Educación Química

A training action for chemistry and science teachers: contribution of problem-solving activities to inclusive education

Una acción de formación para profesores de química y ciencias: contribución de las actividades de resolución de problemas a la educación inclusiva

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Resumen

Este trabajo analiza las contribuciones de una acción de formación docente a la adquisición o mejora de conocimientos sobre los principios de la educación inclusiva, asistida por el uso de la metodología de resolución de problemas (RP). La acción formativa se realizó con 32 sujetos, incluidos estudiantes de grado de las carreras de Química y Ciencias Biológicas de una universidad pública federal brasileña, junto con profesores de Química y Biología de escuelas estaduales de Porto Alegre (Río Grande do Sul, Brasil). Los datos fueron recolectados mediante cuestionarios y diarios de campo. El presente artículo discute dos categorías principales que surgieron de la triangulación de los datos: (i) concepciones sobre la educación inclusiva, y (ii) experiencias y potencialidades de la RP. Los hallazgos mostraron que las actividades del curso de formación contribuyeron al desarrollo profesional de los participantes, utilizando una estrategia donde los principios de la educación inclusiva se asociaron con el estudio de un enfoque investigativo de la enseñanza y el aprendizaje.

Palabras clave

Desarrollo atípico, formación docente, educación inclusiva, resolución de problemas.

Abstract

This work analyzes the contributions of a teacher training action to the acquisition or improvement of knowledge concerning the principles of inclusive education, assisted by use of the problem-solving (PS) methodology. The training action was conducted with 32 subjects, including undergraduates from the Chemistry and Biological Sciences courses at a Brazilian federal public university, together with teachers of Chemistry and Biology at state schools in Porto Alegre (Rio Grande do Sul, Brazil). Data were collected using questionnaires and field diaries. The present article discusses two main categories that emerged from triangulation of the data: (i) conceptions about inclusive education, and (ii) experiences and potential of PS. The findings showed that the training course activities contributed to the professional development of the participants, using a strategy where the principles of inclusive education were associated with study of an investigative approach to teaching and learning.

Keywords

Atypical development, teacher training, inclusive education, problem-solving.

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Introduction

Mól (2019) reported that the teaching of science in the context of inclusive education is a challenge for many teachers, especially in relation to the particularities of the students in the classroom. Hence, there is an evident need to increase the time given during initial training to articulation of the principles of inclusive education with the epistemological dimensions of scientific knowledge. At the same time, it is necessary to develop methodological approaches to teaching and learning processes that can address the diversity of students.

Brabo (2013) alerted that during the training of teachers, there may be gaps due to the lack of a systemic approach to inclusive education, as a principle that aims to ensure the provision of education for all students, with and without disabilities. This could then lead to the absence of a consolidated inclusive culture in Brazilian school and university environments.

The initial training courses for teachers of chemistry in Brazil, analyzed by Ames (2021), meet some of the requirements of national educational legislation, such as offering obligatory subjects that address the issue of the inclusion of people with disabilities. Miranda and Galvão Filho (2012) point out that it is not only the initial training of teachers that should be the focus of attention in educational research, arguing that refinement of the teaching process should continue during ongoing training, to improve the quality of teaching in schools, in accordance with the principles concerning diversity.

Given the importance of creating an inclusive culture in chemistry and science classes, together with the need to reflect on the initial and continuing training of teachers, the following question was posed: In what ways can a teacher training action contribute to addressing the principles of inclusive education, while adopting an investigative approach to teaching and learning, such as using the Problem-Solving methodology (PS)? The present work analyzes the contributions of a training action undertaken to contribute to the development or improvement of knowledge concerning the principles of inclusive education and PS.

Theoretical basis

According to Vigotskian theory, social experiences favor the development of potentials and skills that enable overcoming of the difficulties caused by disabilities (Vigotski, 2010). In typical development, these abilities emerge within a certain established set of conditions. However, in the case of atypical development, which deviates from the norm, these same abilities develop under a completely different set of conditions, with the process becoming individual and specific, rather than being a common trait of human development. The existence of developmental processes that have different significance does not make atypical development less promising, compared to typical development (Lepre, 2008). However, for working with students that present atypical development, an educational institution should be able to create spaces, develop strategies, and provide adequate teaching resources to compensate for the characteristics related to a particular disorder or biological issue, to ensure the provision of full education (Coll, 2009).

