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PARTICIPANTS' PERCEPTIONS OF THE WORKSHOP "BASIC LABORATORY RULES: BLOWING EVERYTHING UP": A QUALITATIVE STUDY WITH TECHNICAL STUDENTS FROM IFAM CAMPUS HUMAITÁ

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ABSTRACT

The text aims to explore the perceptions of the workshop participants in relation to the teaching of chemistry, focusing on the practical and interactive approach to laboratory safety. The methodology adopted was qualitative, involving semi-structured interviews and questionnaires with 20 students from the technical courses of IFAM Campus Humaitá. The data were analyzed through content analysis, identifying emerging patterns and categories. The results reveal that the practical and interactive approach of the workshop was effective in promoting meaningful learning and in the engagement of students in relation to safety in the laboratory. The opportunity to carry out real experiments allowed the practical application of the theoretical concepts, strengthening the learning of the participants. In addition, the interaction and collaboration between colleagues during the workshop developed for cooperative learning and knowledge exchange. The discussion pointed out the importance of pedagogical strategies that offer personalized support to students, complementing the practical and interactive approach. The information provides important insights for the development of future pedagogical strategies in chemistry education, promoting a culture of safety and responsibility in the laboratory. Therefore, the study highlighted the relevance of the interactive practical approach in teaching laboratory safety, highlighting both the strengths and areas for improvement. The students' perceptions provided important subsidies to improve educational practices and promote a safe and stimulating learning environment in chemistry laboratories.

Keywords: Laboratory Safety. Chemistry Teaching. Practical Approach. Students' Perceptions.

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INTRODUCTION

Inclusion in the chemistry laboratory environment determines an essential task in the education of high school students, particularly those enrolled in technical courses focused on any area of knowledge, but mainly on the exact sciences. Understanding basic safety rules and conduct is essential to ensure the physical integrity of students and provide a favorable space for experimental and practical learning. According to data from the Regional Council of Chemistry (CRQ), about 25% of accidents in school laboratories could be avoided with strict compliance with safety standards. In this circumstance, the workshop "Basic Laboratory Rules: Exploding Everything" emerges as a necessary initiative at IFAM *Campus* Humaitá, enabling a dynamic and participatory introduction to the chemistry laboratory environment.

Over time, several studies have shown the relevance of safety at the laboratory site and the effectiveness of forms of educational approach that enable student involvement and the internalization of safety standards. According to Machado (2005), safety in the laboratory is a central issue in the teaching of chemistry, being fundamental to prevent accidents and promote students' confidence in carrying out experiments. The human-centered approach in the teaching and learning process related to laboratory safety, highlighting not only the norms, but also the understanding of the fundamental elements, has been defended by authors such as Sato (2011), as a means of making learning more meaningful and effective.

The workshop "Basic Laboratory Rules: Blowing Everything Up" takes on a dynamic and innovative perspective by reconciling the propagation of theoretical knowledge with the practical development of experiments by the participants. This procedure, based on the theory of practical learning proposed by Kolb (1984), aims to provide an immersive and meaningful experience to students, stimulating not only the memorization of the rules, but also the understanding of their importance and practical application. Following the norms of active pedagogy, as emphasized by Freire (1996), the workshop seeks to empower students as active agents of their own learning, promoting autonomy and responsibility in the laboratory environment.

Thus, it is believed that the study proposed in this work has been of paramount importance to broaden the understanding of students who volunteered to participate, on a voluntary basis, on a non-profit basis, contributing significantly to the accumulation of knowledge in the field addressed. The research questions that guide this study are: What

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are the students' perceptions of the effectiveness of the workshop in conveying concepts of laboratory safety? What challenges and difficulties do students face in applying safety rules during laboratory activities?

By investigating these issues, it is intended not only to evaluate the effectiveness of the workshop, but also to identify areas for improvement that can contribute to the development of more concrete and effective educational procedures in teaching laboratory safety. This study aims to offer valuable insights to educators and researchers interested in promoting quality and relevant education in the context of exact sciences in Brazil.

THEORETICAL FRAMEWORK

SAFETY IN THE CHEMISTRY LABORATORY

Safety in the chemistry laboratory environment is a central concern for both educators and students, being essential to prevent accidents and ensure the physical and emotional integrity of those involved. According to Machado (2005), experimental practice in chemistry involves the handling of potentially hazardous chemical substances and delicate equipment, making it essential to know and apply safety standards and procedures.

