Article

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Chemistry and *Instagram*: how has this mixture been?

Química e *Instagram*: como vem se formando essa mistura?

Quimica y Instagram: como se va formando esta mezcla?

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Highlights

Instagram has been essentially employed to spread general knowledge about chemistry and for pedagogical/academic support.

The focus of the posts has been volatile due to the speed of digital communication.

The characteristics of both social media and posts need to be discussed for improving educational possibilities.

Abstract

This work investigated characteristics of chemical popularization on Instagram employing virtual ethnography for data gathering. The outcomes demonstrated exponential raising of accounts up to 2021 (77 in total), as well as its followers. The administrators' profile is composed of people associated with Chemistry, especially teachers and students from different teaching levels who have mostly worked individually. The accounts were characterized as: pedagogical support, studygram, communication of general knowledge about chemistry and communication of specialized chemical knowledge. Challenges may arise from fluidity of social midia, which require a critical view of the posts.

Resumo | Resumen

Keywords

Public communication of science. Social media. Science education.

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Introduction

As human beings began to organize themselves in society, it became necessary to develop new forms of communication for the socialization of knowledge, contributing to the continuous maturation of knowledge. The creation of the printing press in the 15th century was fundamental to the beginning of mass communication, from which access to knowledge was continuously expanded by new means, such as radio and television (Fosket, 1973). However, in this process, no technology has been as seminal in changing the forms of communication as the Internet. The sharing and flow of news and knowledge, connecting subjects and institutions that form, maintain, undo and reinforce social interactions are fundamental principles of social networks (Vermelho et al., 2014), whose mediation of the Internet has greatly amplified the processes, constituting digital social networks, conventionally called only social networks. As a consequence, the virtual scenario has become a vast field for the spread of knowledge, including scientific knowledge. Social networks offer different opportunities for building cooperation networks, as well as new contexts for public communication of science among different types of people and institutions (Bücchi, 2016; Bombaci et al., 2016, Guidry et al., 2017). Among its advantages is the ease of connections between users with common interests and the reach of new audiences. Social networks enhance publications through new distribution paths, such as ubiquity, acceleration, instantaneity, sharing, connections, interactivity, and can be considered a wide "space" for science popularization.

Such potential of social networks has led institutions or individual scientists to use them to dialogue and disseminate information about their activities. Different purposes have already been reported, such as searching for scientific collaborations (Van Noorden, 2014), sharing scientific research results (Caspari, 2022), scientific dissemination of their own research (Collins et al., 2016), sharing news, data and information (Guidry et al., 2017). Basic education teachers have also used social networks in activities involving the spread of knowledge, the exchange of professional experience, as well as affective issues (Carpenter et al., 2020). In Brazil, one of the first studies on science in social networks was presented by Vaz and Soares (2014). The authors investigated Orkut, signaling the existence of more than 200 chemistry communities, whose central focus was entertainment and social interaction.

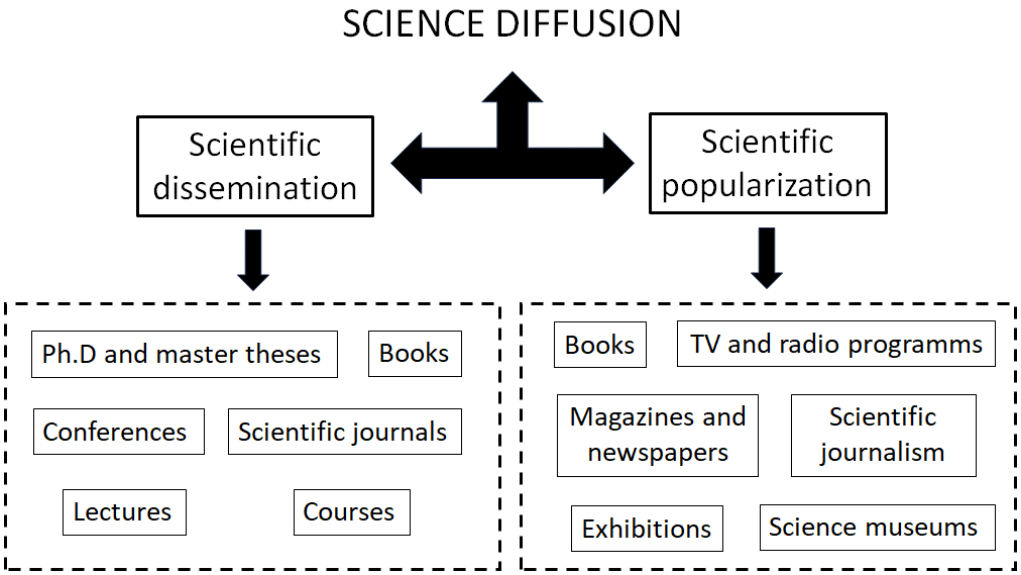
Despite these possibilities, as Alperin et al. (2019) point out, little is still known about how science has been spread on social networks, which audiences it reaches and whether these audiences interact with each other. From this point of view, we agree with Siqueira (2008, p. 11): "it is not conceivable to ignore or reject the mass media. New communication technologies present themselves and it is necessary to study them with a view to seeking a different use of what they have had so far". It is in this spectrum that the present work aimed to analyses actions of popularization of chemistry from the social network Instagram, in order to glimpse correlations with science education. The specific objectives are: i) to map the pages that publish

content related to chemistry; ii) to draw a profile of administrators and; iii) to characterize the shared content. The aim is to answer the following question: what are the characteristics of accounts on the Instagram social network that spread chemistry and the possibilities to expand science education from them? The understanding of the process of public communication of science on social networks can be useful to enhance its reach, as well as its school use, also expanding the process of education for science.

