

# Scientific dissemination in teaching of chemistry: interlocutions opportunized by extensionist actions

Ecléa Rodrigues Pereira<sup>1</sup>, Miquéias Ferreira Gomes<sup>1</sup>, Débora Astoni Moreira<sup>1</sup>, Christina Vargas Miranda e Carvalho<sup>1\*</sup>

<sup>1</sup> Instituto Federal Goiano – Campus Urutaí. Rod. Geraldo Silva Nascimento, km 2.5, CEP 75790-000, Urutaí, GO, Brasil.

\*Corresponding author. E-mail: christina.carvalho@ifgoiano.edu.br

**ABSTRACT.** This article reports the experience in the context of an extension project dedicated to fight against fake news disseminated during the Covid-19 pandemic, whose aim was to promote scientific literacy in formal and non-formal educational environments. Titled "Chemistry, the Central Science", the project was developed over one semester, involving periods of research, elaboration and production of expanded abstracts and posters, and exhibition in different environments and contexts. The group was composed of five professors and five students from the graduation in chemistry course at IFGoiano - Urutaí Campus. The material prepared involved ten themes pertinent to chemistry present in everyday life and the exhibitions were held in different locations in pires do rio and ipameri, cities surrounding the educational institution. The project's execution provided the democratization of knowledge through the teaching of chemistry, as well as favoring the interlocution between community, science, and university.

**Keywords:** University Extension; Scientific Literacy; Chemistry Teaching; Fake news

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## INTRODUCTION

The technological advances and innovations that have occurred in the last few years have greatly influenced life in society, reverberating in human relations and in the way people think, communicate, behave, and build their knowledge, mostly with the popularization of the internet and digital media.

Among the demands of the information society era, Takahashi (2000) points out that knowledge, in its different spheres, emerges as the starting point for people to achieve contemporary benefits and strive for a better quality of life. In this new perspective of society

[...] knowledge has become, today more than in the past, one of the main factors in overcoming inequality, adding value, creating skilled employment, and spreading well-being. The new situation is reflected in the economic and political system. The sovereignty and autonomy of countries worldwide are going

through a new perspective, and its maintenance - which is essential - clearly depends on knowledge, education, and scientific and technological development. (Takahashi, 2000, p. 5).

In more developed countries, in which scientific knowledge is the major differentiator of development opportunities, the valorization of science education comes long before 21st century skills, and these contemporary skills are intrinsically related to scientific literacy (SL) (Demo, 2010).

For Chassot (2003), the understanding of science provides, among others, the power to predict, control and measure possible transformations that occur in nature and, in possession of this knowledge, create conditions to direct these transformations to promote a better quality of life. The author considers science as a language, constructed by men and women so that, through it, the natural world can be explained and that, to understand it, it is necessary to master SL, in which it is not only mediated, but in fact understood as an integrated part of the everyday world. "Science is a language, so to be scientifically literate is to know how to read the language in which nature is written" (Chassot, 2003, p. 91).

When relating science, scientific literacy and society, as coexisting in the natural world, Gadotti (2017) raises some points for reflection, the role of the

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university in relation to society and how social aspects have been brought to the heart of the university. Such questions also include which communication and interaction mechanisms have been promoted by the university for the dissemination of scientific knowledge. By considering the university as the locus where scientific knowledge is produced and disseminated, the author points to university extension as a vehicle that allows this connection.

Universities in Brazil and in the world perform numerous activities of scientific education, in which scientific and popular knowledge intertwine, providing discoveries and demystifications. Extension, as part of the university tripod along with research and teaching, is configured as a fundamental activity for the democratization of the university and the knowledge it produces. Therefore, extension actions are anchored in the principle of inseparability between teaching, research and extension, enabling the construction of knowledge, in a relationship of exchange and transformation (Silva, 2020).

Santos and Briccia (2022), indicate that SL enhances the awakening of critical consciousness of students, when it enables their understanding of the world through learning to read it. The authors corroborate with Chassot (2003) when he points out that SL can be understood by correcting distorted teachings and, previously, wrongly learned.

Thus, for the contemporary student to become able to understand and intervene scientifically in society, it is necessary to include discussions of this nature in the educational process and in other environments, outside the school and university, where it is possible to promote scientific dissemination (SD), in order for people to become science literate. A scientifically literate citizen not only knows how to read scientific vocabulary, but also is able to criticize and write coherently and meaningfully in a context that is not only theoretical (Araújo *et al.*, 2014).

