ACTIO: Docência em Ciências
ISSN: 2525-8923

http://periodicos.utfpr.edu.br/actio

Contributions of scientific literacy workshops in a socio-educational unit to the improvement of chemistry teacher trainees

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ABSTRACT

There are reports in the literature indicating that various unforeseen circumstances to which teachers are exposed in their daily routines can contribute to increased discomfort among educators, as teaching involves not only knowledge transfer but also engagement with social changes, classroom diversity, and contemporary challenges. Consequently, teachers who were not adequately prepared during their training to deal with diverse situations may experience difficulties in their teaching practice. This article evaluates whether the participation of chemistry teacher trainees in a project offering scientific literacy workshops to adolescents under socio-educational measures contributes to the preparation of better-equipped future teachers. Using an autobiographical method, the researcher's experiences were compared with those of other project participants. Content analysis of semi-structured interviews revealed that the experience posed pedagogical challenges for the teacher trainees, while simultaneously fostering their professional well-being. Additionally, it was observed that the length of participation in the project had a positive impact on teaching development, particularly through their formative experiences. The workshops provided direct contact with often marginalized educational contexts, encouraging a more critical and sensitive approach to diversity among future educators. The results suggest that participating in these activities enhanced the teacher trainees' understanding of the challenges inherent in teaching, as well as their pedagogical and interpersonal skills.

KEYWORDS: Science Teaching; Teacher Training; Socio-educational Measures; Teacher Well-being

Contribuições de oficinas de alfabetização científica em uma unidade socioeducativa para o aprimoramento de licenciandos em química

RESUMO

Há na literatura relatos de que diversas circunstâncias imprevistas às quais os professores estão expostos na rotina escolar podem colaborar para intensificar o desconforto dos educadores, pois a prática docente não lida apenas com conhecimentos, mas também com mudanças sociais, com a diversidade em sala de aula e com aspectos da contemporaneidade. Assim, docentes que não foram previamente preparados durante a sua formação para lidar com situações diversas, apresentam dificuldades em lecionar. Neste artigo, avaliamos se a participação de licenciandos em química em um projeto que oferta oficinas de alfabetização científica para adolescentes em cumprimento de medida socioeducativa, contribui na formação de professores melhor preparados para a realidade docente. Pelo método autobiográfico comparamos as experiências da pesquisadora com os demais participantes do projeto. A análise de conteúdo das entrevistas semiestruturadas revelou que a experiência trouxe desafios aos licenciandos na prática pedagógica favorecendo o bem-estar docente. Adicionalmente, observou-se que o tempo de permanência no projeto impactou positivamente no desenvolvimento docente, com destaque para as marcas formativas deixadas pela participação no programa. Observamos que as oficinas permitem um contato direto com realidades educacionais muitas vezes marginalizadas, estimulando nos futuros docentes uma postura mais crítica e sensível às diversidades presentes na educação. Os resultados indicam que a participação dos licenciandos nessas atividades promoveu uma maior compreensão sobre os desafios de lecionar, bem como o aprimoramento de suas habilidades pedagógicas e interpessoais.

PALAVRAS-CHAVE: Ensino de Ciências; Formação Docente; Medidas Socioeducacionais; Bem-Estar do Professor.

INTRODUCTION

"Brazil is facing a blackout of adequately trained teachers in several subject areas of basic education, particularly in the final years of elementary school and in high school" (Bof *et al*., 2023, p. 42). A study conducted by the Union of Higher Education Institutions – SEMESP (2022) projects a shortage of 235,000 teachers in basic education by 2040. Based on the PISA (Programme for International Student Assessment) report released by the OECD (Organisation for Economic Co-operation and Development), eight out of ten basic education teachers have already considered leaving their profession. One of the strategies proposed by SEMESP to retain teachers is the development of socio-emotional skills during their training.

In order for future teachers to develop the necessary competencies for professional practice, it is essential that initial training provides theoretical and practical support that effectively prepares them to handle the wide range of situations inherent in educational practice. Dornfeld *et al*. (2022) present PIBID (Institutional Program of Teaching Initiation Scholarships) as an example of a program that can serve as a training space for undergraduate teaching students.

Participating in such a program can help future teachers gain experience in the school environment and reflect on professional challenges before graduating.

With the aim of identifying relevant aspects to support retention of educators in the profession, this study investigated the contributions of scientific initiation and outreach activities developed by a research group called *School and Society*, composed of chemistry undergraduates from the Federal Institute of Rio de Janeiro (IFRJ) – Duque de Caxias campus. This group of student researchers/outreach practitioners develops a project focused on science workshops titled "Scientific literacy in socio-education as a strategy for social inclusion". The research is funded by the Federal Government through the Institutional Program of Scientific Initiation Scholarships (PIBIC) and "aims to promote scientific literacy workshops inside a semi-liberty unit" (Santo *et al*., 2021, p. 246). The authors further explain that the *School and Society* group seeks "to implement science teaching based on broader educational purposes beyond scientific learning alone and to embrace it as part of literacy, using pedagogical practices that develop intellectual activity and critical thinking" (Santo *et al*., 2021, p. 246). Regarding the concept of scientific literacy as an educational approach through science teaching, Sasseron states that:

> Students interact with elements, practices, and norms of scientific practice to analyze and understand phenomena and situations involving science and, as a result, they incorporate these ways of thinking and acting to support decision-making, stances, and actions at both local and global levels on topics from their lived experiences (Sasseron, 2024, p. 106).