According to Nascimento (2019), the basic safety standards in the laboratory include measures such as the use of personal protective equipment (PPE), such as aprons, gloves and goggles, the correct handling and storage of chemical substances, in addition to knowledge and respect for chemical waste disposal procedures. These precautions are intended not only to protect students from probable accidents, but also to foster an understanding of responsibility and awareness of the threats related to laboratory practices.

Authors such as Andrade (2008) emphasize the importance of continuous training of chemistry teachers in relation to safety issues, in order to ensure safe and responsible practice in the laboratory. In addition, educating students about safety rules from the first grades of school education is essential to provide an understandable and permanent safety culture.

Thus, safety in the chemistry laboratory environment does not consist only in compliance with standards and procedures, but also includes the rise of a behavior of prudence, commitment and mutual empathy among all participants in the laboratory space. It is through the understanding and permanent application of these rules that an assured

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and advantageous place for the teaching and learning process in the area of chemistry is constituted.

PEDAGOGICAL APPROACHES IN THE TEACHING OF LABORATORY SAFETY

In the circumstance of teaching laboratory safety, it is necessary to point out the pedagogical approaches used to ensure the applicability of the teaching and learning process of those involved. As highlighted by Sato (2011), traditional pedagogy, centered on the transmission of content in an expository way, has historically been predominant in the teaching of chemistry. However, this may not be the most, or only, appropriate approach when it comes to fostering a firm and ongoing understanding of safety standards in the laboratory.

Thus, engaging teaching practices appear as favorable proposals for the teaching of laboratory safety. According to Freire (1996), active pedagogy values the active participation of students in the learning process, encouraging critical reflection and the collaborative construction of knowledge. This approach aims to engage students as individuals who participate in their own learning, making them responsible for their education and progress.

Kolb (1984) proposes the theory of experiential learning as a basis for active pedagogical approaches. According to this theory, learning is most effective when students have the opportunity to directly experience learning situations, reflect on their experiences, draw conclusions, and apply this knowledge in new contexts. Thus, when teaching laboratory safety, it is essential to provide students with practical experiences in the laboratory, providing those involved with their own experience in relation to safety standards in practice.

In addition, as emphasized by Giani (2010), the humanized approach in the teaching of laboratory safety goes beyond the simple transmission of rules and norms, seeking to promote a deeper and more meaningful understanding of the concepts involved. This entails not only teaching the norms and rules, but also arguing the reasons behind them, encouraging reflection on the dangers and repercussions of laboratory practices, and providing an understanding of responsibility and mutual care among students.

Therefore, by assuming engaging and humanized teaching practices in the teaching of laboratory safety, teachers can contribute significantly to the formation of more

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responsible, aware and disciplined students to deal with the difficulties of the chemistry laboratory environment.

EXPERIENCES OF WORKSHOPS AND PRACTICAL ACTIVITIES IN THE TEACHING OF CHEMISTRY

Practical activities and workshops in the teaching and learning of chemistry play an indispensable role in promoting meaningful learning and building practical knowledge in students. As highlighted by Andrade and Massabni (2011), practical activities allow students to directly experience the theoretical concepts learned in the classroom, providing a deeper and more concrete understanding of chemical phenomena.

In this aspect, the workshops stand out as an efficient strategy to engage students in an active and participatory way in the learning process. According to Oliveira and Santos (2022), the workshops offer an environment conducive to the practical exploration of concepts, encouraging experimentation, creativity, and collaboration among students. By producing practical group activities, students have the possibility to share knowledge, debate conceptions and develop learning collectively.

A practical demonstration of this approach is the workshop "Basic Laboratory Rules: Exploding Everything", held at IFAM *Campus* Humaitá. This workshop, in addition to disseminating theoretical knowledge about safety in the laboratory, provides those involved with the possibility of developing practical experiments, providing the opportunity to experiment with the safety standards in execution. This approach is compared with the observations of authors such as Santos and Menezes (2020), who highlight the importance of practical activities in chemistry teaching to promote meaningful and lasting learning.

In addition, these authors highlight the benefits of practical activities in the development of cognitive, social and motor skills of students, in addition to contributing to the increase of interest and motivation in the discipline of chemistry. In this way, by introducing workshops and practical activities into their teaching approaches, chemistry teachers are able to enable a more integral and enriching learning experience for their students, preparing them to deal with the demands of the real world of chemistry.

STUDIES ON STUDENTS' PERCEPTIONS IN LABORATORY ACTIVITIES

Understanding students' perceptions of laboratory activities is essential to analyze the effectiveness of these educational experiments and recognize fields for improvement in

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chemistry teaching. According to Braga and Vogel (2023), studies that investigate students' perceptions of laboratory activities provide valuable knowledge about how students perceive the laboratory environment, their practical experiences, and their understanding of chemical concepts. Therefore, it is important to understand student perceptions to improve the quality of teaching and design more effective laboratory activities.