About the SD as a tool to provide scientific knowledge to society, there is the non-formal educational space defined as "any space different from the school where an educational action can occur" (Jacobucci, 2008, p. 56). Specifically, in Science teaching, non-formal education "provides learning of formal schooling contents in spaces such as museums, science centers, or any other where activities are developed in a well directed way, with a defined objective" (Vieira *et al.*, 2005, p. 21).

The importance of social practice in science education is emphasized by Santos (2007, p. 488), when explaining that the focus of SL should be in the "construction of a vision of science teaching associated with the scientific-cultural formation of students, with human formation centered in the discussion of values". Hence, for the emergence of SL as a social practice, SD is the best strategy adopted so that scientific education reaches more and more people of different age groups,

diverse contexts and sociocultural realities. In this scenario, we have extensionist actions as an opportune pedagogical practice to bring scientific knowledge to society.

The purpose of this article is to report the experience of an undergraduate Chemistry student at the Goiano Federal Institute - Urutaí Campus, regarding an extension project, proposed with the aim of combating fake news, involving scientific information and thereby promote SL in formal and non-formal education environments.

## METHODOLOGICAL PROCEDURES

The present research is an experience report of a Chemistry undergraduate student of IF Goiano - Urutaí Campus with narratives about her experiences and the contributions, as a formative teaching experience, of her participation in an extension project entitled "Chemistry, the Central Science".

To accomplish the extension project "Chemistry: The Central Science" meetings were held between the team members, defining the phases to be followed, the goals and objectives to be achieved, as well as the line of work of each participant, as shown in Chart 1.

**Chart 1.** Description of the development stages of the project "Chemistry, the central science"

Stage	Activity
1	Division of subjects, tasks and groups
2	Planning and literature research
3	Elaboration of the expanded abstract
4	Elaboration of posters
5	Organization of the virtual environment
6	Posters exhibition
7	General evaluation of the project and its development

After defining the themes and dividing the teams, the posters were produced from bibliographic research on the selected themes. Each team was composed of one student and one teacher, which together produced two posters.

In order to extend the reach of all the researched content, a virtual environment was created, accessed through a QR-Code, inserted in all posters, which easily directed to the official website of IFGoiano - Urutaí Campus, where all the work produced by the team was made available. By accessing the site, other complementary information was made available on the theme, as well as suggestions for reading and safe web pages to carry

out scientific research, and, also, the disclosure of the courses offered by IFGoiano - Urutaí Campus.

## RESULTS AND DISCUSSION

The project "Chemistry, the central science" was approved by IFGoiano Edital n° 05, of May 26, 2021 (Institutional Notice of Support for Extension Programs or Projects) and Registered in the Extension Board of IFGoiano - Urutaí Campus under n° 1395, being developed in the period from July/2021 to January/2022, by teachers and students from the Chemistry Degree course of the same educational institution.

The project is engaged in bringing, both to the community and to the students, knowledge of a scientific nature, thought out from the daily experiences of society, in which the pandemic scenario caused by Covid-19<sup>1</sup> presented several social impacts, among which, in addition to the spread of infectious diseases, there was the dissemination of numerous false news (fake news), involving science and fighting diseases.

In this context, a project was designed to provide the SD in order to provide scientific knowledge in formal and non-formal educational environments, bringing the community, science and university closer together. To this end, chemistry was used as the science that studies matter and its transformations, in the search for understanding of reaction processes in the environment, as well as in the human body, through the practice of physical activities, through the action of vaccines and the use of medicines, among others.

Takenami *et al.* (2021) emphasize how important it is that actions are taken to improve the quality of information in the country, as well as to provide the population with an acceptable level of scientific information as a whole, its values, precepts and processes employing methodologies accepted by the scientific community. They also highlight that the interest in scientific discussions should not be restricted to specialists, however the use and adequacy of correct scientific language and methodologies should be assertively done, causing a positive impact on the population affected by this news.

Therefore, the objective of the project was to produce posters with scientific information related to the daily activities of people and display them in strategic places of the cities in the region surrounding the university, aiming to promote SL and combat fake news through SD. Chassot (2003, p. 91) states that one of the ways to promote SL is using knowledge inserted in the daily life of the population, especially those presented inaccurately, using the correction

mechanism, as "a possibility to make corrections in distorted teachings".

