Experiencing science communication from a local perspective: an analysis of the volunteer SciCom groups in Chihuahua, Mexico

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Abstract

The Programme for International Student Assessment (PISA) ranks Mexico in one of the last places in science performance [OECD, 2019]. This has been a concern for some local science communication groups (SCGs) in small and medium-sized cities, whose mission is to fill this disparity by performing science communication (SciCom) activities. The SCGs were contacted via a survey to collect information about their dynamics and public reach. A descriptive analysis enabled the identification of the logistics and coordination issues found among SCGs. Consequently, a local network of science communication groups is advised to reinforce their impact.

Keywords

Popularization of science and technology; Public engagement with science and technology; Public understanding of science and technology

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Introduction

Science is a tool that has helped humankind to understand the world; therefore, it is key to social progress and development [Harari, 2015]. The need for scientific thinking has grown significantly as the science and technology we use in our daily lives has become more complex. However, since science is an extended field, it generates specialized idioms and symbology, making the information incomprehensible to a selected few. This represents a bias in the access to scientific culture [Zoubi et al., 2022]. While scientists and universities are the traditional sources of knowledge, the participation of journalists, artists, graphic designers, programmers, musicians, writers, etc. is necessary to build an optimal science communication (SciCom) environment.

The inadequate design and execution of SciCom activities may reduce their efficiency. While it is fundamental to offer appropriate tools to understand science and technology [Holbrook, 2019], at the same time, it is necessary to consider the social context in order to engage with people in a more meaningful way [Lewenstein, 2003].

Scientists may not have enough time or possess the skills needed to facilitate an effective communication process. Taking this into consideration, the role of professional science communicators is crucial, but they happen to be scarce or nonexistent in some of the places. To address this issue, the third sector (non-governmental organizations, charities, and voluntary groups) plays a major role [Nugroho, 2011].

In the 19th century, education in Mexico became a priority of the government as a strategy to produce highly skilled citizens [Zepeda, 2012]. This phenomenon was not exclusive to Mexico. It was also present in Latin America, for different countries recognized the importance of science education in social development [Vessuri, 1994]. In the first stage, science education was only available to the elite classes. One of the first efforts to expand science literacy in the Mexican society was the launch of the magazine *La Ciencia Recreativa*, which was first published in 1871. This publication was one of the earliest efforts to make science more accessible [Fróes da Fonseca, 2017]. In Latin America, there is a heavy dependence on volunteers as more than 60% of the major SciCom groups and associations work with no paid personnel, and more than 90% partially use volunteer staff [Patiño Barba, Padilla González del Castillo and Massarani, 2019]. Without the people's willingness to put time and effort, SciCom would remain to be underdeveloped.

Local science performance and educational characteristics

Chihuahua is the capital of the namesake state and is located in the northern region of Mexico. The city's population is about 878,000 people, with one-third of the economically active population working in the secondary industry, making Chihuahua an industrial city [Instituto Nacional de Estadística y Geografía (INEGI), 2017]. One-third of its total population is currently in educational institutions. More than 4,000 students are enrolled in a science-focused middle school educational program, with enrollment in engineering, manufacturing, and construction as the predominant profile. With regard to college degrees, only 45% of the total students were enrolled in a science-related program. This value drops to 18% for a master's degree and 25% for a Ph.D. degree [INEGI, 2015; INEGI, 2017]. Eight universities operate in Chihuahua, offering 65 undergraduate programs and 51 postgraduate degrees in areas as diverse as engineering, physics, chemistry, biology, earth, space, materials, and health sciences. The local mean years of schooling in Chihuahua is 10.9 years.

The Programme for International Student Assessment (PISA), which measures the engagement of students with science-related issues and ideas, ranked Mexico 66th out of 73 countries in science performance [OECD, 2019], with students showing difficulties in understanding and using basic scientific concepts. At the local level, the National Institute for the Evaluation of Education (INEE, its Spanish acronym), an autonomous entity of the federal government, does not assess science as a whole, instead it evaluates mathematical understanding. However, this metric can also be used as an indirect indicator of scientific performance. According to the latest available results, children in their last year of elementary school are below the national mean for mathematical education [INEE, 2018], while 62.1% of the teenagers in middle school have a poor mathematics level [INEE, 2019]. This contextualizes the local science-understanding problem. 16.9% of the total

population of Chihuahua have educational lag [Consejo Nacional de Evaluación de la Política Publica de Desarrollo Social (CONEVAL), 2020], which positions Chihuahua slightly over the national mean, but it is far from desirable. Additionally, it has been estimated that students could lose as many as two years of schooling owing to the COVID pandemic [García Dobarganes, 2021].

