



Chemistry Teacher Training: a technological approach to the construction of structured material in Chemistry Teaching

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Abstract

This study aims to investigate the application of a technological approach in the training of Chemistry teachers for the creation of structured teaching materials. It analyzes the development process and the perception of future teachers about the use of digital tools in the creation of resources for teaching Chemistry. The results point to the potential of digital technologies in improving pedagogical practice, fostering teachers' autonomy and creativity in the production of relevant and engaging materials for teaching the subject. The research highlights the importance of integrating technology into initial and continuing education, preparing educators for the challenges of contemporary teaching.

Keywords: Teacher Training, Chemistry Teaching, Educational Technology, Structured Material.

Introduction

Continuing teacher training in Brazil faces significant challenges, such as lack of time and resources, in addition to the need for constant updating in light of new technologies and educational demands. However, its importance is undeniable for improving the quality of teaching. According to [1], continuing education is a continuous process of professional development that aims to improve teaching practice and update knowledge. In this context, it is essential to invest in training programs that are accessible and that promote reflection on pedagogical practice.

The theory of Meaningful Learning [2] highlights the importance of relating new knowledge to students' previous concepts, making teaching meaningful. In the training of Chemistry teachers, this approach is essential for future teachers to understand how to facilitate the construction of knowledge by students. In this context, Meaningful Learning occurs when new information is related in a substantive (non-literal) and non-arbitrary way to the relevant aspects of the learner's cognitive structure [2]. Therefore, training should prioritize activities that stimulate reflection, investigation and the practical application of chemical concepts.

Chemistry teacher training should go beyond the mastery of disciplinary content, also covering pedagogical, epistemological and technological aspects. Future teachers should promote an understanding of the nature of science, the development of critical thinking and the application of chemical concepts in real contexts [3]. In this sense, it is

essential that training programs encourage reflection on teaching practice, experimentation and the use of different teaching resources.

Structured material goes beyond the presentation of information, becoming an essential pedagogical tool in the teaching of Chemistry. By organizing concepts in visual and interactive formats, such as concept maps, infographics and simulations, it facilitates the construction of meaningful connections between the different topics of the discipline. This conceptual clarity promotes the understanding of the content included, allowing students to visualize the relationships between abstract concepts and apply them in practical contexts. In addition, structured material stimulates the development of critical thinking, by challenging students to analyze, synthesize and evaluate information. By making classes dynamic and interactive, it increases student engagement, awakening curiosity and interest in Chemistry.

In this context, digital technologies have revolutionized the way structured material is created and used in chemistry teaching. Concept mapping software, interactive simulations, and online learning platforms provide teachers with powerful tools to design visual and interactive materials. The ability to customize structured material to meet individual student needs allows teachers to create dynamic learning experiences. Online collaboration facilitates the exchange of ideas and the collective construction of knowledge between students and teachers.

With this, we take as a central question: What challenges in the training of Chemistry teachers with the use of digital

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technologies and the application of structured materials promote, and contribute to highlighting the Significant Learning of students?

In this sense, our research objective is to investigate how the training of Chemistry teachers, combined with the use of technological resources based on Meaningful Learning with the use of structured material for teaching Chemistry.

Thus, we present below the theoretical framework, the methodological path of the research carried out in this study, the results identified from the analysis process and the discussion guided by the epistemological perspective [2]..

Theoretical Framework

The Meaningful Learning Theory of [2] postulates that effective learning occurs when new information is anchored in relevant prior concepts in the learner's cognitive structure. In the training of Chemistry teachers, understanding this theory is important so that future teachers can plan and implement teaching strategies that promote the construction of knowledge in a meaningful way by students. The simple memorization of formulas and equations, devoid of context, does not contribute to the formation of critical and reflective citizens, capable of applying chemical knowledge in real situations.

The application of Meaningful Learning in the training of Chemistry teachers involves the creation of learning environments that stimulate exploration, investigation and problem-solving. The connection between chemical concepts and students' daily lives, the use of analogies and practical examples, and the promotion of dialogue and argumentation are some of the strategies that can be used to make learning meaningful.

