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Your Favorite Beverage is an Opportunity to Talk About Chemistry: Didactic Application to the Brazilian High School

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"Let he who has had neither doubts nor difficulties in Chemistry in his school life cast the first pipette." This science is full of information but it is often limited to formulas, memorization of concepts, experiments in laboratories and activities that only focus on its contents. The world must be seen through the eyes of science which must be used as a tool that helps to explain phenomena of nature so that all knowledge learned in school may be used for benefiting human beings. Therefore, this study aimed at making Chemistry accessible and attractive by using contextualized dialogues about "favorite beverages and their Chemistry". This study was developed by a High School senior who goes to the Instituto Federal do Triângulo Mineiro - *Campus* Uberlândia Centro, Uberlândia, Minas Gerais (MG), Brazil. Contextualizing Chemistry was a tool that made teaching easier since students participated and mentioned their favorite beverages, such as soft drinks, coffee, alcoholic drinks and energy drinks. Teachers had the opportunity to teach several chemical concepts, such as methods of separating mixtures, fermentation and molecules, besides chemical structures of sugar, caffeine, ethanol and taurine. Teachers and students also talked about solubility of gas in liquid and dissolution of carbon dioxide in manufacturing of carbonated drinks. This project showed that contextualized Chemistry teaching makes students construct their own learning process.

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1. Introduction

The scientific field has developed fast in the last decades; as a result, some theories were refuted and new knowledge has been discovered. Thus, teachers in the field of Natural Sciences must continuously search for new teaching methods

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to teach it to their students. Updated teachers try to avoid traditional teaching by proposing new ways of developing scientific knowledge so that students may really learn different concepts. Therefore, contextualization keeps being important in teaching and learning processes since it is a fundamental strategy to construct significance while it incorporates tacitly perceived relations. The rhizome of the construction of meanings is constituted by using and incorporating relations experienced in the context where the originate and intertwine with reality; in other words, it is contextualization. The term context is often used for referring to a certain situation [1]. To know the context means to have better conditions to appropriate certain knowledge and some information, for instance.

Chemistry plays an essential role in the analysis of products consumed by people worldwide. For example, soft drinks emerged in Brazil around 1906 and consumption per capita is 69 L/inhabitant these days; this beverage is highly consumed by youngsters nowadays [2]. Regarding students' everyday lives, cold drinks have been part of their meals, a fact that also arouses concern for their toxicity [3]. Since coffee is one of the most consumed beverages worldwide, it may be a strong instrument to teach Science [4]. Coffee contains many chemical components, such as alkaloids, phenolic acids, flavonoids and terpenoids, which are the basis of its biological function and taste [5]. Talking about alcoholic drinks in Chemistry teaching has already been the target of some studies in Brazil since it encourages self-directed learning and promotes some skills, such as problem-solving and critical thought [6]. Energy drinks, which are composed of taurine, caffeine and glucuronolactone, are usually consumed not only to increase physical conditions and the alert state but also to avoid sleep [7].

The contextualization shown in the previous paragraph connects Chemistry teaching more to young students' reality. When Chemistry teachers teach this way, they help students understand the content since they develop skills needed to relate, for instance, scientific knowledge to beverages that are part of their everyday lives. To contextualize chemical concepts invites students to actively participate in the construction of knowledge and reinforces that this methodology is a promising strategy to reach significant learning [8].

Based on the previously mentioned facts, this study aimed at carrying out a contextualized scientific dialogue with High School seniors in southeastern Brazil. The socio-educational spectrum of the theme "favorite beverages" enabled them to experience learning that was rich in chemical concepts.

2. Material and Methods

The origin of the study was a pilot project carried out at the Instituto Federal do Triângulo Mineiro - *Campus* Uberlândia Centro, which is a federal institution in Brazil that offers Basic, Technical and Technological Education (its acronym is IFTM - UDICENTRO). The project was developed by a High School senior who has a scholarship and attends the technical course in Commerce. It aimed at investigating the use of contextualization in Chemistry teaching and whether this methodology leads to positive changes in learning. All parameters used by this study were qualitative ones. The target was a group of High School seniors. Thirty 16-18-year-old students – mainly women – were active participants in the investigation. It should be highlighted that several teaching and research projects that are conducted by authors that belong to the IFTM – UDICENTRO have been successfully reported by papers that have been published by renown journals [9-11]. Productive experiences have encouraged researchers to carry our further studies in the field of chemical Education.

