

The Ludic and Human Rights: The Anti-Racist Fight in Science Education for a Political-Scientific Formation through Graffiti Art

Kleber Francisco da Silva ^a

Roberto Dalmo Varallo Lima de Oliveira ^b

Márlon Herbert Flora Barbosa Soares ^c

^a Universidade Federal de Goiás-UFG, Programa de Pós-Graduação em Educação em Ciências e Matemática, Goiânia, GO, Brasil.

^b Universidade Federal do Paraná-UFPR, Departamento de Química, Curitiba, PR, Brasil.

^c Universidade Federal de Goiás-UFG, Instituto de Química, Goiânia, GO, Brasil.

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ABSTRACT

Context: With the growing denunciations of violence and injustices in the social relationship, inside and outside schools, education based on human rights is insurgent in the current system of teaching and learning. Using the concept of school as a process of scientific, social and political construction, we planned the teaching and learning process of chemical interactions using the art of graffiti as a playful activity.

Objectives: Reflection on chemistry teaching beyond the concepts of natural sciences, but also towards social issues to promote an education that transfigures the traditional model established by the hegemonic power during Brazilian history. **Design:** We use an ethnographic case study as a method. **Scenario and Participants:** In this way, we chose to bring graffiti art to chemistry workshops, since the paints are fixed on urban walls through chemical interactions between substances, building images and/or protest phrases that make us rethink the injustices and inequalities existing in Brazilian society and to dialogue the emergence of this art in the black movement with the political aspects of Human Rights. Thirteen students enrolled in a state basic education high school in the city of Goiânia-GO, Brazil, joined the workshops on Human Rights, Graffiti and Chemistry. Eight graffiti artists also participated in the workshop for free.

Data collection and analysis: We used transcripts of semi-structured interviews and video-recorded workshops to categorise the data, analysing them with the Descending Hierarchical Classification technique and the use of dendrograms performed by the Iramuteq Software. **Results:** We obtained categories that evidence the chemical understanding of the content of chemical interactions and the socio-political understanding of human rights, and seven drawings on graffiti murals that show this

Kleber Francisco da Silva. Email: quimica.kleber@gmail.com

correlation. **Conclusions:** The transgression of morals and the empowerment of the subordinate promote playfulness in the individual or collective social visibility of individuals, enabling better assimilation of scientific and social content.

Keywords: Chemistry teaching; Graffiti; Ludic; Human rights; Racism.

Lúdico e Direitos Humanos: a Luta Antirracista na Educação em Ciências para uma Formação Político-Científica por meio da Arte do Grafite

RESUMO

Contexto: Com as crescentes denúncias de violência e injustiças na relação social, dentro e fora das escolas, a Educação pensada nos Direitos Humanos se faz insurgente ao sistema atual de ensino e aprendizagem. Tomando a concepção de escola como um processo de construção científica, social e política, planejamos o processo de Ensino e Aprendizagem das Interações Químicas utilizando a arte do grafite como atividade lúdica. **Objetivos:** A reflexão no Ensino de Química para além dos conceitos das ciências naturais, mas também para questões sociais a fim de promover uma Educação que transfigure o modelo tradicional estabelecido pelo poder hegemônico durante a história brasileira. **Design:** Utilizamos como método o Estudo de Caso do tipo Etnográfico. **Cenário e Participantes:** Optamos desta forma por trazer a arte grafite para as oficinas de Química, uma vez que as tintas se fixam nas paredes e muros urbanos mediante interações químicas entre as substâncias, construindo imagens e/ou frases de protestos que nos fazem repensar as injustiças e as desigualdades existentes na sociedade brasileira, e dialogar o surgimento desta arte no movimento negro com os aspectos políticos dos Direitos Humanos. Participaram da pesquisa treze estudantes matriculados no ensino médio de um Colégio Estadual de Educação Básica na cidade de Goiânia-GO, Brasil, que se inscreveram para participar das oficinas de Direitos Humanos, Grafite e Química, participaram também oito grafiteiros voluntários para o ensino da técnica artística. **Coleta e análise de dados:** Utilizamos as transcrições das entrevistas semiestruturadas e das oficinas gravadas em vídeo para categorizar os dados, analisando-os com a técnica da Classificação Hierárquica Descendente e o uso de dendrogramas realizadas pelo *Software* Iramuteq. **Resultados:** Obtivemos categorias que evidenciam o entendimento químico do conteúdo de Interações Químicas e do entendimento sócio-político dos Direitos Humanos, além de sete desenhos em murais de grafite que evidenciam essa correlação. **Conclusões:** A transgressão da moral e o empoderamento dos subalternizados promove o lúdico na visibilidade social individual ou coletiva dos indivíduos, possibilitando uma melhor assimilação de conteúdos científicos e sociais.

Palavras-chave: ensino de química; grafite; lúdico; direitos humanos; racismo.

INTRODUCTION

In this article, we advocate the importance of symbolically and affectively building the concepts of education in natural and social sciences for scientific learning and for an equal society in rights and plural in diversities, providing learning based on recognising the asymmetries of power that permeate society, as defended by Oliveira and Queiroz (2017), establishing a judgment on the logics of the normalisation of human rights violations¹ and proposing school teaching strategies that allow subaltern groups and subjects to be visible. The philosopher Giuseppe Tosi defends this format of education beyond the area of education:

Education for citizenship is one of the fundamental dimensions for the accomplishment of rights, both in formal education and informal or popular education and in the media. It is not only a matter of “learning” some content, of studying a “discipline”, but of promoting an ethical-political formation, which requires its own methodologies (Tosi, 2004, p. 12).

Science teachers who intend to plan their classes to build humanised values in school life with their students should seek a way to “pedagogise” their specific contents, permeating them with issues related to Human Rights Education (HRE)². After all, learning chemistry content when displaced from attitudinal issues does not ensure that students are educated with an appreciation for justice. Understanding “justice” as the relationship in which equal rights is ensured for any person, this term does not allow the exclusion of any human being and/or their rights to an egalitarian life.

In this context, education is defined as a transgressive theoretical practice of liberation grounded on the determinations and segregationist demands of white colonisation in the historical constitution of human society.

¹According to Tosi (2004), despite a difficult and divergent definition, Human Rights can be considered a social history written by the events of struggles, revolutions and socio-cultural movements, it is a human system forged in the ethical, political, legal, economic, social, historical, cultural and educational dimensions that make up human relations.

²Candau and Sacavino (2013) highlight the complexity and polysemy of human rights education today, taking on the perspective of forming subjects of law, empowering socially vulnerable groups and recovering the historical memory of the struggle for human rights.

It is a reflection about the impacts of European/hegemonic theoretical constructions in the classroom and the importance of teaching being conducted aiming to break with the colonial inheritances of inequalities.

Educational transgressions, recognised as practices of freedom by bell hooks (2013), aim to break with the imposing method of white-colonising thinking in history and current culture. These are actions of critical debates that escape the system of domination established in human construction, in the process of “decentralisation of authority and in the rewriting of the borderline institutional and discursive areas where politics becomes a prerequisite to reaffirm the relationship between activity, power, and struggle” (Hooks, 2013, p.173). Going through this notion of subversion to the dominant method, we ask: What aspects of HR emerge in the teaching and learning process of chemical interactions using the art of graffiti as a playful methodology?

