PRÁTICAS EDUCATIVAS, MEMÓRIAS E ORALIDADES

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Transforming habits: pedagogical workshop in chemistry teaching on smoking addiction

ARTICLE

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Abstract
Chemistry teaching in the Brazilian educational system reveals a growing gap, making the urgency for reforms and updates evident. Faced with this situation, the methodological approach of contextualized teaching emerged. Teaching workshops suggest that teaching occurs in a situated manner, presenting a dynamic and interactive learning space, where students do not absorb information passively, but actively participate in the knowledge construction process. This article aims to explore the effectiveness of a pedagogical approach that uses a generative theme to discuss the implications of nicotine chemistry, both in traditional cigarettes and electronic devices, with the aim of sparking critical reflection on the implications of smoking, enabling students to become agents of change in society, disseminating knowledge and positively influencing those around them.
Keywords: Pedagogical Workshop. Teaching Chemistry. Teaching and Learning.

Transformando hábitos: oficina pedagógica no ensino de Química sobre o vício em tabagismo

Resumo
O ensino de Química, atuante no sistema educacional brasileiro, revela uma crescente defasagem, tornando-se evidente a urgência de reformas e atualizações. Diante dessa situação, emergiu a abordagem metodológica de um ensino contextualizado. As oficinas de ensino sugerem que o ensino ocorra de forma situada, apresentando um espaço de aprendizagem dinâmico e interativo, onde os estudantes não absorvam informações passivamente, mas participem ativamente do processo de construção do conhecimento. Este artigo visa a explorar a eficácia de uma abordagem pedagógica que utiliza um tema gerador para discutir as implicações da química da nicotina, tanto em cigarros tradicionais quanto em dispositivos eletrônicos, com intuito de despertar uma reflexão crítica sobre as implicações do tabagismo e capacitar os alunos a se tornarem agentes de mudança na sociedade, disseminando conhecimento e influenciando positivamente aqueles ao seu redor.
Palavras-chave: Oficina Pedagógica. Ensino de Química. Ensino e Aprendizagem.

1 Introduction

Discussing the teaching of chemistry is a way of reverberating in fruitful reflections on which theoretical and methodological approaches should be used in the context of the classroom, aiming for criticality and the potential for interventions in the teaching and learning processes. In Brazil's educational system, students are dropping out at all levels of education due to the process of memorization and a decontextualized approach to content, making classes unattractive (Arrigo; Souza; Broietti, 2017). Clearly, these situations highlight the urgency of debates, reforms and movements in favor of a dialogical, contextualized chemistry education that allows for transformations in people's way of thinking and acting.

It is well known that scientific and technological development has brought advantages and disadvantages (Auler, 2003) for maximizing ways of teaching and learning. However, it is crucial to exchange knowledge, starting from local realities, culminating in moments of socio-political engagement, through the collective construction of knowledge. Chemistry teaching, in turn, signals that knowledge about chemistry can be found everywhere and that a humanized, dialogical and critical approach is needed to interrelate scientific knowledge with students' realities (Wartha; Silva; Bejarano, 2013).

The scenario experienced by today's society, based on online interconnection, is crucial for science to be presented to students in a more direct way. In other words, this interconnection instigates understandings about the possibilities of elucidating concepts that are considered abstract, generic or decontextualized, in relation to the subjects' experiences. This requires the involvement and engagement of teachers, as well as the creation of formative moments, building paths and possibilities for autonomous action in the socio-educational environment, through actions and interventions aimed at improving teaching and learning.

In the process, it is essential to think about methodological approaches to teaching with a contextualized bias, which strives to connect the concepts to the students' concrete experience (Kurz; Stockmanns; Bedin, 2022). These approaches establish links between

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scientific knowledge and the sociocultural environment in which the students are inserted, aiming to give meaning to the concepts "[...] and, with this, awakening in the students a more critical look at phenomena that surround their context" (Costa; Pinheiro, 2013, p. 37). It is by problematizing this perspective that pedagogical workshops have emerged, presenting themselves as a fundamental tool for implementing this approach, making teaching more dynamic through actions and interventions among the participants (Galeski; Bedin, 2024).

The workshops, within the educational field, foster practices in a situated way, presenting a dynamic and interactive learning space, so that students do not absorb information passively, but actively participate in the process of building knowledge (Rédua; Kato, 2020). Recognizing the importance of teaching chemistry in a dialogical, contextualized and critical way, especially aimed at training for citizenship, it is essential to discuss with students the uncontrolled use of substances such as nicotine, which, besides being addictive, also harms the health of users. Nicotine is widely found in the leaves of the tobacco plant (*Nicotiana tabacum*) and, to a lesser extent, in some other plants of the *Solanaceae* family (Rosemberg, 2002).

Addressing the implications of nicotine in the socio-educational context, linked to chemistry teaching, is essential to understanding the relationship between this substance and addiction. Given its widespread use and marketing, teaching this subject should be informative, engaging and sensitive, exploring the impacts of smoking on the body, especially the lungs. The workshop should promote a dialogue that contextualizes the presence of smoking in everyday life, combining scientific knowledge and critical reflection.

In this field, the pedagogical contextualization of smoking, as a perspective of intervention in society, is fundamental to sensitize students about the dangers of smoking and, therefore, in the teaching of chemistry, the approach should focus on understanding the chemistry of nicotine, the central element of tobacco, responsible for its addictive character. By uncovering the biochemical mechanisms that make smoking a health trap, participants are encouraged to (re)think deeply about their habits and make more conscious decisions about tobacco consumption.