Science education tends to be centralized, making major cities the epicenters of many universities, museums, and science groups. Currently, this gap is being filled by several science communication groups (SCGs), with the goal of improving science accessibility, literacy, and culture. Since financing is a critical issue for all the SCGs, along with institutional interest and professionalization, the voluntary ecosystem of SciCom in Chihuahua struggles to stand out in comparison to the other major cities in Latin America. This study addresses the characteristics of local SCGs and suggests concrete actions to improve their impact.

Methods

To capture the diversity of behaviors and opinions among SCGs, a survey was designed and conducted to inquire about the experiences and perceptions of the SCGs in Chihuahua City. Surveys are a widely used tool to obtain information [Ponto, 2015], and have been used by previous studies for the specific purpose of investigating the behavior of SCGs [Patiño Barba, Padilla González del Castillo and Massarani, 2019; Ferreira et al., 2019]. For the sake of this study, a science communication group was considered to be a unit of two or more persons coordinated to perform SciCom activities. The inclusion criteria required one of the objectives of the group to be the execution of in-person talks, workshops, conferences, science fairs, field trips, or natural observations, and the members to have recognized themselves as volunteers. Only the SCGs with their operational base and impact zone in Chihuahua City were considered and invited to participate via email and telephone. Before the survey application, a screening of SCGs was performed via social networks and personal communication. To the best of the authors' knowledge, every public volunteering SciCom group in Chihuahua City was invited with no bias.

The survey consisted of three different sections: (1) general information about the group, such as size and collaborator profile; (2) characteristics of SciCom events, such as audience profile and planning and evaluation of activities; and (3) perception of science communication at the local level, such as collaborative work and professionalization. The survey had a predominantly qualitative focus and included quantitative questions. It was conducted in Spanish via Google Forms from December 2020 to April 2021. It consisted of 51 questions with preset answers and an option to answer freely if needed. If any clarification was needed, interviews were held with the group representatives using the Zoom platform. The SCGs representatives were informed that the data obtained would be used for this study, with sensible information (such as personal names and addresses) staying private. A non-literal translation of the questions is available in appendix A.

The information obtained was checked manually by the authors to spot the inconsistencies and standardize the answers. As the data obtained were predominantly descriptive, only the basic statistical resources (mean, mode, and percentage) were used.

Results and discussion

Originally, 22 SCGs were considered for this study. Unfortunately, one did not respond. The local SciCom volunteer ecosystem is described as follows.

Internal dynamics of SCGs

An SCG, like any other human endeavor, is subjected to many complexities, and its internal dynamics does affect its objectives. Knowledge about the features of groups allows one to better comprehend their scope, and in the long run, better comprehend how science is communicated [Sánchez-Mora et al., 2015].

Most of the SCGs were created recently, with the oldest dating back to 2001. On average, a new group is created each year; while the creation rate is slow, with half of the current SCGs started their operations in the last three years (Figure 1a). Limitations in the creation of new groups could be related to low salaries, scarce recognition, and institutional apathy [Navarro and McKinnon, 2020].

Half of the SCGs have not been legally recognized, which means that they may not have proper access to public or private financing, which is a critical issue for all the SCGs. This represents a challenge that should be addressed by future research. Only six groups, out of 21, are legally constituted and four groups exist within an educational institution (Figure 1b), both of which facilitate access to resources and joint work with other organizations. Only half of the consulted SCGs are independent organizations with full control of their activities. The rest depend on educational institutions, the government, or other larger organizations (Figure 1c), which may influence how science is communicated [Trench, 2017].