On the other hand, developing scientific literacy workshops by undergraduate teaching students offers an enriching opportunity to refine lesson plans aimed at specific social groups, since the *School and Society* science workshops are directed toward adolescents serving socio-educational measures. Creating workshops that are both adapted and appealing to young people in such a specific context is a real stimulus for creativity. As Santo (2022, p. 45) states, "for future teachers, the experience of building relationships with students and exchanges in the classroom are essential for the formation of a humanized teaching perspective". Thus, "we

can understand it as a process that seeks the appropriation of scientific knowledge so that, from it, the student's citizenship formation is established, making it possible to read, interpret, and act in the world they are part of" (Ricchiero & Moraes, 2023, p. 3).

Paniago (2021, p. 201) says, "teacher training is an important condition for improving the teaching-learning process, and it directly impacts professional development". Additionally, Pimenta and Lima (2018) state that the professional development of educators must involve initial and continued training, always valuing their identity and profession.

The *School and Society* research and outreach project at IFRJ/Duque de Caxias aims to provide undergraduates with teaching experience in science education. Together with the research coordinators, chemistry undergraduates develop workshops in a non-formal educational setting. The project is made up of coordinating professors and undergraduate students who design and mediate science workshops for adolescents serving socio-educational measures. Thus, the project offers chemistry students the opportunity to develop and deliver science workshops to a highly specific and challenging audience: socially marginalized youth who are often disconnected from formal education and significantly behind in their learning. Undergraduate students may participate in the project at any stage of their degree, allowing them early contact with students. This raises the question: How can participation in scientific initiation and outreach projects, such as the one developed by the School and Society group, contribute to improving teaching practices and fostering more resilient, adaptable, and well-prepared future educators for the challenges at the start of their teaching careers?

METHODOLOGICAL APPROACH

This is a qualitative data analysis study of applied nature and exploratory objectives. We describe the impressions and experiences of the researcher during the year 2019, when she was an undergraduate student and participated in the research group *School and Society*, producing and mediating science workshops for the project "Scientific literacy in socio-education as a strategy for social inclusion". The autobiographical chapter, inspired by Bourdieu's (1996) autobiographical account, sought to demonstrate the impact of this experience on her development as an educator, the deconstruction of prejudices, and contributions to her scientific and civic education. Referring to Bourdieu's autobiographical narrative, Flavinês Rebolo (2012, p. 144) states:

> Life stories are complex accounts in which social origin, values, interests and opinions, interpersonal relationships. In short, everything that, in one way or another, contributes to the constitution of the individual and their unique way of acting, is intertwined, including their choice to become a teacher or even to leave the profession.

To compare this with the researcher's account, we conducted semi-structured interviews (Manzini, 2004) with chemistry undergraduates and graduates who also took part in the *School and Society* science workshops. We chose this type of interview because it allows the interviewee to narrate their story more freely, providing important elements to help us understand how specific events, experiences, and emotions come together.

In our study, interviews were conducted online using the Google Meet® platform to record participants' audio and video, "which allowed us to move more quickly through the transcription and analysis procedures" (Bourdieu, 2008, p. 709). The *School and Society* group has existed for approximately 8 years, and during that time, 10 chemistry undergraduates have participated and were invited to be interviewed. Of those contacted, one individual did not reply, and another declined to participate.

We established a minimum participation period of six months in the group for individuals to be eligible for the interview, as we believe this timeframe is reasonable for an undergraduate student to experience the challenges of such a project. Although time is subjective and each participant lives the experience differently, we found it necessary to set a minimum period of engagement with socio-educational students and a reasonable number of workshop sessions mediated.

To avoid identification, the order of interviews was randomized, and we referred to each mediator using the abbreviation "Med." followed by a number (e.g., Med. 2). This method ensured no gender identification.

The interview was divided into two blocks. In the first block, we asked questions to outline the participants' profiles, aiming to determine their average duration in the research group and to identify which stage of their degree they were in (or whether they had already graduated).

The second block included open-ended questions. We intentionally began with more general questions, then moved into more specific ones. This strategy was designed to capture the participants' impressions early on and allow for guided follow-up questions. Given the semi-structured nature of the script, the researcher had the flexibility to add or skip questions depending on the interview's flow.

The interview script was built based on the general and specific goals of the research, and we created *a priori* categories aligned with those goals, as we wanted to verify whether the elements we were seeking would emerge in the participants' responses.