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Many possibilities arise in the education of individuals with atypical development, when value is given to potentialities and there is compensation for disabilities (Coll, 2009). Among such possibilities, PS has been shown to be advantageous in inclusive education (de Lima; Pazinato; Passos, 2019), since it favors a diversity of routes and models for resolving difficulties, while at the same time encouraging student autonomy in the process of theoretical and/or practical investigation to achieve the desired goal. Throughout the stages of implementation of the methodology, the teacher can mediate the process and identify the potentials of the students in the teaching and learning processes. As shown in previous research, PS enables the establishment of a more contextualized and interrelated relationship between the sciences and daily life (Pozo, 1998; Ribeiro; Passos; Salgado, 2022). Furthermore, the student plays a more active role in the construction of knowledge, involving stages with debates, collaborative working, theoretical research, and the elaboration and testing of hypotheses (Martínez; Martínez Aznar, 2014; García; Cortés; Mejía, 2020).

Research methodology and context

This research is qualitative in nature and based on a case study (Yin, 2009). It concerns an action for the training of teachers in the principles of inclusive education, together with a way to implement them using the PS technique. Data collection was performed using initial (IQ) and final (FQ) questionnaires, analysis of problems produced by the trainees, and as well as the field diary of the teacher-researcher who coordinated the training action. The questionnaires contained open questions about professional and academic profiles, conceptions and experiences related to inclusive education and the PS technique, and the perceived contributions of the training action. The questionnaires applied are available in the Supporting Information.

It should be noted that the issues produced by the course participants were verified according to previous studies, considering the characteristics of an effective issue for Science Teaching, which are: contextualization, critical reflection, motivation, and investigation (Ribeiro; Passos; Salgado, 2020).

The results were analyzed by elaborating analysis categories, based on data triangulation. As indicated by Yin (2009), the use of triangulation in case studies is appropriate, since different sources of evidence can provide complementary evaluations of the same phenomenon. The present work discusses two categories that emerged from the data triangulation, namely (i) conceptions concerning inclusive education, and (ii) experiences and possibilities using PS.

The training action was performed with 32 subjects, including undergraduates from the Chemistry and Biological Sciences courses at a Brazilian federal public university, together with teachers of Chemistry and Biology at state schools in Porto Alegre (Rio Grande do Sul, Brazil). All the participants signed a free and informed consent form and agreed to participate in the study. The identity of the subjects was kept confidential, and they were identified as Teacher 1 to Teacher 32. The training action was performed remotely, due to the restrictions related to the new coronavirus pandemic.

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Methodology of the training action

Based on a bibliographic survey and previous experience using the PS technique (de Lima; Pazinato; Passos, 2019; de Lima et al., 2022), the proposed training action was elaborated as shown in Table 1. The classes were coordinated by the teacher-researcher in five live online encounters, each lasting 2 hours, using the MConf platform of the university, together with five non-live activities posted in the Moodle Collaboration virtual environment, totaling 20 class-hours, focusing on the following three topics: (i) principles of inclusive education; (ii) the problem-solving methodology; (iii) how to elaborate problems. The five non-live activities were always complementary and covered the same content addressed in the five live online encounters. Therefore, Table 1 presents the organization of the three topics addressed in the training action over five classes.