THEORETICAL FRAMEWORK

Although the bibliography contains the history of the origin of graffiti as having begun in the ancient scriptures on Pompeii walls, in the Roman empire, drawings by indigenous tribes, and paintings on the walls of Paris in May 1968 during the French students’ political manifestations, it was in New York City and later in Brazil that graffiti gained its own contesting and transgressive aesthetic, which spread messages as a form of indignation to the whole world. The graffiti movement as we know it today came originally from the Bronx, Harlem, and Brooklyn neighbourhoods, places of refuge for Afro-Americans and Latinos. Graffiti emerged as one of the elements of the *hip hop* culture, which incorporates dance, music, and the fine arts into the language and needs of the streets of New York in the late 1960s, denouncing, among other topics, extreme poverty, violence, racism, absence of the State, and drug trafficking (Shishito, 2016). In Brazil, São Paulo was the first city to present this culture in the hybrid format of demonstrations. As in France, the first interventions of this kind were political and became important instruments for confronting the well-known “lead years” of the Brazilian military dictatorship from 1964 to 1985 (Shishito, 2016).

Most Brazilians were excluded from access to cultural goods, remaining only as a peaceful consumer mass. The dictatorial period prepared those oppressed subjects to accept the imposition established by the deterministic thought of command. “The dictatorship – including through the educational process – aimed fundamentally to keep the population as far as

possible away from the processes of education and culture” (Chauí, 2018, p. 201), thinking of cultural goods and culture, in this case, as a government “product” of ideals, emotion, and human appreciation, understanding that everyone is able to produce and consume culture, whereas in the capitalist process, “it is basic that there are many who produce for the profit of a few, in these non-democratic cultural processes there must be a few who produce culture, while the others consume it” (Chauí, 2018, p. 202).

Therefore, when we consume this cultural product, it comes intentionally impregnated with deterministic elements of those who produce and have access to this type of cultural episteme. Called by Andrade (2006) “National Security Doctrine”, this period of the military coup had their impositions disseminated in schools, universities, media, among others, as a “³ civic morality”, organised and centralised in a supposed social order, in artificially neutral scientific progress, in doubtful economic developmentalism and, finally, in a forcibly passive civism within the aggressive and unfair events against human life. Within this thinking, politics can directly and/or indirectly influence connections, attitudes, recognition, and community belonging (Andrade, 2006).

Reflecting on the possible relationships between the art of street graffiti and politics may be relevant in an attempt to understand the constitution of cultural morality that each student carries in their form of expression, i.e., to intend for transgressions on the violations of rights equality and through them to build their political criticism. Our look here investigates the art form produced on all its experienced contradictions. It is a skill that arises from the intentional exclusion of blacks, from the lack of access due to economic reason to other means of entertainment such as clubs, cinemas, and theatres.

It is an art that amuses and warns, bringing political knowledge into the consciousness of economic classes. The art to which the *Hip Hop* movement gave birth works as a sphere of provocation, almost always the only one those young people will be able to access in the peripheries, assuming they have the money to buy the sprays and listen to their songs, which requires financial power to happen (Shishito, 2016). However, it is not a matter of converting this

³According to Adela Cortina, morality is in everyday life and tries to offer normative and practical guidelines for human action. The hypothesis is that “morals should not be confused with what actually happens, but with the awareness of what should happen. Morality is concerned with what should be and from this duty to be critical of what happens” (Cortina, 1990, p. 204, emphasis added).

practice into a solution for all cases, it alone has no pedagogical effect of building all political, social, and economic principles. It is about historically raising awareness of their function and understanding their barriers so that the teacher can use it as a teaching and learning methodology.

Canclini (1998) defines graffiti as an art of production and circulation legitimised by the mestizos of the Latin American borders for the urban tribes of Mexico City, for equivalent groups of Buenos Aires or Caracas, as a territorial deed of the city, destined and affirmed by the presence of the subalternised. The struggles for controlling space are established between their own brands and changes of the others' graffiti. Their manual technique "structurally opposes political or advertising captions "well" painted or printed and challenges those institutionalised languages when it changes them. Graffiti affirms the territory but disrupts the collections of material and symbolic goods" (Canclini, 1998, p. 336). Denoting graffiti as an impure genre from the dominant perspective, Canclini continues.

Graffiti is a syncretic and cross-cultural medium. Some merge the word and the image with a discontinuous style: the agglomeration of signs by several authors on the same wall is like a handmade version of the fragmented and heterocyclic rhythm of the video clip (Canclini, 1998, p. 338).

The ambivalence of the graffiti is constituted by the simultaneity with which it serves to demarcate territories of ethnic or cultural groups and to disrupt the conception of pollution and contravention built by the elites. It is true that graffiti is already part of contemporary urban arts, although it has lost its transgressive interventions in the trajectory of this convention. Graffiti presents different processes and policies according to the intention of the agent or idealising group in its established period of time and space (Mondardo & Goetter, 2008).

Gradually it was transformed into gallery art, losing political strength as a space for intervention and discourse, placing it as resistance to an art model completely subject to the mechanisms of control of museums, galleries, biennials, and advertising (Costa, 2007). Therefore, necessary to rescue historical and political articulations for communication within the cultural reality of urban agents, graffiti establishes the democratisation of political relations that confronts the vertical domination of programmed social policies.

At the federal level, Law n. 9.605/98 sanctioned by President Fernando Henrique Cardoso, coming into force at the beginning of the same year,

prohibited graffiti and writing on the walls. With penalties and administrative sanctions for offenders, it “constitutes a crime against Urban Planning and Cultural Heritage, writing with paint on the walls, graffiti or otherwise defile buildings or urban monument” (art. 65 Law 9.605/98), with the expected penalty of detention from three months to one year and a fine. If the act is carried out in a monument or thing listed due to its artistic, archaeological or historical value, the penalty is from six months to one year of detention and a fine (Law no. 9.605, 1998).

After the expansion of graffiti as an art, Law No. 12.408, of May 25, 2011, sanctioned by President Dilma Rousseff, differentiated graffiti and writing on the walls, decriminalised the graffiti and provided for the prohibition of the marketing of paints in aerosol packaging to children under 18 years old (Law No. 12.408, 2011).

Thus, graffiti and writing on the wall can also be considered as appropriation (and even domination) of territories considered subaltern, underground, alternative, in the search for symbolic (and political) survival of those who seek shelter and protection, through the opposition to the order imposed by the State and bourgeois society (Mondardo & Goettert, 2008, p. 294).

Besides the playful aspect of demarcating territory and “scoring” higher in the dispute with other groups, graffiti has become the checkerboard of a minority. This art is also a reflection of the lack of alternatives for leisure, education, culture, and sport. With rebellion and boldness as characteristics, it is a form of expression and denunciation of the political situation of the country, highlighting the situation in which the youth find themselves. Antagonistic, the prohibition of the collective exercise of freedom and creation provided for in Law 9.605/98 contributes to the artists continuing to transgress, establishing themselves above possible criticism and acceptance of society.