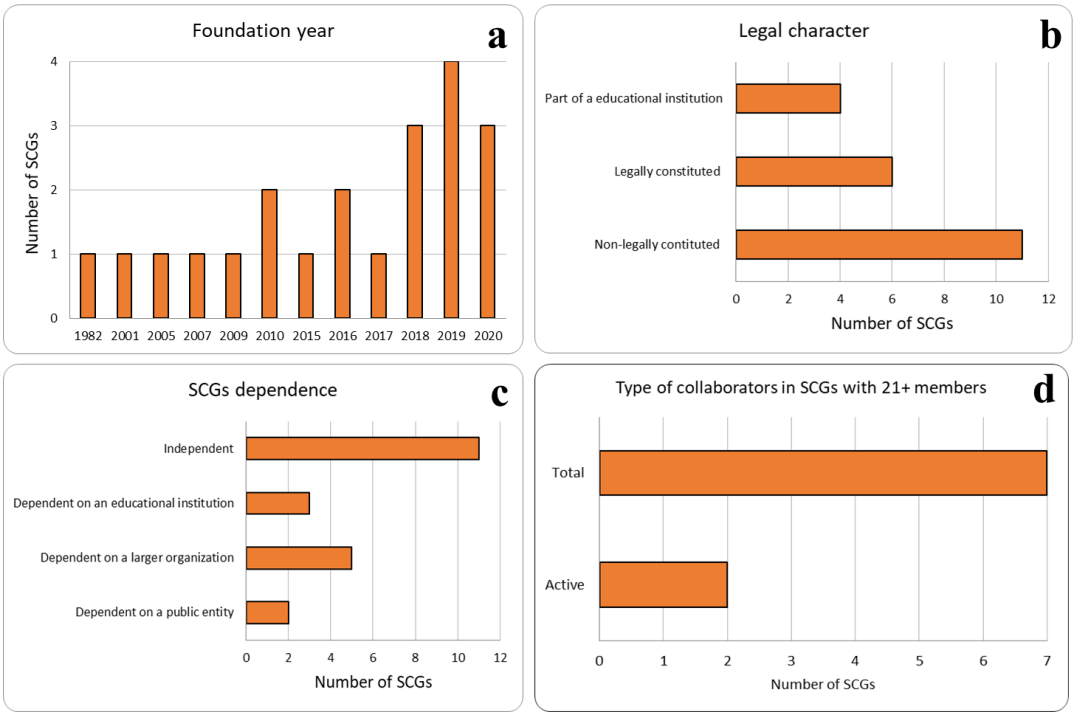

Figure 1. Some characteristics of the internal dynamics of the science communication groups: a) foundation year, b) legal character, c) SCGs dependence, d) type of collaborators in SCGs with 21+ members.

With regard to collaborators, one-third of the groups declared that they had 21 or more collaborators; however, when it came to active collaborators, the same proportion of groups stated that they could only rely on 1–5 active collaborators (Figure 1d). Vuuren suggests that the number of group members is not related to the volunteer's commitment [van Vuuren, de Jong and Seydel, 2008]. Four out of the five groups declared that at least one member had some SciCom training, which is fundamental to the development of skills needed to communicate with the public [Trench, 2017; Magni and Pitts, 2020]. If this training is not provided by others, the groups should put in some effort to inculcate baseline skills among their volunteers [Shivni et al., 2021].

By analyzing the characteristics of our average group, we can conclude that they are small. This represents a challenge to their capacities, and they should find ways to retain their collaborators and train them in order to reach the status of a critical size that allows them to professionalize their vocation.

Public reach

To reach an audience, all the SCGs use electronic media, with Facebook being the most popular. Other platforms such as Instagram, Twitter, YouTube, and LinkedIn were also used by the SCGs (Figure 2a). Social media represent a wonderful strategy to bypass the bureaucracy and connect directly with the public [Jia et al., 2017], and as a rapid communication and discussion tool. However, they do carry serious risks of misinformation [Ho, Ho and Vuong, 2021]. For these platform to achieve a meaningful impact, beyond acting as a substitute for in-person SciCom, they should be treated with professionalism and rigor [Jones et al., 2019]. Only half

