



The Use of Different Strategies in Chemistry Classes for Higher Education*

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ABSTRACT

This report describes the experience that was developed in the discipline of Instrumental Methods of Chemical Analysis of the 4th semester of the Superior course of Technology in Food of a public institution in the countryside of RS. Different activities were used, planned in a sequential manner, and using different strategies and didactic resources: lectures-dialogued; thematic approach; search; planning and carrying out experimental activities; article writing and oral presentation. From the subjects covered in the expository classes and the perception about the social implications of Chemistry and technologies in their lives, the students suggested the theme water for human consumption and the methods of official analysis for conducting a bibliographic research. After that, the students did the collection and physical-chemical analysis of the water samples. Then, they presented the results in the form of an article, followed by an oral presentation. It was observed that the experience motivated and aroused interest in the subjects studied in the discipline and contributed to the learning and appropriation of knowledge. It is also worth noting that, unlike previous semesters, there was no failure due to lack of frequency or grade. Individual assessments, resourcefulness in carrying out laboratory activities, mastery and knowledge demonstrated during the presentation and discussion of results confirm this finding.

KEYWORDS

Chemistry teaching. Contextualization. Different strategies.

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O Uso de Diferentes Estratégias em Aulas de Química para o Ensino Superior

RESUMO

Este relato descreve a experiência que foi desenvolvida na disciplina de Métodos Instrumentais de Análises Químicas do 4º semestre do curso Superior de Tecnologia em Alimentos de uma instituição pública no interior do RS. Utilizou-se diferentes atividades, planejadas de maneira sequencial, e com uso de diferentes estratégias e recursos didáticos: aulas expositivas- dialogadas; abordagem temática; pesquisa; planejamento e realização de atividades experimentais; escrita de artigo e apresentação oral. A partir dos assuntos abordados nas aulas expositivas e a percepção acerca das implicações sociais da Química e das tecnologias em suas vidas, os estudantes sugeriram o tema água para consumo humano e os métodos de oficiais de análise para a realização de uma pesquisa bibliográfica. Após isso, os estudantes fizeram a coleta e as análises físico-químicas das amostras de água. E na sequência, apresentaram os resultados no formato de um artigo, seguido de uma apresentação oral. Observou-se que a experiência motivou e despertou o interesse pelos assuntos estudados na disciplina e contribuiu para aprendizagem e apropriação do conhecimento. Cabe salientar ainda que, diferentemente de semestres anteriores, não houve nenhuma reprovação por infrequência ou nota. As avaliações individuais, a desenvoltura na realização das atividades laboratoriais, o domínio e conhecimento demonstrado durante a apresentação e discussão dos resultados ratificam essa constatação.

PALAVRAS-CHAVE

Ensino de Química. Contextualização. Diferentes estratégias.

El Uso de Diferentes Estrategias en Clases de Química para una Educación Superior

RESUMEN

Este informe describe la experiencia que se desarrolló en la disciplina de Métodos Instrumentales de Análisis Químico del 4º semestre del curso Superior de Tecnología en Alimentos de una institución pública del interior de RS. Se utilizaron diferentes actividades, planificadas de forma secuencial, y utilizando diferentes estrategias y recursos didáticos: conferencias-dialogadas; enfoque temático; buscar; planificar y realizar actividades experimentales; redacción de artículos y presentación oral. A partir de los temas tratados en las clases expositivas y la percepción sobre las implicaciones sociales de la Química y las tecnologías en sus vidas, los estudiantes sugirieron el tema Agua para consumo humano y los métodos de análisis oficial para realizar una investigación bibliográfica. Posteriormente, los alumnos realizaron la recolección y análisis físico-químico de las muestras de agua. Luego, presentaron los resultados en forma de artículo, seguido de una presentación oral. Se observó que la experiencia motivó y despertó el interés por las materias estudiadas en la disciplina y contribuyó al aprendizaje y apropiación de conocimientos. También vale la pena señalar que, a diferencia de semestres anteriores, no hubo reprobación por falta de frecuencia o calificación. Las evaluaciones individuales, el ingenio en la realización de las actividades de laboratorio, el dominio y los conocimientos demostrados durante la presentación y discusión de los resultados confirman este hallazgo.

PALABRAS CLAVE

Enseñanza de la química. Contextualización. Diferentes estrategias.

