A science didactic sequence based on inquiry-based teaching in the 9th year of Elementary School using *Scratch*

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Rosangela Lucia Strieder[1], Marcela Zoratti de Souza[2], Miriam de Lima Hellmann[3] and José Wilson Pires Carvalho[4]

ABSTRACT

The research in question refers to an Investigative Didactic Sequence applied in the teaching of Science to students in the 9th year of Elementary School, as part of a master's thesis defended in the Stricto Sensu Postgraduate Program in Science and Mathematics Teaching - PPGECM , from the State University of Mato Grosso, UNEMAT/Barra do Bugres. The study aimed to understand the contributions of using Scratch Software in teaching the calculation of atomic mass to students in the 9th year of Elementary School and involved 13 students from a public school in the interior of the State of Mato Grosso. The science didactic sequence was developed over six meetings (14h), which consisted of stages of theoretical exploration of Chemistry concepts, followed by the use of Scratch Software to construct the Interactive Periodic Table, covering concepts of Chemistry, Mathematics and programming in block. During this interdisciplinary approach, students were able to understand and explore the properties of chemical elements, as well as calculate the atomic mass and at the end of the Didactic Sequence, a qualitative assessment of the results achieved was carried out, through observation and journaling. fieldwork, analysis of reports and questionnaires. The results highlighted the importance of interdisciplinarity in teaching, arousing students' interest through the construction of the Interactive Periodic Table in Scratch Software. This proved to be an effective pedagogical strategy to mediate the teaching of atomic mass calculation, contributing to the development of students' skills and improving the teaching process.

Keywords: Teaching, Science, Interdisciplinarity, Programming language, Chemical elements.

[1] Master's degree in Science and Mathematics from the Stricto Sensu Postgraduate Program - PPGECM from the State University of Mato Grosso-UNEMAT. Mathematics Teacher at the Mato Grosso State Education Network.
ORCID: https://orcid.org/0000-0002-7532-4996
E-mail: rosangela.strieder@unemat.br
[2] Master's degree in Science and Mathematics from the Stricto Sensu Postgraduate Program - PPGECM from the State University of Mato Grosso-UNEMAT. Science Teacher at the Mato Grosso State Education Network.
ORCID: https://orcid.org/0000-0002-5115-4486
E-mail: marcela.zoratti@unemat.br
[3] Professional Master's Degree in Mathematics on a National Network - PROFMAT from the State University of Mato Grosso. Mathematics Teacher at the Mato Grosso State Education Network.
ORCID: https://orcid.org/0009-0000-2178-5415
E-mail: miriam.hellmann@unemat.br
[4] Doctor in Sciences, Physics-Chemistry concentration area, from the University of São Paulo-USP/Institute of Chemistry of São Carlos-IQSC. Professor of the Stricto Sensu Postgraduate Program in Science and Mathematics Teaching-PPGECM. Professor of Chemistry at the State University of Mato Grosso.
ORCID: https://orcid.org/0000-0002-5969-5105.
E-mail: jwilsonc@unemat.br

INTRODUCTION

Inquiry teaching is based on aspects of scientific research, providing students with the opportunity to engage in activities similar to those developed in Science work processes. (Carvalho, 2013). Sasseron and Carvalho (2008, p. 338), defend the idea "[...] that Science teaching should occur through open and investigative activities in which students play the role of researchers".

For Solino, Ferraz and Sasseron (2015), research-based teaching is an instrument that promotes the integration of scientific and school cultures, promoting the approximation of practices, rules, values and other characteristics of these cultural domains, creating conditions for students to develop school scientific practices.

One approach to implementing inquiry teaching in a school setting is through inquiry teaching sequences. According to Zabala (1998), a Didactic Sequence is a methodological suggestion determined by the ordered and articulated series of activities that make up the didactic units, which have a beginning and end known by teachers and students. For Pais (2002), a Didactic Sequence consists of a series of classes planned and previously analyzed to observe learning involving the concepts foreseen in the didactic research.

The Didactic Sequence developed and applied from a sociocultural perspective can present itself as an efficient option that aims, among other things, to minimize the tensions of decontextualized teaching and the dissociated action of teaching areas in the school environment (Guimarães; Giordan; Massil, 2011).

The model proposed by Delizoicov *et al.* (2002), constituting three pedagogical moments: 1) Problematization: Challenging students to expose their prior knowledge and reflections on the subject; 2) Organization of knowledge: Carry out the pedagogical activities necessary to understand the topic and initial problematization; 3) Application of knowledge: create situations in which students can test their ability to apply knowledge through scientific conceptualizations and real-world situations. In studies of didactic sequences in Science teaching, Guimarães, Giordam and Massi (2011), present a line of research on didactic sequences that investigate teaching-investigative perspectives and actions that facilitate learning. The structuring of the didactic sequences will be composed of the following elements: title, target audience, problematization, general objectives, specific objectives, contents, dynamics, evaluation, references and bibliography used. For these authors, the title must be attractive and reflect the content and creative intent. The target audience must be well defined, as teaching sequences are not universal and there is no definitive method valid in all situations. Problematization, on the other hand, is the agent that unifies and maintains the systemic relationship of the Didactic Sequence; therefore, reasoning about the problem is what anchors the Didactic Sequence through social and scientific issues that underlie the theme and problematize the concepts to be addressed. The proposed objectives must be achievable through the methodology and reflected in the content and evaluation, one of the ways to verify whether they have been effectively achieved.