Science communication and the digital environment

Communication is an act that is directly associated with the production of scientific knowledge. However, it is not only communication among peers that becomes relevant, but communication with a diverse audience. In one of the first attempts to conceptualize the process in Brazil, Bueno (1985) proposed a model based on the idea of diffusion of science divided into two sub-processes: dissemination and popularization/public communication (Figure 1).

Figure 1
Simplified schematic for the science diffusion process.



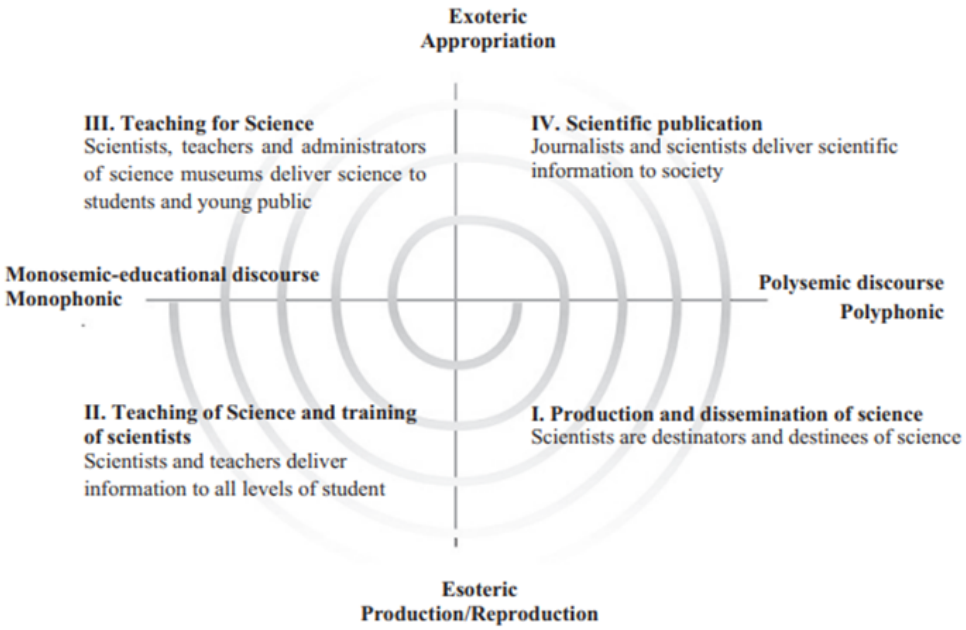
Source: adapted from Gonçalves (2012).

Diffusion may be seen as the broadest phenomenon for the spread of scientific information, encompassing any and all processes. Dissemination can be understood as a type of communication that circulates among specialists (Bueno, 1985), involving a validation process. Scientific popularization (or public communication of science), on the other hand, deals with the communication of/among different professionals (journalists, scientists, teachers) with the general public (Bueno, 1985), occurring in different spaces and media. It is important to emphasize that during scientific diffusion, as a whole, there is a natural and necessary process of transformation or recording of knowledge that needs to correspond to the intended audience. In the case of science popularization, this, according to Bueno (1985, pp. 1421-1422): "[...] comprises the use of resources,

techniques and processes to convey information [...], making terms accessible to common understanding".

Vogt (2012) proposed a spiral model of scientific culture consisted of four quadrants based on a vertical axis that considers the production/appropriation of knowledge and a horizontal axis on the type of discourse (Figure 2). The first quadrant represents knowledge production and dissemination of science. Quadrants 2 and 3 are respectively related to school teaching of science and for science, through which new scientists and teachers would be educated. These, in turn, help science to reach other audiences, such as young people in school. The last quadrant concerns communication to society. The author points out that the process is moving towards a broadening of knowledge and public understanding of science. Although the spiral represents a cyclical feedback, this notion is characterized by a certain linearity between the quadrants.

Figure 2
The spiral of scientific culture.



Source: Vogt (2012).

On the other hand, the digital world dispenses with this sequential path, forming nodes that interconnect. With the Internet, the communication of science has grown in means, spaces, and ways, and is responsible for a new paradigm in the modes of scientific diffusion (Valério & Pinheiro, 2008; Santaella, 2019). The quadrants have been merged and interconnected. For example, science education is hybridizing with outreach, as students bring content from the Internet into the classroom and teachers use it to increase connectivity with students, to connect with other experiences, and to share ideas (Carpenter et al., 2020).

Web 2.0 digital resources continue to evolve and expand connectivity, allowing users to be both consumers and creators of content. As a result, the sharing of

scientific content reaches a large number of people. In this context, Navas et al. (2020) explain that the use of social networks for the diffusion of science production allows access and dialogue between audiences from different fields of knowledge. Bücchi (1996), based on the thought of Ludwik Fleck (1896-1961), argues that the process of science communication mediated by the Internet can take place in different interrelated and non-linear forms, identifying at least four perspectives: intraspecialistic, interspecialistic, pedagogical and popular.