The methodology of this study aimed at going beyond teaching of scientific concepts and ideas since it focused on the fact that schools must provide conditions so the students may know the culture of science. To carry out deep dialogues about chemical themes is to teach what really interests students, rather than wasting time on small talk. In the process, students bring up their doubts and the teacher inserts them into the universe of sciences, i. e., he/she teaches students to construct knowledge and makes them perceive the phenomena of nature so that they may be able to construct their own hypotheses, develop their own ideas and organize them to try to explain the phenomena. When teachers teach Sciences through investigation [12], students are asked to look at real-world issues and then they find out that they are able to develop strategies and action plans. In short, this study was methodologically based on Chemistry teaching that proposes to prepare students who develop skills in class to act consciously and rationally outside school.

3. Results and Discussion

The theme of this study is an instrument to teach Chemistry with the use of "favorite beverages and their Chemistry". Young adolescents who attend High School are energetic and curious, a fact that makes certain contents in Chemistry draw their attention. It should be pointed out that classes in which the teacher gives speeches and merely speaks about a certain content are boring and uninteresting. Students, even immature ones, must be involved in the whole process of knowledge construction. Involving students means creating a student-centered environment and using the knowledge and experiences they bring to class; thus, the methodology called "learning in collaboration or collaborative learning" is applied [13]. This way of addressing the content and constructing knowledge makes students more confident about their skills.

Throughout the dialogues about different beverages, empirical concepts of units of volume, mass, solutions, concentrations and relations between consumption and biochemical metabolism were addressed. The opportunity was also used for discussing dangers of alcoholic drinks and alcohol contents found in distinct trademarks, dangers of soft drinks due to high concentrations of sugar and artificial colorings, the way of dissolving gas in liquid with the use of high pressure, caffeine found in coffee, which is also sold as a sports supplement, and taurine found in energy drinks.

Table 1 summarizes Chemistry contents that were specifically contextualized by this study.

Unfortunately, decontextualized Chemistry classes – in which contents are fragmented and isolated from their contexts of scientific, educational and social production – have been common. Knowledge that is taught inappropriately is knowledge with no precursor, no origin, no place, transcendental. Teaching only aims at reaching results which are separated from the history of concept construction and merely collected from questions that originated them. From this poor teaching perspective, school curricula have become inappropriate to their reality since they focus on very formal contents that neither belong to the students' world nor construct a bridge between what is taught in school and what

is done, observed and experienced in everyday life [14].

Table 1. Chemistry contents contextualized to potentialize learning

Contextualized issues	Students' questions	Answers given to questions
Methods of separating mixtures	- How is artisanal *cachaça* made? - What is distilled beverage? - Are beverages homogeneous mixtures? - May beverages be considered a socio-scientific issue?	*Cachaça*, a distilled beverage whose alcoholic content ranges between 38% and 54%, has been acknowledged worldwide as being genuinely Brazilian. The method of simple distillation was explained as a way of separating liquids at different boiling points and of separating homogeneous mixtures from solids/liquids. Results show the importance of dealing with social classes in Science classes since they contributed to enrich discussions/speeches about consequences of alcohol consumption in the society.
Fermentation	- How is sugarcane juice fermented to produce ethanol?	Fermentation is a chemical phenomenon, with no oxygen, which transforms organic matter and releases energy. It is a common process in the beverage industry which uses fungi and bacteria to carry out the transformation. In sugarcane juice fermentation, there is a chemical reaction, catalyzed by enzymes that produce yeast, which breaks molecules of saccharose into glucose and fructose (enzyme invertase) and then transforms them into ethanol and carbon dioxide (enzyme zymase).
Atoms and molecules	- Which is the conceptual difference? - Which is the relation between atom and molecule? - How can I understand something that is not visible to the naked eye?	All matter consists of tiny particles called atoms, whose union by chemical bonds forms molecules. A molecule is a set of atoms that are chemically bonded and form compounds with specific chemical properties.
Compounds: sugar (saccharose), caffeine, ethanol and taurine	- Does table sugar consist of two molecules of different sugars bonded together? - Which are their chemical structures and functional groups?	The teacher wrote their chemical structures on the board and review their functional groups (**Figure 1**).
Solubility	- How is gas solubilized in a liquid? - Is there any special condition to make sparkling water or softdrink?	Gas solubility in liquids depends on three factors: pressure exerted on gas, temperature of the liquid and gas reactivity. Henry's Law: gas solubility is directly proportional to its pressure on the liquid.