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If smoking is perceived as a socially acceptable behavior, adolescents, who often want to resemble adults, may see smoking as a way to achieve this image. It is therefore essential to address not only the family environment, but also the social context when developing smoking prevention strategies among young people. This approach should provide information and prompt critical reflection on the implications of smoking, enabling students to become agents of change in society, so that they can disseminate knowledge and positively influence those around them.

Based on these initial questions, this article aims to analyze the effectiveness of a pedagogical workshop with basic education students in understanding chemical knowledge, using nicotine as a generating theme in chemistry teaching, in order to discuss its implications in the socio-educational environment. This objective is justified by the fact that it contributes to the students' scientific understanding of chemistry and, above all, to the construction of a socio-political identity based on a local theme.

2 Theoretical Framework

The teacher training process encompasses a variety of issues, including legal, theoretical, practical, organizational and operational aspects. The teaching internship, conceived as a crucial period for the development of teacher training, represents the moment and the environment in which the student, in the process of initial training, assumes the duties of a teacher. These responsibilities include, in addition to the classroom context, actions that extend, such as participation in administrative meetings, meetings with parents and guardians, coordination of events and projects and other relevant activities (Lima; Pimenta, 2006).

In this context, teachers in their initial training can teach pedagogical workshops as part of their supervised internship, which can provide further practical experience to improve their teaching practice. From this perspective, pedagogical workshops are spaces that focus on the student as the center of learning, where experiences are produced that allow for the integration of theory and practice and foster the development of teacher

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autonomy. Rédua and Kato (2020, p. 2) state that “[...] the pedagogical workshop is a modality that allows the mobilization of knowledge from the interactions between the participants”, and the teacher creates moments that awaken the students' knowledge, through interaction derived from experiences.

In this respect, it is essential that teachers are constantly involved in renewing their knowledge, both scientific and cultural, in order to master the use of technologies for teaching and learning processes. This type of teaching can facilitate classroom interaction in group or individual activities, as well as improving the teacher-student relationship (Freire, 2009), since the use of active methodologies is perceived as enhancing learning, as it is associated with stimulating students in their search for new knowledge (Rédua; Kato, 2020).

In view of this, using generating themes as propellants for a fruitful and counter-hegemonic debate allows us to break with the culture of exclusion, lack of information and the process of alienation. Costa and Pinheiro (2013, p. 41) emphasize that “working with generating themes is based on the principle of practice permeated by reflection, since there is a harmonious union between the knowledge built by humanity and its re-reading to understand the peculiar situations that involve the local reality”.

Through practical and engaging activities, pedagogical workshops allow students to explore curricular concepts by applying them to real everyday situations (workshops). Freire (2009) states that knowledge, through the practice of contextualization and attribution of meaning, must be constant in education, and must be faithful to the objectives outlined, with a view to the critical development of teaching and learning processes. To this end, Wartha, Silva and Bejarano (2013) understand that, when teaching chemistry, it's not enough just to include the students' everyday lives; it's necessary to contextualize, creating moments of interconnection between the various types of knowledge and awakening the students' attention to everyday issues.

Costa and Pinheiro (2013, p. 38) believe that “students must develop the ability to understand and interpret the various situations that surround their lives, recognizing their active role”. From this perspective, when it comes to teaching chemistry, the construction

of knowledge takes place through assimilation and interaction with themes that are consistent with the students' reality, interrelating them with issues from everyday life. Thus, using the workshop as an educational approach involves considering the teaching and learning process not just as a cognitive act, but as a creative, critical, interventional and innovative process (Anastasiou; Alvez, 2004).

In addition, it is important to distinguish education from schooling: education is a continuous process of human formation, while schooling encompasses both school and family education (Freire, 2009). In this sense, problematization serves as a basis for integrating diverse knowledge, in line with Freire's perspective of contextualizing reality in teaching, which incorporates technologies, virtual games and other resources to bring the school closer to the students' experience (Vieira; Volquind, 2002).

However, when using workshops in the school context, one should look for themes that connect with the students' daily lives, in a dialogical and contextualized way. Teaching about smoking addiction becomes fundamental to the process of new knowledge, guiding chemistry teaching as a propellant for (re)thinking hegemonic issues that reverberate in social coexistence. Santos and Neto (2023, p. 261) point out that smoking is considered "[...] a global epidemic with very overwhelming repercussions, posing a major threat to public health worldwide, as its consumption has claimed the lives of more than 8 million people a year". Chemical dependency due to smoking can contribute to the appearance of serious illnesses and can, in many cases, lead to death.

As argued by Precioso (1999), the acquisition of the smoking habit can be influenced by various factors, including social, environmental and personal aspects. Among these factors, the behavior of friends stands out as the most impactful social element in the formation of smoking habits among adolescents, represented by them as a social activity. The influence of companies is an important mechanism for maintaining the habit, since many adolescents try smoking in groups, as a collective action.

Studies show that more than 1 billion people smoke, and tobacco is associated with the five leading causes of death (Szklo *et al*., 2020). Similarly, "excessive tobacco use makes people highly dependent and incapacitating, especially at the peak of their most

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productive years, which indicates smoking as a chronic progressive disease" (Santos; Neto, 2023, p. 261). In this sense, due to the importance of educational environments, the development of pedagogical workshops with warnings about this problem provides students with a more comprehensive understanding of how chemical substances interact in different contexts and how they can influence the functioning of the human organism, as well as signaling how chemistry behaves in physiological processes (Aguiar; Silva, 2021).

