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Fire: A dual force in chemistry – A safety culture questionnaire for chemistry students

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Abstract

The Chemistry Department constantly works to enhance students' safety awareness through courses, seminars, and symposiums. One of the most critical safety topics is fire safety guidelines. A questionnaire was prepared to assess the students' understanding of fires, and 127 undergraduate and postgraduate students in the Chemistry Department participated. The questions were prepared and focused on essential topics within the topic of the fire, through which the extent of students' knowledge of the research topic can be accurately determined. The Chemistry Department needs to make more efforts to enhance the safety culture, even though the students' answers can be considered valuable information. The students' suggestions came mainly from their need for more practical practices, firefighting activities, and the implementation of evacuation plans

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INTRODUCTION

The discovery of fire and its disciplined use is one of humanity's first and most critical innovations. Nowadays, we quickly start fires using lighters or matches, which is a quick and easy process, whereas, in the past, this process was not simple; it required people to keep the fire burning or re-igniting it with difficulty using friction heat. Fire is the rapid oxidation process of a burning substance resulting in heat and light, and the main combustion products are carbon dioxide, water vapor, nitrogen, and oxygen (Dhalait, 2019).

The statement "Fire is a good servant but a bad master" upholds an essential fact about our relationship with fire. Thus, those who use fire should know more about its characteristics and behavior in order to live with it as a friendly helper and not as a destroyer. This is not only important but extremely vital.

Nearly every place worldwide has a record of fires. Fires have happened and will continue to occur for various reasons, with significant implications for both people and nature. Today, science can help us understand complicated issues related to fires. Integrating fire science into management, training, and educating current and future fire professionals is paramount. Sustainable fire management will guide us to a safer future (Rego et al., 2021).

Fires have played a crucial role in the Earth's system for thousands of years, with atmospheric oxygen for combustion, forests for fuel, and lightning as an ignition source, as shown in Figure 1 (Bowman et al., 2009).

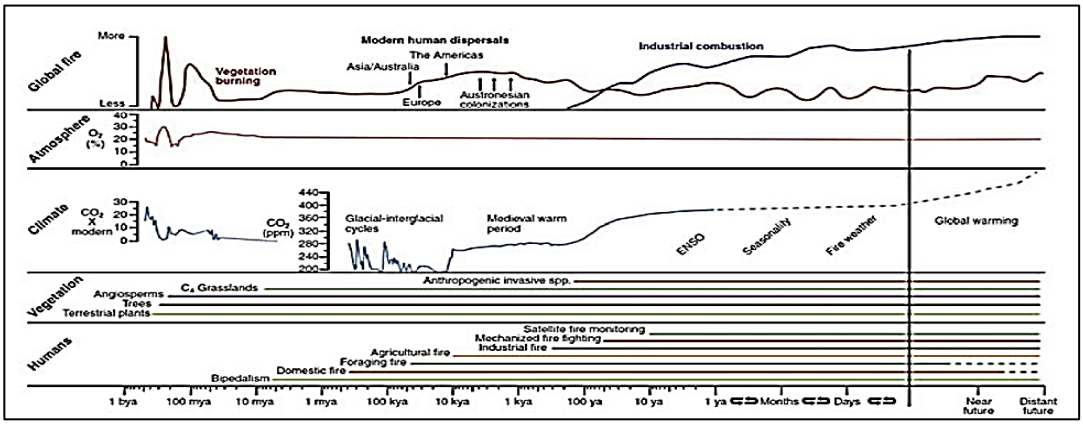

Figure 1. The Earth's system has been heavily influenced by fires, with atmospheric oxygen for combustion, forests for fuel, and lightning as an ignition source.

National Fire Prevention Association (NFPA) 921 defines fire as "A rapid chemical oxidation reaction, resulting in light and heat (Babrauskas, 2003). The main elements for combustion, or fire, are fuel, ignition source, and Oxidizing Agent, which comprise the traditional fire triangle.

In today's fire science literature, a fourth element is the chemical Chain reaction represented in the Fire Tetrahedron, which is necessary after ignition for the fire to be self-sustaining and spread through the fuel. Dust explosion, which occurs when fine particles suspended in the air in an enclosed area quickly burn, is the third theory of fire. It consists of five elements: combustible powder, dispersion of powder particles, oxidizing agent, ignition source, and confinement of the mixture (BSI, 2020).