This study received ethical approval from the Fiocruz Research Ethics Committee on November 12, 2024, under CAAE (Certificate of Presentation for Ethical Consideration) number: 83573824.4.0000.5248

PREPARING AND ANALYZING THE DATA

At the end of each interview, a video file was generated with subtitles already included. Once the interview was completed, although not yet fully organized, we formatted the questions and answers in Microsoft Word. After this step, we organized the responses from the first block of the interviews, which concerned the profile of the project mediators, in Microsoft Excel. This allowed us to analyze and compare information such as length of participation in the *School and Society* group with the research's impact on each mediator.

After preparing the responses from the first block, we began a qualitative study of the data through Bardin's (2011) content analysis, seeking indicators that

would allow the creation of categories for the second interview block. Additionally, we looked for similarities and differences between the interviewees' narratives and the researcher's impressions and lived experiences.

Because the initial questions in the second block allowed for broad responses and the researcher made it clear that participants could speak freely, some provided a wide range of contributions. Minayo & Costa (2018, p. 149) state that "each person's speech should be valued, but not in an absolute way, as the individual is not limited to the context they live in". The authors further explain that "the narrative must be framed by the thoughts of others, as it also reveals the group to which one belongs and their historical moment" (Minayo & Costa, 2018, p. 149). Thus, personal narrative should be understood in relation to the broader social and historical context. In other words, when individuals speak, they do not only express their personal experiences, they also reflect the values, norms, and conditions of their group and historical period. Further advantages of semi-structured interviews include:

> By allowing informants to express themselves freely, the semi-structured interview makes it possible to gather new information or explore unknown aspects of the issue. Another advantage lies in the flexible duration of the interview, which may vary based on the researcher's perception of whether further exploration of narrated events is needed. In this regard, "the greater the interaction between researcher and interviewee, the stronger the affinity, closeness, and reciprocity concerning the subject discussed" (Lombardi *et al*., 2021, p. 160).

As we had already created *a priori* categories based on the objectives of this research, we analyzed the interview responses, searching for indicators that these objectives were addressed in each category. We began with Bardin's free-floating reading method, which proposes that the analyst remain open to the meaning of the text, without focusing on specific parts, "allowing oneself to be influenced by impressions and directions" (Bardin, 2016, p. 126). When we identified indicators for a category that had not been previously created, we established a new one. This approach ensured we didn't limit ourselves to fixed hypotheses and allowed for new possibilities to emerge. Valle & Ferreira (2025, p. 7) assert that "content analysis is a constitutive and constructive process which, according to Bardin (2016), involves the production of inferences, becoming an interpretative activity of messages present in the data through objective systematization."

Following Bardin's proposed steps, we created six (6) categories. Initially, we conducted content analysis manually, without using specialized software. After that, we used the MAXQDA software to compare our analysis with the one generated by the program. MAXQDA offers various features, including the use of Artificial Intelligence (AI) to generate categories aligned with research objectives. After the author's manual categorization, we also performed an AI-based analysis using MAXQDA and incorporated some additional category suggestions that we found relevant to the study.

RESULTS

RESULTS BASED ON THE AUTOBIOGRAPHICAL ACCOUNT: THE FIRST IMPRESSION OF THE PROJECT

The researcher participated (alongside other undergraduate teaching students) as a creator and facilitator of science workshops for adolescents serving socio-educational measures, within a research and outreach group titled *School and Society*. Only after being selected to join the research group did she fully understand what the role entailed: each week, she and two other students were responsible for preparing a lesson plan for a science workshop to present to the group coordinators. If the plan aligned with the project's objectives, they would move forward and carry out the activity with adolescents under socio-educational measures at DEGASE Duque de Caxias (General Department of Socio-Educational Actions). This institution is located near the IFRJ/Duque de Caxias campus and operates as a semi-liberty unit. In other words, the adolescents stay overnight at the institution during the week and leave during the day to attend school (if enrolled). On weekends, they return home.

The beginning of the research was challenging and filled with uncertainty and tension, mostly due to the researcher's unfamiliarity with the socio-educational system. Still, trying not to show her apprehension to the rest of the group, she attended the first workshop. She gave special consideration to the clothes she would wear. From a Foucauldian perspective, it became apparent that these socio-educational units are spaces of bodily control, not only of the youths but of everyone present. In discussing the emergence of disciplinary processes, Foucault (2014, p. 135) explains:

> A "political anatomy", which is likewise a "mechanics of power", is emerging; it defines how power can be exerted over others' bodies, not merely to make them do what is desired, but to operate as desired, using techniques, with the speed and efficiency determined. Discipline thus produces submissive and trained bodies: "docile bodies".

"In this process, which Foucault refers to as the domestication of bodies", Bender & Berticelli (2020, p. 5) emphasize that discipline serves as a means to manufacture docile bodies. Importantly, this impact is not limited to adolescents. Those who work or conduct research in spaces like DEGASE are also subjected to these processes of bodily discipline, which, according to the researcher's experience, affect women even more profoundly.