Classes	Focus	Content
1 and 2	Inclusive education history and legislation; initial concepts.	Introduction to the topic and use of the Persona tool (creation of an idealized student with specific characteristics). History of the exclusion of individuals with disabilities and steps in the path of rehabilitation (Mól, 2019). Report on national and international inclusive education legislation guaranteeing human rights and equal access (Brazil, 1988; 2008; 2015; United Nations, 1990). Reading of a review article concerning inclusive education in science teaching (Silva; Bego, 2018; de Lima et al., 2022). Conversation about capacitism and pejorative terms used to identify individuals with disabilities (Torquato, 2016).
3 and 4	The problem-solving methodology in the context of inclusive education.	Revisiting of the idealized students created using Persona and completion of the exercise, with the distribution of an ICD number to each course participant. Sharing of observations concerning how this diagnosis affects the teaching of students with medical histories. Concepts of atypical and typical development (Vigotski, 2010; Lepre, 2008). Examples of inclusive activities in the classroom (Coll, 2009; Mól, 2019; Moreno; Murillo, 2018). Continuation of the previous reading of work concerning use of the problem-solving methodology (Pozo, 1998; Ribeiro; Passos; Salgado, 2022). Concepts regarding the problem-solving methodology and its possibilities in inclusive education (de Lima; Pazinato; Passos, 2019). Continuation of the previous reading of two articles and elaboration of problem statements (Martínez; Martínez Aznar, 2014; García; Cortés; Mejía, 2020). Characteristics of an effective problem and some examples (Ribeiro; Passos; Salgado, 2020).

Table 1. Summary of activities developed during the training action.
Source: the authors 2022.

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5	Practical activity involving the elaboration of problem statements.	Continuation of readings and discussion of the article concerning how to prepare an effective problem statement for use in science teaching (Ribeiro; Passos; Salgado, 2020). Construction of an inclusive education problem.

The activities developed in live online encounters were carried out through dialogue, so that the theoretical assumptions and legislation of Inclusive Education could be related to the classroom contexts of the Chemistry and Science teachers who participated in the training program. Examples of didactic proposals presented in the classes, as well as in the readings and non-live activities, were related to chemical or scientific concepts, as can be identified in the references in the Table 1 (Coll, 2009; Silva; Bego, 2018). One notable example is the use of the problem-solving methodology in an inclusive context, with the use of problems related to the concept of sustainability (de Lima; Pazinato; Passos, 2019), as well as the game of carbons (Moreno; Murillo, 2018) presented in classes 2 and 3, respectively. In addition to discussions on the relationship between theoretical frameworks and principles of Inclusive Education with the teaching of Chemistry, course participants developed problem statements to be applied in their future school contexts. In class 5, to enable the relationship between theory and practice, participants chose content and themes to develop a issue statement for the teaching of Chemistry or Science, considering the principles of Inclusive Education and the characteristics of an effective problem statement. These characteristics were presented and discussed with the teachers during classes 4 and 5, as they were proposed based on extensive research on the use of problem statements on pesticides in Chemistry classes at different levels of education (Ribeiro; Passos; Salgado, 2020). These will be detailed in this manuscript throughout the presentation of the results.: Training presentation.

Results and discussion

The academic profiles of the 32 participants in the training activity showed that 63% were undergraduates studying for degrees in Chemistry or Biological Sciences, while 28% were graduates with qualifications in Chemistry, Industrial Chemistry, or Chemical Engineering. The remaining 9% were graduates in areas such as Biological Sciences and Social Communication. In relation to the institutions at which the courses were studied, 80% of the participants studied at the federal public university where the research was conducted, while 20% studied at private institutions. In terms of professional activities, many of the participants held scholarships for teaching or scientific training, acted as monitors, or contributed to other educational activities at the university. Those who were already teaching had been working for between 3 and 10 years in public state education, or as volunteers in pre-university courses.

It was considered that the diversity of academic and professional experiences of the subjects contributed to enriching the discussions, providing varied perspectives on the topics addressed.

Conceptions about inclusive education

The aspects discussed in the first category concerned the perceptions of the research participants regarding inclusive education, different concepts, doubts arising, and assessment of ideas developed during the training and recorded in the IQ, FQ, and field diary.

When asked in the IQ about what they understood inclusive education to be, 38% of the participants presented concepts in line with those found in Brazilian legislation (Brazil, 2008; 2015) and in the theoretical framework on which the research was based (Vigotski, 2010), as illustrated by the answer:

> Inclusive education is an education in which the concepts and practices are constructed with everyone and for everyone. The group is viewed in an equitable way, with the development of learning methods appropriate to each individual. Inclusive education thinks of each person as being different from the other. (Teacher 1)

The answers that did not consider all these principles were considered as being partially convergent with the concepts of inclusive education, totaling 38%, as illustrated by the answer:

> Inclusive education helps students with some disability to absorb content in the best way for its understanding, respecting their limitations and including them as much as possible in their class. (Teacher 15)

The remaining 24% of the answers did not converge with the above concepts, as exemplified by:

> To provide education opportunities to persons with special learning needs. (Teacher 8)

These data reinforced the importance of encouraging research and training actions that can favor the development of a culture that is inclusive and provides comprehensive learning opportunities for all (Ames, 2021). The training of teachers in inclusive practices should not only concern the development of techniques for attending students with disabilities, but also encourage a change in the way of thinking about disability, giving value to the potentials of all the students (Brabo, 2013).