Thus, it is observed that teacher training should prioritize reflection on pedagogical practice, case analysis and experimentation with different teaching approaches. According to [4], collaboration between students gains notable relevance, allowing them to share information, participate in activities together, solve problems, develop projects and evaluate each other's progress. This dynamic is already evident outside the school environment, in social network groups, where interests and experiences are mutually shared.

It can be said that the use of structured material, such as concept maps, infographics and simulations, plays an important role in the training of Chemistry teachers, as it helps future teachers to organize and visualize chemical concepts, facilitating understanding and memorization. The creation and use of structured material require that teachers master the disciplinary content and teaching strategies, in addition to developing the ability to select and organize information clearly. Teacher training should, therefore, prioritize the creation and analysis of structured material, as a way of promoting reflection on pedagogical practice and the development of didactic skills [5].

The use of structured material in the training of Chemistry teachers also contributes to the development of communication and collaboration skills among future teachers. Discussion about the organization and presentation of information, and critical evaluation of the different materials produced are some of the activities that can be used to promote Meaningful Learning and the development of communication skills. Teacher training should, therefore, create opportunities for future teachers to work in teams and learn to communicate clearly.

Methodology

The methodology adopted in this research comprises a set of steps, structured from the perspective of qualitative research. In line with [6], the objective of qualitative research lies in understanding individual interpretations of the events that make up their experiential contexts. The author emphasizes the relevance of accuracy in interpreting the narratives of the interviewees, considering potential distortions and the level of willingness and confidence in sharing their perceptions.

In line with the assumptions of [7], the case study strategy was chosen, aiming to deepen the analysis of the understandings developed in a specific context, namely, Chemistry teachers from the Regional Education Coordination (CREDE 12), Ceará, Brazil. According to [7], the case study is characterized by being developed in natural environments, privileging descriptive data, adopting flexible planning and approaching reality in a complex and contextualized way. Additionally, [8] defines the case study as an empirical investigation that examines a contemporary phenomenon in its real context.

This study focuses on the continuing education of Chemistry teachers in the state of Ceará.

In this research context, studies on the development of teacher training in the educational context have been conducted since 2020. Several instruments have been used over the years to identify constitutive characteristics of the subjects, which can demonstrate the development of one or more Chemistry teachers working in public high school institutions.

The data for analysis were collected through a virtual questionnaire, with the voluntary participation of teachers, by signing the Free and Informed Consent Form (FICF).

The content analysis methodology of [9] was used to support the investigation, comprising three phases: organization of the analysis, description and interpretation of the data. To preserve the confidentiality of the participants, the students are identified by P1, P2, and so on.

During the analysis of the responses provided by the teachers, we sought to establish parallels between the three categories presented by the author, which were adapted to the specific context of this study: structured material, which covers the contents of Chemistry, focusing on the teaching-learning area; use of technological resources, seeking an affective interaction, but with sufficient attention to the specific

contents of the knowledge area. The organization of the participants is detailed in Table 1.

Thinking Styles	Subjects	Sum
Educator	P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P12, P13, P14, P15, P16, P17	17

Table 1: Thinking style evidenced in the training of Chemistry teachers: Prepared

All questions were transposed into an electronic spreadsheet in Excel software. Of the 37 responses collected from teachers, 17 were selected for analysis of training data.

Results and discussion

When analyzing the responses of Chemistry teachers about the role of the Educator, we observed a common trend: the emphasis on the pedagogical aspects of Brazilian education. Most demonstrated concern in interacting affectionately in the training process, prioritizing pedagogical issues to the detriment of mastering the specific content of their areas of knowledge.

In the context of teaching Science and/or Chemistry, core content in the training of these teachers, P7's response stands out. When asked about the contributions of the theoretical discussions in the training, P7 stated that it provides: "I can only thank you, because it always enriches our classes even more with the content and tools that you provide".

Professor P7 reinforces the importance of theoretical discussions during the course, highlighting how they transformed his view of the experiences he had during the course. When mentioning references used in these discussions, he cites Vygotsky, whose influence, according to him, is evident both in the classes and in his own writing.