In terms of content, Guimarães, Giordam and Massi (2011) highlight that, despite the disciplinary organization, interdisciplinary and transdisciplinary references can be established to the other curricular components. The dynamics concern teaching methodologies that establish learning situations, emphasizing that the diversity of dynamics must be linked to the structural and social context provided by the target school.

The assessment must correspond to the objectives and contents set out in the Didactic Sequence. Continuing, the item bibliographic references refers to the works, books, texts, videos actually used in the development of the proposed classes and in the bibliography the works that were used in the preparation of the sequence or as support and study material must be presented. for teachers who will apply this Didactic Sequence (Guimarães, Giordam and Massi, 2011).

To compose the didactic sequence, Science textbooks from the final years and high school Chemistry textbooks were consulted, as well as articles and publications in the area of Science and Mathematics teaching, in addition to the references of this research, such as Giordam and Massi (2011), Carvalho, (2013), which served as a base reference for this sequence for investigative classes: presentation of a problem; raising hypotheses in monitored groups; carrying out an investigative, experimental or bibliographical search activity; data analysis and discussion of results during which we intended to contextualize current affairs and the students' daily lives; moments of conversations and practical activities and as a way of recording data, the researcher's own website was used, which incorporates an online school platform https://rosestrieder.mat.br/ , from the Investigative Didactic Sequence to record the actions.

SCIENCE TEACHING SEQUENCE

Teaching methodology refers to the act of teaching involving a series of efforts and choices, reflected in suggested paths called methodological options. The teacher is the one who organizes and proposes situations in the classroom to present specific content. In this sense, we can say that the teaching methodology is implemented in its theoretical assumptions through the application of teaching methods and that the methodology used by the teacher is related to their worldview and knowledge. This methodology is subject to change when the teacher can systematically reflect on their professional practice (Anastasiou, 1997).

As this research presents a qualitative approach to analysis, according to Carvalho and Gonçalves (1999) some characteristics are essential to guarantee teaching through investigation: teachers are responsible for planning activities and creating an environment conducive to investigation; activities related to problem solving and collaborative work.

In this way, the Science Didactic Sequence: teaching by investigation in the 9th year of elementary school presented in this research is composed of an investigation plan/script (Table 1). Regarding this, Ponte (2002, p. 18) states that "investigations into practice use the most common work plans and techniques of social and human sciences and, in particular, studies in education". The script serves for students to familiarize themselves with all the moments of the classes and what will be analyzed in the next meeting and is divided into 6th Meetings, each being subdivided into content, objective, intended learning results, teaching activity and teaching activity. learning in order to achieve the objectives for data production and analysis.

Table 1: Didactic Sequence Script

INTERACTIVE PERIODIC TABLE IN SCRATCH: A MATHEMATICAL APPROACH TO PERIODIC PROPERTIES IN CHEMISTRY TEACHING		
TEACHING SEQUENCE SCRIPT This itinerary helps students to familiarize themselves with all the moments of the classes and what will be analyzed at the next meeting. The Didactic Sequence is divided into 6th Meetings, each subdivided into content, objective, intended learning results, teaching activity and learning activity.		
1st Meeting - Survey of students' prior knowledge and contextualization of the topic.	**Duration: 100 min. (02 classes of 50 minutes)**	**Location: Computer Laboratory**

Contents	Periodic table
Objective of the lesson	➢ Socialization about the research, the methodologies used, the subjects covered, the teaching resources that will be applied; ➢ Delivery of image and voice authorization terms, the informed consent form and the itinerary of activities that will be carried out during the six meetings and a printed periodic table. ➢ The aim is to promote strategies that contribute to the contextualized knowledge of the Periodic Table and the development of students' skills.
Results learning objectives	▪ Know the origin of the Table Periodic; ▪ Understand the organization of the Classification Periodic;
Teaching Activity	➢ Identify what students already know about the content and what their difficulties. ➢ Identify in the Periodic Table – structure and organization of the elements. ➢ Distribution of Periodic Tables: the tables will be distributed to all students to be used as reference during class;