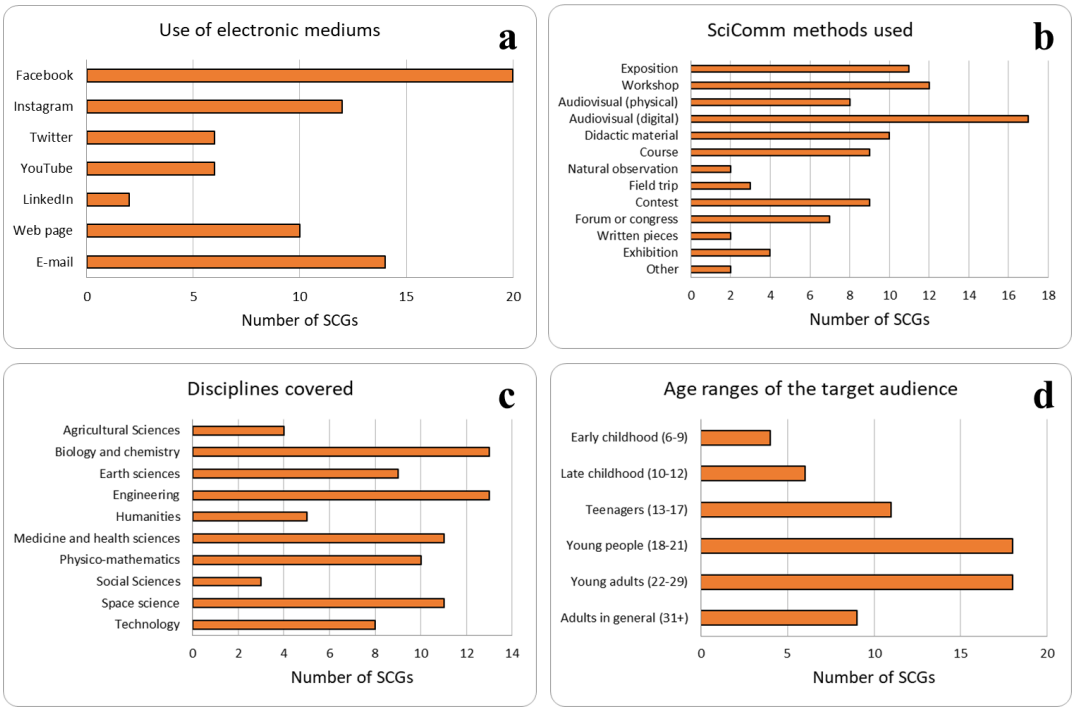

Figure 2. Aspects of how SCGs reach the public: a) use of electronic mediums, b) SciCom methods used, c) disciplines covered, and d) age ranges of the target audience.

of the SCGs use a web page to offer information to the public; nonetheless, 67% of the SCGs do offer some kind of a newsletter. These strategies should be encouraged and adapted to different social contexts, but an institutional approach is also needed to establish a more formal communication channel with the audience.

With regard to the diversity of scientific communication methods, 80% of the SCGs declared the use of audiovisuals as their main SciCom method, which were followed by the use of workshops, expositions, didactic materials, courses, and different kinds of contests. Figure 2b presents the comprehensive usage of these approaches. It is worth noting that techniques that involve direct contact between the audience and a natural phenomenon (e.g., natural observations or field trips) are not used commonly as they require complex logistic and economic resources. Only *Liga Astronomica Chihuahua*, an astronomic enthusiast league, performs a star observation night once a year, and its representative commented on the difficulties of carrying out the activity (volunteer commitment, equipment, and institutional support). Written content is also scarce, with only one group having access to a local newspaper, wherein they publish a SciCom section every Sunday. Two more groups declared that they have SciCom pieces written in their web portals, but lacked a formal editorial process. With regard to the other less used SciCom methods, only three groups performed field trips to observe natural phenomena or visit local scientific facilities. These field trips usually do not take more than half a day and are attended by small groups owing to the logistics involved.

Although experimentation and hands-on activities are essential for any learning process [Waldrop, 2013], these activities are practiced quite less. The alternative to the majority of the consulted SCGs is the use of (1) digital resources and (2) different kinds of massive events, such as conferences or workshops designed to stimulate the audience and improve their attitudes toward science [Schmidt and Nixon, 1996].

SciCom approach is related to the size and nature of the group. Only two groups declared of having a digital-only presence, which was the most common approach in SciCom during the COVID pandemic [Xiao, Borah and Su, 2021], while most of the groups offered some kind of in-person activities. Five groups operate at the state level, whereas only six groups operate at the city level. Furthermore, five groups executed only focused activities, which may take place in some specific schools, institutions, or places. Therefore, we can say that the SciCom approach is diverse and responds to the different characteristics of SCGs.