There are five categories of fire, which primarily rely on the fuel type: Fires classified as Class "A" are started by ordinary combustible materials; Flammable liquids, combustible paints, petroleum greases, tars, oils, lacquers, alcohols, and flammable gases start class "B" fires. Class "C": electrical equipment fires. Class "K" pertains to fires in combustible cooking medium, while Class "D" deals with combustible metals (UOP, 2022).

METHOD

Research Design and Instrumentation

A questionnaire-based study assessed university students' awareness, knowledge, attitudes, and perceptions of fire and safety. To identify students' level of understanding in the Department of Chemistry for undergraduate and graduate studies, several questions on the main topics of fires were directed to 137 participants in this questionnaire. A schematic figure describes the study process, shown in Figure 2.

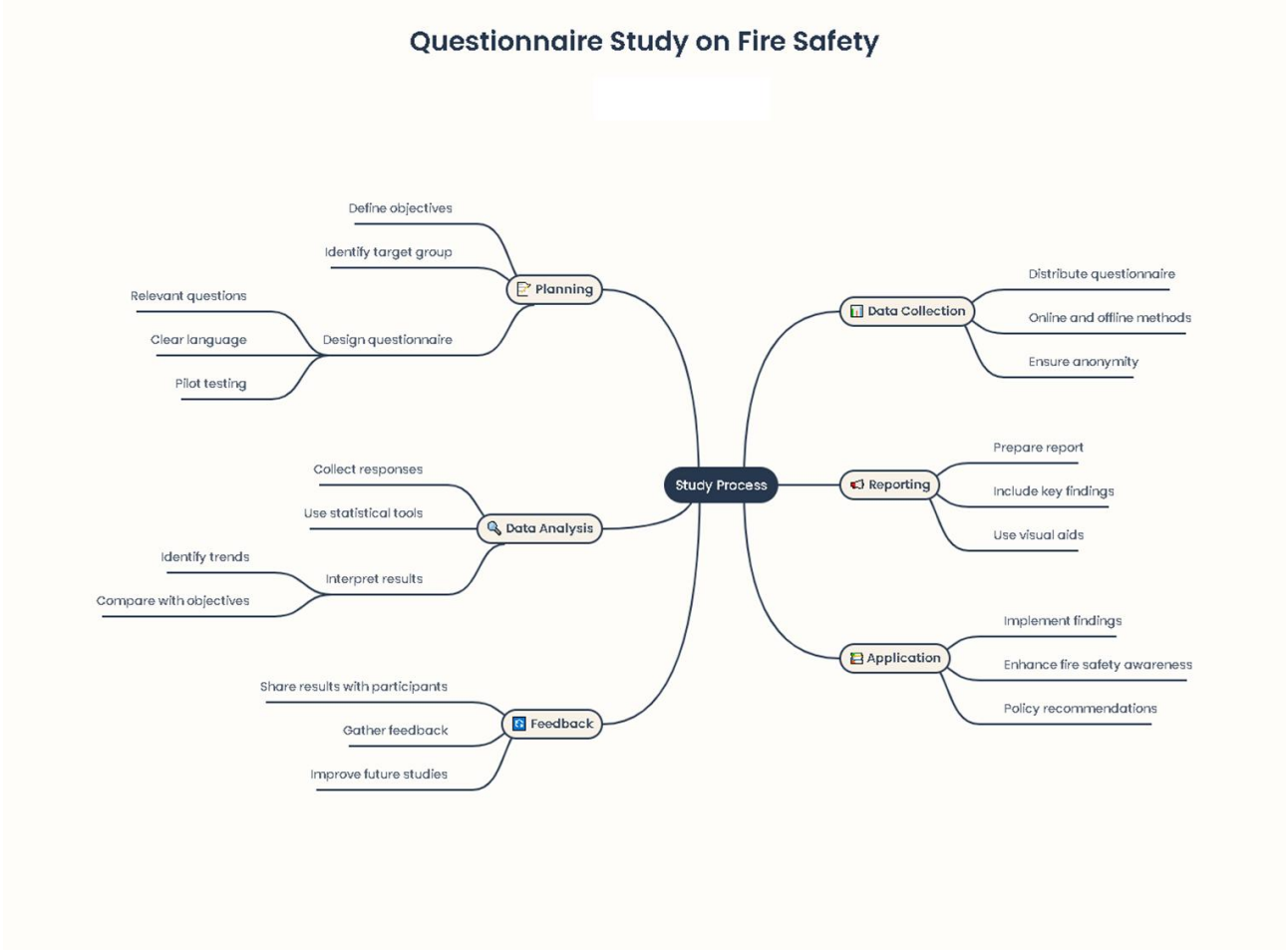

Figure 2. A schematic figure describes the study process.