In this way, the development of pedagogical workshops, contextualized in the teaching of chemistry, on nicotine and smoking provide an opportunity to raise students' awareness of the harmful effects on health, fostering the adoption of healthy habits and a broader understanding of addictions in general. Through dialogue and the promotion of debates and activities in the classroom, the teacher can explore the impacts that nicotine addiction has on society, with a view to making students aware of the importance of raising awareness in the community about the harmful effects caused by smoking and encouraging them to adopt healthy habits.

3 Methodology

This research, approved by the Ethics Committee for Research with Human Beings of the Universidade Federal do Paraná (Federal University of Paraná), under CAAE: 75725823.4.0000.0214 and approval number: 6.651.029, is fundamental and exploratory in nature, using a qualitative approach. Chizzotti (2003, p. 221) understands that "the term qualitative implies a dense sharing with people, facts and places that constitute objects of research, to extract from this conviviality the visible and latent meanings that are only perceptible to a sensitive attention [...]". The nicotine workshop focused on the process of contextualization and dialogue about the possible problems that nicotine use can cause for users, as well as for society in general. The data was initially gathered from the experience of applying the workshop in the classroom and then analyzing the responses of the participating students in the workshop evaluation.

The pedagogical workshop was carried out with the participation of 17 students from the senior year of high school at a private institution in Curitiba, state of Paraná, Brazil, and was applied directly and in person in the chemistry class, with the supervision of the teacher of the curricular component responsible for the class. The workshop lasted a total of 50 minutes and was divided into three sequential parts. First, there was a detailed explanation of the composition of tobacco and a socio-cultural exploration of smoking. Next, the topic of chemical dependency was addressed, exploring its causes and consequences. Finally, the chemical molecule of nicotine was emphasized, using the three representational levels to facilitate understanding.

In order to compile and analyze the data, the classes were observed with notes in a journal and the escape room activity, as well as the application of an evaluation form. The escape room activity, whose plot was related to smoking and featured riddles related to the topics previously discussed in the workshop, lasted 30 minutes. The form consisted of twelve questions, four of which were open-ended and eight of which were multiple choice. The purpose of these questions was to assess the participants' perception of the workshop's effectiveness in promoting understanding of chemical knowledge. In addition, the form included a section for the profile of the respondents, with questions about gender, age group, school subject of affinity and interests in relation to the future profession.

The statements used a five-point Likert scale to assess the participants' level of agreement or disagreement, ranging from 1 to 5. The number 1 represents a high degree of disagreement, while the number 5 represents a high degree of agreement. To present the results, answers 1 and 2 were combined and classified as “disagree”, answers 4 and 5 were grouped as “agree”, and answer 3 was considered “neutral”. In this way, the combination of quantitative and qualitative analysis, using the interpretative-inductive method (Marconi; Lakatos, 2006), made it possible to draw up a profile of the students and evaluate the results of the pedagogical workshop. This design occurred when observation was used to justify the data from the questionnaire.

4 Results and Discussion

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4.1 The application of the workshop: pedagogical intervention

Initially, the workshop was planned, taking into account the relevance of the topic today, especially in the socio-educational context. After that, the workshop was presented to the class, considering the numerous reports from teachers about the low participation and interest of students in chemistry classes. Wartha, Silva and Bejarano (2013) understand that chemical knowledge is present everywhere, but it is necessary to create problem situations for students to make interconnections with existing knowledge. This is how the pedagogical workshop activity was proposed, with the aim of stimulating engagement and teamwork.

The workshop was applied after four weeks of monitoring the students in class. First, a presentation was made using slides, with a photo, containing name, course, shift, semester, in order to present the teacher in initial training, in a more horizontal way for the age group of the students (between 16 and 18 years old). Thus, “empathy, based on deep respect and authenticity, creates an environment that makes it possible for students to get closer and, through conversation, empathy and respect develop” (Ferreira; Alvarenga; Evangelista, 2021, p. 17).

The second stage began with an investigative approach to the students' knowledge of the subject, using five questions, as follows: a) What is addiction?; b) What are the symptoms and signs of a developing addiction?; c) How can addiction impact on interpersonal relationships?; d) How does addiction develop in biological factors?; e) Why do young people smoke? From this survey, the students' knowledge was revealed, helping to guide the rest of the workshop's activities.

Regarding the third, the answers were discussed collectively, explaining: a) chemical or physical dependence on something or someone; b) manifestations of abstinence, mental confusion, stress and a constant need to consume; c) addiction has a negative impact on social relationships, often resulting in aggression and sometimes leading to social isolation due to the difficulty of asking for help; d) in terms of biological

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factors, the neurological system undergoes changes in neurotransmitters; and e) influence and acceptance from friends play a significant role.

In this way, this approach provided a moment to listen to the students about their understanding, addictions in general and their thoughts on what leads to the use of certain substances. Through dialog and the promotion of debates and activities, the impacts of nicotine addiction on society were explored. The dialog advocated here is an essential element within the classroom context, instilling in students a critical thinking about the problems that are present in the most varied spaces, going beyond the school walls (Freire, 2009).

In the fourth stage, to promote a scientific approach, an experiment was carried out on the effects of smoking on the lungs. The “PET bottle lung” (figure 1) consisted of a two-liter PET bottle, two cotton balls, a lighter, the bottle cap with a hole in the middle, three cigarettes and a liter and a half of water. The experiment took place visually, and the students were encouraged to record their observations and perceptions, identifying signs of the evils of smoke and predicting why the yellow coloration on the cotton occurred.

Figure 1 – “PET bottle lung” experiment

Source: Authors (2023).