Introduction

Nowadays, discoveries and technological advances are frequently published in specialized scientific journals or broadcast by the mass media. In this sense, it is essential to incorporate new principles into the daily work in the classroom, which can no longer be restricted to the transmission of information specific to a discipline, but must articulate knowledge in order to contextualize and form people with a global vision of the world.

The student, besides acquiring certain information and developing skills, must be prepared to continue learning throughout life. In times where changes occur quickly and are less and less predictable, it is essential to change the structure of classes and the way of teaching (SILVA; MACHADO; TUNES, 2010). However, according to Schnetzler (2002), the dominant model of teaching in Higher Education courses is still the transmission/reception model, with an empiricist/positivist view of science.

Alternatively, to teaching methods focused on the transmission of knowledge, teaching environments in which students are active agents have been proposed. These consist of cooperative learning environments in which students achieve more effective learning and logically develop new ideas through processes that involve reasoning (HUTCHINSON, 2000).

The subject of Instrumental Methods of Chemical Analysis is part of the area of Natural Sciences and it is expected that the following abilities should be stimulated and encouraged: the capacity for adequate representation; reading scientific texts of interest; interpreting graphs, tables and images; questioning natural and technological processes; using calculus, measurement and explanatory models; making use of Biology, Physics and Chemistry to explain the world; recognizing technologies as products of scientific research; relating science to society and its environmental implications. Instrumental Methods, more specifically, relates to the study of the instrumental analytical techniques most commonly used in chemical analysis laboratories for both quality control and industrial and environmental purposes. In the Food Technology course, the subject belongs to the 4th semester and, although the contents are clearly related to the professional profile of the student, for the students these relations are not so obvious and direct. Many have no notion of the fields of professional activity of a Food Technologist. This disconnection, associated with the difficulty in initial training in Chemistry may be the vector for the lack of interest in the subject and is reflected in the high rates of failure by infrequency or grade (greater than 50% in the 4 semesters in which it was previously offered). Based on these reflections, strategies were sought to motivate learning and success in the subject.

This paper is the report of the experience conducted during the second semester of 2018 in the subject of Instrumental Methods for the Higher Education Course of Food Technology in a federal public institution in the interior of Rio Grande do Sul.

Different strategies and didactic resources were used: expositive-dialogical classes, thematic approach, research, planning and carrying out experimental activities, writing a paper, oral presentation and evaluation.

Methodology

1st Stage: Lectures, Thematic Approach and Research

Initially, it was made expository lessons of the syllabus, interspersed with the resolution of exercises, examples of use and application of the concepts studied, among others.

Teaching in the contemporary context should go beyond the mere presentation of theories, laws and scientific concepts, implying reflection on what students understand by science and technology in the society in which they live. And how such knowledge, when applied, generates transformations in the environment (home, street, school, river, stream, atmospheric air, one's own body, etc.). In this sense, the CTSA perspective (Science, Technology, Society and Environment) according to Pérez (2012) has shown the importance of an education in Science and Technology for all citizens, so that they understand how science works in society, discovering the ways it is articulated with certain interests and how it changes our relationship with society and nature.

This requires a content base articulated with issues related to scientific, technological, social, economic and political aspects. This articulation will make students appropriate cultural tools to act in a participatory manner in the world in which they are inserted. (SANTOS *et al.*, 2010, p. 131-132)

In order to provide real problematic situations that require knowledge to understand them and seek solutions, the thematic approach was used. A potential theme to apply the contents studied is the quality of water for human consumption, according to the CTS/CTSA approach. Within this approach, Auler and Bazzo (2001), in a literature review study, consider that the goals of the movement range from using the issues of science, technology and society as a form of motivation in teaching to understanding the complex relationships established by these issues. This approach also allows contextualizing the issues addressed in school, giving greater meaning to what is taught (ZUIN, 2008). In addition, students are stimulated to reflect on the social reality and the information is interpreted in a more critical way.

From the discussions held in class and the perception about the social implications of chemistry and technologies in their lives, the students suggested studying the quality of water for human consumption.

The topic of drinking water quality relates to people's lives, their interests and needs, and an education that seeks to respond to social problems and connect the school to the reality of its students. Water is extremely necessary for life, including for human beings, who use it not only for personal consumption, but also for various economic and socio-cultural activities. People need water for food production and processing; for industrial activities; for energy production; for cleaning environments, clothes, and utensils; for personal and environmental hygiene; for the maintenance of parks and gardens; for recreation, and for sports. The complexity of multiple uses causes significant environmental degradation and a considerable decrease in the availability of quality water, producing countless problems for human health (PEREIRA, 2004).