In the intraspecialistic mode, the recoding of language is embryonic, and information such as that of a technical-scientific article prevails, with empirical data, methodological procedures and results intended for a group formed by those who share specific practices and knowledge of a given field (Fleck, 2010). The intraspecialistic circulation is already characterized by a greater recoding of language, especially in the form of technical texts, which may concern professionals in training or with common interests but working in different fields. The pedagogical process already has a body of consolidated knowledge that appears, for example, in textbooks and is the subject of study in school education. There is a characteristic of the accumulation of knowledge and language aimed at a wider audience. In the popular perspective, knowledge has undergone a process of recoding language and is present in different forms and media in order to cover the entire population. Based on Fleck's (2010) propositions, this communication structure comes from four types of sciences: periodicals, technical manuals, textbooks (school) and popular science. Strictly speaking, there is a simplifying movement in all of them:

> No matter how a given case may be described, the description is always a simplification permeated with apodictic and graphic elements. [...]. Otherwise, each world would require a footnote to assign limitations and provide explanations. Each word of footnote would need in a turn a second pyramid of words [...] (Fleck, 2010, p. 168).

In general, what the Internet offers through the network is that knowledge with intraspecific characteristics, for example the result of an experiment or images from a microscope, can be directly accessed by the "popular" or school public. In other words, there is no linearity in the process, and the dialogue can be multifocal and multidirectional, with the public interacting directly with scientists and their results. Although Fleck developed his ideas in a very different context, based on studies related to medicine, his ideas are particularly useful as a starting point for understanding the circulation of knowledge on the Internet.

Methodology

The research was based on the principles of netnography or virtual ethnography, which is interested in social practices on the Internet, as well as the meanings and meanings constructed for the participants who integrate them (Hine, 2000). Netnography incorporates fundamental aspects of ethnography, including a high degree of immersion of the researcher in the field of study (Hine, 2000). Thus, ethnographic approaches are limited to the context of the research and also become adaptable to the circumstances in which they take place (Hine, 2000).

Interpretation of meaning requires detailed descriptions that emerge from direct observation, considering the time and context of immersion.

In particular, this thesis focused on the social network Instagram, which has become increasingly popular, especially among young people. The data collection procedure was divided into two phases: initial immersion and netnographic immersion monitoring. The initial immersion consisted of a preliminary survey of the accounts intended to spread chemical content. In the initial immersion phase, the term "chem" was used as a search engine in the search tool. The search was carried out successively over an interval of 13 days. The survey was conducted in December 2021 and all accounts were organized in a spreadsheet for quantification and analysis. Firstly, the accounts were assessed in terms of the adequacy to the purposes to spread the chemical knowledge. As exclusion criteria were also considered: the time of existence, inactivity and privacy of the account, keeping for analysis only open accounts with at least six months of existence and that had not been inactive for more than 2 months. This resulted in a total of 77 (seventy-seven) accounts that were mapped by creation date and number of followers. The immersion phase was configured by monitoring publications as well as observing publications made up to that point. The immersion took place between December/2021 and January/2022 for the initial survey and between November and December 2022 for the final survey. These two moments aimed to assess possible changes in the number and characteristics of accounts.

The immersion made it possible to obtain information about the profile as well as the focus of the publications in terms of chemical content. For the study of the administration profile, the description in the biography was taken into account, as well as the information provided in the publications. Thus, categories were created according to the type of administration (individual, collective or institutional). The individual profile is managed by a single user without institutional association (e.g., research group, university, undergraduate/graduate courses or companies). Collective profiles are those managed by more than one user, again without institutional ties. Institutional profiles are characterized by their relationship with research, teaching or extension groups of universities, scientific societies and other organizations that can present CNPJ (National Register of Legal Entities). Also in the profile, the professional performance of the administrators was studied, especially in the case of individual and collective accounts, which resulted in the following categories: student, teacher, scientist/researcher, curious about science. The results were quantified and described qualitatively.

The monitoring of publications enabled the identification of characteristics about their content and focus. A field notebook was used for descriptive and interpretive records typical of ethnographic studies. These records were read and analyzed by at least two researcher-authors (one more and one less experienced) to identify descriptive patterns, which were used for thematic coding based on labels (passages, words, ideas) in common (Flick, 2009). Divergences were discussed with a third (more experienced) researcher-author until consensus was reached. Records such as: "synthesis of school concepts through schemes", "use of images", "language close to that of textbooks", "study tips", allowed to infer about

didactic characteristics of the publications and subsequent categorization of the account as *pedagogical support.* In turn, from descriptions such as "specialized scientific article", "use of technical language", "specific academic knowledge", the category *Specialized knowledge in chemistry* was deduced. The other categories constructed were studygram (labels: "daily study", "study tips", "student life reports") and general knowledge about chemistry (labels: "interrelation of science with daily life/practical applications", "recoding of language for a wider audience", "use of less technical language with explanations, "cites sources of information"). The categories were constructed by mutual exclusion, based on the publications monitored during the period analyzed. The discussion took place in an interpretative way based on the references about science communication on the Internet and the circulation of knowledge by Fleck (2010).