As a result, the students were enthusiastic about the experiment, getting involved in social and scientific discussions within their teams and recording their comments on the

Padlet® online platform. These notes included observations, such as the smell of cigarettes, praise for the representation, as well as questions about dehydration in the body and deductions related to the darkening of cotton due to cigarette compounds, simulating the reaction that occurs in the lungs of smokers. In this sense, the students had the opportunity to visually understand how the chemical substances present in cigarettes interact and how they can influence the functioning of the human body.

Notably, this approach provided an opportunity to make students aware of the harmful effects of smoking on health, encouraging the adoption of healthy habits and a broader understanding of the lung. This is important because Santos and Neto (2023, p. 261) point out that “the chemical dependency caused by tobacco has been growing mainly in developing countries due to the enormous marketing potential of the tobacco industry, which mainly targets adolescents and young university students”. This exposure is in line with the prerogatives of the promoted activity, since young people end up becoming vulnerable to the use of tobacco, mainly due to the fact that there is little information and action to raise awareness.

The fifth stage focused on the chemical approach, with the aim of explaining the effects of nicotine on the body, addressing the biological factors related to its actions on the lungs and explaining why chemical dependence on nicotine occurs; this stage dealt with the nicotine molecule and the active ingredient in tobacco products. At this stage, it was noted that the students did not participate actively when asked about chemical knowledge, such as the distinction between the nitrogens attached to the aromatic rings, the molecular formula and the association of the nicotine molecule with the stimulating effects of tobacco.

Wartha, Silva and Bejarano (2013) explain that students will generally speak up when they have some kind of knowledge about the subject being debated. Given the specific nature of the subject, it is inferred that the low level of participation is related to the distance between the students' knowledge and scientific knowledge. After all, in general, the answers at this stage were insecure and uncertain, indicating that the students had identified the difference in the position of the nitrogen atoms and the hydrogen count,

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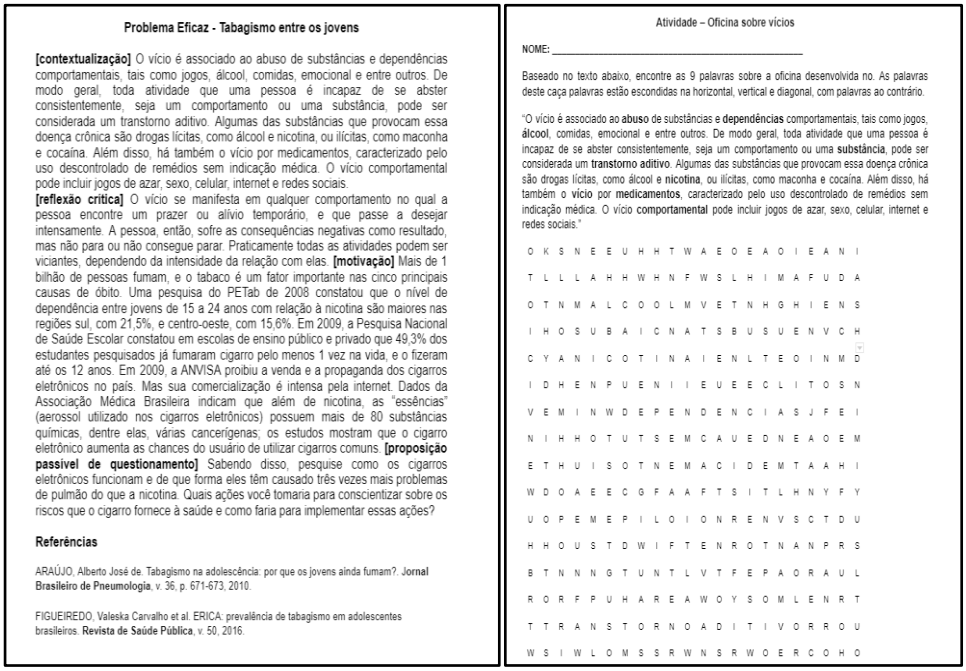
among other aspects. However, after watching a video explaining the effects of nicotine on the body and a detailed explanation of the molecular structure, the students were able to identify which part of the chemical structure reacts in the body and understand what happens in the experiment.

After this conceptual explanation, the students were given a word search and a summary of the rates of nicotine addiction in young people (figure 2).

Figure 2 – Post-workshop activities



Problema Eficaz - Tabagismo entre os jovens

[contextualização] O vício é associado ao abuso de substâncias e dependências comportamentais, tais como jogos, álcool, comidas, emocional e entre outros. De modo geral, toda atividade que uma pessoa é incapaz de se abster consistentemente, seja um comportamento ou uma substância, pode ser considerada um transtorno aditivo. Algumas das substâncias que provocam essa doença crônica são drogas lícitas, como álcool e nicotina, ou ilícitas, como maconha e cocaína. Além disso, há também o vício por medicamentos, caracterizado pelo uso descontrolado de remédios sem indicação médica. O vício comportamental pode incluir jogos de azar, sexo, celular, internet e redes sociais.
[reflexão crítica] O vício se manifesta em qualquer comportamento no qual a pessoa encontre um prazer ou alívio temporário, e que passe a desejar intensamente. A pessoa, então, sofre as consequências negativas como resultado, mas não para ou não consegue parar. Praticamente todas as atividades podem ser viciantes, dependendo da intensidade da relação com elas. **[motivação]** Mais de 1 bilhão de pessoas fumam, e o tabaco é um fator importante nas cinco principais causas de óbito. Uma pesquisa do PETab de 2008 constatou que o nível de dependência entre jovens de 15 a 24 anos com relação à nicotina são maiores nas regiões sul, com 21,5%, e centro-oeste, com 15,6%. Em 2009, a Pesquisa Nacional de Saúde Escolar constatou em escolas de ensino público e privado que 49,3% dos estudantes pesquisados já fumaram cigarro pelo menos 1 vez na vida, e o fizeram até os 12 anos. Em 2009, a ANVISA proibiu a venda e a propaganda dos cigarros eletrônicos no país. Mas sua comercialização é intensa pela internet. Dados da Associação Médica Brasileira indicam que além de nicotina, as "essências" (aerossol utilizado nos cigarros eletrônicos) possuem mais de 80 substâncias químicas, dentre elas, várias cancerígenas; os estudos mostram que o cigarro eletrônico aumenta as chances do usuário de utilizar cigarros comuns. **[proposição passivel de questionamento]** Sabendo disso, pesquise como os cigarros eletrônicos funcionam e de que forma eles têm causado três vezes mais problemas de pulmão do que a nicotina. Quais ações você tomaria para conscientizar sobre os riscos que o cigarro fornece à saúde e como faria para implementar essas ações?