Currently, everyone is concerned with the surveillance and management of the planet's waters, both in aspects related to their quantity and regularity of supply for human activities, and with the physicochemical and microbiological qualities that can be determinant for the onset of human diseases (NUNES *et al.*, 2013; YANG *et al.*, 2012). Thus, the quality of water for human consumption was defined for the students to conduct a research.

The class of 12 students was divided into two groups and each group was guided to conduct a literature search on the quality of water for human consumption, legislation and official methods of analysis of the physical and chemical quality of it.

Education through research, according to Demo (2011), requires propaedeutic care (knowing how to think and learn how to learn), both by the teacher and by the student. This care implies directly in the educational quality, which presupposes the formation of formal and political competence. Research is a complex action that involves aspects beyond the mere transmission of content or exposure of actions to be followed. Demo (2011) states that doing research suggests an emancipatory perception of the subject that seeks to make and make itself an opportunity, as it begins to reconstitute itself by systematically questioning reality, including practice as a necessary component of theory and vice versa. This emancipatory conception proposed by Demo (2011) can begin with the awakening of interest in research. Within a classroom, the teacher can instigate, propose dialogues, because for the interest in research to arise, there is the need to identify a problem to be investigated that does not arise from the teacher.

It is pertinent to point out that, although teaching through research arouses informal conversations, formal elements are required for its construction and elaboration. After the definition of the topic of interest to be researched, other phases, which are inherent to research, begin. These phases involve the objectives, procedures, discussions with the theoretical references, evaluation of the results obtained, and presentation according to the Brazilian Association of Technical Standards (ABNT). In each phase of the research, the teacher and the students who set out to do it should follow an appropriate methodology, which will avoid the risk of "getting lost" in the research.

2nd Stage: Planning and Carrying out Experimental Activities, Writing the Article, and Oral Presentation

The activity that followed the research was the execution of physical and chemical analyses of the water quality. The students themselves collected and analyzed different water samples according to the methodology of the Practical Manual of Water Analysis (BRASIL, 2013).

According to Zômpero and Laburú (2016), investigative activities in science teaching consist of didactic moments based on the resolution of problems of everyday and/or scientific situations, in order for the student to develop certain skills such as observation, registration, identification of regularities, hypothesis raising, search for information, discussion among peers, as well as communication of the results in oral or written form. The authors also consider that, in an investigation in the school context, students should be involved in scientifically oriented questions, use evidence to evaluate, formulate, communicate and justify scientific explanations, based on evidence, analyze their explanations in light of alternative ideas. Also according to these authors, one of the essential aspects in an activity with an investigative focus is the existence of an instigating problem. The problem becomes important because it introduces new concepts based on knowledge already learned, creating conditions to solve it. Thus, if a class is organized in a way that puts the student in front of a situation (problem), it can contribute to the student to reason logically about the situation and present ideas in an attempt to analyze the data and present a plausible conclusion. According to Carvalho (2018), a good problem is the one that allows students to solve and explain the phenomenon involved; it gives students the opportunity to relate what they have learned to the world in which they live, valuing empirical and spontaneous knowledge; it favors the use of scientific knowledge in other areas of study.

Next, each group was asked to write an article presenting and discussing the results of the physicochemical analyses performed. The choice of this textual genre took into consideration its relevance in academia and the students' difficulty in writing it. Thus, the integration of activities was sought to motivate students to the practice of reading and writing academic-scientific texts associated with the appropriation of knowledge acquired in class (GÜLLICH, 2013).

Finally, each group presented their work to the other classmates through an oral presentation in the format of a "conversation circle".

3rd Stage: Evaluation

All activities took place during class and were accompanied by the teacher, which allowed for a continuous evaluation of the students' participation and involvement.

In addition, the students made an individual written evaluation with discursive questions about the studied contents. And the results when compared to those obtained by previous classes are better.

Results and Discussion

1st Stage: Lectures, Thematic Approach and Research

The research was the strategy used to deepen the knowledge about the subjects studied and the intention was to instigate the students to assume a posture of permanent search for updating, consolidate the use of chemical knowledge and make explicit the relations Science-Technology-Society (ROTHBERG, 2006). This step was very important, because it required study and understanding of the theoretical basis and the experimental methodology to be used, besides being indispensable to discuss the results obtained.