HOW THEMES WERE DEVELOPED

The facilitators asked the adolescents what subjects and topics they were interested in learning during the workshops. These curiosities were noted and later discussed in meetings of the *School and Society* group to develop potential workshop proposals. Topic selection also considered what the group deemed relevant to the socio-educational population. Relevance could include knowledge that might later generate income, such as soap-making workshops. Workshops covering health-related topics were also prioritized (e.g., the digestive system, sexually transmitted infections, medicinal plants), as they could help the youths

care for themselves and their families. Often, workshops stemmed from scientific themes or curiosities brought up by the adolescents during sessions (like liquid density, the environment, pollution, soil composition, etc.). The aim was always to promote autonomy, encouraging participants to handle materials and build experiments alongside facilitators. The workshops sought to be immersive and participatory. As Santo (2022, p. 44) explains, "the goal of the work carried out at DEGASE was to escape 'content for content's sake' and pursue teaching focused on nurturing individuals who think critically and act in society".

Once a theme was selected, the undergraduates submitted a lesson plan to the project coordinators, who reviewed and suggested adjustments if needed. The sessions were designed to ensure direct involvement from the adolescents. As workshops progressed, the researcher's initial fear and doubt faded. Sessions used a wide variety of materials, and the adolescents responded enthusiastically, even when the tools were simple. It was a moment where they felt empowered and took the lead. There was a collective effort to dissolve the barriers between youths and mediators, fostering a strong connection to knowledge.

WORKSHOP ROUTINE

At the start of each session, the chemistry students introduced themselves to the adolescents, explaining they were IFRJ students presenting a science workshop. There was considerable turnover among participants. Over 100 adolescents were serving socio-educational measures in the unit at the time. The project was designed to engage a group of around 8 students over a three-month cycle. In practice, however, the group never stabilized, as new adolescents arrived weekly, while others left. Reasons for this turnover included reassignment to other workshops, progression in their socio-educational measures, dropping out (escape or not returning after the weekend), participation in youth employment programs, enrollment in school at the same time as the workshop, or the arrival of new participants. Because of this fluctuation, students had to introduce themselves repeatedly. After introducing themselves, they would ask if the adolescents knew what IFRJ was, then explain that the institution was located just a few meters away. They would also describe the technical high school and undergraduate programs offered at IFRJ Duque de Caxias. The intent was to show the youths that a quality educational opportunity existed nearby; one that could lead to internships and future employment after graduation.

DIALOGUES

One of the ways to build rapport with the adolescents was through conversations that used language similar to theirs, including slang and informal expressions, and by trying to understand what they were talking about. This strategy of engaging them using their own terms created a sense of connection between the undergraduates and the socio-educational youths. From a sociolinguistic perspective, Santos (2020, p. 14) concludes that adolescents in restricted freedom settings use stylistic resources as a form of communication. He adds that "in this way, knowing and recognizing slang used among social groups is also a way of understanding the context of that community."

Building a bond with them through dialogue, especially by giving them space to speak freely, express their thoughts, and ask questions, was meaningful for both sides. For the socio-educational youths, it felt as if someone was finally seeing them, acknowledging them. For the researcher (then an undergraduate student), it meant learning to listen to her students, to understand their needs and potential.

The goal of these workshops was to spark curiosity about science, to use that curiosity as a gateway to encourage them to return to school and pursue new life paths after progressing through their socio-educational measures. Education has the responsibility of forming citizens and building knowledge, even in non-formal or informal learning environments. The researcher realized she was, in some way, contributing to the development of young people who often live on the margins of society and need to cultivate critical thinking, develop argumentative reasoning and build a worldview. They need to "learn how to learn" in order to build tools to fight against their own exclusion.

Miranda *et al*. (2020) argue that everyone working in socio-educational units has, inherently, the mission of socio-education in their roles. This makes socio-educational actions a way to initiate the construction, or reconstruction, of real, achievable life projects. The authors assert that those working in these units must, through education, help transform the life paths of the adolescents and guide them away from committing further offenses.

TRANSFORMATIONS

The author of this study affirms that her experience as a facilitator of scientific literacy workshops contributed significantly to her development as an educator, mainly by helping her become more empathetic than she already believed herself to be. Being part of the *School and Society* group helped her better recognize students as individuals. She also strengthened her creative skills, as the workshops often had to be conducted with limited resources. Even with the materials provided by the project, the group of undergraduates managed to design engaging activities with minimal means, like transforming a cardboard box and a phone flashlight into a prototype of a camera.

Her greatest challenge was in distilling content and simplifying the format of the workshops, adapting the language for kids who often couldn't read or were functionally illiterates with severe learning gaps. Lesson plans had to be flexible. Even when she already knew the participants, a new adolescent would often join the following week with an unknown educational background. There was always the challenge of bringing material that could reach the majority, including participants who didn't know how to read, for example.