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Atividade – Oficina sobre vícios

NOME: _____

Baseado no texto abaixo, encontre as 9 palavras sobre a oficina desenvolvida no. As palavras deste caça palavras estão escondidas na horizontal, vertical e diagonal, com palavras ao contrário.

"O vício é associado ao **abuso** de substâncias e **dependências** comportamentais, tais como jogos, **álcool**, comidas, emocional e entre outros. De modo geral, toda atividade que uma pessoa é incapaz de se abster consistentemente, seja um comportamento ou uma **substância**, pode ser considerada um **transtorno aditivo**. Algumas das substâncias que provocam essa doença crônica são drogas lícitas, como álcool e **nicotina**, ou ilícitas, como maconha e cocaína. Além disso, há também o **vício** por **medicamentos**, caracterizado pelo uso descontrolado de remédios sem indicação médica. O vício **comportamental** pode incluir jogos de azar, sexo, celular, internet e redes sociais."

O K S N E E U H H T W A E O E A O I E A N I
T L L L A H H W H N F W S L H I M A F U D A
O T N M A L C O O L M V E T N H G H I E N S
I H O S U B A I C N A T S B U S U E N V C H
C Y A N I C O T I N A I E N L T E O I N M D
I D H E N P U E N I I E U E E C L I T O S N
V E M I N W D E P E N D E N C I A S J F E I
N I H H O T U T S E M C A U E D N E A O E M
E T H U I S O T N E M A C I D E M T A A H I
W D O A E E C G F A A F T S I T L H N Y F Y
U O P E M E P I L O I O N R E N V S C T D U
H H O U S T D W I F T E N R O T N A N P R S
B T N N N G T U N T L V T F E P A O R A U L
R O R F P U H A R E A W O Y S O M L E N R T
T T R A N S T O R N O A D I T I V O R R O U
W S I W L O M S S R W N S R W O E R C O H O

Source: Autores (2023).

At this stage, the students were interested in how addictions develop. However, in general, they understood the idea of molecular proportion, given that the head teacher was covering organic functions in the quarter.

The sixth stage consisted of running an escape room, a type of game in which a team of players unravels clues, solves puzzles and carries out tasks to achieve a specific goal within a set time limit (Cleophas; Bedin, 2023). During the game, the students played an escape room entitled "Tabagismo: uma sessão criminalista" (Smoking: a criminal

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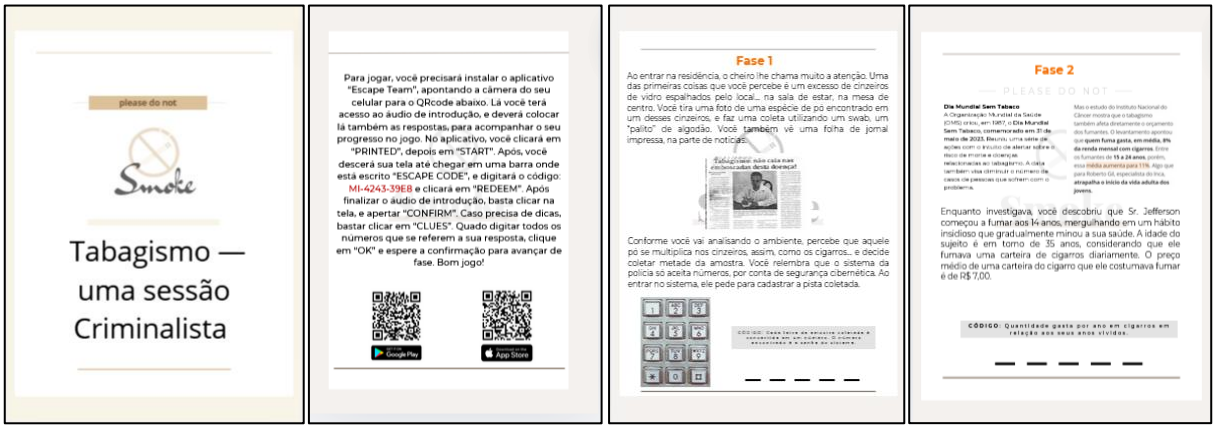
session) (figure 3). The narrative takes place from the point of view of a criminalist solving a case related to smoking, exploring clues in a scenario that highlights the dangers of addiction and its consequences for individual health and the criminal context. The content of the game involved solving five riddles, intrinsically linked to the crime narrative and the content of the workshop. The answers to the riddles are five-digit numerical sequences to be entered into the “escape team” mobile application.