Aiming at a teaching profile that the individual understands the points of tension so that a probable accommodation of knowledge is established in the teaching and learning process of chemical content, we planned the workshop of intermolecular interactions organised within a contemporary and latent context in the students’ lives, proposing why a type of paint interacts so strongly

with⁴ the place on which it was applied and thus explore the idiosyncrasies of black resistance in the historical path, passing through the *Hip Hop* movement and the art of graffiti to this day.

But after all, how do intermolecular interactions appear in this narrative? First of all, it is necessary to elucidate the substances that make up the paints. Overall and in a reduced way, there are three main components:

- **The resin** or polymer – is macromolecules, i.e., a long and resistant molecule, formed by smaller units called monomers (Atkins & Jones, 2012) – also called a non-volatile substance. It is a binding agent of the pigment responsible for the pigmented film;
- **The pigment** is a substance of organic or inorganic origin that determines the colour of the paint through its light-reflecting power (Fazenda, 2013);
- **The solvent**, also called a volatile substance, is responsible for dissolving the resin, which is temporarily in liquid form, giving the appropriate viscosity for its application. This is a physical property that characterises the resistance of a fluid to flow at a given temperature (Fazenda, 2013).

Among the ionic molecules and compounds of those chemicals, electromagnetic forces of attraction and repulsion provide specific characteristics and properties for the blend (paint). Those forces are defined as chemical interactions in chemistry teaching.

The subject is little discussed and, in most cases, each of the intermolecular forces is presented individually, without any correlation between them and, mainly, without connection with significant situations of the students' daily lives. Thus, the main problem regarding the teaching of intermolecular forces is that the context lacks significance for the students (Reis, 2008, p. 9).

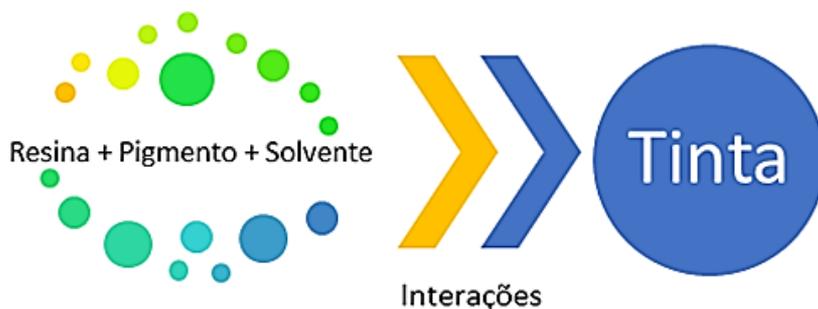
For this reason, we seek to present the content as an educational game, considering that it is half a game and half education, with different separations but always balancing the two functions between theory and practice (Soares,

⁴"In the electromagnetic system, the magnitudes are determined from the dimensions of the magnetic pole. According to Coulomb's law, the force between two electrical charges is given by $F = \frac{ee'}{r^2}$," (Maxwell, 1954 cited in Silva, 2002, p. 162).

2015). Chemical interactions are the forces of attraction and repulsion, of an electrostatic nature, that hold molecules together in solid and liquid states (Atkins & Jones, 2012). The ionic molecules and compounds of these three main substances: resin + pigment + solvent, interact with each other to form the expected final product, the paint, as shown in Figure 1.

Figure 1

Schematic representation of the formation of the blend known as paint



Chemical interactions can occur between molecular compounds (Intermolecular Interactions), as well as with ionic compounds. In this work, we emphasise the teaching of the content of intermolecular interactions present in the reference curriculum of the state of Goiás. The components of the mixture (paint) have a difference in the nature of the order of the electromagnetic force and can be classified in a simplified way as London dispersion (also known as induced dipole-dipole, or van der Waals interactions), dipole-dipole interactions, and hydrogen bonding interactions, as defined by Atkins and Jones (2012), presented in Table 1. The different intensities of forces in the interactions between molecules can be represented in increasing order. According to Atkins & Jones (2012) and Junqueira, (2017):

London dispersion < dipole-dipole interactions < hydrogen bonding

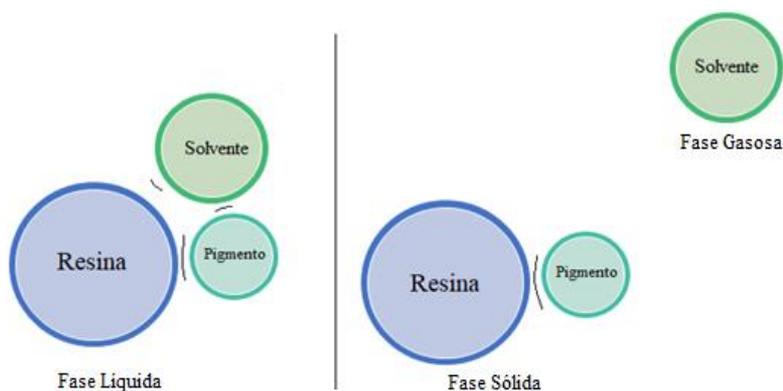
Table 1

Definitions of the Different Types of Intermolecular Interactions (Atkins & Jones, 2012)

Interações intermoleculares	Definição conceitual
Dispersão de London	Tipo de interações que surge da atração entre os dipolos elétricos instantâneos da molécula vizinha e agem em todos os tipos de moléculas. Sua energia aumenta com o número de elétrons da molécula. Moléculas polares atraem moléculas não polares devido as interações fracas dipolo-dipolo induzido.
Dipolo-dipolo	As moléculas polares sofrem ação deste tipo de interações, que decorre da atração entre as cargas parciais em suas moléculas, as forças de atração diminuem rapidamente com a distância entre as moléculas.
Ligação de hidrogênio	Ocorre quando átomos de hidrogênio estão ligados a átomos de oxigênio, nitrogênio ou flúor presente na molécula, é o tipo mais forte de força intermolecular.

Figure 2

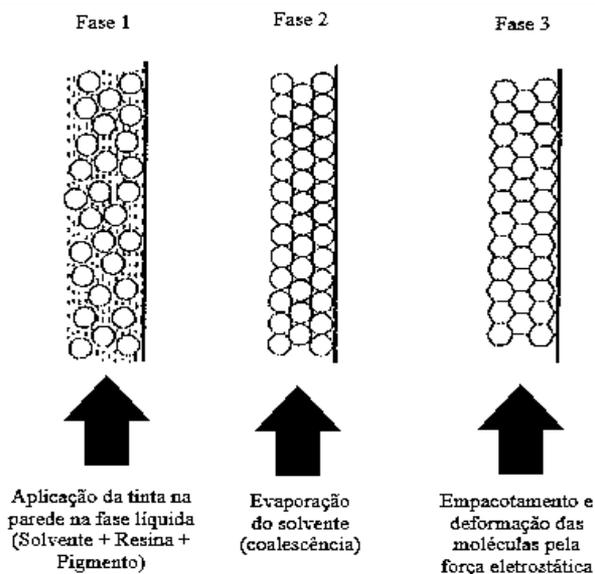
Schematic representation of the breakdown of solvent interactions with the resin and pigment molecules



The logic inserted in the manufacture of the paints requires using a solid phase that can adhere a defined colour to a surface where it will be applied. However, for efficient application, it must be in liquid form when applied. In this case, the solvent acts as an agent that transforms the resin-pigment into a liquid mixture for a certain time. Then, this solvent leaves the mixture (liquid phase) by evaporation, passing to the gaseous state, allowing the resin-pigment to solidify on the surface to be coated. This is only possible due to the intensity of the intermolecular interactions, the interactions between the resin and the pigment is stronger than between them and the solvent, thus, after application, the solvent breaks its forces of interactions, mixing with the air (gas phase). The representation in Figure 2 elucidates this phenomenon.