Learning Activity	▪ To gather prior knowledge, a roundtable will be held. conversation. ▪ Applicability of the elements in everyday life and curiosities.		
2nd Meeting - Contextualization of the theme (Continuation of the 1st Meeting)		**Duration: 100 min. (02 classes of 50 minutes)**	**Location: Computer Laboratory**
Contents	Periodic table		
Objective of the lesson	The aim is to promote strategies that contribute to the contextualized knowledge of the Periodic Table and the development of skills of students.		
Intended learning outcomes	▪ Know the symbols of chemical elements and their origin; ▪ Learn to write/position and locate the symbols;		
Teaching Activity	➢ Using the current Periodic Table printed; ➢ Present the elements and symbols chemicals;		
Learning Activity	▪ Learn the writing/position and location of symbols in the Periodic Table; ▪ Activities for understanding.		
3rd Meeting – Introduction to *Scratch*		**Duration: 200 min. (4 classes of 50 min.)**	**Location: Computer Laboratory**
Contents	*Scratch* interface , event block, movement, appearance and control.		
Objective of the lesson	*Scratch* block programming environment .		
Intended learning outcomes	▪ Recognize and classify the different types of blocks in the *Scratch* ; ▪ Develop the beginning of the construction of the Interactive Periodic Table using programming blocks presented.		
Teaching Activity	➢ Delivery of a practical guide to *Scratch;* ➢ Present the *Scratch interface* and exemplify the use of event blocks, movements, appearance and control; ➢ Read and explain the construction script “Periodic Table Interactive”; ➢ Present the Questionnaire classroom.		
Learning Activity	▪ Start building the “Periodic Table” in *Scratch* Interactive”; ▪ Answer the questionnaire classroom.		
4th and 5th Meeting – Construction of the interactive periodic table in *Scratch* .		**Duration: 300 min. (6 classes of 50 min.)**	**Location: Computer Laboratory**
Contents	Steps in the process of building the Interactive Periodic Table in *Scratch* .		
Objective of the lesson	Present the steps in the process of building the Interactive Periodic Table in *Scratch.*		

Intended learning outcomes	You students after The construction from the Table Periodic interactive, can interact with it in order to understand a historical context, understanding that each chemical element inserted there has its properties, its characteristics, its applications and its history.		
Teaching Activity	➢ Present the elements that make up the Periodic Table and exemplify the process of construction; ➢ Read and explain the script for constructing the Interactive Periodic Table; ➢ Show The Table Periodic Interactive already built for the teacher in *Scratch* based on the research script developed.		
Learning Activity	▪ Construction of the Interactive Periodic Table in *the Software Scratch* ; ▪ Questionnaire of meetings.		
6th Meeting - Atomic Mass		**Duration: 100 min. (02 classes of 50 minutes)**	**Location: Computer Laboratory**
Contents	Calculation of average atomic mass		
Objective of the lesson	Address interrelated concepts in Chemistry and Mathematics, how to calculate atomic mass and check whether the constructed Periodic Table will help students in this stage.		
Intended learning outcomes	▪ Define and determine mass atomic; ▪ Calculate The pasta atomic in one element through from the equation of the arithmetic mean weighted; ▪ Use of the Interactive Periodic Table built by student himself as support in solving activities.		
Teaching Activity	➢ Conceptualize what the atomic mass of an element is chemical; ➢ Show where to find the atomic mass in the Periodic Table ; ➢ Conceptualize and determine the equation for calculating atomic mass using the weighted arithmetic mean; ➢ Explain and comment on some examples of calculations.		
Learning Activity	▪ You students should calculate The pasta atomic in some elements, through activities and resolution, have as assistance the Interactive Periodic Table built by him same; ▪ Questionnaire regarding Sequence Didactics; ▪ Forums.		
Totaling a workload of 800 minutes (16 classes of 50 minutes)			

Source: Prepared by the authors (2024)

At the first meeting, a survey of the students' prior knowledge and contextualization of the topic was carried out. At this meeting there was a presentation by the teacher/researcher to the participating students and vice versa, in addition to a brief speech about the contextualization of the research and initial access to the website created by the researcher, which includes an online school platform https:// rosestrieder.mat.br/, from the Investigative Didactic Sequence to record the actions of all meetings. The image and voice authorization terms were then handed over: informed consent form – TALE and informed consent term/record – TCLE, as well as the script of activities carried out during the six meetings and a printed Periodic Table. The study carefully followed the guidelines of the consolidated opinion of the UNEMAT Research Ethics Committee, numbered 5,823,782. The identity assigned to the students was made with the letter "A", followed by a number: "A1", "A2", "A3" ... "A13", successively, to identify the thirteen participants, with the aim of preserving their identity.

The Science Didactic Sequence: Teaching by Investigation in the 9th year of Elementary School was applied with thirteen students from the 9th year "A" of Elementary School in the morning in person with six meetings, one in each week totaling six weeks, 16 classes of 50 minutes each (800 total minutes). All meetings were held between March and April 2023 in the computer laboratory of the Escola Estadual Professor João Batista de Tangará da Serra -MT.

Data were collected through questionnaires, conversation circles and observations , following the guidelines proposed by Flick (2009), which values the quality of information in qualitative research, highlighting the importance of these resources in the process of collecting, investigating and analyzing information. .

Given the outlined context, this research used the inductive method for the treatment and analysis of the collected data, due to its flexibility and adaptability to the research context, enabling the identification of patterns and trends emerging from the data (Oliveira, 2016). Data analysis involved organizing information based on the criteria of research sources, moments and instruments used, identifying units of analysis and building categories to group similar information (Sampieri, Collado, Lucio, 2013; Lüdke, André, 1986).