A study conducted by Carriello et al. (2023) investigated students' perceptions of practical chemistry activities. The results indicated that the students valued the practical activities as an opportunity to apply the concepts learned in the classroom in a concrete and tangible way. In addition, the students highlighted the motivating aspect of the practical activities, which contributed to their interest and engagement in the chemistry discipline.

Another relevant study was conducted by Gomes (2017), who investigated the perceptions of university students about their experiences in chemistry laboratory activities. The results showed that students perceived laboratory activities as an opportunity to develop practical and technical skills, as well as deepen their understanding of the theoretical principles of chemistry. The students also highlighted the importance of *feedback* from teachers during practical activities, which contributed to their learning and self-confidence in the laboratory.

In the context of the workshop "Basic Laboratory Rules: Blowing Everything Up", understanding the perceptions of the participants involved in relation to experimental practice is essential to analyze its applicability and identify probable fields and possible improvements. By investigating participants' perceptions through qualitative methods such as interviews and questionnaires, it is possible to gain valuable insights into how students perceive safety rules in the laboratory, their hands-on experience during experiments, and their motivation to adhere to safe practices in the laboratory setting.

Therefore, studies on student perceptions of laboratory activities provide a solid basis for the development of more effective and student-centered educational strategies, contributing to the continuous improvement of chemistry teaching and to the promotion of a culture of safety and responsibility in the laboratory.

METHODOLOGICAL PROCEDURE

To achieve the objectives of this study, we adopted a qualitative research approach, based on understanding the perceptions of the participants of the workshop "Basic Laboratory Rules: Blowing Everything Up". The choice for a qualitative approach is justified

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by the need to deeply explore the experiences and impressions of the participants in relation to the workshop, enabling a richer and more contextualized understanding of the phenomena under study.

The sample was composed of 20 students from the technical courses of IFAM *Campus* Humaitá, who voluntarily participated in the workshop. The selection of participants was intentional, aiming to include students with different levels of previous experience in practical laboratory activities. Inclusion criteria were established to ensure sample diversity:

- Students enrolled in technical courses at IFAM *Campus* Humaitá;
- Participants of the workshop "Basic Laboratory Rules: Blowing Everything Up";
- Availability and consent to participate in the interviews and answer the questionnaires.

Semi-structured interviews and structured questionnaires were used for data collection. The choice of semi-structured interviews is due to their flexibility, allowing them to explore emerging themes during the conversation and gain a deeper understanding of participants' perceptions. The interviews were conducted individually and lasted between 20 and 30 minutes. The interview questions were elaborated based on the objectives of the study and the main areas addressed in the literature review, ensuring that all relevant aspects were explored.

Structured questionnaires were applied to collect demographic data and complementary information about the participants' experience in practical laboratory activities. The questionnaire included questions about age, gender, academic background, and previous laboratory experience, as well as specific items about the perception of the workshop.

The results collected during the interviews were reproduced in full and required a content analysis, from the perspective of Bardin (2011). This methodology makes it possible to detect models, themes and categories resulting from the participants' narratives. This analysis development covered the following steps:

> Pre-analysis: at this stage, the transcripts were read repeatedly for an initial familiarization with the material. Preliminary notes were made and recurring themes were identified; Coding: the data were segmented into units of meaning, which were coded according to the emerging themes. Open codes were used, allowing the identification of new categories during the process; Thematic grouping: the codes were grouped into larger thematic categories, which reflected the main topics of

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> interest of the study, such as perception of the workshop, challenges in the application of safety rules; Interpretation: the thematic categories were analyzed and interpreted in the light of the theoretical framework and the objectives of the research. Direct quotes from the participants were used to illustrate the main findings, providing a detailed view of the students' perceptions. (Bardin, 2011).

The results acquired from the questionnaires were statistically examined to enable a demographic scenario and integrate the qualitative data obtained during the interviews. The answers to the completed questionnaires were standardized and analyzed using specified methods to verify schemes and trends.

Thus, this demanding procedure enabled a detailed investigation of the points of view of those involved in the workshop "Basic Laboratory Rules: Exploding Everything", collaborating for the process of knowledge in the area of chemistry teaching and for the improvement of pedagogical standards in the educational context.

RESULTS AND DISCUSSION

The analysis of the data obtained through the interviews and questionnaires revealed significant perceptions about the understandings of the participants of the workshop "Basic Laboratory Rules: Exploding Everything". The results presented below provide a comprehensive overview of the participants' experiences, reflections and opinions regarding the workshop.