Figure 3

Phases for the formation of solid ink film applied to a surface (Uemoto, 1998, adapted)

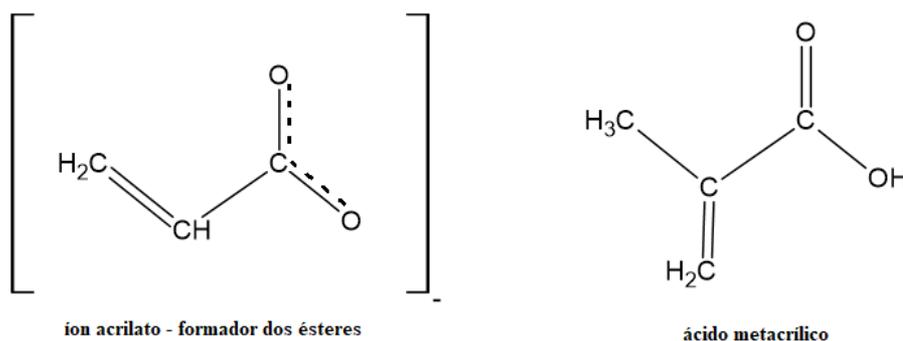


Intermolecular interactions appear due to forces that are essentially electrical, causing one molecule to influence the behaviour of another molecule that is nearby. "In the study of chemical forces, the distance between species is essential, since it directly influences the values of interaction energy" (Reis,

2008, p. 11). In this case, the closer the molecules are, the greater their interactions, causing both to undergo deformation in their structure, as shown in Figure 3.

Figure 4

Acrylic polymer forming substances most used for the production of acrylic paints (Fazenda, 2013)



The most used paints on murals and artistic panels, such as graffiti, use acrylic resins sold in aerosol spray cans. The most used acrylic polymers for paint production are acrylic esters formed from acrylate ion and methacrylic acid, whose flat molecular formula is shown in Figure 4 and are found in solution form (Fazenda, 2013).

According to Fazenda (2013), these polymers used in paints can be classified as:

- **Thermoplastics** : with the evaporation of the solvent, the regrouping of the polymers does not undergo chemical changes during drying. In their finished state, they can be repeatedly softened and hardened by increasing or decreasing the temperature;
- **Thermosetting polymers**: also known as thermosets, they have functional groups that react with groups such as epoxy, forming, in the evaporation of the solvent, a tangle of well-interpenetrated macromolecules, i.e., their three-dimensional structure results in a film of low permeability and high resistance. In their final state, they are insoluble and infusible;

METHODOLOGY

This research consists of an ethnographic case study that aimed to observe students during five theoretical-practical workshops of Intermolecular Interactions/Human Rights/Graffiti, which ended with the production of seven graffiti panels created through students' learning on the topics. We used this method because the ethnographic case study is based on participant observation, supported by the interview, in the same way as in anthropological or cultural studies. "For it to be recognised as an ethnographic case study, first it must emphasise the singular knowledge and fulfil the requirements of ethnography. Usually the case turns to a specific instance" (André, 2008, p. 24).

This exploratory qualitative methodology was developed a priori with 13 students (self-identified as five women and eight men) enrolled in the workshops and with the professor-researcher of the chemistry discipline. All students were enrolled in a morning regular state basic high school in the city of Goiânia-GO. Each workshop was planned to last for about 3 hours, videotaped and transcribed. Interviews were also conducted with the students who chose to participate in the project and the eight graffiti professionals who collaborated with the application technique and art knowledge.

Table 2

Categories of Analysis Presented as Topics in the Text and the Analysed Contents

Categories	Conteúdos analisados
Visão Política no Grafite	A arte do grafite promovendo discussões políticas entre os alunos
Química na Arte Transgressora	A construção de discursos com base em conceitos químicos na relação entre a tinta utilizada no grafite com a superfície aplicada.

We structured the writing with the transcribed interlocutors' speeches compiled with the theoretical frameworks in the introductory categories of

analysis, as shown in Table 2. The categories were exposed in the format of subtopics that show some data with their relative results already under discussion. The data obtained in the drawings produced by the students were also analysed, besides those extracted from the Descending Hierarchical Classification (DHC) technique and the use of dendrograms made by the *Iramuteq Software*. This research is part of a project duly submitted and approved by the Ethics Committee of the Federal University of Goiás under number 08468819.8.0000.5083.

Subsequently, in the subtopic “drawing reflections on the data obtained” of the topic results and analyses, we will present analytical considerations on the graffiti panels constructed by the students, together with their explanations about their idealisations. The article closes with the conclusions topic, which brings our final considerations.

INTRODUCTORY CATEGORIES OF ANALYSIS

Political view on graffiti

This first category emerged from the transcripts of the interviews with the graffiti artists and the students. In the discourses of the graffiti artists - represented by the letter (G), followed by the number in the order of transcription -, we found contents that reveal the political particularities that each individual has as an axiom. Even when the artist does not know that he is a political agent, those aspects somehow arise naturally as in the transcription of the interview:

G.4: “I do not have that political view, of the protest, that many have this view on graffiti, that really the original [thing] of graffiti emerged through this, I do not have this view, although sometimes I make some protest paintings, especially against the government, which are the flaws that we see and experience”.

According to Huizinga (2007), when the recognition of personal honour in correspondence with political life is at stake, the struggle is permanent for prestige, “which is a fundamental value covering both law and power. Revenge is the satisfaction of the sense of honour, and honour needs to be satisfied”, and in Greek iconography, revenge is often confused with justice. Even if the graffiti artist does not believe he/she is politicised, the elements appear in the construction of resistance with the knowledge of the origin of

graffiti as a protest, against the injustices that those artists feel in different social spheres.

As the research was carried out during the inauguration period and the proposals for changes by President-elect Jair Messias Bolsonaro, discussions on politics were potentialised. As a consequence, a large portion of the students was interested in making political criticism of the new government, especially about the new educational proposals. The teacher-researcher sought to instigate students to debate with each other, aiming not to strengthen the opinion of any specific student. The criticisms were made on the second day of the workshop that related HR with the graffiti, among the students' statements - represented by the letter (A), followed by the number in the order of transcription -, of which we highlight the following:

A.10: *“And I think that the government does not give us education, because... They are afraid of us being better than them, and that is why education does not improve...”*.

A.4: *“It is like removing philosophy and sociology, which is what makes you understand things...”*.

A.1: *“However offered or not, philosophy and sociology are already very estranged in school, you cannot defend the critical state, defend one ideology, or another”*.