RESULTS OF THE DIDACTIC SEQUENCE AND DISCUSSION

The research results were produced (through questionnaires, conversation circles and observations), through discussions within the scope of the application of a Science Didactic Sequence: Teaching by Investigation in the 9th year of Elementary School. The discussions presented reflect the conceptions of the research participants on the proposed theme, which addresses the construction of an Interactive Periodic Table in *Scratch* , with a mathematical approach to periodic properties in the teaching of Chemistry.

The Periodic Table is a fundamental and relevant resource for obtaining information about chemical elements and their properties, being considered an indispensable instrument for the study of Chemistry (Oliveira *et al,* 2015). The central idea of the Periodic Table comes from its name itself, it is its periodicity, that is, the regular repetition of some physical-chemical properties throughout a period (Berbaum; Maldaner, 2016). To better understand the importance of this resource, it is necessary to know its history and understand its structure. In this sense, it is important to analyze students' knowledge about the Periodic Table, in order to identify their ideas and perceptions on the topic, questions were asked and a conversation circle was promoted.

When asking students what is the Periodic Table about? It was observed that the majority of students defined it as a resource for organizing chemical elements already discovered, by their physical-chemical properties and in increasing order of atomic number. *"The Periodic Table is a tool for organizing the chemical elements already discovered, grouping them by similarity of physical-chemical properties and in increasing order of atomic number." TO 1.*

Some students mentioned the importance of grouping these elements into families or groups, for example, *"The periodic table is a table that indicates chemical elements, which are discovered over time, organizing the elements and grouping them into families/groups" A3* . One student highlighted the history of the Periodic Table by mentioning Russian chemist Dmitri Mendeleev. As presented by Leite (2019), the milestone in the history of the Periodic Table occurred in 1869, when Dmitri Ivanovic Mendeleev, a Russian, exposed his first diagram of the organization of the elements to the Russian Chemical Society. This historical milestone was elucidated by student A6.

> "The Periodic Table is a tool that aims to organize and group all the chemical elements ever discovered by human beings. It was developed in 1869 by the Russian chemist Dmitri Mendeleev, who organized elements with similar properties into groups and placed them in ascending order of mass" (A6).

It is important to highlight that the Periodic Table is an indispensable resource for the study of Chemistry, but why is it called Periodic? According to the students' responses, the name is due to the organization of chemical elements into periods, resulting in the repetition of properties at intervals of time, where elements with similar characteristics are grouped together, highlighting the close connection between the domains of Mathematics and Chemistry.

As emphasized by student A1, *"it is due to periodicity, that is, the repetition of properties, from interval to interval"*. In this context, interdisciplinarity becomes evident, since the organization by periods allows the grouping of chemical elements according to their characteristics, simplifying their classification and identification. This approach involves concepts from both Mathematics and Chemistry.

This arrangement, which is the result of the interdisciplinarity between these two disciplines, allows the properties of the elements to be analyzed in a systematic and organized way, as highlighted by student A6.

> “elements are classified in a tabular arrangement in which a row is a period and a column is a group. Elements are arranged from left to right and top to bottom in the order of their increasing atomic numbers” (A6).

The Periodic Table is also a resource that serves teaching purposes, as student *A2 points out: "It helps the elements to be identified in an easier way."* Furthermore, it is used in advanced scientific research to predict the properties of unknown elements.

In short, the Periodic Table is called Periodic due to the organization of chemical elements into periods, which allows the repetition of properties at intervals of time. Understanding these periodic properties of chemical elements allows us to understand how they are organized in the table, indicating the possibility of a certain chemical bond occurring and, also, the projection of new compounds and materials (Atkins; Jones, 2012)

Through a conversation circle, students participated in a broad discussion about the history of the Periodic Table, which included topics about its creation, development and evolution, as well as its importance for understanding Chemistry and Science in general. Additionally, students explored the practical applications of the elements of the Periodic Table in their everyday lives. From the students' reports, it was possible to identify the following relevant perceptions.

Student A2 highlighted the importance of the meeting, highlighting the rich learning about the history of the table and its evolution over time, mentioning the transition from spiral-shaped tables to a more visible and easy-to-identify form . This broad understanding provided a solid foundation for further study.

> Today was our first meeting, and there was a lot of learning, with the history of the periodic table, which has existed since the 19th century (19), evolving over time, with new elements and tables, which were previously spiral-shaped and now It has a more visible and easier to identify shape. (A2 – RC 03/15/2023).

Student A6 shared his understanding of the history of the Periodic Table and the discovery of its elements. Furthermore, he noted the presence of these elements in our daily lives, recognizing the practical importance and relevance of the table for understanding the world around us.” *I learned about the history of the periodic table, about its elements, that some elements from the periodic table are in our daily lives. (A6).*

The A10 experience was marked by an interesting class, dedicated to the study of the Periodic Table. He valued the comprehensive approach that included not only the history of the table, but also the scientists who contributed to its discoveries and the table model we know today. The personal affinity with the topic made the experience even more rewarding and stimulating.