- Insights into the hands-on, interactive approach

Participants expressed significant appreciation for the practical approach of the workshop, highlighting that conducting real experiments provided a more concrete and meaningful understanding of laboratory safety rules. Many participants mentioned that the practical experience facilitated the memorization and application of safety standards.

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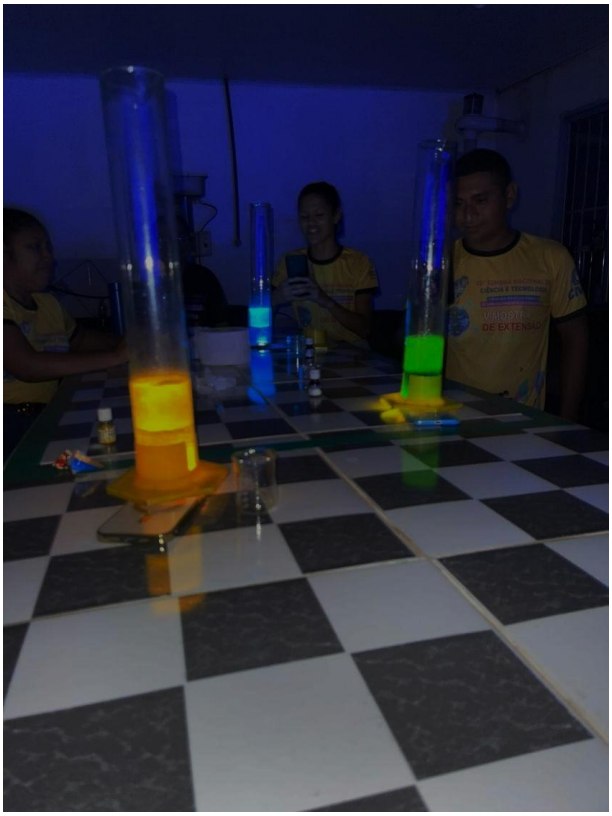
FIGURE 1: HOMEMADE LAMPSHADE EXPERIMENT



SOURCE: OWN AUTHORSHIP

"It was very good to be able to do the experiments for real. We learn better this way, getting our hands dirty." (Student A).

These findings are in line with the research of Silva (2006), who highlights the benefits of practical activities in the engagement and motivation of students, providing more effective learning.

However, some participants reported difficulties in correctly applying safety rules during the experiments. These challenges have been attributed to the complexity of some standards and the need for more individualized guidance.

"Some rules are difficult to remember when doing the experiment. It would be good to have more help from teachers." (Student B).

According to Gomes (2017), the need for continuous and personalized feedback is crucial to ensure that students understand and correctly apply safety standards, an observation that corroborates the participants' reports.

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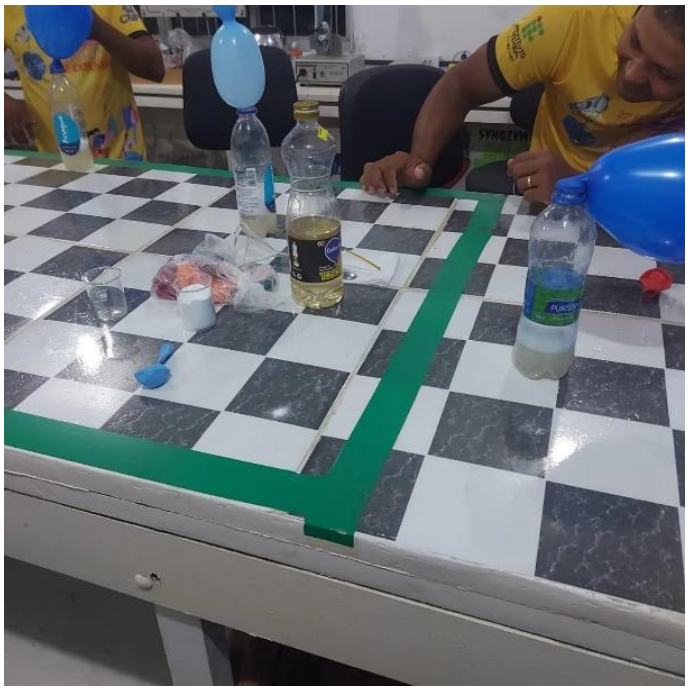
- Impact of interaction and collaboration

The interaction and collaboration between colleagues during the workshop was widely appreciated by the participants. They reported that working in groups and exchanging knowledge with colleagues made the workshop more attractive and stimulating, increasing their engagement and motivation to learn.