At different times in the training, discussions with the participants were used to exchange knowledge and experiences, and to identify areas of doubt. The work with the *Persona* tool was employed to bring the participants together, with the task of creating idealized students or archetypes with particular physical, emotional, social, and behavioral characteristics, principally in the school context.

As recorded in the field diary, this approach caused some insecurities in the participants, related to the threshold between idealization and the pejorative characterization of the hypothetical student. Various doubts were raised, such as:

> How should I address or refer to students with disabilities? How can I avoid exposing this student to peers? I feel insecure in developing activities that favor inclusion and especially the learning of students with disabilities. (Teacher 24)

As a way to alleviate such insecurities and doubts, after providing information concerning the history and legislation related to inclusive education, a video ("Can I give you a hand?"; Torquato, 2016) was worked on, where the concept of capacitism was explained,

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with several examples and showing the capacitist attitudes that hinder the relationships of people with disabilities and their development in social and school environments. Torquato (2016) explains, capacitism is related to preconceptions regarding people with disabilities, considering, for example, that such a person needs to be repaired, to adapt to the so-called "normal" pattern. The author points out that such preconceptions are not lessened only by living with someone with a disability. Bonfim et al. (2021) highlighted that the concept of capacitism is hardly addressed in the context of science teaching, despite being incorporated in the social environment, in the actions of teachers and students in the classroom.

Continuing the exercise with the *Persona* tool, a number was given to each idealization and the participants were asked what it signified. Some of them knew and related the number to the International Classification of Diseases (ICD), where it is a code that is often used in reports sent to guide the conduct of schools concerning students with disabilities. The course participants reported that they had tried to adapt their classes to meet the needs of the students, and shared some of their experiences with people whose diagnoses were delayed, and how this affected their learning.

During the training, the concept of atypical development, which is also infrequently addressed during teacher training (de Lima et al., 2022), was introduced to achieve a less capacitist perception of students with disabilities, since it considers the possibility of using both direct and indirect routes in teaching and learning processes. Typical development occurs when it proceeds according to direct and known routes considered "normal". Atypical development occurs when the direct path is blocked by some factor, generally imposed by the environment in which the student lives, such that the development of the individual needs to proceed according to alternative or indirect paths (Lepre, 2008; Vigotski, 2010).

Here, the history of the challenges of inclusive education and the concept of capacitism were used in the training course as a way of explaining the social model of disability considered in Brazilian inclusion legislation (Brazil, 2015), as well as in the references concerning cognitive development that supported this research, as an option for effectively guiding inclusive teaching practices.

A premise adopted was that atypical development is more inclusive, since it considers that it is not only people with disabilities who should benefit from a school educational experience that gives value to the potential of the individual. Inclusion at school is for everyone! It is understood that the awareness of atypical development should favor a paradigm shift in relation to the processes of teaching and learning in school science and chemistry classrooms. It was evident that understanding of the concepts of inclusive education was one of the most important aspects of the training action. Therefore, in the FQ, the participants were again asked what they understood inclusive education to be. In this case, at the end of the course, 88% of the answers converged with the principles laid out in legislation and in the theoretical framework used in this work, such as the social model of disability (Brazil, 2015) and the presuppositions concerning cognitive development (Lepre, 2008; Vigotski, 2010), as illustrated by the following answer:

> It is education that ensures quality in teaching and the possibility for all students to develop to their maximum potential, respecting their differences and particularities. (Teacher 30)

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Even in the final questionnaire, some answers (around 12%) only partially converged with the principles established for the implementation of inclusive education. These answers lacked scope and were directed towards the individualized care of the student and the medical diagnosis, such as:

> It is the ability to create an interaction different from the contents and activities. (Teacher 12)

As Brabo (2013) points out, inclusion should relate to the quality of education for all individuals, which is much more than just inserting children with disabilities into the same educational spaces. It should be highlighted that this question was precisely intended to stimulate discussion, throughout the course, concerning the social model of disability established in Brazilian inclusion legislation (Brazil, 2015), where the parameter considered is not the functional limitation of the person, but rather the resources available in the environment.