Figure 3 – Some images of the escape room applied to the students



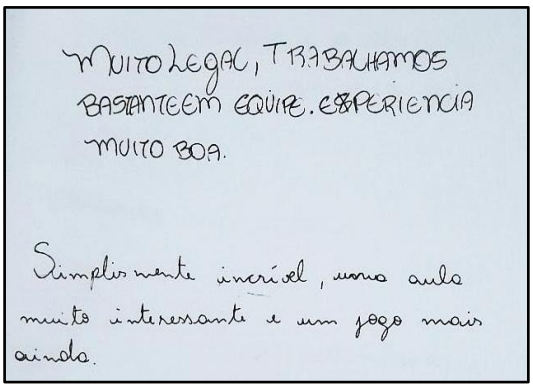
Source: Authors (2023).

The first riddle was an interpretation problem related to the composition of tobacco. The second puzzle was a mathematical challenge to identify the annual expenditure on cigarettes. In the third, students had to identify, using the text and clue two, the year when the fight against smoking began in Brazil. In the fourth phase, the players had to relate the decline in lung function to the length of time the subject of the narrative had lived. In the last puzzle, it was necessary to solve the puzzle showing the chemical structure of the active ingredient and count the atoms to obtain the molecular formula.

After solving all the riddles, the students concluded that the cause of the character's death was related to lung problems from smoking. In short, the activity involved the students, who showed a strong interest in the narrative presented and the playfulness. There was continuous collaboration between team members, who shared ideas, analyzed

clues and found solutions to the problems presented, as reported by team 3 (figure 4), after being the first to finish the game.

Figure 4 – Participating team report



Source: Research data (2023).

The use of teaching resources plays a crucial role in transforming education (Rédua; Kato, 2020). In the light of this activity, it stands out that the escape room gave the students moments for reflection, collective construction, engagement and participation. This intrinsic motivation is essential for maintaining long-term interest and fostering lasting learning (Galeski; Bedin, 2024). In addition, the use of the escape room provided an interdisciplinary approach, articulating different knowledge (Fazenda, 2015) and allowing students to interrelate concepts from different areas of knowledge, exchanging knowledge and making up new learning; this integration of disciplines can create a more holistic and in-depth understanding of the topics under study.

4.2 Evaluation of the Pedagogical Intervention: student perceptions

The students played an active role in drafting questions and answers during the workshop, showing interest in the topic. As part of a pedagogical evaluation, based on the participants' perceptions of the concepts covered in the workshop, a questionnaire was created consisting of twelve questions, four of which are open-ended and eight of which

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are multiple choice questions. The purpose of these questions was to assess how the participants perceived the achievement of the workshop's objectives.

In addition, the form included a section on the profile of the subjects, including questions on gender, age group, discipline of identification and interests related to the future career. The class consisted of 17 students aged between 16 and 18, mostly female (52.9%). In relation to the evaluation of the students' profile, they were asked to indicate their subjects of greatest affinity, with 47.1% (n = 8) having a preference for PE, 17.6% (n = 3) for literature and 11.8% (n = 2) for history. The rest (23.5%, n = 4) were divided between philosophy, Portuguese, geography and art.

Considering that the educational aspect is intrinsically linked to the objectives of critical teaching, regardless of the student's preference for the area of knowledge, through the teaching process, the development of critical awareness in individuals was promoted, enabling them to think independently. When someone has a strong interest and affinity for a subject, they are likely to feel intrinsically motivated to study and immerse themselves in that area (Anastasiou; Alvarez, 2004). This can result in better academic performance and greater involvement in the search for knowledge in this field, as well as in the professional aspirations to be pursued (graph 1).

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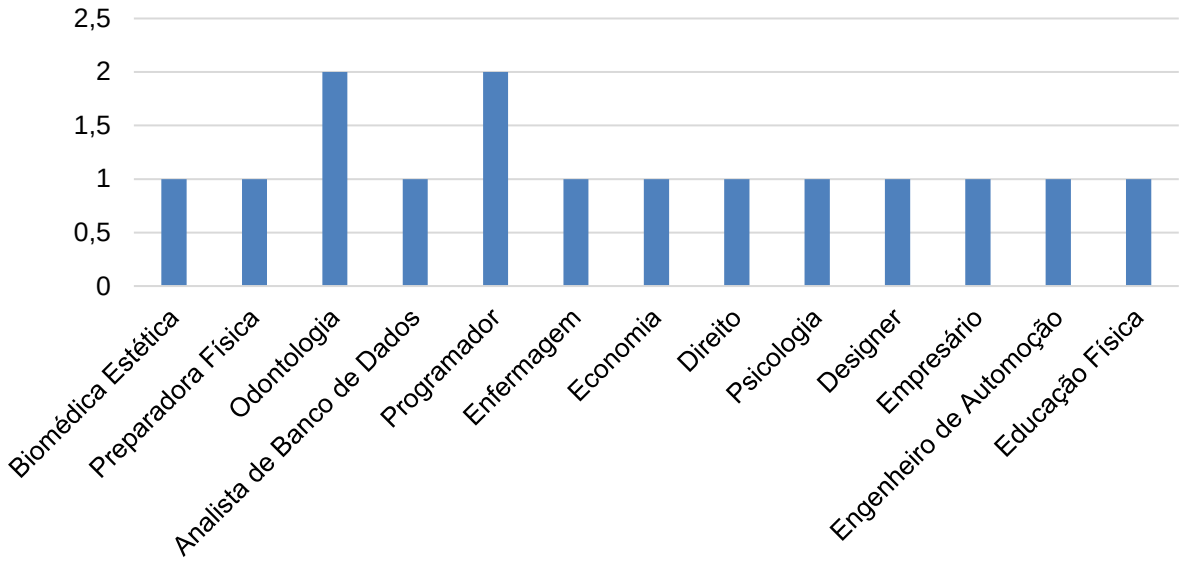
Graph 1 – Students' career aspirations



Source: Research data (2023).