The data gathered from the questionnaires underwent thorough statistical analysis, using suitable methods to determine the participants' levels of awareness, knowledge, attitudes, and perceptions.

Sampling Strategy and Response Rate

The study's participants were drawn from a major public university in Iraq. The sampling method focused on undergraduate students, yielding an 88% response rate.

Data Analysis and Interpretation

The data were analyzed using descriptive statistics, including frequencies, percentages, and means. Inferential statistics were applied using Microsoft Excel to examine differences in awareness levels across various disciplines and education levels.

FINDINGS AND DISCUSSION

Findings

In a question directed to the students about their knowledge of the causes of fires and fire theories, the answers to the first question were excellent, as 99.2 % of them answered that they know the causes of fires, as shown in Figure 3, and this is a good indicator that reflects the department's interest in spreading the culture of safety among students through scientific seminars and lectures. As for fire theories, the

percentage was lower, as 66.9% of students expressed their knowledge of this (see Figure 4), while the remaining part expressed their lack of understanding. This requires involving students in development programs for safety culture.

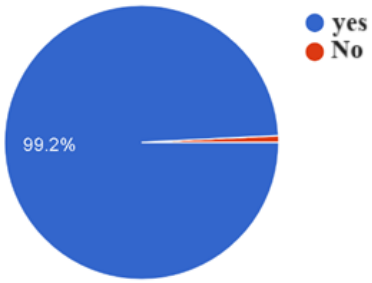

Figure 3. Student knowledge of the causes of fires

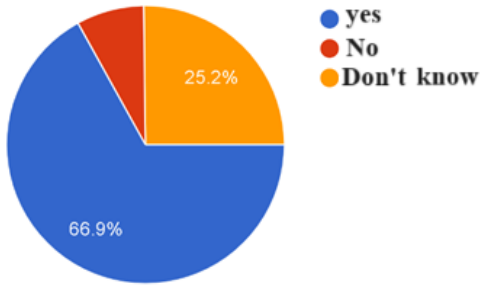

Figure 4. Student knowledge of the theories of fires

Cooking fires

Cooking is the leading cause of house fires. According to the NFPA, 1 in 8 homes will have a cooking fire yearly. The leading causes of cooking fires are unattended food on the stovetop, leaving burners on after cooking, and placing combustible materials too close to heat sources.
Our question for the students is: How do you put out burning oil in the kitchen?

The answers came at a reasonable rate (75.6%), indicating that extinguishing requires a special extinguisher. This shows that the students understand that oil fires are different from other types of fires and that extinguishing them requires a particular type of extinguisher. 2.3% of the students answered that the great danger lies in using water to extinguish. Figure 5 shows the students' answers about cooking fires.

In connection with kitchen accidents, cooking gas is a fundamental factor in kitchen fires. The question for students was how to deal with a cooking gas leak. Coping with such dangerous situations requires extensive knowledge of the procedures for gas leaks or gas fires. Around 78% of students answered that they did not know or did not have any information in this regard (see Figure 6), which indicates the need to educate on this aspect by implementing practical practices and applications to prevent gas accidents or the correct behavior in the event of a gas leak.

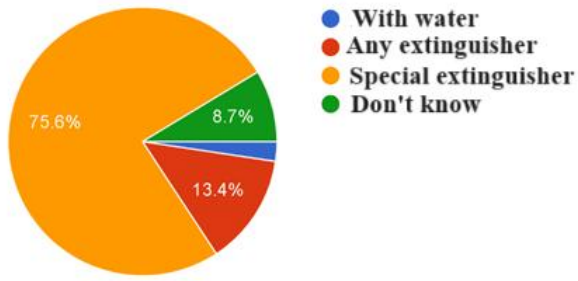

Figure 5. Student's answers about cooking fires

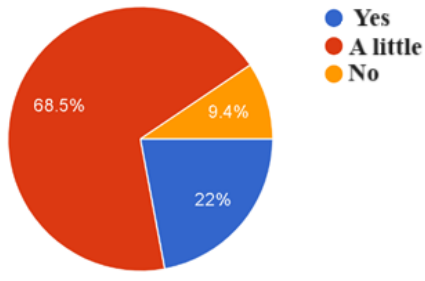

Figure 6. Voting rate for a question related to cooking gas leak

Fire extinguisher and fire alarm

Fire prevention is a priority, but extinguishing procedures are also necessary and require attention. The essential elements of fire have been mentioned, and we are referring to the means of extinguishing fires. Removing any or all aspects of fire is considered an extinguishing process, mainly starvation, smothering, and cooling.