> Today was an interesting class, we studied the periodic table, its history, the scientists who contributed to the discoveries of the elements and also the table model we know today. It's a

topic that I'm very interested in, and I really enjoyed having the opportunity to study the subject! (A10 – RC 03/15/2023).

Student A13 expressed his appreciation for learning about chemical elements and their importance for our survival. He highlighted: *"I thought it was cool, I learned that we have several chemical elements that are important for our survival, such as iron, hydrogen, nitrogen, among others"* . This discovery emphasizes the practical relevance of the Periodic Table in our daily lives.

These different perspectives and discoveries shared by students during the conversation demonstrate the enrichment of knowledge and the connection established between the history of the Periodic Table, its practical application and the importance of chemical elements in our world. The theme of the Periodic Table is of great relevance not only for learning Chemistry, but also for life. Understanding the concepts and properties of chemical elements is fundamental for understanding various natural phenomena and for the technological and scientific development of various areas, such as health, energy and the environment. In Figure 1, we can see some images from the 1st meeting.

Figure 1: Photos from the 1st meeting

Source: Prepared by the Authors (2024)

In the second meeting, the contextualization and general notions of the Periodic Table continued, addressing the names of groups/families and classifications. Students carried out research on chemical elements on *Chromebooks* , seeking information about the history and physical and chemical properties of each element, which expanded their knowledge about them.

This deepening allowed them to better understand the concept of a chemical element, defined by the students as a set of atoms with the same atomic number, that is, the same number of protons in the nucleus. This definition not only highlights the importance in Chemistry, but also reveals the direct relationship with Mathematics, as atomic numbers are integer values that underlie the organization of the Periodic Table, thus highlighting the interdisciplinarity between these areas of knowledge.

In A6's view , *"chemical elements are a set of atoms that have the same atomic number (Z), that is, the same number of protons in the nucleus, and that, therefore, have the same physical-chemical properties."* That is, chemical elements have similar properties due to the number of protons in their nuclei.

A9 *states* that *"It is a set of atoms that have the same atomic number (z)".* Student *A3* highlights the *"discovery of elements by scientists over the years, and how these elements are often provided by nature".*

In fact, the concept of a chemical element is like a set of atoms with similar characteristics. This definition was presented by Russell (1994), who stated: an element is a pure, fundamental *and elementary substance. An element cannot be broken down into other, simpler substances* . Furthermore, according to Brown et al. (1999) an element is a substance that cannot be decomposed into simpler ones, as each element is composed of only one species of atom.

When asked about the importance of chemical elements for our lives, students highlight the immense relevance of these elements for our survival and for maintaining the conditions necessary for life on the planet. As they pointed out, chemical elements play an essential role in the proper functioning of our organism and in preserving environmental balance. These students' perceptions exemplify the interdisciplinarity inherent to the topic, supported by Miranda's (2013) vision of interdisciplinarity, which is based on reading the individual's reality, considering their singularities, nuances and present diversity.

For *A2* , chemical elements are *"extremely important, as we need them to live".* This is due to its presence in the constitution of our body, as well as in the composition of the water we drink, the air we breathe, the food we consume and the medicines we use. A3 highlights this importance *by* mentioning that *"hydrogen and oxygen provide us with water and air, which are essential for our survival."* These student observations demonstrate the interconnection between Chemistry, biology and health, reinforcing the need for an interdisciplinary approach.

Chemical elements also play a very important role in the manufacture of products that are part of our daily lives, as *A6 explains: "Chemical elements form everything we know, from our body to the fuel that drives our car. They are part of the our food and diet."* This highlights the interdisciplinarity in the integration of Chemistry with areas such as engineering, technology and nutrition. The way we use these chemical elements is, therefore, fundamental for preserving the environment and promoting a sustainable future, which reflects the interdisciplinary complexity of the topic.

In general, participants A8, A10 and A11 highlighted the indispensability of chemical elements for our lives and the proper functioning of our bodies. These students' perspectives corroborate Miranda's (2013) vision of interdisciplinarity, which highlights the importance of an integrated approach to fully understand the impact of chemical elements on our existence, involving not only Chemistry, but also biology, ecology and other related disciplines.

Regarding the question about students' familiarity with the nomenclature of chemical elements, it is clear that not everyone has prior knowledge on the subject. The nomenclature of elements is fundamental to understanding Chemistry, Science and the world around us.

While some students claim that they do not know the nomenclature of chemical elements, such as A1 and A7 stating *"no",* others demonstrate some knowledge, such as *A4* who stated that they know " *some, such as iron (FE) which is located in our body, for example , and oxygen, which is identified by the letter (O) which represents air"* . And *A3* mentions that he knows *"a little"* of the nomenclature, but not much.