As the project involved the SD of several themes present in people's daily lives and that, in a way, these people already had prior knowledge of these themes, the team had to be prepared for the dissemination of information and discussions with the public at the time of the exhibitions. Therefore, the members were divided into pairs that were composed of one teacher and one undergraduate student, each pair being responsible for two themes. Chart 2 shows the themes that were worked on and their respective objectives.

After the division of the pairs, there was a preparatory phase about the themes that would be addressed in the exhibitions, to ensure that the explanations and discussions were enlightening and scientifically proven. Therefore, a bibliographical survey was made about the addressed themes, in order to promote a theoretical background to the project participants, as well as to provide subsidies for the elaboration of the materials that would be produced and disseminated.

Thus, there was the phase of elaboration of expanded abstracts on each theme and, from these, the production of posters. The materials were produced with quality scientific content addressing the themes already presented, seeking to relate them to situations present in people's daily lives and, also, to address information in order to combat fake news of scientific nature.

The elaboration of the expanded abstracts involved a more in-depth study of the themes, leaving the members prepared for possible questions and discussions that could arise during the presentations. Moreover, the preparation of these texts had another purpose: to bring them together for the publication of a book that will have a simpler language, but will cover everyday topics that involve chemistry and will present information that promotes SL.

Regarding SL, we must be cautious about oversimplifying what is complex (Mueller, 2002), which can go against science education, especially when considering chemical knowledge, since Chemistry is a science already widely discussed by authors in the educational field as abstract and difficult to understand (Santos & Schnetzler, 2000; Machado & Mortimer, 2007).

<sup>1</sup> Name given to the acute respiratory infection caused by the potentially serious, highly transmissible, globally distributed SARS-CoV-2 coronavirus (Source: Brazil, 2021).

Chart 2. Thematic approach to scientific disclosures

Theme	Aim
Chemistry involved in the pH of substances	Know the different pH values of body fluids, presenting the risks generated by pH changes in the body.
Chemistry of Vitamins and Minerals	Differentiate vitamins and minerals, their importance, and how they are acquired and/or produced by the body.
Chemistry and Physical Exercise	Highlight the importance of physical activity for health and the chemicals involved in this process.
Chemistry of vaccines	Know the mechanisms of vaccines and how they act on the body.
Chemistry of beer	Know the chemical reactions involved in the production and natural process of alcoholic fermentation of beer.
Chemistry of happiness	Know the chemicals that trigger neurotransmitters responsible for the feeling of well-being.
Chemistry of medicines	Present in general terms organic and inorganic chemistry in pharmacological action.
Chemistry of garbage and household waste	Highlight the main chemical pollutants present in garbage, rejects and wastes, and their interaction with the environment.
Chemistry of pesticides	Understand what pesticides are, their action and ways of dispersion in nature.
The chemistry of esthetics and cosmetology	Highlight the use of acids in body esthetics and understand the chemical structure of hair.

QR-Codes (Figure 1) were made available on the posters so that people who were interested in more information about the project could access them. The digital environment that stores the project information is the IFGoiano - Urutaí Campus website. By accessing the project's page on the IFGoiano's website<sup>2</sup>, one can find information about the project, its goal and proposed actions, the disclosure of the project's members, and the list of all the themes addressed with a hyperlink that directs to the poster.

**Figure 1.** QR-Code that redirects to the information of the project "Chemistry, the central science" on the IFGoiano - Urutaí Campus website



The exhibitions did not always occur with the dissemination of all posters together in the same place,

due to space limitations in the environments. Hence, making the QR-Code available was a way found for people interested in the project to access the posters of the other themes and, also, to disseminate the project and the information in order to promote SL without the need to be in the exhibition.

In addition, the access to the project by QR-Code was a strategy found by the team to publicize IFGoiano itself and the actions that are carried out in this educational institution, in order to bring the community closer to the institution.

Adding up the collective and individual presentations, eight exhibitions of the posters were held in different places of the cities around IFGoiano - Urutaí Campus, in Pires do Rio and Ipameri. In each location the exhibition took place, on average, for four days and, in one of these, there were dialogues between the project members and the community. Figure 2 shows two posters that were part of the project and that were elaborated by the academic author of the present report.