When students were asked whether they had fire extinguishers or fire alarms in their homes, the answers indicated that more than 57% did not have fire extinguishers, as shown in Figure 7, and more than 81% did not have fire sensors (see Figure 8). This highlights the need for more culture and training in this regard.

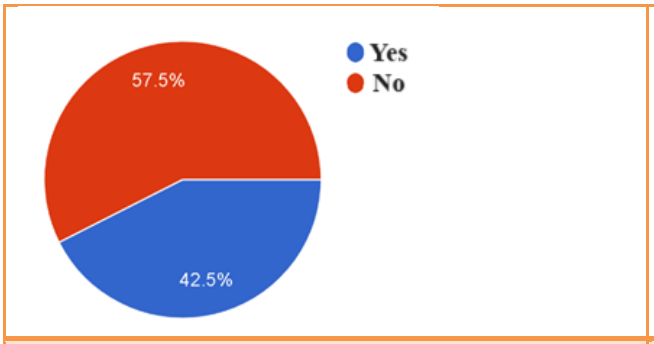

Figure 7. Student Fire Extinguisher Possession Questionnaire

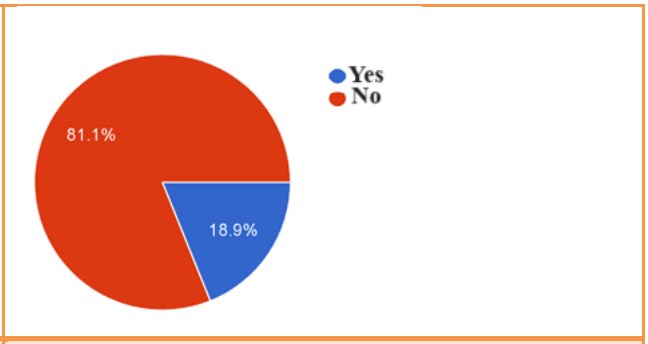

Figure 8. Student Fire Sensors Possession Questionnaire

Material Safety Data Sheet (MSDS)

Several sources of information on fires exist, the most important of which is the internationally recognized Safety Data Sheet (SDS). In the United States, the SDS was previously known as the Material Safety Data Sheet (MSDS).

The document thoroughly details the substance or mixture's composition, physical and chemical properties, and health and environmental impacts. It also contains instructions on the handling, storage, and disposal of the product (Willey, 2012).

Students were asked if they knew how to get information about fires and how familiar they were with the Safety Data Sheet. More than 60% answered the first question that they could obtain such data, as shown in Figure 9. Using the Internet is one of the most critical methods. Still, about 50% indicated they were familiar with the Safety Data Sheet (see Figure 10), considering that the Chemistry Department has distributed such documents to the laboratories.

These percentages are not considered encouraging, given that the Chemistry Department has made great efforts to educate students through a specialized course on safety issues, lectures, seminars, and discussion groups to enhance the safety culture.

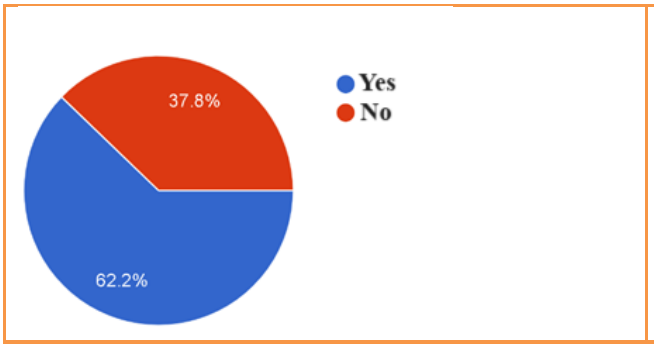

Figure 9. Student answers: Do you know how to get fire information?