Students recognise themselves in different speculations of educational policies discussed in networks and social media, visualising and affirming students' identity issues. They evaluate the articulation between politics in the process of knowledge and a plural/critical education, not detaching the liberating issues from learning, supporting action policies aimed at strengthening the processes of democratic construction that cross all social relations, from the micro to the macro, from the perspective of radical democracy, as Candau and Russo (2012) put it.

In the execution of the workshop that related the HRs and graffiti, we read and discussed the articles of the Universal Declaration of Human Rights (UDHR), established after the period of horrors promoted by the two world wars. The atrocities carried out by liberticidal and totalitarian regimes, with “scientific” attempts on an industrial scale to exterminate Jews, enslave blacks, indigenous peoples, and the genocide perpetrated by the launching of the atomic bomb of Hiroshima and Nagasaki (Tosi, 2004).

The political leaders of the great allied powers established the United Nations (UN) on June 26, 1945, seeking to establish peace among the peoples and prevent a third world war. One of the first acts of the UN General Assembly was the proclamation of the UDHR on December 10, 1948. In it, we highlight: “Everyone has the right to equality, life, freedom, housing, decent employment, education, health, among others. The guarantee of these rights enables the construction of a more just and plural society” (Dionysio *et al.*, 2015, p. 64).

We show here that the UN and the UDHR were built by specific political leaders. We will not enter into a thorough analysis of the intentions of their constitution and their articles, we will only use their writing to strengthen the concepts expected in⁵ the minimum ethics required for a humanised and egalitarian formation in rights.

During the reading and discussion of some articles of the UDHR, the students took the same kind of stance, now strengthened by a document that legitimises the ethical morality of freedom and choice. According to Article 19 of the UDHR, “Everyone has the right to freedom of opinion and expression, which implies the right not to be disturbed by their opinions and to seek, receive, and disseminate, without regard for borders, information and ideas by any means of expression” (United Nations, 2000).

The following transcript highlights the student’s position during the class discussion:

A.2: *“Just like they are saying now that Bolsonaro wants to remove philosophy and sociology, in my opinion, it is against article 19 (of the UDHR) because the individual will not have freedom of choice... He wants to take away the freedom of choice... He wants to keep what he likes, he doesn’t want to think of other people, just in himself”.*

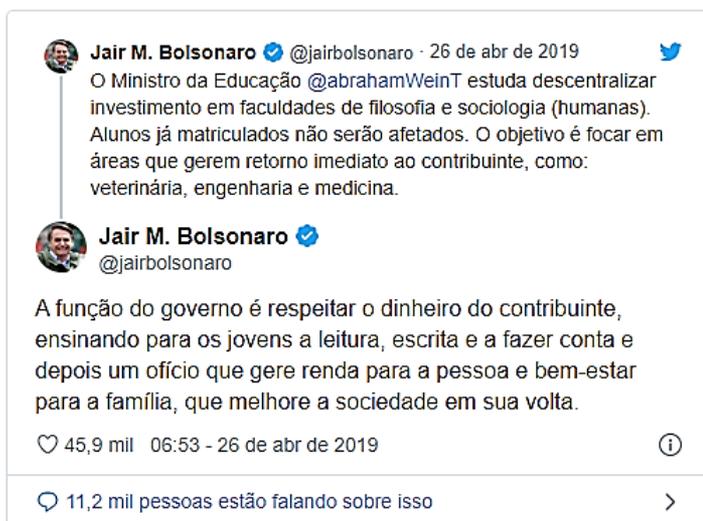
We highlight the politicised problematisation in reading a document that aims to ensure equity and social alterity within those students’ context. We analyse in this category and in the graffiti arts the demand for social policies and moral/judicial laws that subsidise marginalised groups, reaffirming politics as one of the fundamental intentions of graffiti. These comments on the possible

⁵Ethics is a philosophical study on people's moral behaviour, it does not aim primarily at guiding human conduct, even if it does so indirectly. Its central task is to reflect on the rational foundations of the moral phenomenon, that is, the “awareness about the duty to be” or about the “normative judgments” (Cortina, 2001, p. 133).

exclusion of the subjects of philosophy and sociology were made after publications on the current President's social network *Twitter*, as shown in Figure 5, in an attempt to explain to the Minister of Education, under the command of former Minister Abraham Bragança de Vasconcellos Weintraub, the cuts in financial resources in these areas.

Figure 5

Publication of the President of the Republic of Brazil (Twitter on 04/26/2019)



The researcher did not take this publication to the workshop. It appeared with the students' anger at the educational events of the moment. This point has an especially relevant normative and political dimension for both students and teachers. It is important not only to view teachers as intellectuals but also to contextualise, in political and normative terms, the concrete social functions performed by them, as Giroux (1997) puts it. We understand that it is essential for the class of teachers, transforming intellectuals, to make the pedagogical more political and the political more pedagogical.

Chemistry in transgressive art

In this category, we could observe the students' speeches in the workshops that referred to the scientific aspects of chemistry and the content of intermolecular interactions. During the discussions about interactions of the

paint and its components in the workshop of intermolecular interactions in graffiti, the students established a logic about the intensity of attraction between the molecules to try to identify the probable interactions present:

A.9: *“The resin and the pigment present a weak interaction...”*.

A.5: *“No, it’s strong! The [interaction between] the resin and the solvent is weak...”*.

A.9: *“That is why it separates from the solvent, because it is weak”*.

Besides the chemical interactions with its components, the paint also interacts with the surface where it was applied. As graffiti is a process of artistic construction on walls and mortar covered masonry, the paint interacts with the concrete used to build those structures and the mortar used in the finishing. Both are formed mainly by cement, which promotes great influence on the growth of resistance, conferring the main physical and mechanical properties of the hardened concrete, such as shrinkage, permeability, resistance to weathering, and creep (Neville & Brooks, 2013).

The most used cement in constructions, the Portland, meets the compositional standards. It consists mainly of “95-100% Portland clinker and 0-5% secondary constituents, which may have cementing or filler characteristics to improve water workability or retention” (Neville & Brooks, 2013, p. 25). Clinker is a source of tricalcium silicate $(\text{CaO})_3\text{SiO}_2$ and dicalcium silicate $(\text{CaO})_2\text{SiO}_2$, so most of them are the compounds present in the walls of the cities today. After we taught the concepts of intermolecular interactions in the workshop and presented the composition of the concrete, the students could propose that the components present in the cement also have interactions:

A.9: *“To have cement you need to have interaction, because they are together (molecules), you can see, you can pick it up and touch it (solid)”*.

It is common to observe conceptual errors confusing interactions between molecules with bonds between atoms. A chemical interaction means that species attract or repel each other without breaking the atomic bonds or forming new chemical bonds (Reis, 2008, p. 11). Based on these statements, we can propose some of the many chemical interactions that acrylic-based paint makes with the concrete found in constructions. To instigate students to reflect on the conceptual content of chemistry when painting graffiti, we proposed that they create assumptions about those probable interactions. When asked, in the

3rd workshop, about which chemical interactions the main molecules of acrylic paint could make with the main components of the cement, the students raised the hypothesis of being a very strong interaction, which explains the resistance of the paint on the wall:

A.10: “The gases, you can go across them, unlike the solid, because the bond is very strong...”.