The results indicated that the activities developed during the training action contributed to the acquisition of knowledge regarding inclusive education and its importance in terms of the social and democratic principles of education. As described above, the concepts of typical and atypical development were used in this training, aiming at a more inclusive and less capacitist approach to the education process. Therefore, a question in the FQ was used to assess the course participants' understanding of atypical and typical development. All the responses converged with the theoretical framework adopted and the examples presented during the training, as illustrated by the following answer:

> I believe it is the best way to identify the real needs of individuals, without judging them by their disabilities. (Teacher 7)

The effectiveness of the training action regarding the understanding of this concept was evident, since many participants described typical development as being related to an established norm, which should not necessarily influence the behavior of the teacher in the classroom, where consideration should be given to the particularities of the students.

To evaluate the advances made by the participants in terms of their understanding of inclusive perspectives, they were asked how the training action had contributed to their perception of inclusive education. The contributions identified by the participants were mainly clarification of the needs and possibilities of inclusive education, in order to avoid narrow capacitist attitudes that only take the ICD diagnosis into consideration. The following answer is an example:

> During the course, we had the opportunity to analyze how the elaboration of a class or activity might need greater inclusion, which is little addressed in schools, and to see that an inclusive education can make all the difference, as viewed from a more general and non-victimist perspective, with the establishment of ways of working that address the real needs of students, not based only on a medical diagnosis, but respecting the real condition of each student. (Teacher 2)

This first category of analysis highlighted that the training action contributed to the development or advancement of knowledge concerning the principles and purposes of inclusive education, the assimilation of the concepts worked on (inclusive education,

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and typical and atypical development), and especially the understanding that inclusive education is for all students. This is a principle found in the Brazilian federal constitution (Brazil, 1988), which guarantees the full development of the individual and defines education as a right for all, together with other legislation such as the National Special Education Policy in the Perspective of Inclusive Education (Brazil, 2008), and the Brazilian Inclusion Law (Brazil, 2015).

Problem-solving experiences and possibilities

The IQ enabled identification of the conceptual aspects that needed to be worked on during the training activity, as well as assessment of the experiences of the participants with investigative teaching and learning methodologies, such as PS. Only 10% of the participants mentioned having had knowledge or experience of PS during their academic training or professional life. The theoretical lecture was the teaching methodology most frequently found in the answers to the IQ and in the discussions recorded in the field diary.

Throughout the course, PS was presented as a possible methodology for the development of inclusive teaching practices, capable of assisting the teacher in mapping the diversity of the class at the start of an educational cycle (de Lima et al., 2022). The use of an effective (Ribeiro; Passos; Salgado, 2020) and inclusive problem can help in identifying the potentials and characteristics of students with and without disabilities. This can make teaching more inclusive, since it does not differentiate students according to their limitations, but instead allows analysis of the potential of each student, which depends only on incentives and means for its development in a context of social interaction.

According to Vigotski (2010), the process of educational interaction presupposes a shared action among active and interactive subjects who construct meanings based on different levels of knowledge and development. In this way, PS can be considered a possible methodology capable of promoting school inclusion, since it enables social engagement, interaction, and action involving students and teachers, which can favor alternative routes of cognitive development. It should be highlighted that there may be a diversity of possibilities for the proposal of resolutions for the same problem, based on different methodological approaches, such as theoretical research, interviews, experimental activities, use of media resources, and physical models, among others (Pozo, 1998; Ribeiro; Passos; Salgado, 2022).