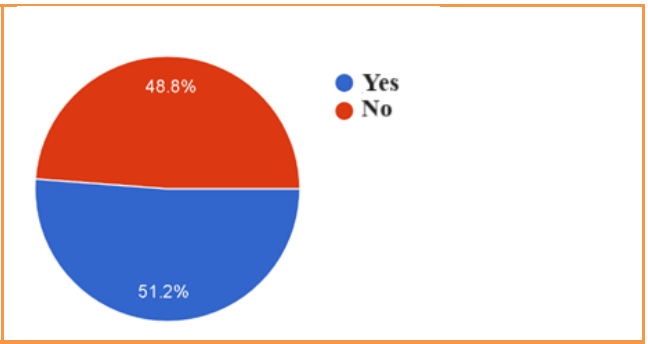

Figure 10. Students' answers about how familiar they were with the Safety Data Sheet

Students' Suggestions

After the students answered the questionnaire questions, which allowed us to determine the extent of their knowledge of an important topic—fires—there was a final question: Do you have any suggestions you would like to share regarding the subject of fires?

Through this, we can identify whether the students have information or suggestions about the research topic. 19.7% answered that they have suggestions, as shown in Figure 11. This can be summarized as the students' need for more information that the department is required to educate them about, in addition to a vital topic: conducting firefighting practices with the participation of students, activating emergency plans, and adopting them as an annual activity.

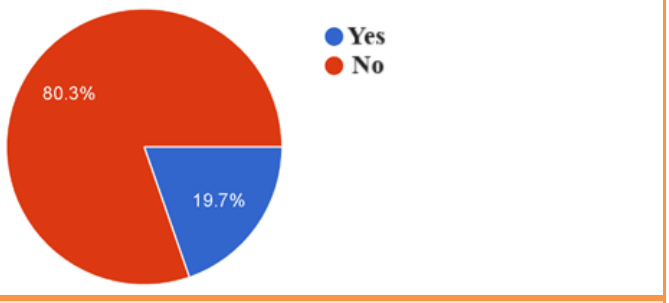

Figure 11. Students' Suggestions

CONCLUSION AND IMPLICATION

Fire can be defined as "a rapid chemical oxidation reaction, resulting in light and heat. The main elements for combustion or fire are fuel, an ignition source, and an oxidizing agent, which comprise the traditional fire triangle. A questionnaire was prepared for the students of the Chemistry Department to determine the extent of their knowledge of a significant topic, fires, through questions formulated by the researchers. In summary, the results indicate that while most students have a basic understanding of fire safety, there are significant gaps in knowledge and preparedness, particularly in specific scenarios like cooking fires and gas leaks. Additionally, the low possession rates of fire extinguishers and sensors among students suggest that further efforts are needed to enhance their practical fire safety measures.

Therefore, the authors recommended the following points as crucial to undertake:

- Enhanced Training: Conduct more frequent and focused workshops on specific fire safety scenarios, such as handling cooking fires and gas leaks.
- Practical Demonstrations: Include hands-on demonstrations of fire extinguisher use and the importance of fire sensors.
- Mandatory Safety Equipment: Encourage students to equip their living spaces with fire extinguishers and sensors.

These steps will help ensure that all students in the Chemistry Department are fully equipped with the knowledge and tools to handle fire-related emergencies safely.

REFERENCES

Babrauskas, V. (2003). *Ignition handbook*. Fire Science Publishers/Society of Fire Protection Engineers.

BSI Engineering. (2020). Dust Explosion Pentagon: Protecting Your Process (White Paper - Volume 2). Retrieved from https://bsiengr.com/wp-content/uploads/2020/10/Dust-Explosion-Pentagon.pdf

Bowman, D., Balch, J., Artaxo, P., Bond, W., Carlson, J., Cochrane, M., D'Antonio, C., DeFries, R., Doyle, J., Harrison, S., & Johnston, F. (2009). Fire in the Earth system. *Science*, 324(5926), 481–484.

Dhalait, I. (2019). *Chemistry of fire*. Science Reporter.

Rego, F., Morgan, P., Fernandes, P., & Hoffman, C. (2021). *Fire science: From chemistry to landscape management*. Springer Textbooks in Earth Sciences, Geography and Environment.

South Australian Metropolitan Fire Service. (n.d.). Home fire safety fact sheet: Extinguishing a fire. Retrieved from https://www.mfs.sa.gov.au/community/safety-and-education/fact-sheets-and-brochures/fact-sheet-pdfs/MFS-fact-sheet-Extinguishing-A-Fire.pdf

University of Pennsylvania, Division of Public Safety. (2022). *Guideline 5: Classes of fire*. Retrieved from https://www.publicsafety.upenn.edu/files/2022/03/Guideline_5._Classes-of-fire.pdf

Willey, R. (2012). Understanding a safety data sheet (SDS) in regard to process safety. *Procedia Engineering*, 45, 857–867.