Some students also highlight the importance of nomenclature for understanding chemical elements and their histories, as mentioned by *A6: "it serves to help memorize chemical elements",* and by student *A8: "because it helps memorize the elements and write down their history ".* Furthermore, *A9* highlights that *"the names and symbols of the elements have to do with their original names, which are usually in Latin or Greek".*

It is important to remember that, just like the nomenclature of elements, the nomenclature of other inorganic functions, such as acids, salts and oxides, follows some rules, as stated by *A10* . Understanding these rules is essential for understanding Chemistry and for the proper use of elements and substances. In Figure 2, we can see some images from the 2nd meeting.

Figure 2: Photos from the 2nd meeting

Source: Prepared by the Authors (2024)

Considering that Digital Technologies are present in school environments through various resources, such as applications, *software* and the internet, generally contributing to the development of research, the streamlining of classes and the restructuring of the teaching process, *Scratch Software* is stands out as a methodological resource and its importance goes beyond simple programming, as it acts in an interdisciplinary way, establishing connections between concepts of Chemistry, Mathematics and Digital Technologies.

In addition to being an interdisciplinary resource, *Scratch* allows students without specific programming knowledge to develop their skills through programming blocks, where each block represents a function or control. This approach contributes to the development of Computational Thinking (Resnick *et al.* , 2009).

In the third meeting, the introduction to the Scratch software was carried out. Students were then invited to access the *Scratch platform* via the *link* https://Scratch.mit.edu and register, creating a login and password using their *Chromebooks* . The purpose of this meeting was to prepare students to develop programming skills and competencies in order to understand how it works and its contributions to the construction of the Interactive Periodic Table.

After having access to the platform, students had the opportunity to carry out exploratory activities in the *Scratch Software* , in order to familiarize themselves with its resources, they were able to try out different functionalities, such as movement, interaction between characters, creating a background and inserting score, among others. Furthermore, they were encouraged to create their own activities, freely exploring *Scratch* and discovering more features on their own, as highlighted by Silva *et al.* (2016). These activities allowed students to use *Scratch* autonomously, stimulating their creativity and learning in an integrated way, improving their understanding and skills in different disciplines.

Scratch *empowers* students by granting them the power to create and control elements in the virtual world. Through this *Software* , they stop being just consumers of media and become producers, developing their own projects. They then have the opportunity to share their creations on the Internet, while learning and improving their computational skills (Passos, 2014).

Handling the *Scratch Software* in the computer laboratory, the students were asked about the experience if they already knew the *Scratch Software* . In general, responses indicated that using the program presented both challenges and positive aspects.

These responses reflect different student perceptions regarding the use of *Scratch Software* . Some students mentioned initial difficulties, such as understanding and creating elements, but highlighted that, with practice, they were able to overcome them and find programming easier. Student A1 mentioned " *more or less, he may have some difficulties in understanding* . Student A6 shared that " *It wasn't very difficult. The biggest difficulties I had were when assembling it, but once I got the hang of it, I was able to do it easily"* . Finally, student A10 highlighted that " *I found it difficult at first, but over time it became easier and practical as well as fun"* .

Other students expressed that they found *Scratch* fun and interesting, valuing its ability to teach programming in an engaging way. Student A4 already had some prior knowledge and found the experience fun, while A9 had his first experience with the program and found it interesting and enjoyable. Student A4, who already had some prior knowledge, described the experience as fun, stating: "yes, it's fun to program and your games are fun." Likewise, student A9, who had his first experience with the program, considered it interesting and enjoyable, commenting: "no, I thought it was really cool and fun, I liked it because it teaches us how to program in a cooler way".

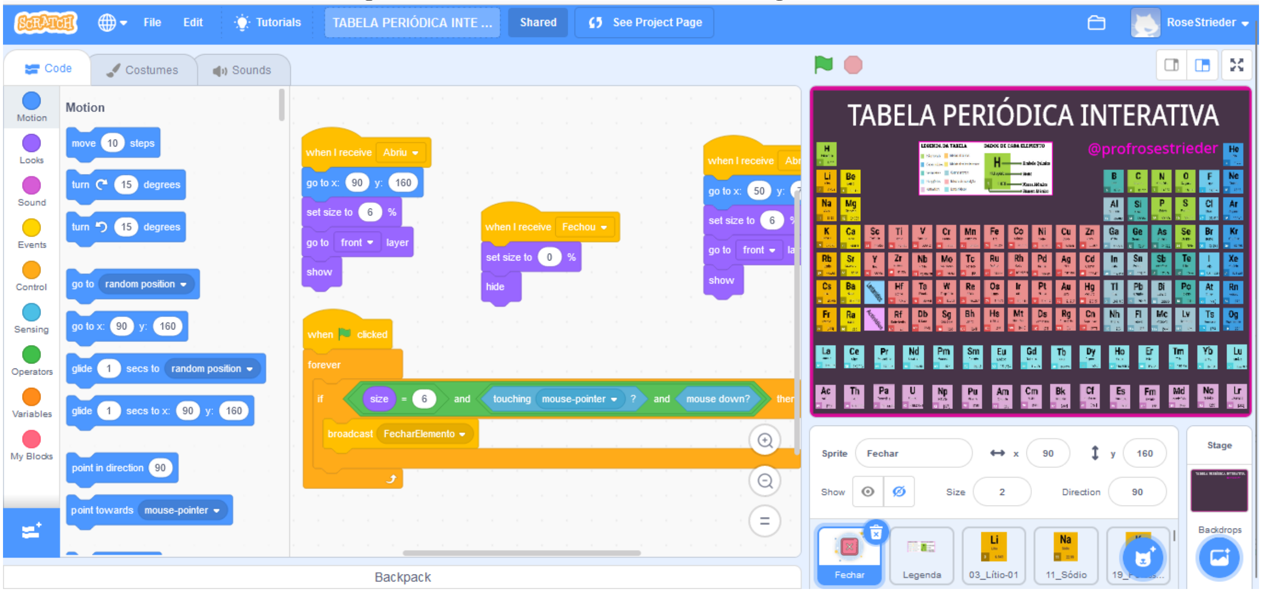
The different perspectives highlight the challenging yet rewarding nature of prior *Scratch knowledge* and programming experience. In Figure 3, we can see some images from the 3rd meeting.