About the theme "The chemistry of garbage and household waste", we based our discussion on social consumption and excessive disposal of garbage and household waste, through the chemical interaction between the discarded materials, as well as their shelf life in the environment. Our goal was to explain the interactions of these materials in water, soil, and air, and their possible consequences on animal and human health, as well as on the environment, thereby working on environmental awareness.

<sup>2</sup> Link to access the informations of the project "Chemistry, the central science" on the IFGoiano - Campus Urutaí website: <https://www.ifgoiano.edu.br/home/index.php/ultimas-noticias-urutai/18703-projeto-quimica-ciencia-central.html>

Figure 2. Posters on the topics "The chemistry of happiness" and "The chemistry of garbage and household waste"

**DOPAMINA, OCITOCINA, SEROTONINA, ENDORFINA E GABA: A QUÍMICA DA FELICIDADE EM DOSE G.**  
Ecilene Rodrigues Pereira; Débora Moreira Astoni; Miquelins Ferreira Gomes.  
Instituto Federal Goiázar - Campus Uruaçu, Rodovia Geraldo Silva Nascimento, Km 2,5, CEP 73.790-000, Uruaçu, Goiás, Brasil  
contato: ecilene.rodrigues@ipfedgoiar.edu.br, debora.astoni@ipfedgoiar.edu.br, miquelins.gomes@ipfedgoiar.edu.br

**QUAL O ENDEREÇO DA FELICIDADE?**  
Um dos princípios e mais complexos sistemas fisiológicos do ser humano, é o conhecido Sistema Nervoso Central (SNC), responsável, dentre outras, pela comunicação neural, atividades sensoriais e motoras, bem como emocionais. Uma vez que nosso cérebro está diuturnamente processando informações, o que é possível devido à comunicação entre as células nervosas?

**QUÍMICA X FELICIDADE**  
Além da comunicação neuroquímica, acontece também a comunicação neurotransmissora, por meio dos sinapses, elétricas ou químicas. As sinapses elétricas acontecem através de íons de cálcio, e em menor escala, em relação às sinapses químicas, estas por sua vez, acontecem por meio dos neurotransmissores. A dependência do cérebro neurotransmissor, controlam ações, pensamentos e sentimentos?

**COMO CONTACTAR A FELICIDADE?**  
Dentre as diversas formas de comunicação no organismo humano, destaca-se as neurotransmissoras, que acontecem por meio das fendas sinápticas, através de substâncias químicas denominadas neurotransmissores<sup>1-3</sup>.

**SUBSTÂNCIAS QUÍMICAS QUE CONTRIBUÍM PARA A FELICIDADE<sup>1-3</sup>**  
**-DOPAMINA (C<sub>9</sub>H<sub>9</sub>NO<sub>2</sub>):** hormônio do humor, compensação e prazer. Sua falta pode gerar doenças como Mal de Parkinson, esquizofrenia e depressão. Sua produção pode ser aumentada através de alimentação saudável, prática de atividade física e ouvir música.  
**-OCITOCINA (C<sub>41</sub>H<sub>65</sub>N<sub>13</sub>O<sub>9</sub>S<sub>2</sub>):** hormônio do amor e empatia. Sua falta pode gerar estresse, insônia, distúrbios do sono, etc. Sua produção pode ser aumentada através de alimentação saudável e troca de carinho.

**-SEROTONINA (C<sub>10</sub>H<sub>11</sub>N<sub>2</sub>O):** hormônio do humor e bem estar. Sua falta pode gerar irritabilidade, ansiedade e depressão. Sua produção pode ser aumentada através de alimentos ricos em triptofano, tomar sol, manter o positivado.  
**-ENDORFINA ( C<sub>26</sub>H<sub>35</sub>NO<sub>3</sub>):** hormônio da disposição física e mental, antienvelhecimento natural. Sua falta pode gerar dores excessivas no corpo, ansiedade e tristeza. Sua produção pode ser aumentada através do contato com a natureza e atividade física, e sorrir.  
**-GABA (C<sub>4</sub>H<sub>7</sub>NO<sub>2</sub>):** hormônio da calma, ajuda a relaxar e tonificar os músculos. Sua falta pode gerar insônia e ansiedade. Sua produção pode ser aumentada através de consumo de chá, pró-bióticos e prática de atividade física, e sorrir.