This influence, when analyzed from the perspective of [10] epistemology, reveals a phenomenon of harmony of illusions. In this context, teachers play a significant role in students' choices, shaping their preferences and approaches. P7's choices, in this sense, reflect the marks of his continuing education, aligning with a specific line of pedagogical thought.

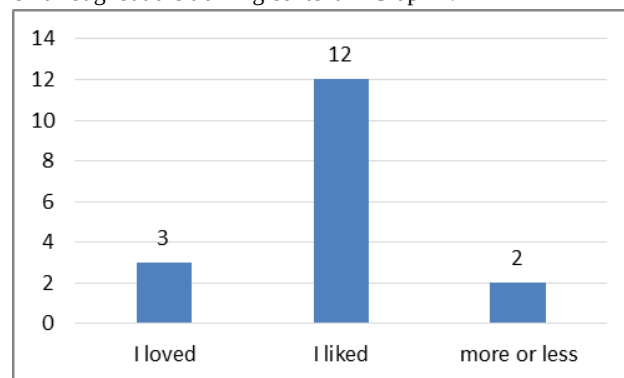
With this same understanding, P12 states that the readings carried out during the course: "the face-to-face training established the sharing of each colleague, the experience in the classroom with the practices during the readings". In his report, P12 emphasizes that the theoretical discussions addressed in the training are important to shape his vision about the future profession, highlighting the relevance of the pedagogical references mentioned.

Keeping this same line of thought, P2 answered the questions as follows: "the discussions provided significant moments of reflection, essential for my development as a teacher". When mentioning the authors, she uses most in her training, she cites: "Paulo Freire, Lev S. Vygotsky, Miriam Krasilchik, these references are used in her classes".

With this, P2 reinforces that the theoretical discussions were extremely valuable, offering important opportunities for reflection that contributed to his continued education. By citing references from both Science teaching and education in general, and considering the training of these authors, it becomes clear why P2 fits this profile of Educator. These authors are widely used throughout the training and, mainly, are presented by teachers of various Chemistry disciplines, as theoretical support.

In this regard, we argue that specific content training was not neglected, although this is not the predominant perception among the teachers participating in this study. We emphasize that the Educator's perspective may be a result of the incentive to participate in teaching initiation programs and the Institutional Program of Teaching Initiation Grants (PIBID).

In this context, we carried out research related to training with some direct alternatives for reflection on the themes worked on throughout the training context in Graph 1:



Graph 1 – Assessment of Chemistry teacher training: Prepared by the authors (2025).

Thus, we recognize the importance of the pedagogical training offered in the training of Chemistry teachers investigated, which stands out in the speeches of the students. However, we express concern about the development of the specific knowledge of the Chemistry teacher throughout the initial and continuing training process.

Conclusion

The training of Chemistry teachers is the central theme of this article, in which we investigate aspects related to the development of the thinking of teachers in this area. Our objective is to emphasize the relevance of addressing epistemological perspectives in teacher training processes. To this end, we use the categories proposed by David Paul Ausubel as an epistemological reference and analyze the discourses of future Chemistry teachers in the process of continuing education.

By adopting Meaningful Learning as a theoretical basis, we consider that understanding the development of the Educator in different contexts requires the analysis of situations from the perspective of the collective. Based on this author, we understand that thinking is not individual, but rather inherent to the social context in which one lives.

During the study, we identified that pedagogical knowledge about teaching activities was expressed more frequently by Chemistry teachers, contributing to highlighting the development of an Educator in this context.

In this sense, we recognize the urgency and need to discuss the continuing education of teachers in the area of Natural Sciences, given the constant changes required by the new curricular guidelines in Brazil. Furthermore, we reiterate the importance of this study in the context of the use of structured material and digital technologies, a relatively new institution where monitoring the profile of trained teachers is essential.

In view of this, it is worth highlighting that we have come a long way in the areas of training Chemistry teachers, and we have seen the potential of epistemological analyses, specifically through Ausubel epistemology.

Therefore, we reiterate the importance of focusing studies that investigate epistemological aspects in the training of teachers in the area of Natural Sciences, as we understand that the way teachers think directly influences the actions developed in the classroom with high school students.

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