She noticed her growth as an educator when two new undergraduate students joined the project after she had been involved for six months. She recognized in them the same doubts and struggles she had faced at the beginning. For the researcher, the experience gained during the workshops helped undergraduate students develop essential teaching perceptions and skills, ones that should be cultivated throughout teacher training.

RESULTS FROM THE INTERVIEWS

PROFILE OF UNDERGRADUATE STUDENTS THROUGH SEMI-STRUCTURED INTERVIEWS

A total of eight (8) current and former members of the *School and Society* group were interviewed, all chemistry undergraduates at IFRJ Duque de Caxias. The interviews lasted an average of 21 minutes. They were semi-structured, allowing follow-up questions to be asked or omitted when participants spontaneously addressed points that would otherwise have been prompted. The resulting data are presented in Table 1:

Table 1

Profile of participants in the science workshops

Code	Finished the chemistry degree?	Time spent in the project
Med. 1	No	2 years and a half
Med. 2	Yes	3 years and a half
Med. 3	No	6 years
Med. 4	No	6 months
Med. 5	Yes	2 years
Med. 6	No	1 year and 3 months
Med. 7	Yes	10 months
Med. 8	No	6 months

Source: Author's own work (2025).

The time participants spent in the scientific initiation project "Scientific Literacy in Socio-Education as a Strategy for Social Inclusion" within the *School and Society* group ranged from 6 months to 6 years. The average duration was approximately 25 months, or 2 years and 1 month. However, this average is skewed by participant Med. 3, who remained in the group for 6 years. Regardless, the table enables us to assess the contribution of the science workshops at DEGASE to the training of IFRJ students and to guide our analysis of the impacts of participating in this PIBIC initiative. Table 1 will also be referenced later (see Table 3) as we examine whether length of involvement correlates with the depth of contributions revealed during the second part of the interviews.

IDENTIFYING CONTRIBUTIONS OF SCIENTIFIC INITIATION ACTIVITIES TO THE DEVELOPMENT OF SCIENCE TEACHERS

The second part of the interview focused on identifying the contributions of participating in a challenging scientific initiation project that provided diverse experiences during teacher training. Open-ended questions were used. We created Table 2 in Excel, listing the mediators and how many times excerpts from

their interviews were assigned to each category. After coding the interviews using MAXQDA software, some category adjustments were made (additions), and we incorporated these results into our analysis, as they enriched the findings.

The researcher's initial analysis produced six (6) categories: (a) perception of personal change (before and after the project); (b) increased empathy; (c) revision of pedagogical practices; (d) appreciation of students' prior knowledge; (e) adaptability and (f) improved ability to handle student diversity.

In Table 2, we can see indicators reflecting the maximum number of times a participant was assigned to a given category compared to others. The figures represent how many times a category/code was tagged in each transcript. The maximum number of times any one category was applied to an interview was 8; thus, we considered 8 to represent 100%. The blue horizontal bars in the cells visually represent this percentage, filling the cell entirely for a score of 8 and decreasing proportionally.

Table 2

Table of category coding indicators

Code	Time spent in the project	Perception of personal change (before and after the project)	Increased empathy	Revision of pedagogical practices	Appreciation of students' prior knowledge	Adaptability	Improved ability to handle student diversity	Total
Med. 2	3 years and a half	5	7	5	1	7	4	29
Med. 3	6 years	7	6	8	2	4	1	28
Med. 5	2 years	2	4	8	2	6	2	24
Med. 7	1 year	6	3	5	4	1	2	21
Med. 1	2 years and a half	5	4	8	0	1	3	21
Med. 8	6 months	1	5	3	0	2	1	12
Med. 6	1 year and 3 months	1	0	3	0	6	1	11
Med. 4	6 months	1	1	4	0	2	1	9

Source: Author's own work (2025)

We added two more columns to clarify our findings: "time spent in the project", which shows how long each participant was involved, and "total", which reflects the total number of excerpts categorized per interview.

Notably, there is a difference in the number of categorizations for Med. 2, Med. 3, and Med. 5 compared to Med. 4, Med. 6, and Med. 8. There may be a correlation between how long Med. 3 remained in the project (6 years) versus Med. 4 and Med. 8 (6 months). Although Med. 6 was involved for about 1 year and 3 months in total, he reported an intermittent experience: after participating in person for a time, he paused their involvement during the COVID-19 pandemic. Later, he returned briefly before IFRJ went on strike in early 2024 for three months. Following the strike, he left the project again. These interruptions shaped a remarkably different research experience for this individual.