**VIVENDO MAIS E MELHOR**  
Além de proporcionar estímulos a felicidade, as substâncias químicas já citadas, colaboram para uma melhor qualidade de vida, uma vez que reíb o surgimento de doenças como Alzheimer, mal de Parkinson, e até mesmo o câncer, que conforme estudos realizados podem surgir ante a situações de estresse externo.<sup>4</sup>

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**QUÍMICA DO LIXO E REJEITOS DOMÉSTICOS: DO LIXO AO LIXO.**  
Ecilene Rodrigues Pereira; Débora Moreira Astoni; Miquelins Ferreira Gomes.  
Instituto Federal Goiázar - Campus Uruaçu, Rodovia Geraldo Silva Nascimento, Km 2,5, CEP 73.790-000, Uruaçu, Goiás, Brasil  
contato: ecilene.rodrigues@ipfedgoiar.edu.br, debora.astoni@ipfedgoiar.edu.br, miquelins.gomes@ipfedgoiar.edu.br

**A ORIGEM**  
A produção e o consumo, fazem parte da vida humana desde os primórdios de sua existência. Quase todo consumo, gera um descarte, que seja orgânico ou inorgânico. Segundo FADINI & FADINI (2001), o lixo produzido durante a idade média, era descartado por ruas e céu aberto, onde se acumulavam, gerando doenças epidêmicas e mortais. Com o advento da revolução industrial, a população urbana aumentou consideravelmente e consequentemente a produção e o consumo. Logo a produção de lixo, resíduos e rejeitos, têm seu aumento acentuado.<sup>1</sup>

**CONCEITO**  
**LIXXO:** constituição de materiais que podem ou não ser reutilizados.  
**REJEITO:** todo material oriundo do lixo e que pode ser reaproveitado.  
**RESÍDUOS:** todo material oriundo do lixo que não pode mais ser reaproveitado.<sup>1-4</sup>

**SUBSTÂNCIAS QUÍMICAS PRESENTES NO LIXO E SUA INTERAÇÃO COM O MEIO**  
Os diversos compostos que constituem o lixo nascem de cada dia, são constituídos de inúmeros elementos químicos, que podem ser tóxicos ou não. Como Mn, O, C, N, P, K, Ca, Mg, Cu, Zn, Zn, Fe, Al, Ba, Cd, Co, Cr, Ni, Pb, Sr, Ti e V. Alguns elementos formam nutrientes ao solo, como compostos orgânicos, contudo outros são nocivos e podem gerar danos ao solo, ar, água e consequentemente a saúde humana.  
Considerando que "na natureza nada se perde, nada se cria, tudo se transforma", os elementos constituintes de uma matéria podem sofrer interação, reagir e dando origem a outros elementos, e assim sofrer um processo de transformação ao longo dos anos, e que, de alguma forma interfere positiva ou negativamente sob as mais diversas formas de vida, chegando a vida humana.<sup>5-8</sup>

**TEMPO DE DEGRADAÇÃO DOS PRODUTOS**  
De acordo com a natureza química dos elementos constituintes de cada material, está posto um tempo de vida útil, até se decompor. Alguns elementos levam até 500 anos para se degradarem, conforme observa-se na (Tabela 1).  
**Tabela 1:** Tabela de tempo de decomposição dos materiais.  

MATERIAL	TEMPO
Jarrete	3 a 5 meses
Folhas de cigarro	2 anos
Cartão de papel	1 a 4 meses
Chão de fibra	3 meses
Descartável de papel	2 meses
Folheto	2 meses
Quilates	5 anos
Plástico	98 a 475 anos
Saco e garrafa plásticas	300 a 700 anos
Lata de alumínio	100 a 150 anos
Telaço de plástico	100 a 100 anos
Folheto	100 a 150 anos
Quilates e Branco de vidro na plástico	100 a 150 anos

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In the theme "The chemistry of happiness" our focus was directed to some reactions that affect our body when facing environments and situations we are exposed to. We approached in the discussions the chemistry under the action of dopamine (pleasure hormone), endorphin (feel-good hormone), serotonin (good mood hormone), oxytocin (love hormone), and gaba (calmness hormone), correlating the chemical knowledge of these hormones, in order to measure how the happiness mechanism is processed, by means of chemical synapses, which the individual can develop in face of the day-to-day adversities.

During the exhibitions, it was possible to talk directly about the themes addressed in the posters with students from middle school and high school, from different shifts of the visited schools (formal educational spaces), as well as with customers and patients from other places that lent space for the exhibition, such as gyms, clinics, and drugstores (non-formal educational spaces).