SciCom activities have different frequencies, depending on the function of the group scope and resources. Most of the SCGs executed at least one activity per month. This recurrence is linked to the time available with the volunteers, and there is a tendency for this time to increase when SCGs have external support (e.g., university or government). In the micro-universe of voluntary SCGs, there is no single group that can communicate science in a permanent state (various activities per week over several months).

The disciplines covered by SCGs are highly diversified; however, engineering, biology, and chemistry are the main fields covered (Figure 2c). SciCom activities are commonly focused on a specific age band; in the case of consulted groups, their events are predominantly focused toward teenagers to young adults (Figure 2d).

Early and late childhood, as well as adulthood in general, are frequently overlooked and represent a niche that should be approached. Translating science to children assists them in their cognitive development and increases their scientific engagement [Juarez and Kenet, 2018], and science culture may improve their quality of life and decision-making processes [Padgaonkar and Schafer, 2021].

Financing is a critical issue for all the SCGs. It is worth noting that no consulted group operates to seek profit, for most of them offer their activities at no cost to the attendants. In cases where there is a charged levied, it is declared as a recovery cost. It is through the individual contributions of its members or specific fundraising activities that most of them can be financed. In some cases, an educational institution or government agency may partially sponsor them. Seeking finance can be a complex task because of the distinct criteria of the financing entity. As a result, the way SCGs operate is partially shaped by their sponsors [Palmer and Schibeci, 2014]. Material resources (e.g., auditoriums, chairs, tables, projectors) are often borrowed from a patron or institution, and only a few SCGs can be counted of having limited infrastructure, from didactic and laboratory materials to other types of assets.

Perception of local SciCom

SCGs perceive that the number of local activities is limited and that their diversity is barely adequate (Figure 3a). Although this perception is generalized, the activities executed are considered to be of good quality (Figure 3b). The different educational institutions operating in Chihuahua are considered to be the entities

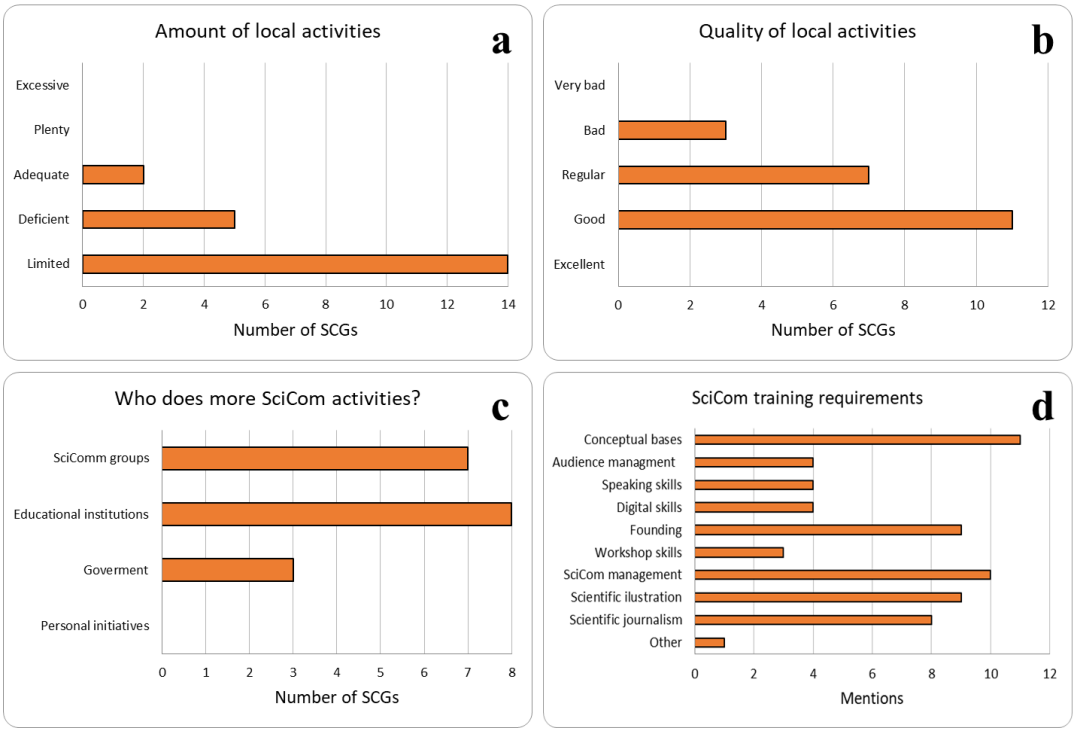

Figure 3. SCGs' perceptions of local SciCom activities: a) amount of local activities, b) quality of local activities, c) who does more SciCom activities?, and d) SciCom training requirements.