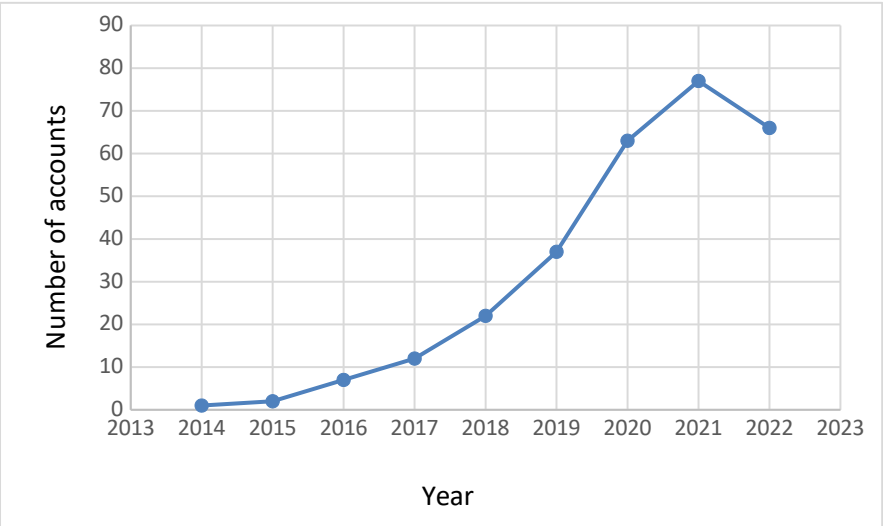
Results and Discussion

The presentation of the results was divided into three parts. The first part presents the general mapping of the number of accounts and reach of followers. Next, the profile of account management is presented and, finally, the characterization regarding the content and focus of publications.

General mapping

The preliminary survey revealed temporal growth with an apex in the year 2021 (77 accounts). The first account appeared in 2014, four years after the creation of the social network. Until 2021 there is an exponential growth with a slight decrease in the year 2022 (66 accounts). The data are consistent with the study by Santos and Müller (2022) regarding the periods of activity growth. Between the years 2016 and 2020, the authors indicate that the activity of promoters on digital platforms began intensively, and the pandemic period was also a significant period for growth.

Figure 3
Temporal variation in the number of accounts.



Source: Survey data (2022).

This growth is related to the growth of the platform, as well as the intensification of the use of social networks. The number of users of Instagram in 2013 was 150 million, reaching 2 billion in December 2022 (Dixon, 2022). In Brazil, in October 2018, there were 61.7 million users, a number that increased to 88.4 million in August 2020. Combined with the growth of Instagram as a platform, the pandemic caused an increase in the use of different communication technologies, reflecting the use of social networks for the purpose of searching and communicating information related to science (Fontes, 2021). As a result, the number of followers has also increased, and the reach of users is another relevant fact. In December 2021, the 77 accounts had a total of 737.6 thousand, a number that slightly decreased to 723.5 thousand in the second study due to the decrease in accounts. However, it should be noted that this decrease is not significant and actually represents a slight increase, about 10%, in the average number of followers per account.

The variation in the number of accounts and followers reveals the fluidity of the social network, which has been pointed out as a perennial characteristic of the Internet in general and, more specifically, of the communicative process established by it (Siqueira, 2008). Santaella (2019) discusses the process of ambivalence resulting from the speed of the communicative processes mediated by digital technologies. On the one hand, there are the benefits of the ubiquity and high circulation of news; on the other hand, there is the ease of manipulation and distortion of what is published. The increase in accounts indicates that chemical knowledge can circulate more widely, reaching a larger and more diverse audience. The increase in Internet activity has also occurred in other fields of knowledge, such as literature (Nunes & Geller, 2023), archaeology (Caspari, 2022), and biology (Bombaci et al., 2016).

From a school perspective, teachers can use this material and the growing circulation of chemistry for classroom discussions, as well as guide students to follow specific publications and their content as a way to reinforce or produce new learning. At the same time, ambivalence requires caution about the quality of the publications. First, because of what Fleck (2010, pp. 85-86) argues during the circulation of knowledge:

> Thoughts pass from one individual to another, each time a little transformed, for each individual can attach to them somewhat different associations, for each individual can attach to them somewhat different associations. […]. After a series of such encounters, practically nothing is left of the original content. Whose thought is it that continues to circulate? It is one that obviously belongs not to any individual but to the collective.

Instagram posts imply constant modifications in thinking that result in simplifications and even distortions. In addition, there is a risk of harmful effects of discourses that deny scientific knowledge (Brotas et al., 2021). Particularly in the accounts analyzed here, there were no negationist arguments, on the contrary, the publications tended to value scientific knowledge. In part, this may be associated with the profile of administrators, very close to science, as well as not addressing more controversial topics such as vaccination, which dominated this pandemic

scenario. But like any resource that may have an educational purpose, a careful analysis is pertinent.

Hottecke and Allchin (2020) discuss the process of media scientific literacy and the need to critically understand the science present in modern media and social networks. In addition to the analysis of publications in terms of their content, they point out about learning how media work, including financial interests, the "bubble" and "mirror" effect (control of what appears to the user based on their behavior on the network). From the point of view of a critical education based on contemporary challenges, it is necessary not only to understand the mode of operation of social networks, but to make sure of sources, to perceive implicit discourses and to confront what is published, since social networks have been configured as a fertile space for the proliferation of false news and pernicious allegations (Santaella, 2019; Brotas et al., 2021).

Account management profile

The account management profile was characterized in terms of the type of account, individual, collective or institutional, as well as in relation to the professional activity of administrators. The data indicate a strong predominance of individual accounts, with a greater difference in the last survey conducted. Of the individual accounts, in the first survey 25 were managed by men and 24 by women. The final survey maintained the proportionality of the gender issue (22 men and 23 women).