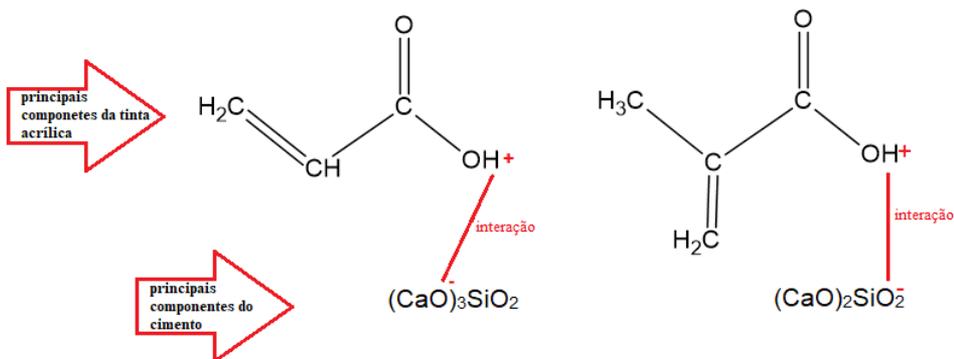
A.5: “That is why we cannot cross the wall”.

When presenting the molecules in Figure 6, the students concluded that the paint and the wall make hydrogen-bonding type of interactions, explaining the resistance of the concrete and identifying the presence of hydrogen bond to oxygen (an atom with great electronegativity) in the acrylic-type molecules, consistent with this speech during the workshop.

A.4: “I know that it has a hydrogen intermolecular interaction, from the wall with the cement, then it sticks, but I can't explain it well... I know that it has hydrogen bonding because it is the strongest”.

Figure 6

Probable chemical interactions between paint and concrete proposed by students



During the graffiti drawings, empirically, the artists reinforced the content of chemical interactions mentioning the content in their speeches,

which were used by the researcher to promote a reinforcement, seeking to accommodate this knowledge to the concepts studied.

G.5: *“At the end of the last century, there are cans suitable for graffiti, but before, when the first graffiti artists appeared, it was all testing, trying which can, which spray is not good for drawing... If you are going to paint on wood, if you are going to paint on ceramics, it is not any spray that holds (fix) on the material, it is not any paint... the wall paint you are going to stick there (points to ceramics) someone will run their hand on it and it will come out, this is the science of the business for me...”*.

In this case, we observe an articulation of the content between the teacher, the students, and the graffiti artists, the confluence of this knowledge does not manifest a Western philosophy, but knowledge of black culture and the local knowledge of the various cultures historically dominated and silenced. The assumption of the work of an intercultural deconstruction as opposed to the elitist, Eurocentric, and instrumental knowledge proposed by the global academic reality suggests alternatives towards a cultural “pluriversity” that interconnects all forms of knowledge, i.e., promoting diversity as an emancipatory inter-epistemic proposal defended by Estermann (2017).

This perspective of knowledge present in black culture has decolonial aspects defended by postmodern authors such as Catherine Walsh (2006), revealing the structuring and perverse operations of racism that tries to remove black knowledge and presence in positions and spaces of power. Those knowledges can implode the imposition of power by being subalternised, they are knowledges revealed and constructed by subjects in and of the struggle, by subjects of affirmation, formed by emotions and colours, thus challenging the positivist view of science. In the dialogue transcribed by G.6, we also note the presence of knowledge acquired by cultural practice:

G.6: *“Surely the graffiti has not only science but also mathematics and various elements of the school, it has calculation for height, calculation of the amount of ink, the chemistry of colours, it has... wow! A lot, lately I was thinking, because I am studying again, I was thinking about these things, because sometimes even to make a drawing you have to know how to calculate the right force, so it starts from there”*.

These legacies of knowledge are intrinsic to graffiti, besides being political and epistemological. Graffiti born of the black movement, previously enslaved and removed from education, produces a kind of knowledge that emerged from a reality of socio-political confrontations. This knowledge changes the way of perceiving and interpreting the reality imposed by the colonial and oppressive configuration; it is knowledge of resistance, existence, and affirmation.

These transcriptions of the speeches of G.5 and G.6 show that the content of intermolecular interactions was not limited during the theoretical class developed in the workshop format on these concepts, it transcends to practice and transports itself to the macroscopic visualisation of the ink taking shapes in the drawing.

With students motivated and engaged in the processes they propose to develop, interaction with ideas and concepts -often abstract, but which, when constituted and created in situations of students' experience, can be better elaborated and understood in their various senses and meanings- favour the development and acquisition of scientific language (Soares, 2015, p. 51-52).

These aspects arise naturally and present a great potential for politicised education, which respects the diversity of interests and learning difficulties normally found in the classroom. We consider that these results emerge from the success in the planning of the workshops, since we can achieve the playful commitment of fun and pleasure and strengthen the entire scientific theme involved in the construction of this writing.

RESULTS AND ANALYSES: DRAWING REFLECTIONS ON THE DATA OBTAINED

The final artistic result that we will see in Table 3 presents how the complex content of intermolecular interactions was portrayed by the students in their works. When asked during the interview with the question: "How did you represent the intermolecular interactions in your drawing?" they exposed abstract conceptions and expressed the social aspects of the HRE. Each panel was developed exclusively by the students, built from the discussions in the workshops and their understandings of the concepts discussed. After being sketched on paper, the drawings were graffitied in the school with the cooperation of eight graffiti artists volunteers experienced in the techniques of

this art. The volunteers helped only with the tips and finishes, practically the entire process was in the students' hands and decision.

Table 3

The Chemistry Behind the Graffiti

Painéis de grafite	Falas transcritas dos estudantes
	<p>A.2 e A.8: <i>“A gente tentou representar os átomos lá no desenho, que são aquelas bolinhas, que é uma teoria aceita que os átomos têm a forma de esfera, por isso a gente fez aquelas bolinhas representando os átomos para juntar muitos e formar uma mão [...] Porque são milhares de átomos para formar uma mão, eu acho que tem interação na mão entre as moléculas e é forte, porque se não tivesse não haveria nada disso, não ia ter carne, não ia ter os dedos [...] Então tem que ser muito forte para sustentar tudo isso”.</i></p>
	<p>A.9 e A.13: <i>“Como eu já tinha estudado um pouco de Química, eu aprendi que realmente a Química está em tudo, tudo que está ao meu redor é Química, eu ficava: “Mas será mesmo que isso é Química? O professor fala, mas será? Na prática, será que é?” E aí o senhor mostrou mesmo que existe Química em um lugar que eu achava que não tinha Química nenhuma, eu comprovei que a Química está em todo lugar mesmo, até no grafite”.</i></p>



A.7: “A Química foi representada pelas cores, aquele fundo meio que galáxia, com a conexão das cores e como elas se interagem, no jeito que elas se combinam uma com a outra, o verde, o rosa e o roxo formando o cabelo, representa as interações entre as moléculas”.



