publications.

These six articles share thematic characteristics that closely resemble the *cluster of reasonable interaction*, which includes other topics that pique curiosity. However, they appear as a separate group in the statistics due to their significantly different engagement levels. We can speculate that, in addition to offering intriguing content, other factors contributed to their enhanced visibility: the playful nature of the video in the first case, with appealing and captivating visuals, and in the case of the pitaya material, a kind of "do it yourself" interest, urging viewers to plant and engage in practical activities. This case is partially suggested by the video's caption, which mentions that pitaya is a source of income for family farming.

These analyses suggest that topics with *reasonable interaction*, which generate satisfactory engagement, can enhance their dissemination by employing communication strategies that boost them: the angle of approach (in the case of pitaya), the playful nature (in the case of the robot), the frequent use of the term "myths" (pork and milk), and the popularity of the researchers featured in the video (vaccines and coffee).

(iv) *High performance by reach*: This category encompasses four posts: the development of a digital stethoscope that facilitates medical exams, the creation of a hydrogel that can replace soft tissues in the body, errors in guidance by nutritionists on Instagram, and the weight loss effect of hibiscus tea. These topics involve innovation (in the case of the first two) and encompass aesthetics and quality of life. Initially, they could fit into the posts with *reasonable performance* due to their thematic proximity to people's daily lives. The topics also resemble the publications in the *high performance by interaction cluster*, but the difference lies in the interactions. Despite reaching more people, the interaction through shares, comments, and

reactions in the *high performance by reach cluster* had a lower average. This result contradicts, to some extent, the results of the correlations, which show a strong and positive association between reach and these interactions. The result may be related to some form of prioritization made by the Facebook algorithm regarding these topics, spontaneously boosting their reach. However, even so, the audience's response in terms of interaction was proportionally low. The explanation may lie in the absence of attractiveness factors reported in the previous cluster or even in the fact that, although the topics are appealing, the content of the posts addresses them in a limited manner.

(v) *Record performance*: This cluster consists solely of the material about the difference between free-range eggs and farm eggs. It is a topic closely aligned with everyday interests and involves a controversy widely disseminated in Brazil. However, we attributed a unique performance to both the strength of the topic and the posting resources: the text starts with questions (Is free-range egg more nutritious than farm egg?), which, according to Hargittai, Füchslin, and Schäfer (2018), stimulates interaction. There is also a dose of humor in the sentence, "We only do not answer who came first: the egg or the chicken...". It is a good example of a post with significant potential to mobilize the public and a promising initiative for popularizing science. It is the post with the most reactions, criticisms, questions, and tags, indicating public interest in perpetuating the dialogue. However, as mentioned before, it was a topic that generated little engagement among the young audience.

From the perspective of prioritizing dialogic science communication, this post came closest to the goal because it generated participatory interaction between the public and science. Science communication cannot choose only to disseminate content that fits this perspective, as it would limit possibilities and prevent the public from accessing the diversity of knowledge. However, the results indicate that this type of topic can represent a good starting point for breaking down language and production barriers that separate science and society.

Final considerations

In this work, we adopted the perspective that science popularization should occur through dialogue, meaning that science and technology institutions and their scientists should communicate their findings to society by promoting horizontal interaction and encouraging the public to participate in discussions. This perspective favors the empowerment of citizens, motivating them to engage in other debates that, in turn, result in impactful policy decisions for social life.

This article analyzed the initial phase of the Science Communication Center at UFLA (Federal University of Lavras) in Minas Gerais, focusing on a media platform that enables dialogue – Facebook. The quantitative evaluation of public interaction allowed for reflections on the project's dialogic potential. A future qualitative study could complement the analyses,

but we considered that obtained quantitative data reveal and provide valuable parameters for future project planning and improvement.

Filling the research gap identified by Hargittai, Füchslin, and Schäfer (2018), this article concerned itself with the potential of social media for sharing science-related content. The main observations derived from the statistical analysis were as follows:

(i) The public reacts to science content differently – engagement varies depending on the subject matter, the characteristics of the audience (gender and age group), and the communication strategies used in the posts.

(ii) Even in publications with higher engagement, overall participation in criticisms and questions is relatively low. This point reveals a culture that still needs to be inclined to discuss science, corroborating Mejlgaard *et al*.'s (2012) statement that the mere existence of participation opportunities does not imply a highly mobilized public sphere around science and technology.

(iii) The participation of young people aged 13 to 17 is insignificant in all analyses, indicating an audience that needs to be stimulated.

(iv) Younger people aged 18 to 24 and 25 to 34 exhibit particular behaviors. They constitute the most frequent audience in terms of post-reception (mainly because most undergraduate and graduate students of the issuing institution fall within these age groups), but their interaction could be improved. For example, they share posts less frequently (a negative correlation exists between these age groups and shares). Another characteristic of the 18-34 age groups is their higher interaction with technology-related topics and specific areas of study, while they had minimal participation in the most widely discussed subject.

(v) Age groups above 55 years old are the least reached by the posts, but they are the ones that engage the most. They tend to increase interactions such as criticisms, questions, and shares. However, to reach this type of audience, it is necessary to increase the reach of the posts. This audience demonstrates a preference for everyday topics.

(vi) The articles can be classified into five groups according to public engagement. Topics with very particular applicability fall into the *low-performance cluster.* Topics that explore food, curiosities, environmental issues, media topics, health care, and aesthetics *achieve reasonable performance*. The *high-performance cluster by interaction* demonstrates that a topic belonging to a reasonable group if explored with more strategic communication resources, can expand its results significantly. In the *high-performance cluster by reach*, some topics found an additional boost by meeting criteria set by Facebook to stimulate greater reach.

(vii) The publication that mobilized the public the most – about the difference between eggs from farms and free-range eggs – was the one that came closest to the dialogic model because it provoked more interactions, including questions and criticisms. Its characteristics fully coincide with those Pieczka and Escobar (2012) pointed out when discussing the marks of the dialogic perspective of science communication. The publication addresses science applied

to everyday life and suggests its complexity and controversies. Drawing on Santos (1988), it is a post that puts science in dialogue with common sense.

These results allow us to raise a hypothesis that requires qualitative methods to be verified: if we use the theoretical perspectives of science communication presented by Pieczka and Escobar (2012), we can say that the project's actions still predominantly reflect the perspective of the public engagement – using more creative and interactive methods than the deficit perspective, but still in a hierarchical communication with the public, where the continuity of a dialogue is not observed through the institution's responses to comments made on the posts, as found by Lee and Vandyke (2015) in their studies. However, based on the interaction numbers, the practices evaluated in this article flirt with the dialogic perspective and have the potential to achieve it. A critical discourse analysis could more appropriately determine the type of relationship the posts establish with the audience.

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Silva, A. E. F. A.: funding acquisition, project administration, conceptualization, formal analysis, writing – original draft, writing – review and editing; Moraes, G. S. M.: conceptualization, writing – original draft, writing – review and editing; Antonialli, L. M.: supervision, methodology, writing – review and editing.

Data availability

The data that support the findings of this study are available from the authors upon request.

Conflict of interest

The authors declare that there is no conflict of interest.

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