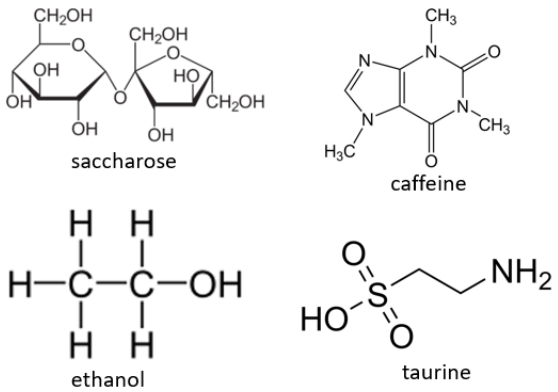

Figure 1. Chemical structures of compounds found in beverages that are part of students' everyday lives.

To reinforce this proposal of teaching contextualization, the teacher asked students spontaneously and informally which differences they could perceive between traditional Chemistry classes (decontextualized ones) and contextualized ones. To encourage contextualized teaching, some answers given by students are shown below:

(Student A): "My learning was actually better and I felt more involved and participative in class. I liked it when the teacher truly contextualized what I experience with my family and friends."

(Student B): "The way the teacher taught made me understand meanings better and relate it to previous experiences and my personal ones."

(Student C): "Contextualization in Chemistry classes enabled me to formulate problems, it was challenging and encouraged me to learn more, besides making me feel part of my own educational process. I actualy thought: Wow, I know Chemistry!."

(Student D): "It was extremely interesting to bring up relations among facts, objects, events, notions and concepts in class. It has actually changed the way I see and learn Chemistry, mainly because it contributed to show that Chemistry is definitely found in simple sparkling water. Now, I am able to explain it in detail."

(Student E): "The contextualized Chemistry class about our favorite beverages was different and I got very satisfied.

Now, when I go to the supermarket and look at the beverage aisle, I think about our classes and every chemical concept in those liquids in glass and plastic bottles and even in cans."

Education is a process that requires teachers to commit to citizens' development. Therefore, teachers must continuously search for scientific knowledge and new teaching practices, use precise scientific terminology, enable students to exchange ideas and design tasks that use scientific knowledge and active experimentation that are inserted in debates of interest to contribute to develop students who may change reality [15]. The theme addressed by this study highlighted the importance of scientific literacy since the discussion triggered the need to explore interdisciplinary contents connected to Chemistry, Biochemistry, Health-Medicine, Cultural History, family, social life, psychiatric disorders (interaction between drugs and alcohol) and contemporaneity (social behavior of adolescents who attend school). In short, scientific literacy is an innovative way of making students aware of their socio-scientific development [16].

4. Conclusions

Educators' primary responsibility in Chemistry – and other courses – teaching is to enable students to transform themselves to become more critical and conscious men and women. In Brazil, quality Education is believed to make students become agents of transformation in the world they live in. From the educational point of view proposed by this study, the conclusion is that students' motivation to learn significant and understandable contents through appropriate methods is a relevant factor in their concentration, attention and, consequently, significant learning.

In short, even though the theme contextualization is not a novelty in literature, its appropriate use must be advocated since it should not be restricted to mere insertion of facts and phenomena related to students' lives into classes and exams, such as the Exame Nacional do Ensino Médio (ENEM), which has been used for college application. The mere citation of everyday examples will never be enough to break the dichotomy between teaching that merely focuses on college exams and the one that aims at the development of critical citizens. Finally, contextualization must be understood as an attempt to add more sense to Chemistry teaching and to overcome content fragmentation with the use of interdisciplinarity.

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Author Contributions

G.G.G and M.L.D.M. outlined the whole research project. All authors contributed to the writing of the manuscript. M.L.D.M was in charge of the final review and submission to *Orbital: The Electronic Journal of Chemistry*.

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