that execute the most SciCom activities, followed by the SCGs themselves, and finally, the government (Figure 3c). When it comes to collaboration with the other SCGs, while most of them are aware of their existence in a micro-universe, almost a third have never collaborated with any other group at any moment. While most of the groups are not sure if there exists a cohesion between them, they do remember at least one SciCom activity executed by another group in the last six months.

While the consulted SCGs expressed that the challenges to be faced are subjective, they recognized that dealing with institutional interests and obtaining human resources are common to most of them. Nevertheless, once a solid volunteer team is consolidated, its motivation is considered to be the main strength.

There are five main interests for having training carried out by the SCGs: SciCom conceptual bases, illustration, management, funding, and journalism (Figure 3d). They declare the need to study the conceptual bases and techniques of SciCom in-depth to procure financing for their activities, since most of them are self-made science communicators. Other training concerns revolve around how to write and illustrate SciCom materials and how to manage the activities.

General discussion

National capital and large cities account for most of the country's economic, scientific, and artistic production [García-Guerrero and Lewenstein, 2020]. In the case of Mexico, these roles are covered by Mexico City, Guadalajara, and Monterrey. The question that then arises is: "What happens to middle-sized cities like Chihuahua?" They struggle to stand in the SciCom scenario. Although social media has facilitated the public's access to high-quality SciCom resources, from memes and videos to courses and crowd science projects [Scheliga et al., 2018; Anderson and Becker, 2018], a hands-on approach is vital for achieving a more comprehensive engagement [Ferreira et al., 2019]. This is where the local SCGs become relevant.

Local volunteer SciCom groups exist because of there being a number of students and professionals who are willing to communicate science freely [García-Guerrero, Lewenstein et al., 2020]. As they share this passion, they also face challenges pertaining to training, financing, and reaching. In Chihuahua, the SCGs have relatively homogeneous characteristics. Their main challenges are that most of them involve only a small number of collaborators and are not legally established, which hinders their access to material resources. More importantly, in the long run, they tend to work in isolation from each other. Almost each of the groups plan their upcoming activities, and half of them always make *ex-post* evaluations based on evidence. This exercise is based on collected evidences such as oral feedbacks or surveys, which are acknowledged to be the tools that are crucial for the success of a SciCom activity [Lozano and Sánchez-Mora, 2008].

Although SciCom requires natural talent and vocation, some degree of specialization is also perceived to be necessary. Postgraduate degrees or diplomas in diverse aspects of SciCom are offered in Latin America (e.g., Diploma in Science Popularization by the National Autonomous University of Mexico or Master's Degree in Science, Technology, and Innovation by Rio Negro National University

in Argentina). SCGs consider formal education to be necessary at the local level, which to this date is non-existent. Training on the conceptual bases of SciCom and its management are especially desired [Massarani et al., 2016].

As declared by the consulted SCGs, there is no sense of unity among the different groups, but almost everyone agrees that the creation of a local SciCom network could benefit the practice. For this reason, and as a natural conclusion, we propose the creation of a local SciCom network with the objectives of communicating diverse SCGs, promoting their activities, offering training, and disseminating information. This is the first time a network with such characteristics has been proposed locally, and it can be anticipated that the network would face several challenges. To persuade the different SCGs on the importance of collaboration is crucial, so is delegating tasks that surely will take time and effort. Obtaining an institutional shelter that provides resources that are not possessed by SCGs is critical.