Figure 3: Photos from the 3rd meeting

Source: Prepared by the Authors (2024)

In the fourth and fifth meeting, the Interactive Periodic Table was constructed in Scratch. Using the *Scratch platform* (Figure 4), students had the opportunity to build one of the Interactive Periodic Table, demonstrating the application of interdisciplinarity, integrating Chemistry concepts with Digital Technologies and programming. Interdisciplinarity occurs when students apply knowledge of Chemistry to represent chemical elements in the Periodic Table and, at the same time, use programming to create interactions so that, when clicking on an element, information about it is displayed, such as the symbol, atomic number , atomic mass and other relevant properties. As shown in figure 4.

Figure 4: Construction of the interactive periodic table



Source: Prepared by the authors (2024)

During the construction of the Interactive Periodic Table in *Scratch,* the students encountered some difficulties in the process. One of the main difficulties was in relation to understanding and applying the programming concepts necessary to create interactions and display element information. A1's report highlighted that the *Software interface* can be confusing, requiring care not to get lost. " *You have to be careful because you might get lost."* A2 highlighted the importance of planning to avoid surprises *"I thought it was doing groups".* A6 mentioned that the complexity of the controls was a challenge " *All the complexity of being able to assemble the exact controls".* A7, on the other hand, only had difficulty fitting in some things " *only when fitting in some things, but it wasn't difficult".*

It is important to consider the students' lack of ability to deal with the *Software* and the programming required, since this was their first experience, which naturally makes the task more complex. On the other hand, this need for students to change commands and redo procedures can instigate reflection on the obstacles encountered, leading them to rethink mistakes and redo programming until they reach the final objective of the project (Pinto, 2010; Malan and Leitner , 2007). From this perspective, what could have initially been seen as a negative aspect can be interpreted as a characteristic with benefits. In addition to the difficulties encountered during the construction process, the students also identified some advantages. Student A1 cited the ability to change commands in real time as an ease " *you can fix the wrong commands whenever you want"* .

A6 mentioned that, once he learned the repetitive commands, creating the Interactive Periodic Table became easier " *At first, it was quite complex, but once I learned it it became easy, mainly because of the repetitive commands"* . This demonstrates the importance of repetition and commitment to the learning stages.

A7 highlighted the organization of commands according to their use " *the commands organized according to use, it is easier to find that way"* . This made the search for solutions easier, as the location of specific resources was grouped by function.

Student A10 mentioned the ease of use of the *software* and the clarity of the teacher's explanations as positive points: " *the way to program, as the commands are easy to use, and the teacher explains very well"* . The *Scratch* commands were considered easy to learn and use, and the teacher's ability to explain how the *software works* helped students understand the concepts necessary to construct the Interactive Periodic Table.

Finally, student A13 expressed that he found the process dynamic and did not face significant difficulties " *look, I found it very dynamic, the teacher explained it well so I didn't find it difficult at all"* . He highlighted that the teacher's good explanation contributed to his understanding and the fluidity of the work in the *Scratch Software* .

By building the Interactive Periodic Table in *Scratch,* students improved their programming skills. They planned and structured the logic behind the interactions and information displayed, in addition to learning basic programming concepts, such as variables, conditionals, also allowing them to interact with their own creations in order to perceive a historical context, understanding that each chemical element there inserted has its properties, its characteristics, its applications, its history and the calculation of atomic mass, as it is an interrelated concept in Chemistry and Mathematics and of course they shared their creations with colleagues, promoting collaboration and the exchange of knowledge.

Overall, this construction provided an enriching educational experience, integrating concepts from Chemistry, Mathematics and programming in an interactive way, that is, students improved their programming skills, planned interactions and information, demonstrating how interdisciplinarity can expand knowledge and deepen their knowledge in Chemistry. In Figure 5 A, B we can see some images from the 4th and 5th meetings.