Table 1
Mode of administration of accounts serving chemical content via Instagram:

Accounts	Initial survey / %	Final survey / %
Individual	49 / 63,6	45 / 68,2
Collective	14 / 18,2	12 / 17,3
Institutional	02 / 2,60	02 / 3,0
Not identified	10 / 15,6	07 / 10,6
Total	77	66

Source: survey data (2021 and 2022).

Nunes and Geller (2023), in a survey of Instagram pages on literary education, also point out that individual administration prevailed in 48% of the accounts. Santos and Müller (2022), investigating the profile of 179 Brazilian science communicators in different networks, revealed that the individual administration has been also prevailed. However, the data represented less disparity, with about 46% of science communicators working alone and 34% in groups of two to five people. This difference probably stems from the multiplicity of platforms used in the study, some with a greater tendency to collaborate, such as websites and blogs. In turn, gender does not seem to be a determining factor. Santos and Müller (2022) indicated that the gender difference was less than 3%. However, it is worth mentioning that the gender issue becomes more stratified with the advancement of the scientific career. Women occupy a greater number in undergraduate and postgraduate courses and in basic education teaching, levels of education that correlate with the profile of

communicators. In university teaching, productivity grants and awards (such as the thesis or Nobel Prize), the number is less significant (Naideka et al., 2020).

Regarding educational developments, individual administration poses greater challenges in terms of time and adequate preparation of material. Discussing the people responsible for publications is also a way to insert the debate about the production and circulation of scientific knowledge, including the issue of gender and its stratification at the highest rungs. Science is a social and collective production, whose understanding of its practices and functioning is as important as its content. Allchin (2013, p. 3) goes further by arguing that:

> For decision making in everyday life situations, whether in personal or social settings, one of the knowledge needed is about how science works. Knowledge about the nature of science can be as important, if not more important, than content knowledge.

Thus, analyzing and interacting with accounts managed by scientists, including university researchers, doctoral and master's researchers, is a possibility for discussion on scientific work in school science education. Couto Junior and Santos (2019), investigating social practices of scientists mediated by Facebook, indicate that the dynamics of interaction enable formative experiences and the creation of "learning-teaching" networks. Social networks are thus potential spaces-time for the population to interact directly with scientists. The teacher in the school context could enable such interactions, bringing about educational practices in cyberspace that allow discussion about how it is done, who does it and what the characteristics of doing science are.

Regarding the profile of professional activity (Table 2), the vast majority of accounts are managed by teachers of basic education, followed by undergraduate students. Research/extension groups, projects and laboratories were identified with the third highest occurrence, while higher education teachers represented the fourth most present profile. Postgraduate students, science enthusiasts and institutions jointly represented around 15%. This result indicates the strong presence of teachers with a chemistry background and a high relationship with academia in the production of digital content.

Table 2
Professional profile of science communicators:

Profile	Initial survey	Final survey
Teacher Basic Education	35 / 45,5%	29 / 43,9
Undergraduate Student	17 / 22,1%	13 / 19,7
University Research or Extension Groups/Laboratories/Projects	10 / 13,0%	08 / 12,1
Higher Education Teacher	05 / 6,50%	05 / 7,60
Postgraduate student	03 / 3,90%	03 / 4,50
Science enthusiasts	04 / 5,20%	05 / 7,60
Institutional accounts	02 / 2,60%	02 / 3,00
Not identified	01 / 1,30%	01 / 1,50

Source: Survey data (2021 and 2022).

Santos and Müller (2022) also point to the close relationship of science communicators in digital media to the academic environment, with almost half of the communicators being Ph.Ds., M.D.s, or undergraduate students. Nunes and Geller's (2023) results for literary education accounts also indicate a high participation of teachers, accounting for about half of the profiles identified. Carpenter et al.'s (2020) research shows that teachers rely on social media, particularly Instagram, for a variety of purposes, including being inspired by and learning from the experiences of other educators, building collaborative groups and support communities, sharing experiences, and increasing interaction with students. Thus, Instagram appears to be configured as an unconventional space for teacher education and knowledge sharing, suggesting an area of inquiry that includes both practicing and pre-service teachers, as students also make up a significant portion of those using this social network to share chemistry content. On the other hand, the participation of university/research institutions in actions to spread chemistry is still below what is necessary, either from a personal or institutional point of view. Although research groups/projects/laboratories have an institutional character, they represent an isolated collective action and not with institutional support. The possibility of a more direct traffic of knowledge between those who produce science and the population is little explored. The Internet is also a contested territory, significantly influenced by ideological issues (Massarani et al., 2020), which needs to be occupied by those who do science and know it from the inside, that is, scientists. For Escobar (2018), Brazilian science communication has always been deficient, with a gap between the scientific community and society that urgently needs to be overcome. To this end, the scientific community needs to take more responsibility.

> Logic and scientific truths on paper are not enough. In order to put pressure on politicians, society must first be convinced; and that is where science communication comes in (or should come in). For people to defend science, they must first understand why science is important to their lives; and no one better to explain this than the scientists themselves. (Escobar, 2018, p. 32)

Escobar (2018) argues that currently the Internet and social networks would be a way for scientists to engage with outreach, this being both an individual and institutional challenge. While it is agreed that scientists need greater engagement in this practice, it should be noted that only good intentions and individual interest are insufficient for the quality of public communication of science. Although the actions of teachers, students and researchers may be commendable, it is necessary, among other factors, to understand the role of the media, the use of resources and language, as well as time and funding for the promotion of qualified science communication. It is essential that science communication programs are promoted for their implementation and institutionalization, raising actions for science diffusion and stimulating individual projects that would become equally more qualified.