From this data, we observed that the number of categorizations per interview suggests that longer participation in the project, particularly one that places

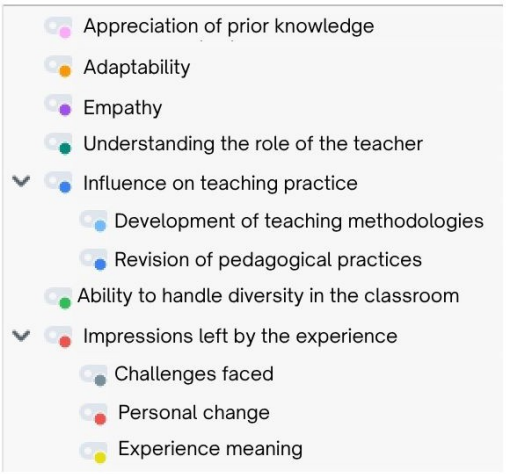
undergraduates in challenging settings, has a significant impact on their learning and overall experience.

REANALYSIS OF CATEGORIES USING MAXQDA SOFTWARE

After the initial categorization carried out by the researcher, we began using MAXQDA: a software for qualitative and quantitative data analysis. Through it, one additional category emerged, and two preexisting categories were expanded into subcategories, as shown in Figure 1.

Figure 1

Categories and subcategories created using MAXQDA's AI



Source: Author's own work (2025).

After selecting and assigning new excerpts to these updated categories, we generated a frequency graph of category appearances (Figure 2). This visualization focuses on higher-level codes (excluding subcategories), which helps clarify the overall distribution of our data.

We observed that the three most frequently cited categories were: *"Impressions left by the experience",* with 86 citations from the interviews and autobiographical account (making it the most referenced category); followed by *"Influence on teaching practice",* with 67 citations; and *"Empathy",* with 40.

"Impressions left by the experience" included mentions of feeling personally transformed after engaging with the socio-educational youths. Many participants cited overcoming prejudices, marking the project as a powerful entry point into a different social reality, broadening participants' worldviews. Overall, participants reported adopting more inclusive principles, as well as experiencing both personal and professional growth. From an anthropological standpoint, this transformation could be linked to a *"liminal event"*, a concept developed by anthropologist Victor Turner, which refers to transitional experiences that prompt a reexamination of previously held beliefs and the formation of a new worldview (Haggar, 2024).

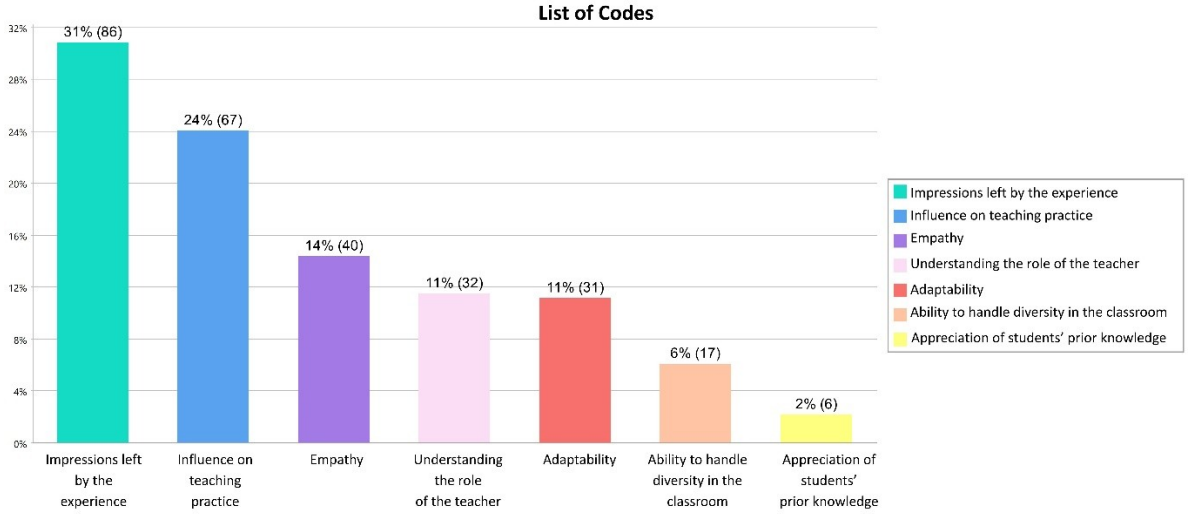
> "For me, it was basically my first real encounter with teaching, because I didn't get into the chemistry degree thinking I'd become a teacher. I started off planning to switch majors, and

> during my second semester, while I was still preparing to retake the entrance exam, I joined the research group and began mediating the workshops. (…) That was the first time I saw myself as a teacher." (Excerpt from Med. 2's interview)

Minayo (2012, p. 623) writes that "to understand someone, you must consider their individuality, as subjectivity is a manifestation of a person's entire lived experience". She adds that "interpretation is a continuous act that follows understanding and is also present within it: all understanding contains the possibility of interpretation, that is, the appropriation of what one has grasped". This implies that although all participants, including the researcher, were involved in the same scientific initiation project, each one's experience was inherently unique.

Figure 2

Frequency graph of category appearances



Source: Author's own work (2025).