It can be said that critical teaching, so called because of its direct impact on socio-economic and pedagogical objectives, is based on a specific approach to the context of social relations that prevail in educational practice. In this respect, considering the heterogeneity of the subjects, whether in relation to their future field of work or study interests, it can be said that the workshop covered the vast majority of the class's specificities, since the students participated actively. After all, the workshop brought entertainment activities, numerical data, scientific texts and, among other things, the need to learn through discovery and in a collective way.

In the part dedicated to discussing the workshop, the students were asked to express, in a single word, what the addictions represented to them. The majority of students associated the word “dependence” when thinking about addiction. This connection between addiction and dependence has profound implications for understanding the workings of nicotine chemistry. By understanding the relationship between “addiction” as a general concept that encompasses nicotine, students can acquire relationships about how

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chemical substances affect the body and mind, making the study of chemistry a practical example of how science relates to everyday experiences.

Continuing with the discussions, we present the eight objective statements in the questionnaire, which had values on a scale of 1 to 5 (table 1). The statements were about how much the workshop contributed to their understanding of chemistry, where 1 indicates little or no agreement and gradually increases to 5, which indicates a lot of agreement.

Table 1 – Questions posed to students after the workshop

Nature of the question	Question
Objective (Likert scale)	1. I know about the effects of nicotine 2. I was able to understand the molecular structure such as atoms, equations and structures in the effect of nicotine on the body 3. I already knew the composition of a cigarette 4. The workshop contributed to my understanding of the risks associated with smoking 5. I was able to understand how dopamine is released when smoking 6. Even though I'm a non-smoker, I know how exposure to tobacco smoke can affect my health 7. I have assimilated the chemicals present in e-cigarettes and how they compare to those found in traditional cigarettes 8. The playful and practical approach of the escape room helps to convey the harmful effects of smoking
Dissertation	1. How would you evaluate the overall experience of participating in the applied escape room? 2. Do you have anything to add?

Source: Authors (2023).

According to the perception of the majority of students, the workshop played a crucial role in stimulating their interest in chemistry and facilitated the connection between chemical concepts through contextualization, as shown by the data illustrated in graph 2.

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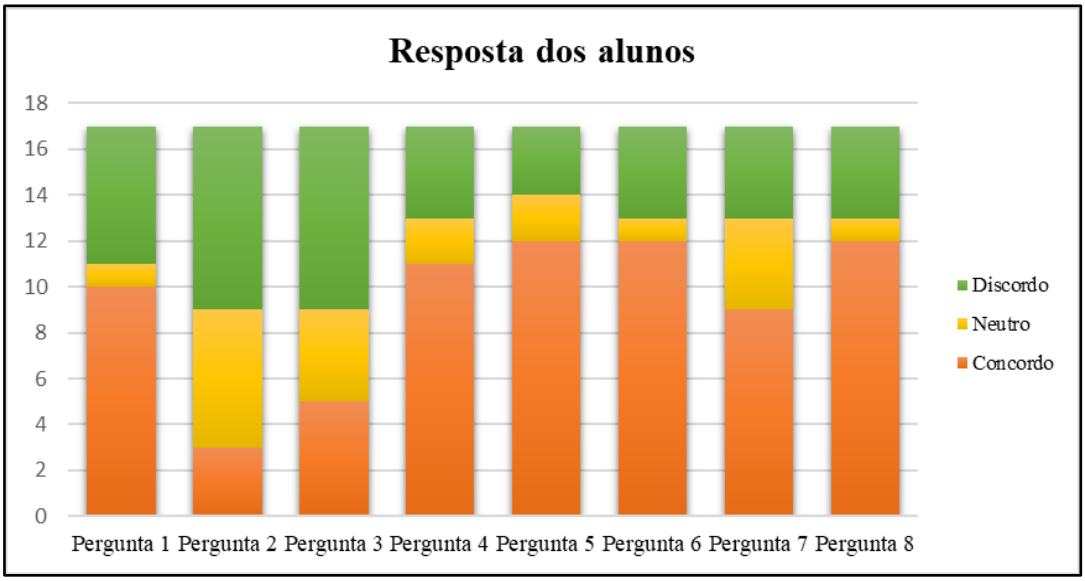
Graph 2 – Responses after the workshop



Source: Research data (2023).

In graph 2, the results collected after the students indicated their degree of agreement or disagreement with the statements were consolidated and distributed into three categories. The answers were divided into: scales 1 and 2 (indicating low agreement), represented in green; scale 3 (indicating a neutral response or lack of knowledge), shown in yellow; and scales 4 and 5 (indicating high agreement), represented in orange.

Looking at graph 2 and categorizing group 1, it can be seen that questions 1, 5 and 6 focus on the effects of nicotine. Notably, the greatest variation in the students' degrees of agreement occurred when they stated that the workshop provided a more critical perspective on the effects of nicotine consumption. This is relevant, since the primary objective of the theme was to understand how chemical substances interact in certain contexts. Furthermore, it is believed that this result reflects the success in raising awareness about how nicotine interacts with the human body and the dangers of exposure to tobacco, even for non-smokers.

In this sense, it is believed that these findings in group 1 show that the workshop was effective in promoting learning in the students, especially in understanding the effects

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of nicotine, which not only reinforced the learning of chemical concepts, but also sensitized the students to public health issues. Understanding how nicotine affects the human body, including the release of dopamine and how exposure to second-hand smoke can damage health, helps to form more informed and responsible citizens. Therefore, approaching the chemistry of nicotine and its effects made it possible to integrate knowledge of biology and health, enriching the students' understanding of the interconnection between different scientific areas. That said, elements of multidisciplinarity must be considered, especially since “multidisciplinarity seems to be exhausted in attempts by teachers to work together between disciplines in which each deals with common themes from its own perspective” (Pires, 1998, p. 176).