After implementation of the training activity, the FQ was used to assess the contribution of the action to the training of the participants and to discussion of the conceptual aspects of inclusive education associated with the PS technique. The responses showed that 90% of the individuals considered that the activities contributed to clarifying how to work with contents using PS, with some of them already knowing the methodology and believing in its suitability for use in the teaching of science, as shown by the following answers:

> Yes, mainly due to the combination of the reading of the articles and the reports provided by the invited teachers and the organizer. (Teacher 8)

> Yes, they contributed a lot. It was evident during the course that the characteristics of the problem statements were effective for the development of autonomy. (Teacher 31)

Nonetheless, 10% of the subjects thought that the activities partially contributed to the use of PS in science teaching. This was probably because the central focus of the

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training was the study and discussion of theoretical aspects, so PS was not experienced by the subjects, but instead was presented by means of readings and reports. This is illustrated by the following answer:

> I ended the course with mixed feelings, believing that it was useful for understanding a little more about the methodology, but without gaining further clarifications concerning its application. This could have been because I already had previous experience of the methodology at other times in my training process. (Teacher 23)

In relation to the objective of this work, the FQ asked whether PS was suitable for identifying the potentials and abilities of students. In all cases, the response was positive:

> Yes, it enables us to perceive the student from a different aspect, with his/her difficulties and abilities shown in a more autonomous way. (Teacher 12)

However, 15% highlighted concerns about specific difficulties, such as the reading and the understanding of problems:

> I consider it as one more instrument, among others. It could be seen that during the resolution of problems, students express their difficulties with specific aspects that are not just conceptual. For example, I perceived that many have difficulties in interpreting the problem. (Teacher 31)

The reservations illustrated in the above answer support the interpretation that PS can provide a more comprehensive analysis of the teaching and learning process, considering the particularities and specificities of each student. With PS, the learning process is benefited by the different possibilities and divergences of results, comparisons, defenses of hypotheses, agreements and disagreements, and especially by allowing a diversity of resolution models, according to the possibilities of each group of students (de Lima; Pazinato; Passos, 2019).

In the case of the specific question concerning the teaching and learning of scientific concepts, it could again be seen that the participants considered the methodology as a possibility for use in the teaching of science, as well as for identifying the potentials and characteristics of the students:

> It is certainly appropriate, as indicated in the first question of this form. This methodology promotes the development of autonomy in the students, which is a very important ability because it allows other skills to be developed and enhanced in the teaching/learning process, such as self-esteem, confidence, teamwork, and even individual work. (Teacher 2)

As the final activity of the training action, participants were requested to develop an effective problem statement for teaching Chemistry that could be applied in the context of inclusive Science education. A total of 38 statements were produced. All statements were classified as having a qualitative approach (Pozo, 1998) and satisfactorily met the guidelines for an effective problem statement proposed by Ribeiro, Passos and Salgado (2020).

Ribeiro, Passos and Salgado (2020), based on extensive research on the use of PS in chemistry classes, indicate that a problem statement is effective when it promotes contextualization, critical reflection, motivation, and investigation. Contextualization based on daily life is considered a guiding principle that enables students to assign meaning to

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what they learn and relate it to their experience in a reflective and non-reductive manner, rather than just as an exemplification of the studied content's application. For the authors, a student who is capable of critically reflecting on the surrounding reality can change it for the common good. Therefore, a problem used in chemistry classes should encourage the ability to formulate hypotheses and conduct investigations. This way, the student can develop their knowledge by becoming aware of the relationships between social, environmental, political, and economic issues and the thematic and scientific content of the proposed problem. Motivation is an intrinsic characteristic of human beings, but it can be mobilized by external factors, such as a school activity that is stimulating, such as the PS, to encourage students to solve it with effort in the search for solutions (Ribeiro; Passos; Salgado, 2020).

According to Ribeiro, Passos and Salgado (2020), in addition to the characteristics of the issues used, collaborative planning and execution of the pedagogical proposal are fundamental to the success of the activity. The main factors that influence PS based activities are the desired objectives, the envisioned content, the knowledge that students are intended to appropriate, the elaborated didactic sequence, and the mediation by the educator to enable interaction among students.