It is important to emphasize that formal and non-formal educational spaces are suitable places for SL, which complement each other as a pedagogical action. However, it is the non-formal spaces that have the potential for scientific dissemination, by providing the opportunity to develop scientific education not only for those who attend school and academic environments, but for society as a whole.

The knowledge that the adult public has about the most current and relevant scientific topics does not come from school experiences, but from the action of scientific dissemination, quality electronic media, and science museums, which bring to their exhibits both classical scientific/technological knowledge and current and/or controversial topics (Valente, 2005, p. 54).

In the experience lived in one of the schools in the city of Ipameri, there was a notorious interest for the theme "The chemistry of garbage and domestic waste", with the request of a teacher to focus on this theme, emphasizing the lifespan of materials, proper place for garbage disposal, and interaction with the environment.

Regarding the preference given to the theme, we were later informed that the school was starting a project on sustainability and, for that reason, both the students and the teacher were too interested in directing the explanations at the time of the exhibition. The fact that these participants interacted with deeper questions about the approached theme allowed the undergraduate students to exercise the pedagogical

practice of the teaching profession, a moment when we realized the project's contribution to this formative aspect.

About the participation in the extension project "Chemistry, the central science", this opportunity provided the undergraduate student in Chemistry with the opportunity to expand her formative experience, due to the involvement with the studies and readings in the preparatory stage, discussions about how the dialogues with the community should be conducted, to then reach the stage of the SD in search of promoting the SL of the participants of the exhibitions.

According to Assis and Bonifácio (2011), becoming a teacher is a process that is built throughout their experiences and that part of this experience occurs in university centers. The authors explain that training and performance are two fundamentally important vehicles in this process, which constitute being a teacher as a professional.

In this scenario, the triad that underlies higher education was contemplated in the formation of the student as a member of this project, once there was the articulation of teaching, research and extension throughout its execution. Furthermore, the proposed action made it possible for us to educate and re-educate distorted concepts in society, helping in the understanding of phenomena and in the development of communication skills, oratory, and interaction with several segments of society.

[...] extension and research activities are vital to the teaching and learning processes in teacher education, as they provide a training based on the relationship between theory and practice, contextualized, which articulates scientific and pedagogical knowledge and experience in the development of teaching practice and situates the undergraduate as to his role and social responsibility. This teaching model based on the tripod teaching-research-extension is the teaching model defended and pursued by Brazilian public universities, because it constitutes excellence in higher education, to the extent that it promotes knowledge production in a given social reality, social commitment and possible transformations (Freitas & Araújo, 2012, p. 190).

Therefore, by participating in this extension activity, many formative dimensions of teaching were contemplated, such as: the articulation of theory and practice, which involves knowing how to be a chemist and how to teach chemistry; planning and organization, which encompasses time and

commitment to the people involved in the action; socioemotional, aesthetic, and cultural aspects, which dialog with empathy and respect for diversity; and the opportunity to develop pedagogical practice for society, that is, as a social practice.

## FINAL CONSIDERATIONS

The project "Chemistry, the central science" fulfilled its objective in promoting SL, bringing the community, science and university closer together, thereby contributing to social transformation. By linking extensionist actions to SL as a way to combat the circulating fake news, due to the pandemic situation experienced, the project proposed to contribute to improve the quality of information. Such actions aimed not only to involve scientific knowledge linked to chemical content, but also knowledge that dialogued with the reality of the population.

In this sense, the poster exhibitions took place in different locations with diverse audiences, enabling SD in different contexts and socioeconomic and cultural realities. In addition, the project provided concise and easily accessible material, offering solid and scientifically based information to the community, thus providing the democratization of knowledge through the teaching of chemistry, and favoring the dialogue between community, science and university.

Finally, it is worth mentioning that, besides the quality scientific content and the fight against false news in the fight against the Covid-19 pandemic, the project acted as another tool to spread the word about IFGoiano, especially about the Urutaí Campus and the Chemistry course, in the scope of its teaching, research, and extension activities.

Presently, the project is in its second season, and the team has been working on the elaboration of new materials and other SD actions continue to be implemented in the cities surrounding Urutaí, increasing the number of disseminators of scientific education, thereby providing more and more SL through SD.

## CONFLICT OF INTEREST DECLARATION

The authors declare no potential conflict of interest in connection with the research, authorship, and/or publication of this article.

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