Characteristics of accounts in terms of shared content

In terms of the characteristics of the accounts, four main groups were identified according to the content of the publications (Table 3), highlighting two data. The first is the broad predominance of pedagogical support-type accounts in the initial

survey. The other aspect was the abrupt variation of this type of account, resulting in growth of the general knowledge about chemistry category. The studygram type accounts also underwent variation that can be seen as significant.

Table 3
Categorization of accounts according to the content of publications in the initial and final surveys:

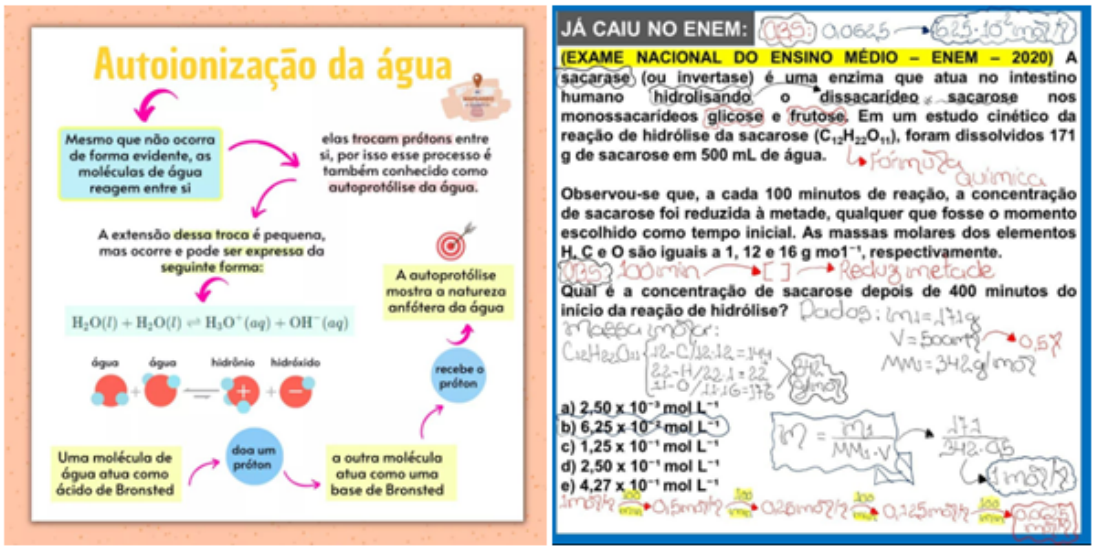
Types of accounts	Initial survey / %	Final survey / %
Educational support	44 / 57,1	24 / 36,4
Studygram	15 / 19,5	08 / 12,1
General knowledge about chemistry	15 / 19,5	31 / 47,0
Specialized knowledge about chemistry	03 / 3,90	03 / 4,50

Source: survey data (2021 and 2022).

This variation seems to indicate that the types of accounts are related to the management profile. Accounts about chemistry general knowledge administrated by researchers (individually or in groups/projects/laboratories) did not vary significantly and even showed, in some publications, theoretical fundamentals about public communication of science. The pedagogical support and study program accounts are administrators who start the activity without a defined perspective, usually still as undergraduate students or early career teachers. Therefore, the uncertainties and changes that usually occur in these phases also affect the published content and account types (Santos & Müller, 2022). In addition, with the return of face-to-face activities and the shorter time of activity on the Internet, part of the accounts also changed the focus of the publications, with some becoming inactive.

In terms of the characteristics of the publications, pedagogical support accounts are focused on school content, making strong use of language recoding processes that seek a humorous effect, including as resources images, memes, synthesis of information (Figure 4A), study tips and resolution of questions/exercises (Figure 4B). In general, they are managed by students or teachers who want to create new spaces for dialogue with a wider audience, including students.

Figure 4
Publication in pedagogical support account presenting synthesis of information (4A) and resolution of question (4B).



Source: Research data (4A - Mapeandoaquimica, 2021; 4B - Adrianoalves_quimica, 2021).

It was also noted that publications vary in order to obtain greater public engagement, strongly associated with interaction with the content (Costa et al., 2019). The concern with a language accessible to a wider audience is the keynote. The communication characteristics move between the educational and the popular, approaching what Fleck (2010, p. 166) called popular science, "[...] for nonexperts, that is, for the large circle of adult, generally educated amateurs", which would present a simplified, less detailed, illustrative and aesthetically pleasing character. The aesthetic dimension comes from the emotional plasticity, typical in adaptations for a wider audience (Fleck, 2010). Emotive plasticity is evidenced by resources "to make information meaningful, which involves, in addition to images (graphics, drawing and photos), the use of touching metaphors" (Oliveira, 2012 p. 131). Studies on the pedagogical possibilities of Instagram report that teachers frequently post and search for tips, examples of teaching activities, didactic-pedagogical materials (Carpenter et al., 2020) and organize activities with students (Carpenter & Justice, 2017). Social networks, more generally, would also have the potential to bring students and teachers together (Pinheiro & Santos, 2019).