Group 2, made up of questions 2, 3 and 7, refers to questions about understanding chemistry in the macroscopic field (visible to the naked eye). Thus, it can be seen that statements 2 and 3 show a degree of disagreement. This can be explained by the fact that students are faced with complex concepts such as the molecular structures of nicotine, the composition of cigarettes and the chemicals present in cigarettes. During the workshop on the risks of smoking, it was evident that many students did not feel confident in answering or debating questions related to the molecular structure of nicotine, the composition of cigarettes and the chemicals they contain. This may have revealed gaps in the students' pre-existing knowledge, but it may also have provided a basis for further understanding and discussion.

This lack of trust can be attributed to several factors. Firstly, organic chemistry is a highly specialized discipline in the molecular structures, chemical bonds and reactivity of organic compounds. Many of the students who took part in the workshop were just beginning to explore this field of study, which naturally limits their familiarity with the concepts needed for an in-depth understanding of nicotine and the chemicals in cigarettes. In addition, the students may have felt overwhelmed by the amount of information presented in the workshop in the short development time.

In summary, the students' lack of understanding of the molecular structures of nicotine, the composition of cigarettes and the chemicals associated with cigarettes can be

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attributed to their inexperience with organic chemistry. The right approach and the support of educators are essential to help students overcome these challenges and develop a deeper understanding of the scientific field, so much so that “workshops constitute a democratic space in the relationship between educator and student, when they horizontalize their relationship with knowledge [...]” (Aguiar; Silva, 2021, p. 5).

However, it should be noted that the workshop provided an opportunity to build a solid foundation in chemical concepts, encouraging students to understand the molecular structure, chemical reactions and composition of tobacco products, allowing them to develop analytical and critical thinking skills. Thus, understanding the technical aspects of tobacco chemistry, even if the students have difficulties, prepares them for more advanced and complex studies in chemistry, enabling a more robust scientific progression. After all, with the growing popularity of e-cigarettes, it is vital that students understand the chemical differences between these and traditional cigarettes, making them better able to make informed decisions.

Group 3, the last group under analysis, focuses on the didactics of the approach used in the workshop, covering questions 4 and 8, in which the playful approach through the escape room stands out. This approach provided an immersive and fun experience, as was also evident in the students' essay responses, in which they expressed their desire to see this approach applied in their classrooms.

During the escape room activity, the students were challenged to solve clues related to the topic of smoking, while at the same time gathering information about the harmful effects of smoking. This practical approach involved the students actively, encouraging team collaboration, problem-solving and the application of previously learned concepts. After all, throughout the workshop, the students expressed that this innovative approach not only gave them a deeper understanding of the risks associated with smoking, but also inspired them to re-evaluate their attitudes towards tobacco consumption. The active interaction with the concepts and the team experience made it likely that the students would incorporate the knowledge acquired and consider making healthier choices for the future.

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In this field, it is possible to highlight that the workshop was also important in demonstrating that active and interactive teaching methods are necessary, since the playful approach, such as the escape room, made learning more engaging and fun, increasing students' motivation and participation. Nevertheless, it is known that practical and immersive actions have been shown to increase knowledge retention, as practice helps to fix concepts in a more lasting way, which is essential for effective learning. Therefore, the workshop demonstrates the effectiveness of new pedagogical approaches, which can be incorporated into mainstream education, promoting a more dynamic and effective learning environment.

Finally, it can be seen that the degrees of agreement vary according to the familiarity and complexity of the topics covered in the different groups. The workshop was more successful in raising general and critical awareness about the effects of nicotine (group 1) and in using innovative didactic approaches (group 3). With regard to the more technical concepts of chemistry (group 2), the students found it more difficult to assimilate, which points to the need for continued in-depth study and additional support for these topics. Still on the subject of contextualizing chemical knowledge about smoking, it is stated that actions developed from the context in which the subjects are inserted can reflect on the process of scientific literacy, reverberating in decision-making and the exercise of citizenship.

5 Conclusions

The use of the workshop as a didactic resource played a crucial role in chemistry teaching, especially as it discussed nicotine, a social, political and cultural issue. This type of teaching facilitates classroom interaction in group or individual activities, as well as improving the relationship between teacher and student.

The participating students showed great interest in the workshop, especially in the practical parts, such as the experiment and the escape room game. They were actively involved in discussions, team collaboration and finding solutions to the problems

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presented. The workshop contributed to the students' deeper understanding of the risks associated with smoking, both from a scientific and social point of view. The use of innovative teaching resources, such as the escape room game, played an important role in engaging the students and promoting their interest in chemistry.

The game enabled an interdisciplinary approach, connecting concepts from different areas. The questionnaires showed that the workshop increased the students' understanding of the effects of nicotine, its chemical structure and the relationship with addiction, arousing interest in exploring other addictions didactically. It was concluded that the workshop had a positive impact on raising awareness about the harms of smoking. The study points out that creative approaches, such as escape rooms, QR codes and experiments, are effective in mediating scientific knowledge and raising awareness of contemporary issues in the socio-educational context.

Planning training activities that are contextualized with the students' reality can be a way of stimulating the development of their critical sense, with a view to social participation, the exercise of citizenship and quality of life. Likewise, a dialog of knowledge is pertinent, aiming to (re)think contemporary problems that make up the daily lives of students and teachers.

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