In order to exemplify and contextualize the production requested during the course, two statements related to the environmental theme (P3 on the 3 R's policy and P28 on water pollution) are presented, as it was the most recurrent among the statements elaborated, as well as on the topics of atomic models (P13) and organic functions (P7), as they were the most used for elaboration of the statements. The excerpts from the statements are identified with colors corresponding to the characteristics of an effective problem: purple - contextualizes the theme with the student's reality and brings it closer to the proposed question; orange - raises critical reflection on the topic addressed; blue - motivates the student to seek solutions; and green - makes the proposal capable of becoming a hypothesis, investigated, questioned, and discussed, leading to a decision-making process.

> P3: One of the environmental problems of our time is the large production of waste and its inadequate disposal. Efforts have been made in the last decade and, since August 2010, based on the concept of shared responsibility, society as a whole - citizens, governments, private sector, and organized civil society - has become responsible for the environmentally sound management of solid waste. The search for solutions in the waste area reflects society's demand for changes motivated by high socio-economic and environmental costs. With the aim of reducing waste accumulation and the waste of economically valuable materials, and thus reducing the exploitation of natural resources, the international policy of the "three Rs" has been adopted: Reduce, Reuse, and Recycle. Research the impact that this "three Rs" policy has on the environment. Think and suggest changes in your daily habits that demonstrate your active role in environmental responsibility.

> P28: Checking her phone, Gabriela read a news article that stated the ban on plastic straws sales in Porto Alegre since February 2020. Curious, she decided to research more about the environmental damage caused by them and found out that they end up polluting the oceans. You are Gabriela's friend and have been contacted to assist her in researching this material and its waste left in the water. Are plastic straws really harmful? Why? To whom?

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P13: Poliana enjoys going to nightclubs, dancing, and having fun with her friends. They like to get together at one of their houses and get ready together. One of the accessories they like to use is glow-in-the-dark bracelets. She noticed that after the party, some bracelets were still glowing the next day, while others were not. Explain how this phenomenon occurs by relating it to atomic models. Research if this happens with other objects and present illustrations.

P7: Cicrano has Chemistry class in the first period of the morning, at 7:30 am. To ward off sleepiness, he drank two energy drink cans before leaving home. It is known that there are stimulating substances present in various foods and beverages, such as mate, green tea, coffee, energy drinks, and chocolate, which can help keep us awake. Research how energy drinks affect our bodies and check if excessive consumption of this beverage can interfere with health and cause harm to Cicrano. What are the organic functions present in the stimulating substance found in energy drinks and beverages such as coffee and mate?

What was observed in the statements produced is that most of them present attractive themes for the age group of elementary school students. As a result, the scientific concepts required to solve the problems will be used in a way that relates to the context presented in the statement. This gradual deepening of concepts enables more students to be served, regardless of their academic background or medical diagnoses. Science education researchers suggest that through investigative methodologies, it is possible to establish a more contextualized and interconnected relationship between science and every day, social, environmental, technological, and historical issues (Pozo, 1998; Martínez; Martínez Aznar, 2014; García; Cortés; Mejía, 2020). In this sense, the PR methodology allows for discussions and investigations on themes, processes, and contents that are typically studied linearly in school and academic curricula (Ribeiro; Passos; Salgado, 2020).

In general, the statements produced can facilitate the development of inclusive teaching practices that can assist the teacher in mapping the specificities of students, especially when utilized at the beginning of an educational cycle (de Lima; Pazinato; Passos, 2019). PR can help identify the potentialities and characteristics of students with and without disabilities, thereby promoting more inclusive teaching practices that do not differentiate learners based on their limitations, but rather analyze each student's potential, encouraging their development in a context of social interaction.

As the last question about the methodological experiences in the FQ, the subjects were asked whether PS would be suitable for use in inclusive education. All the responses were affirmative:

I consider PS to be inclusive, because this type of activity can be better adapted to the students in the classroom. Different to a single type of activity with only one way to provide an answer, PS opens up a much greater range of possible methodologies, consequently enabling better inclusion of the students in the proposed activities. (Teacher 8)

However, 15% of the participants highlighted issues related to the necessity of diagnosing the requirements of students in inclusive education. An example is as follows:

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> Yes, I consider it suitable, as long as it is based on an assessment of the class and the needs for inclusive education that are present, so that the problem-solving methodology can be applied most successfully. I think that the presentation of problems can stimulate creativity and a sense of teamwork, which can be helpful in inclusive education. (Teacher 28)

It is pertinent to highlight that the above reservation again strengthens the benefits of using PS in the context of inclusive education, given that different needs and potentials are not always identified and attributed value in traditional classes (Mól, 2019).