SciCom networks are rare to come across. Latin America is an example of a region trying to coordinate SciCom efforts at different scales [Moronta-Barrios et al., 2021; Gouveia and Kurtenbach, 2009]. *RedPOP* (Latin American and Caribbean Science and Technology Popularization Network) is a supranational initiative that includes different national SciCom associations, universities, and museums (redpop.lat). In Mexico, other organizations perform similar duties, such as the Mexican Society for Science and Technique Divulgation (www.somedicyt.org.mx), *Red Mexicana de Periodistas de Ciencia* (Mexican Network of Science Journalists; redmpc.wordpress.com), and *Asociación Mexicana de Museos y Centros de Ciencia y Tecnologia* (Mexican Association of Science and Technology Museums and Centers; ammccyt.mx). All these initiatives, even if well intended, do not usually appeal to small local SCGs. In this context, it is beneficial for small groups to organize locally, as their coordinated efforts may impact the community [de Saille, 2015].

Conclusions

The results of the applied survey suggest that all the voluntary SCGs in Chihuahua are, in some way, amateur. To the best of our knowledge, there are no similar studies on other Mexican cities that assess this problem.

Volunteers are essential for the functioning of each group, but their lack of commitment in certain moments of organizational life is well known [Llorente, Revuelta and Carrió, 2021]. Offering training, challenges, and a feeling of accomplishment is the best way to retain them, as has been indicated by some of the successful experiences in museums and schools [Castellanos, Munilla and Sprünker, 2020].

An effective way to overcome the isolation of SCGs is to facilitate articulation among them, which is crucial for increasing their impact. As a result of the present study, the creation of a local SciCom network was encouraged to achieve professionalization. The first step is to know the characteristics of local SCGs via a formal study, and from there, coordinating them to optimize the resources and benefit the local science culture. This approach should be noted and replicated in other mid-sized cities in Latin America to level up the field for all the people interested in participating in local SciCom.

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Appendix A. Questions applied to local science communication groups

Section 1: general information

- Email address
- Full name of the person who answers this survey
- What position do you hold within your science communication group?
- What's the name of your science communication group?
- Since when has your science communication group been operating?
- What's the physical address of your science communication group?
- Is your science communication group part of an educational institution, part of the government, a legally constituted civil association, a group of volunteers without any legal character, or other?
- What is your operational character?
- What electronic resources does your group handle regularly?
- Please share with us the addresses and links of the electronic resources you use.
- How many collaborators does your science communication group have?
- Of all your collaborators, how many participate regularly in your divulgation activities?
- Are your collaborators mainly students or non-students?
- In your science communication group, is there a higher proportion of men or women?
- In your group, are there people who have taken a course, or have formal education in any aspect of scientific communication?

Section 2: science communication activities

- What type of scientific communication activity do you execute?
- What is the coverage of your science communication activities?
- In general terms, what is the frequency of your science communication activities?
- Which areas of knowledge do your activities include?

- Which age ranges do you serve?
- Is your audience mostly male or female?
- Do your science communication activities have a cost to the public?
- Where does your science communication group get its founding?
- To whom do your material resources (auditoriums, computer equipment, sound, etc.) belong?
- Do you spend a reasonable amount of time planning your science communication activities?
- Do you evaluate your science communication activities results based on evidence?
- What kind of evidence do you collect of your activities?
- Do you have a recurring audience?

Section 3: how SCGs perceive local science communication efforts

- List three strengths that you as a science communication group have.
- List three weaknesses that you as a science communication group have.
- How do you perceive the amount of science communication activities conducted in the city of Chihuahua?
- In general, how do you perceive the quality of science communication activities in the city of Chihuahua?
- In your opinion, who executes more science communication activities?
- Do you know other science communication groups that operate in the city of Chihuahua?
- Indicate the name of the science communication groups you know in the city of Chihuahua.
- Have you collaborated with another science communication group in any activity in the last 6 months?
- Please tell us what other science communication groups you have previously collaborated with.
- Which is the main challenge for science communication groups?
- Which is the main strength of the science communication groups in the city of Chihuahua?
- Do you consider that there is cohesion between science communication groups in the city of Chihuahua?
- How long ago did your last science communication activity happen?
- Do you remember any activities carried out by another divulgation group in the last 6 months?
- Do you consider that the figure of a science communicator is an activity that requires a certain degree of specialization?

- Do you think it is necessary to have local science communication training?
- Which areas do you think your science communication group requires training in?
- Do you consider the creation of a local science communication network relevant?
- Which activities do you consider relevant for this network?
- Does your science communication group know the federal and local public policies related to science communication?
- Does your science communication group have its own?
- List 3 words that come to mind when you talk about scientific communication.
- Finally, this space is for you to share any comments or reflections with us.

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