In the category "Influence on teaching practice", participants described changes in how they observed student profiles, simplified content delivery, and began to contextualize lessons using everyday references from students' lives. In a comparative analysis, this category stood out as the most frequently cited by the researcher herself, and it was also strongly represented in interviews with Med. 3 and Med. 5: two participants with longer project involvement (Figure 3).

> "What's the practical application of that content in their life, not just teaching content for content's sake. The idea is for the material to have meaning. Not just knowing the chemical formula for water, but understanding the process behind it and how chemistry is present in so many everyday things. It's all chemistry, and we didn't really see it that way when we were students." (Excerpt from Med. 3's interview)

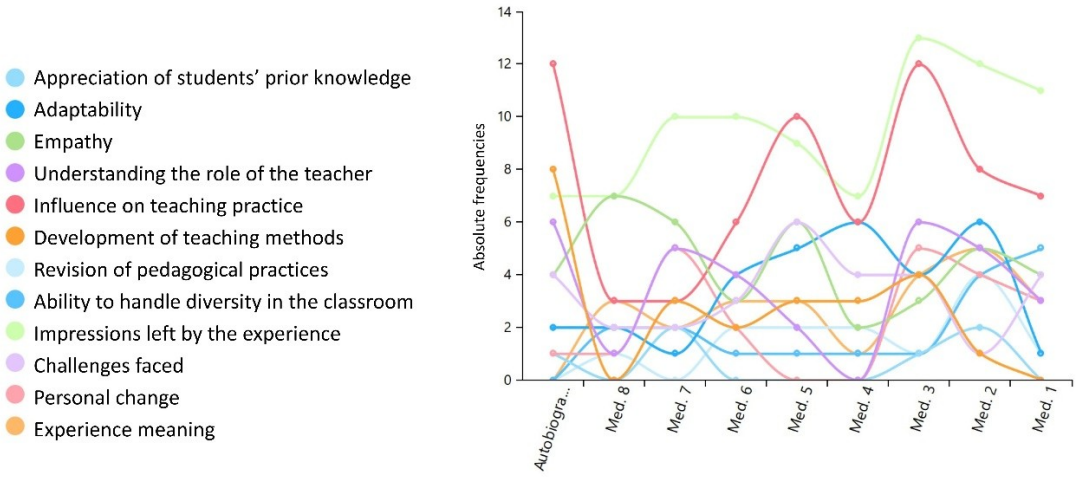
As for the *"Empathy"* category, several participants said they already considered themselves empathetic, but acknowledged that they began to think more individually about their students. In some excerpts, empathy wasn't mentioned explicitly, but participants described adapting their teaching, striving to help their students learn, and emphasizing how much their students mattered to

them. This aligns with Korzenievski & Karpinski (2019, p. 4), who argue that "affection as an educational agent can emerge through interactions between teacher and student, rooted in respect, dialogue, trust, and motivation". Such dynamics tend to create healthier, more harmonious school environments.

> "Then I started to understand that other side. I think from the moment you begin to see it, as a teacher, you change too. So we learn. I believe that participating in socio-education really allowed that. It helped me understand the other side." (Excerpt from Med. 7's interview)

Figure 3

Visualization of the intensity of categories and subcategories for each research participant



Source: Author's own work (2025).

FINAL CONSIDERATIONS

This research identified the contributions of science workshops for socio-educational youths to the training of chemistry undergraduates, highlighting the importance of these experiences in professional development and in building a more reflective and inclusive teaching practice. The results indicate that participation in these activities fosters a deeper understanding of the challenges of teaching, as well as enhancing pedagogical and interpersonal skills.

According to the researcher, the analysis revealed a clear gain in teaching experience, as preparing and mediating science workshops for a socially vulnerable audience is undeniably challenging and demands both knowledge and skill development essential to the profession. It goes beyond simply delivering content: it involves collaborative planning of activities that are engaging, scientifically stimulating, and meaningful for youth who are often disconnected from school.

Through her involvement in the group, the researcher experienced a clear evolution, from student to teacher, marked by a shift in perspective and better understanding of a specific group of students who are, in fact, part of the broader

reality of Brazilian classrooms. The structure of the workshops encouraged teamwork and continuous production of teaching strategies, helping to train professionals better equipped for real-world classroom environments.

We observed that the length of time spent in the research project influenced the depth and diversity of contributions made by the participants. Prior exposure to different and demanding situations appears to better prepare undergraduates for their future professional paths. In this sense, participating in a scientific initiation project that challenges its members prompted mediators to reevaluate their values, dismantle prejudices, and refine their teaching practice.

Another important aspect was recognizing the value of adaptability in both initial and ongoing teacher education as a crucial element for promoting more effective and inclusive teaching. By acknowledging this skill's importance, teacher education programs can prepare future educators not only to deliver content but also to navigate the complexities and diversity of the Brazilian educational context, potentially preventing early burnout and career abandonment.