A.10 e A.11: “Representei a Química pelos planetas, as galáxias como as interações intermoleculares, porque nos planetas também existem interações entre eles. Existem substâncias na tinta dentro do spray que quando ele está lá dentro ele está uma coisa (líquido), quando ele sai vira sólido pregando na parede, é uma interação muito forte, então o sol, a água, essas coisas não rompem facilmente por causa da ligação que é forte”.



A.4: “Eu acho que aquelas manchas azuis e rosas parecem quando as moléculas vão se juntando [...] Porque tem várias bolinhas, parece que vai grudando [...] Eu sei que a tinta tem uma interação intermolecular de hidrogênio, com a parede e com o cimento, ai gruda, mas eu não sei explicar direito [...] Eu sei que tem a ver com a ligação de Hidrogênio que é a Interação Intermolecular mais forte”.



A.5: “Eu representei a Química com aquela matéria saindo dela, todo mundo um dia vai virar matéria, todo mundo é matéria aliás [...] vamos retornar para o pó [...] O jeito que cada molécula ou átomo se comporta e interage promove a formação de tudo, para poder ter a textura, a cor, as características físicas”.



A.3 e A.12: “A Química eu representei com os quebra-cabeças, os quebra-cabeças precisam de todos para formar uma coisa, eles se entrelaçam para formar algo, igual os átomos [...] essa mesa aqui (aponta), ela tem vários átomos para forma isso [...] igual um quebra-cabeça mesmo, os quebra-cabeças se faltar uma peça não é a mesma coisa, se faltar um pedaço aqui, um monte de átomos aqui no meio, não vai ser uma mesa, vai ser uma coisa plana com um buraco no meio. Deu pra ter uma noção que quando a tinta gruda na parede é parecido com os quebra-cabeças”.

The chemical concepts about intermolecular interactions are interpreted by the artists according to the imagination because it is an impossible phenomenon to be seen microscopically, it is then up to the imagination to create their representation: “playing is a mutation of meaning, of reality: there, things become another thing. It is space on the margin of common life [...] The objects, in this case, may be different from what they present” (Brougère, 2010, p. 106). Therefore, the content of interactions between molecules is more abstract in the reality of drawing compared to aspects of human rights, although we note a mistake in the speeches by A.2 and A.3 on interatomic interactions with intermolecular interactions. It is easy to notice the students’ assimilation of the existence of science - in this case, chemistry - in art and in various things around us, as shown in the statements of A.3 and A.9.

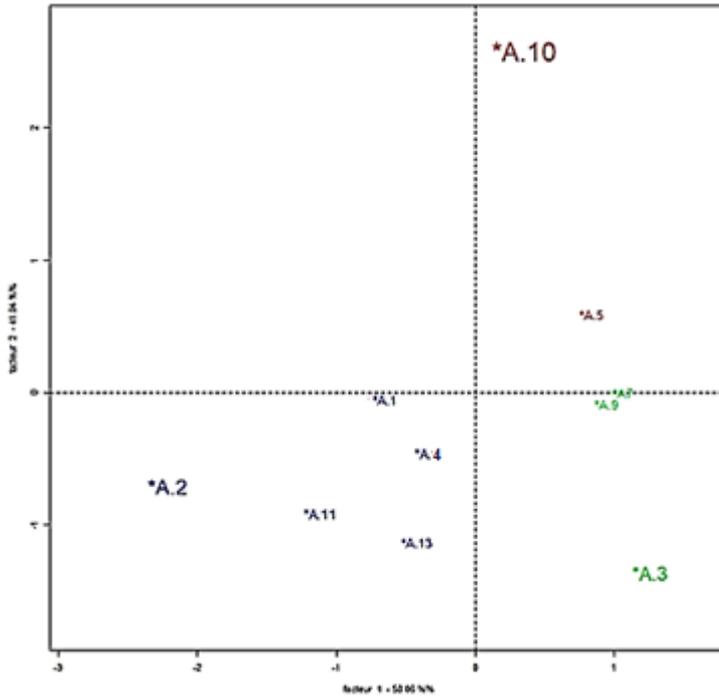
The essence of this study of science and art may be centred on the changes by which this knowledge had in the students’ cognition to materialise in the drawings, creating unique mental schemes and thus evidencing that there is room for changes in the methodology of building a scientific influence on people immersed in diverse cultural practices. It also raises questions about how this popular knowledge emerges in the form of “innovation” in science - relating the existing power - and visualising how art can transfigure these stiff contents into something alive, pulsating and significant.

Subsequently, we investigated the understanding of the ethical-social aspects delimited by the HRE, which covers the anti-hegemonic conception of the world and equality in rights for all people without any distinction. We asked the ten students that had related the HR with the graffiti during the interview the following question: “How did you represent or would represent HR in your drawings?”

Subsequently, we used the answers obtained in the Iramuteq *Software* to obtain the CHD technique. The text segments called “classes” are classified according to their respective vocabularies and their gathering is divided according to the frequency of the reduced forms. This analysis aims to obtain classes of segments of the transcripts of each subject that, at the same time, present similar vocabulary to each other and vocabulary different from the text segments of the other classes (Camargo & Justo, 2013). We can observe the similarities between the students within the classes in the graph in Figure 7.

Figure 7

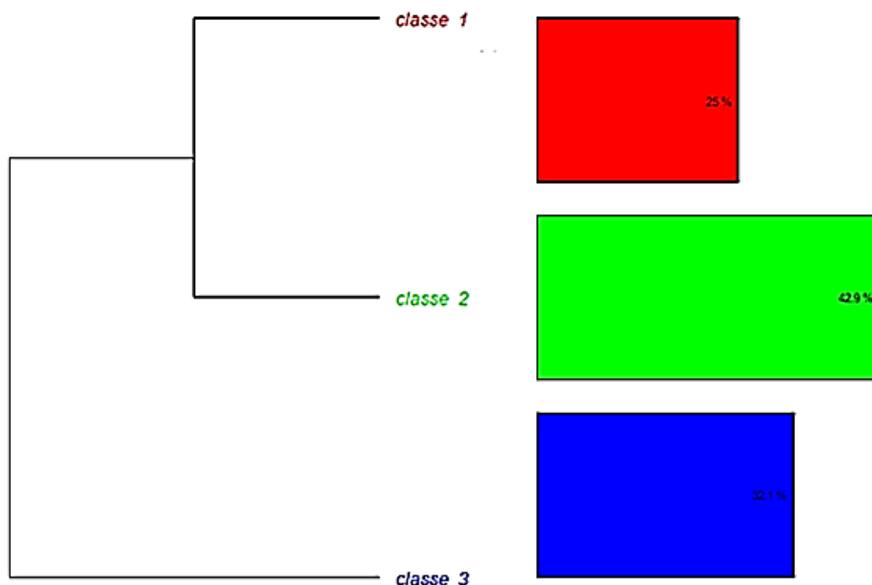
Similar vocabulary by CHD students



From these analyses in matrices, the *software* organises the data in a dendrogram of the CHD, which illustrates the relationships between the classes, presented in Figure 8. The program performs calculations that show the percentage of affinity between the texts analysed and provides results that allow us to describe each of the classes mainly by their characteristic vocabulary (*lexicon*).