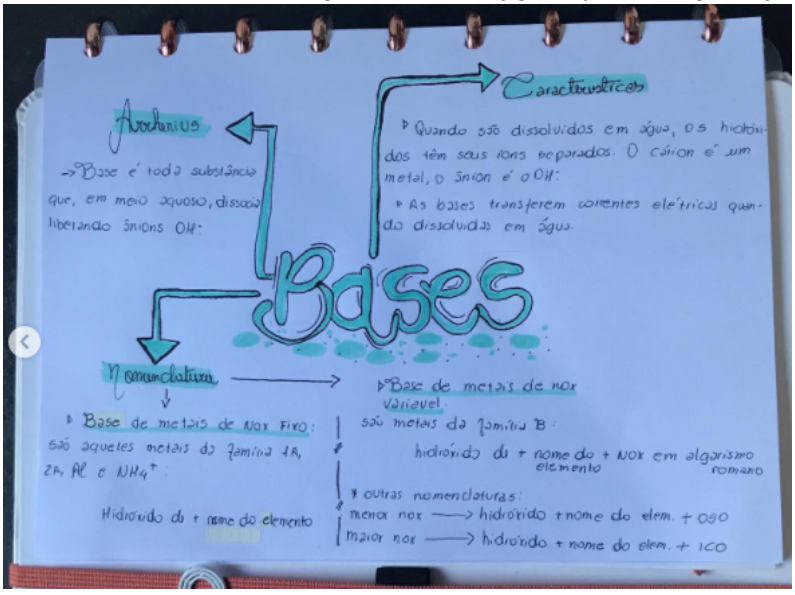
On the other hand, the use of simplifications and didactic retextualizations often incurs conceptual simplifications. In some cases, alternative conceptions or misconceptions are reinforced, with the valorization of superficial and animistic information (Figure 5). In this case, there is a reinforcement that chemical bonds essentially refer to electrons, either through transfer, sharing or mobility, to the detriment of their understanding as a force of attraction between atoms that act in the energetic stabilization of the system. In fact, this is already a misconception reported in the literature (Taber & Coll, 2002), but it takes on new contours in digital networks and requires a careful look at its problematization.

Figure 5
Account post categorized as pedagogical support featuring content with an element of humor (meme).

Source: Survey data (Quimicaanime, 2021).

Studygram accounts are very common among students. Literally translated as "study plan," these are accounts that are generally organized to report on aspects of daily study, including tips, summaries, and outlines. According to Costa et al. (2022), studygrams have become an informal space for learning concepts and attitudes for those who produce and access the content, usually because they focus on issues related to teaching (Figure 6).

Figure 6
Publication in account categorized as studygram presenting study scheme.



Source: Survey data (Quimicaanime, 2021).

The type of content shared varies, but very common is the use of photos and videos that socialize study notes, books, and various academic activities, as well as the discussion of aspects of chemistry, the challenges and achievements of student life. Given that some of the reasons for the use of Instagram among teachers and students are to seek not only content, but also experiences that can inspire, as well as emotional support and interactivity with peers (Carpenter et al., 2020), studygram accounts can function not only for the spread of knowledge, but also of academic experiences. These findings are consistent with the study by Vaz and Soares (2014) on the social network Orkut. The authors point out that the focus of chemistry communities was not on educational aspects per se, but on entertainment and social interaction.

For Fleck (2010, p. 159): "The complex structure of modern society results in multiple intersections and interrelations among thought collectives both in space and time," bringing together individuals with similar perspectives and forming support networks. It is worth noting, however, that virtual communities are not always entirely healthy (Nagle, 2018). Virtual space, due to a supposed protection of distance, potentiates prejudices and discrimination and can create an arid terrain, although this is not the case in any of the accounts analyzed, which seem to be configured more as a space for positive experiences.

The accounts of general knowledge about chemistry are characterized by the fact that they form a nexus between different specialists of the science of chemistry, working in different fields. These include researchers-teachers in higher education, teachers in basic education, postgraduate students-researchers. Another factor in this profile of accounts is the language used. An analysis of the publications shows a process of transformation of the language, which is presented in such a way as to seek dialogue with the widest possible audience, while maintaining technical aspects (Figure 7). Attention is paid to more formal content, including sources of information. Thus, the science involved has technical-scientific elements, but the communication process moves from an interspecialistic character to an educational and popular one.

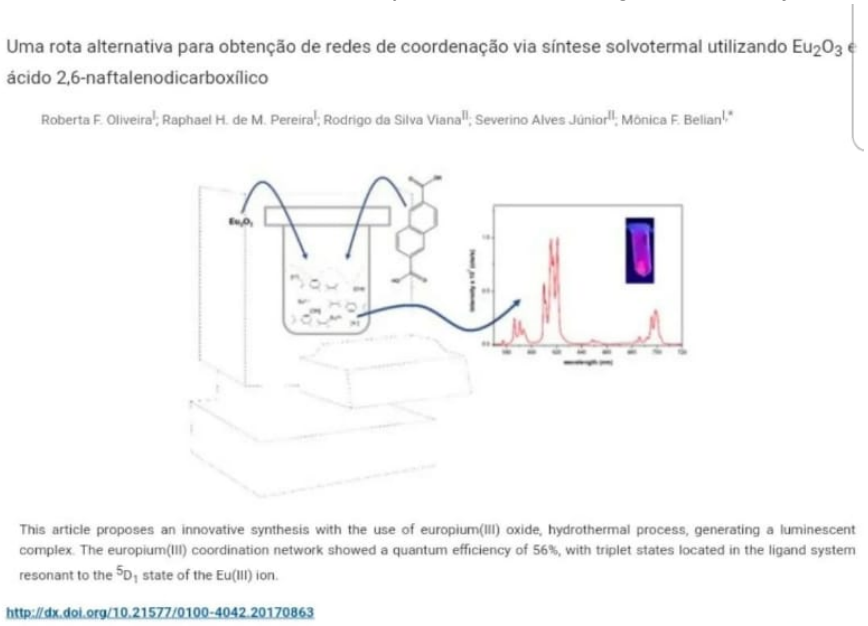
Figure 7
Publication in account categorized as "general knowledge about chemistry".