FIGURE 2: BALLOON BLOWING EXPERIMENT



SOURCE: OWN AUTHORSHIP

"Working in a group helped a lot. We learn from our colleagues too." (Student C).

These results are consistent with the active pedagogy approach proposed by Freire (1996), which values the active participation of students and the collaborative construction of knowledge.

- Challenges and needs for improvement

One of the main difficulties mentioned by the participants was the lack of individualized feedback during the workshop. Many felt that closer and more specific guidance could have helped to clarify doubts and improve the application of safety rules.

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FIGURE 3: HOMEMADE LAMPSHADE EXPERIMENT

SOURCE: THE AUTHORS

"It would be nice if teachers could follow more closely and give personalized tips." (Student D).

These reports reinforce the importance of continuous and personalized feedback in the learning process, as discussed by Gomes (2017).

Participants suggested several improvements for future editions of the workshop, including more practice sessions, greater availability of instructors for individualized guidance, and the inclusion of support materials such as safety manuals.

"I think more time to practice would be great. It would also be nice to have a manual with all the rules." (Student E).

The results of this study confirm several observations of the existing literature. The appreciation of real practice and the need for *continuous feedback* are in line with the research of Silva (2006) and Gomes (2017). The effectiveness of interaction and collaboration in increasing student engagement and motivation is also well documented by Freire (1996).

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However, the challenges reported by participants, such as the difficulty in applying complex rules and the need for individualized guidance, point to areas of improvement that are not so often discussed in the literature. These findings suggest that while the hands-on, interactive approach is effective, it needs to be complemented by pedagogical strategies that offer more personalized support to students.

The results of this study highlight the effectiveness of the workshop "Laboratory Ground Rules: Blowing It Up" in promoting meaningful learning and engagement on laboratory safety. However, they also reveal the need for improvement, especially in terms of individualized feedback and personalized guidance. These findings offer valuable insights for the development of future pedagogical strategies in chemistry education, contributing to the promotion of a culture of safety and responsibility in the laboratory.

FINAL CONSIDERATIONS

This study sought to examine the perceptions of the participants of the workshop "Basic Laboratory Rules: Exploding Everything", inserted in the context of chemistry teaching. The research adopted a qualitative approach to analyze in depth the experiences and reflections of those involved. The results obtained revealed a significant range of understandings about the effectiveness and impact of this current educational practice, evidencing both its main attributes and the areas with potential for improvement.

One of the main conclusions of this study is the importance of a practical and interactive approach in teaching laboratory safety. The opportunity to conduct real experiments provided participants with a concrete and meaningful experience, allowing them to apply the theoretical concepts learned in the classroom in a practical and tangible way. This approach is in line with the recommendations of authors such as Silva (2006), who highlight the benefits of practical activities in the engagement and motivation of students.

In addition, the emphasis on peer interaction and collaboration during the workshop was effective in strengthening cooperative learning and knowledge exchange. Educators from different disciplines can adopt similar strategies to foster active participation and excitement in students. Elements such as group activities and collaborative discussion can be integrated into hands-on activities to promote more dynamic and engaging learning.

Although the data obtained are propitious, the result of this study manifests some problems that point to gaps for future research. Future studies would be able to deepen

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this analysis, involving students from different locations and pedagogical environments, with the objective of acquiring a broader view of the reality of the workshops involving the study of laboratory safety.

Another area to explore in future research is the importance of continuous and personalized feedback. Complementary studies can investigate different ways of offering feedback to students during practical activities, analyzing the effect of these strategies on the assimilation and application of safety standards. In addition, the use of technological devices, such as instruction resources and instant opinions, can be classified as a possibility to provide personalized support in a competent way.

Also, investigating the real existence of aid components, such as safety guidelines and exemplified videos, could incorporate laboratory research and enable complementary instruments for students. Further studies will be able to verify how these resources motivate the teaching and learning process in the use of the safety guidelines applied by the students.

The workshop "Basic Laboratory Rules: Exploding Everything" stands out as an effective and motivating strategy to teach about laboratory safety at IFAM Campus Humaitá. By empowering students with essential safety knowledge, this initiative strengthens the quality of education and prepares future professionals to meet the challenges of the scientific environment.

It is hoped that the results of this study will serve as inspiration and guidance for new projects and research in the field of chemistry education. This contributes not only to the development of knowledge, but also to the continuous improvement of educational practices in Brazil. With a solid education aligned with the needs of the market, institutions and educators play a key role in ensuring that students are prepared for their future scientific careers.

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