It's also worth emphasizing the value of institutional programs within higher education courses (like scientific initiation or outreach initiatives) that bring undergraduates closer to the realities of school life. An undergraduate who lacks such opportunities, whether because their degree program doesn't offer them or because they chose not to participate, may face significant difficulties in forming bonds with students, building empathy, and adapting to diverse classroom situations.

By contrast, undergraduates who are supported by institutional initiatives throughout their studies are more likely to develop the tools and resilience necessary for meaningful engagement with students. *"Experiencing teaching during one's undergraduate studies is key to building a stronger professional identity, as it allows future teachers to better understand the challenges of the career and strengthens their commitment to it"* (Gomes, 2025, p. 37). Creating bonds with students tends to foster more effective teaching and learning, which in turn contributes to greater professional satisfaction and teacher well-being. Marcelo (1999) argues that teacher training programs should offer opportunities for future educators to engage in authentic situations that challenge them to construct real pedagogical solutions, navigating the contradictions and constraints of educational institutions. It is in this process that the teacher begins to develop what the author calls "practical knowledge", formed not only from curricular prescriptions but also from relationships with students, colleagues, and the broader school community. While all programs include supervised internships, these typically occur in the final third of an undergraduate course. Outreach projects, like the one carried out by *School and Society*, are available to students at any stage of their degree, meaning undergraduates can gain classroom experience early on and approach their internship already equipped with practical knowledge, reducing anxiety and insecurity. *"We found that the initial contact with the school environment often generates anxiety, fear, and uncertainty among undergraduates, making it a crucial point to be addressed in professional training"* (Dornfeld *et al*., 2022, p. 301).

Although there has been significant progress, the literature points out that there's still room to improve the implementation and systematization of scientific

initiation and outreach projects. Researching the contributions of the *School and Society* project can help ensure that all undergraduates benefit equally from such initiatives. Despite their importance, these projects are still not fully integrated into the curricula of teacher education programs in Brazil. They're often seen as optional rather than fundamental. This reflects the need to better value and structure these experiences within academic planning. University outreach should be seen not as complementary, but as central to teacher formation. Ideally, undergraduate programs would integrate outreach activities into their curriculum as core components: planned, executed, and evaluated in ways that bridge theory and practice. According to Saviani (2011), teaching work is directly influenced by academic training, as a quality education is essential to developing effective teaching practice. Conversely, inadequate training tends to negatively affect teaching quality.

After also participating in the *School and Society* project, Santo (2022) emphasized the importance of socio-educational teaching in the Chemistry Education program, noting it as a unique opportunity for future educators to deepen their understanding of the relationship between education, science, and society:

"Based on our findings, the positive impact of this experience on the undergraduates' education was evident, contributing to the formation of more critical, resilient, adaptable, humanized, and better-prepared teachers capable of addressing diversity and promoting inclusion" (Santo, 2022, p. 7).

The workshops allowed for direct contact with often marginalized educational realities, encouraging a more critical and empathetic stance among future teachers. Interacting with socio-educational youths not only broadened their perspective on science education but also enhanced their ability to adapt and innovate in classroom settings.

Thus, we reaffirm the relevance of outreach projects that foster dialogue between universities and diverse educational contexts, highlighting their transformative potential in teacher training. *"*The devaluation of teachers' knowledge by educational, school, and university authorities is not an epistemological or cognitive issue, but a political one*"* (Tardif, 2011, p. 13). In this context, initiatives like *School and Society*, which offer pedagogical and practical experiences through science workshops, contribute significantly to teacher development and can serve as valuable models for expanding access to PIBIC scholarships, for example.

By immersing undergraduates in diverse educational realities, these projects not only enrich their formation but also reinforce the value of teachers' practical knowledge in addressing the challenges of education.

ACKNOWLEDGMENTS

To the academic excellence program (PROEX) – CAPES for the scholarship awarded to the first author and to FAPERJ for supporting scientific research and innovation in the state of Rio de Janeiro.

NOTES

This article was translated into English by Juliana Pereira de Moraes. The authors would like to express their appreciation for her work.

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Recebido: 09 abr. 2025
Aprovado: 13 jun. 2025
DOI: https://doi.org/10.3895/actio.v10n2.20139

Como citar:
Dias-de-Azevedo, Thaís; Coutinho-Silva, Robson. Uma proposta didática para o ensino dos números racionais utilizando representação semiótica. ***ACTIO***, 10(2), 1-21. https://doi.org/10.3895/actio.v10n2.20139

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Received: Apr. 9th, 2025
Approved: Jun. 13, 2025
DOI: https://doi.org/10.3895/actio.v10n2.20139

How to cite:
Dias-de-Azevedo, Thaís; Coutinho-Silva, Robson. (2025). A didactic proposal for teaching rational numbers using semiotic representation. ***ACTIO***, 10(2), 1-21. https://doi.org/10.3895/actio.v10n2.20139

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