Source: Research data (Foto Quimica, 2022).

The example (Figure 7) bears the central characteristics of the perspective of science popularization, with direct language and the search for dialogue with the possible interlocutor ("Hey guys! Who here has ever smelled the perfume of a lady of the night?"), the use of examples and everyday situations, technical terms, chemical structures and explanations with linguistic recoding.

The category specialized knowledge about chemistry had the lowest number of accounts, a fact probably associated with the profile of the audience for which it is intended. The publications cover the dissemination of content on chemistry and interface areas usually aimed at an audience with academic training in this area (Figure 8).

Figure 8
Publication with the character of specialized knowledge in chemistry.



Uma rota alternativa para obtenção de redes de coordenação via síntese solvotermal utilizando Eu_2O_3 e ácido 2,6-naftalenodicarboxílico

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This article proposes an innovative synthesis with the use of europium(III) oxide, hydrothermal process, generating a luminescent complex. The europium(III) coordination network showed a quantum efficiency of 56%, with triplet states located in the ligand system resonant to the $^5D_1$ state of the Eu(III) ion.

http://dx.doi.org/10.21577/0100-4042.20170863

Source: Survey data (Quimicanovasbq, 2022).

There is no particular care with the recoding of language for a broader audience, resembling in some extent the idea of scientific popularization described by Bueno (1985). Communication of a more intraspecialistic nature and the science of journals predominates, which requires knowledge about the subject addressed. It is the publication of a journal specialized in chemistry, with graphic and textual summary, in more technical (and foreign) language, while using visual and aesthetic resources. Although the more intraspecific character is verified, the virtual scenario is already configured in a space of multiple languages and transformation of communicative modes. Thus, aesthetic plasticity is perceived, but unlike what Fleck (2010) pointed out about its presence in popular science, here they are related to a specific area in order to draw the attention of a particular group of people to the publication. Such characteristics give greater support to the networked perspective of scientific communication. Not only the actors in the process, but also the modes and resources employed become part of the different types of science in the Fleckian sense. What used to be published in print and disseminated only among members of a given scientific organization, can now be accessed free of charge by more people.

Final considerations

In order to analyze the actions of circulation of chemistry through Instagram and to establish possible educational developments, the present work undertook virtual ethnographic research to answer the following question: what are the characteristics of accounts in the social network Instagram that spread chemistry and the possibilities to expand science education from them? The results show an increase in the circulation of chemistry knowledge in this social network,

characterized by an increase in the number of accounts and followers. At the same time, there is volatility in the social network, that is, there is a positive and negative variation in the maintenance of virtual activities. A detailed assessment of this phenomenon will require more longitudinal monitoring of publications.

Regarding the characteristics of the accounts, those managed individually are predominant, as well as those managed by teachers of basic education and students, who represent most of the pedagogical support and studygram accounts. The pandemic shows a strong correlation with these data, due to the need for greater connectivity for studies, as well as the intensification of activities on the Internet. At the same time, they show that public communication of chemistry through Instagram is somewhat random and amateurish. That is, the communicators often start their activities without established objectives and without any theoretical knowledge about what science communication is and what its characteristics are. The accounts of general knowledge about chemistry are usually produced by researchers (individuals or groups/projects/laboratories) who, in some publications, even demonstrate basic knowledge about the process of science communication and care about citing sources. In addition, there was a strong migration from pedagogical support accounts to general knowledge, showing a greater approximation to aspects of science communication.

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Resumo

Este trabalho investigou características da divulgação em química no Instagram apoiando-se na etnografia virtual para coleta de dados. Os resultados evidenciaram acentuado crescimento de contas (77 ao total) até 2021, bem como do número de seguidores. O perfil de administradores é de pessoas ligadas ao campo da química, especialmente professores e estudantes de diferentes níveis de ensino, atuando majoritariamente de forma individual. Foram identificadas contas de apoio pedagógico, studygram, de divulgação de conhecimentos gerais sobre química e de conhecimentos especializados sobre química. Desafios derivam da fluidez das redes sociais, que exige um olhar crítico sobre as publicações.

Palavras-chave: Divulgação científica. Redes sociais. Educação em ciências.

Resumen

Este trabajo investigó características de la divulgación en química desde *Instagram* con apoyo en la etnografía virtual para el levantamiento de datos. Los resultados mostraron un fuerte crecimiento de cuentas hasta 2021 (77 en total), así como en el número de seguidores. El perfil de los administradores és de personas vinculadas al campo de la química, como docentes y estudiantes de diferentes niveles educativos, actuando la mayoría individualmente. Fueran identificadas cuentas de apoyo pedagógico, estudigrama, de divulgación de conocimientos generales sobre química y de conocimientos especializados sobre química. Desafíos derivan de la fluidez de las redes sociales, lo que requiere una mirada crítica sobre las publicaciones.

Palabras clave: Divulgación de la ciencia. Redes sociales. Educación de ciencias.

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