These results indicated the development of the participants concerning aspects of the PS methodology. Although they did not experience it in the role of students during the training periods, they were able to become aware of its possibilities by means of the reports provided by the participating teachers and shared during the classes, as well as in the activity of elaborating problem statements. The literature in this area places great emphasis on the difficulties that science teachers face in the elaboration of issue statements (Ribeiro; Passos; Salgado, 2020), so the present approach was chosen for this reason. It should be noted that for a next edition of the training action, an activity will be developed to provide experience of problem resolution, together with a more detailed study of the steps for implementation of the methodology, in order to fill the gaps identified in the present work.

However, it is considered that the central objective of the study was achieved, since the formative process allowed for discussion of the principles of inclusive education related to a teaching methodology and the content that future chemistry teachers will work with in the classroom, a characteristic that can contribute to promoting understanding of the concept of disability from a social perspective (Brazil, 2015) and creating an inclusive culture in chemistry and science classes (Coll, 2009; Brabo, 2013; Mól, 2019).

Conclusions

As shown by the analysis of the set of data acquired in this study, the interaction among schoolteachers, undergraduates, and the teacher-researcher made the training action classes a plural space that aggregated various possibilities for inclusive education methodologies. The characteristics of the training course contributed to the professional development of the participants, combining the principles of inclusive education with the study of an investigative approach to teaching and learning of the scientific concepts.

It should be noted that the PS methodology is not being proposed as an infallible approach suitable for all educational situations and contexts, but as an alternative technique that can favor the interaction between teachers and students in a way that is less capacitist and more inclusive. The use of PS can assist in mapping the potentials of different students in the educational process, contributing to the provision of chemistry and science classes that consider all the students, whether or not they present atypical development, as it makes the forms of modeling more flexible for solving problems and presentation of resolutions.

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Supporting Information

Initial Questionnaire

The objective of this questionnaire is to carry out a diagnosis of their knowledge in relation to working with the problem-solving methodology and Inclusive Education. The questions are open-ended and therefore it is important that you answer them as completely as possible and express your opinion freely.

1. Do you already have an undergraduate course? If yes, which one and in which institution?
2. Do you work in your area of training? How long?
3. Do you access specialized magazine(s) or newspapers? Which?
4. Do you participate in scientific events? Which?
5. What teaching methodologies did you experience or experience during graduation?
6. Have you experienced as a student or used the Problem Solving or Case Study methodology? At what times?

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7. What do you understand by inclusive education? What did you experience or study to arrive at this thought?
8. Do you think it is important to study inclusive education at graduation? Justify.
9. Did you have contact with Inclusive Education during your graduation or training course? If yes, where?
10. Have you ever developed any teaching practice in a school with a student with a disability? If yes, briefly describe how the experience was?
11. Have you noticed the need to adapt materials or content to the reality of some students? If yes, tell us how was the experience?

Final Questionnaire

The objective of this questionnaire is to ascertain your impressions about the problem solving methodology and the possibilities of its use for teaching Chemistry/Science in the context of Inclusive Education. The questions are open-ended and therefore it is important that you fill them in as completely as possible and express your opinion freely.

1. Did the activities developed during the course help to clarify how to work the school contents of Chemistry/Science from the Problem Solving methodology? If yes, cite examples.
2. Does the experience of studying Problem Solving in training motivate you to use the methodology in your professional practice? Explain.
3. Do you consider that the Problem Solving methodology is appropriate to identify, develop and improve students' potential and abilities? Justify with notes on the experience developed during the training.
4. Do you consider the Problem Solving methodology as an adequate proposal for Inclusive Education? Justify and exemplify.
5. What do you understand by Inclusive Education?
6. Do you practice Inclusive Education? Justify.
7. What do you understand by Atypical and Typical Development?
8. How did the training contribute to your perception of Inclusive Education?
9. Are you interested in continuing to study Problem Solving?
10. What (or what) difficulty(s) did you encounter when elaborating the problem statements?

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