The samples presented the physical-chemical parameters measured according to the established by the legislation (BRASIL, 2011). It should be noted that the objective of the work was not to verify compliance with the legislation and therefore there is no further discussion on this aspect.

2nd Stage: Planning and Implementation of Experimental Activities, Article Writing and Oral Presentation

The results were presented and discussed in an article. The choice of this textual genre took into consideration its relevance in academia and the students' difficulty in writing it. In this perspective, specifically the written work contemplates an integral formation of the students, providing opportunities for growth through manual and intellectual work and their reflections on them. This is because, according to Marques (2001, p. 26), we write to think, because writing serves as a "provocation to think, as a gentle sliding of reflection, as the search for learning, the principle of investigation". This provides a better organization of thought and facilitates learning.

3rd Stage: Evaluation

It was evaluated that the proposal effectively contributed to the learning process, because the students presented better performances in the evaluations; progress in the level of reasoning and critical thinking skills; greater understanding of the concepts; higher levels of attention and, concomitantly, less dispersion in class; greater motivation to learn; positive attitudes towards the subject; higher self-esteem, and development of social skills. Unlike previous classes, there were no dropouts or failures in this class.

The good results in the individual written evaluations that the students did, as well as the discussions and reflections they made during the presentations, are worth mentioning.

Below are transcribed some excerpts from the students' statements about the proposal:

"I thought it was very good because it brought theory closer to practice and made us understand that the content is very important." (Student A)

"(...) it helped me to see how we can use the knowledge obtained in class in situations in our daily lives." (Student B)

"It made me visualize the subject in practice, which I had difficulty." (Student C)

"Writing the results in the form of an article required a lot of reading and study, I found it very important to start because soon we will have to do the course completion paper." (Student D)

"It was great because we could see how the knowledge acquired in the discipline will be used in the future and also have the first contact with writing an article, for many of us it is the first." (Student E)

"I liked it a lot, I think I learned more this way than if it was in traditional classes only. Especially the practical part ("hands on") from collecting the sample to the analyses in the laboratory. Writing I didn't like it very much, it's hard." (Student F)

"I learned a lot, I think more than if it was just a theoretical class and practice in the lab. I was able to relate what we studied in the course to everyday life issues." (Student G)

Although the statements do not make it possible to evaluate, it is possible to infer that these opinions are expressed with greater confidence, mainly because they are based on the results of their own research and work, instead of reading and discussing texts written by others.

Final Considerations

Thinking about learning is not limited to considering teaching as a process of knowledge transmission only and learning as the reproduction of concepts and information received, where the teacher is the holder of knowledge, acting as a transmission agent, and students as receivers. It has been observed that there has been a change in the student profile due to the profound changes in the contemporary world: the ease of access to a huge amount and variety of information, the provisional nature of the truths built on scientific knowledge, and the speed in the production of knowledge. This fact imposes a significant change in higher education and in the process of training professionals.

The proposed activities employed diversified strategies. Initially, dialogued lectures addressed the concepts to be studied during the semester. In Chemistry, many of the fundamental concepts are of a nanoscopic nature, which makes the relationship between the

theoretical (explanatory) concepts and structures and the aspects we perceive empirically (sight, smell, hearing and touch) complex. At this moment, the change of methodological strategy for the thematic approach of water for human consumption and the promotion of the investigative character through documentary research of scientific texts, legislation, and official analysis methods encouraged the adherence, interaction, and participation of the students.

The theme of water is quite comprehensive, can be used in different contexts, and refers to numerous interrelationships. Therefore, the teacher's role as a knowledge mediator was fundamental to guide and define the research focus.

Next, the strategy used was the implementation of laboratory experiments by the students. Thus, the collection and the physical-chemical analysis of different water samples helped in the articulation between theory and practice. Another important factor to be considered is contextualization. This enables the attribution of meaning and the use of concepts that help in the understanding of reality.

The visualization of the practical applicability of the content studied; the different ways of learning; the exchange of experiences and the creation of bonds to carry out the activities, the stimulus for active participation in the development of the activities awakened the interest in learning. Thus, the proposal met its objective of motivating students in the Food Technology course to study and succeed in the Instrumental Methods subject.

The results indicate that the progress, autonomy, and other skills developed through the activities are not immediate, and demand time and resources from both the teacher and the students. This may be a limiting factor in their execution.

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