Figure 8

Relationships between classes with calculations that show the percentage of affinity between the texts analysed



What are these word classes and text segments? At the computer program level, each class is composed of several text segments according to classification according to the vocabulary distribution of these text segments, at the interpretative level known as *Reinert* (Camargo & Justo, 2013). We used the similarity of the texts provided by the transcripts of the interviews to categorise each class:

Class 1. Equal Rights: The transcripts of students A.5 and A.10 belong to this class and manifest the assimilation of the HR as equal rights, present in the speeches discourses of equality between people without any distinction, characterising the difference in power that permeates society and interpersonal relations, in addition to claiming rights to those who are at a disadvantage in this process. There are also aspects of empathy for the life story of the other.

A.5: “I represented human rights on the part of equal rights, everyone is equal inside and outside, we are matter, in scientific concepts. If you think you are superior to a person, you are being hypocritical and closed-minded, because you do not

know what they do, what they have been through, you do not put yourself in their shoes”.

A.10: *“The richest part of the population usually judges graffiti, so there are no human rights in judgment. Everyone has to have rights, and most of this prejudice, not all, but most of the white population is trying to attack blacks, wanting to judge blacks, thinks that they do not have equal rights, the man’s suit represents the richest powerful part, and others do not [have the power]”.*

Class 2. Identity Reaffirmation: In this class, the transcripts of students A.3, A.7 and A.9 reveal the understanding of HR as recognition and reaffirmation of their identity, they declare the black and peripheral movement as organised and articulated actions, politically positioned by the fight against racism and the affirmation of identity, culture, the black presence in the country, and in the African diaspora in which we live. It is a position of alterity of humanisation in a dialectic of seeing the “I” and the “other” in society, to resignify the aesthetics and the peripheral black identity.

A.3: *“In my drawing, there is that black woman with tall black hair that most human beings discriminate against, blacks had to hide how they were, you were born with your hair and had to smooth it because such a person did not accept it, so I wanted to show in my drawing that the blacks can be the way they want, I even dyed her hair to turn it black and put a green of hope, the hope of ending this racism. Slavery took many years to “end” and there are still people who look at you the wrong way because of the colour of your skin or your hair, or something you have, such as a tattoo.”*

A.7: *“The symbol of peace is to stop the war, stop the fight between colours (races), we are improving, but there is still a long to go, there is still a lot of racism, a lot of prejudice, people do not like to see other people’s happiness and they keep meddling. The woman is saying: “I am here, I exist”, that smoke coming out of her mouth represents an outburst, that the slums dwellers are human, that they are there, that they are part of society, that they are people in spite of everything”.*

A.9: *“I represented human rights because the zombie is dressed in clothes trying to be a normal human, only every time you*

look at the drawing the first thing that comes into your head: It's a zombie! And he's trying to be just like us, often we are like that. We try to wear clothes and we are judged, by my hair (black power) sometimes I am judged, you may even be well dressed that people will judge you for what you are, for your colour”.

Class 3. Antiracism: Students A.1, A.2, A.4, A.11 and A.13 think that the structural racism, daily racism of relationships, the way they relate, and how blacks see themselves is an aversion. They build a political-epistemological posture comprising blacks within a racist power structure. Racism affects blacks, indigenous peoples and other individuals to dehumanise them, remove them from the place of humanity, inferiorise them, subordinate them, as if the excluded were not worthy of taking their place, making black bodies invisible. We found those students were brave enough to take a stance of assimilating the HR as a way to denounce racism in an anti-racist conduct.

A.1: *“It was possible to work even more on the historical issue: that the blacks have been suffering since the beginning of history, but I think that I have always respected and will continue to respect, I think it is ethical, there is no way to fail it. I wanted to represent Human Rights in the same way that they represented at that time, police repression in society, with racism, the question of monetary condition and such. This is our story, where we came from, I always had for myself that to know where we want to get to, we must know where we came from, to know the roots, cultures and history”.*

A.2: *“Enough of all the prejudice, racism, xenophobia, enough of all this. It all starts with respect, if we respect others, none of this will happen, that's enough of that, bullying, prejudice will no longer happen. People disrespect others a lot because they think they are superior because they are white and heterosexual.”*

A.4: *“Everyone must be equal in rights and must respect. I made a black woman who was where we came from and who today are the ones who suffer the most, and those who will always suffer, have always suffered”.*

A.11: *“Everything that happened because of the inequality of the black race... every day I see on television those issues of*

racism, manifestations because of racism, social inequality. I liked to show the beginning, about hip hop, because I already like those singers, I like them a lot, it showed that I was at home, “look there are more people who like it too”, this is already part of me, I was born singing the rap... (laughs)”.

A.13: *“What I liked most about the workshops was to learn to separate graffiti from wall-writing and the part that we start to graffiti and use the strength of the expression, the drawing shows that people see graffiti artists and blacks as somebody that are not from their world, somebody that is not part of it, then it represents by the zombie, which is something supernatural”.*

Through the analysis of the three classes, we can previously consider that the students use socio-political principles to justify the influence of HR in the construction of the drawings. Moreover, we verified that power relations are highlighted in all classes. All students positioned themselves through ethics and respect for groups that are wronged in society.

CONCLUSIONS: COLOURING CONSIDERATIONS

We can infer that the chemical and social concepts were assimilated, possibly forming subjects who understand chemistry as a science present in the movement of black women and men throughout history. Assimilating the black movement as a producer, organiser, and systematiser of knowledge in society is a democratic and counter-hegemonic theoretical practice.

The valorisation and rescue of knowledge produced by the black movement represent in itself a political practice of equity, insofar as it redefines the orientation of the Western conception of the world to the philosophical concepts of black culture, totally excluded from the so-called hegemonic knowledge. Also, seeking support in elements, values, and principles that constitute such knowledge generates the interruption with the modern Western paradigm and brings out new epistemological proposals in science teaching.

We emphasise that graffiti manifested knowledge in this epistemological construction, and we found that the expected objectives were achieved. Using the art of graffiti as a pedagogical methodology for the teaching and learning process of intermolecular interactions in the light of theoretical frameworks goes beyond the assimilation of chemical content,

enabling a playful manifestation of the resignification of black culture, which brings out social aspects of more humanised ethical values that elevate social respect, such as empowerment, political vision in the social relationship, the understanding of power in society, the claim for equality in rights, identity reaffirmation, and the anti-racist struggle. Those social aspects support the HR and corroborate the harmony of intercultural interactions.

All that given, we can state that the objectives of this research were achieved, as we could teach chemical concepts with workshops planned in the HRE, making the scientific contents of intermolecular interactions emerge from the contemporary cultural practice of graffiti. Through the methodology presented in the workshops, we provided a political observation of the social relations through the historical and economic understanding of black and peripheral culture.

AUTHORSHIP CONTRIBUTION STATEMENTS

KFS conceived the idea presented, carried out the activities and data collection. RDVLO and MHFBS proposed an adaptation of the methodology to this context. All authors actively participated in the discussion of the results, reviewed, and approved the final version of the work.

DATA AVAILABILITY STATEMENT

The data supporting the results of this study will be made available by the corresponding author, KFS, upon reasonable request.

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