Figure 5: A) Photos from the 4th Meeting , B) Photos from the 5th Meeting

Source: Prepared by the Authors (2024)

In the sixth meeting, the interrelationship between Chemistry and Mathematics was addressed, focusing on the calculation of atomic mass and the use of the Periodic Table constructed by students as an aid in this process. Chemistry has vast contents and many peculiar languages, full of nomenclatures and notations as a way of understanding the meaning of phenomena, suggesting memorization and deciphering that often makes no sense to students. This often makes it difficult to know how to connect chemical theories to the behavior of materials. However, the importance of this language and different approaches to teaching interrelated Chemistry and Mathematics content cannot be underestimated. About the factors that can create challenges in teaching Chemistry. Santos, Silva and Lima (2013) point out that the lack of a solid theoretical foundation in Mathematics, as well as the lack of connection between the content taught in the classroom and the daily lives of students students is a fact.

By interrelating these disciplines, students have the opportunity to explore the relationship between chemical elements and the mathematical calculations necessary to determine properties such as atomic mass. According to Russel (1994, p. 242) “the atomic mass of an element is calculated by the average of the masses of the isotopes of that element. The average needs to be weighted to take into account the relative abundance of the isotopes.” To calculate the atomic mass of an atom in Chemistry, it is essential that the student has a good understanding of the mathematical concepts related to equations, as well as the operations involved in them. Therefore, to calculate the atomic mass of an atom, the student must add the atomic mass value of each isotope multiplied by its percentage of occurrence in nature. Then, this value must be divided by 100 to obtain the result in percentage form. This relationship can be expressed through the following equation:

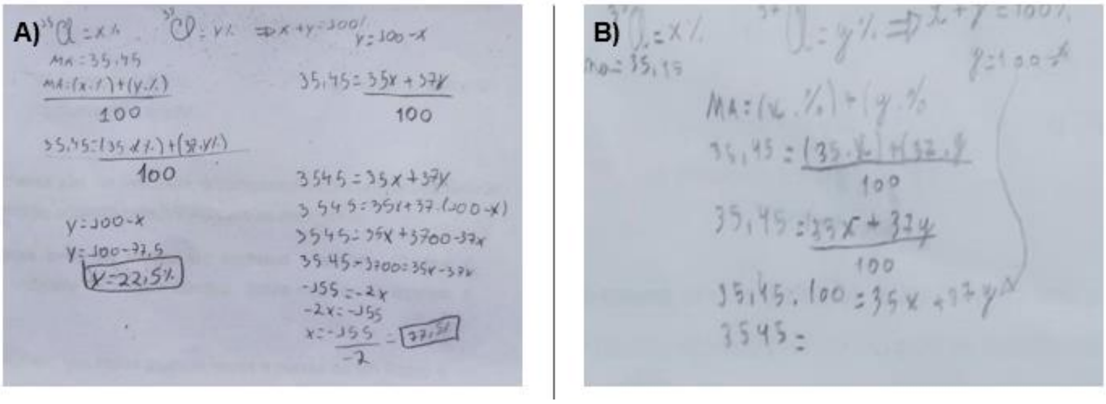
$$MA = \frac{[(\%_1 \text{ x } \mathrm{MA}_1) + (\%_2 \text{ x } \mathrm{MA}_2) + \ldots]}{100}$$

Where:

- MA: Atomic Mass,
- $\%_1$, $\%_2$: Percentage of isotope abundance,
- MA_1, MA_2: Atomic mass of isotopes.

After developing the interdisciplinary class with the help of the Interactive Periodic Table, problem situations were presented to the students so that they could put their knowledge into practice. One of the situations addressed was the following: (FGV) Chlorine is found in nature in two isotopic forms of 35 and 37 atomic mass units. Given that the average atomic mass of chlorine is 35.45 µm, what is the percentage of the two isotopes in nature? The resolution of this situation made by students A3 and A11 is shown in Figure 6A and B.

Figure 6: A) Resolution of the complete MA calculation, B) Resolution of the partial MA calculation.



Source: Researchers’ archive (2024).

The students were able to correctly formulate the equation and perform the operations appropriately. In total, 9 of the students solved the problem completely, while 4 were able to correctly operationalize the elements within the equation. In this way, we believe that the approach to mathematical concepts to assist in the teaching of Chemistry had significant results in students' understanding.

In order to evaluate the influence of the Interactive Periodic Table on the process, we asked students to answer the following question: What was it like to solve the questions about calculating atomic mass when interacting with the Interactive Periodic Table that you built in *Scratch Software* ? (Figure 7).

Figure 7: Interaction with the Interactive Periodic Table to calculate atomic mass.

Source: Prepared by the Authors (2024).

Based on student responses, using the Interactive Periodic Table to solve atomic mass calculation activities proved to be a beneficial and positive experience. As mentioned by student A2, *"it helped a little with the calculations of classroom tasks and other things"*. On the other hand, student A4 recognized that *"it's a little complex because we can get lost in the middle of the process, but I believe that, as we do more activities, it can become simpler and even fun"* . Student A11 expressed that *"it was a little difficult at first, as the mathematics is very complex"* , highlighting the complexity of the Mathematics involved in the calculations, which makes using the table initially challenging. Despite this noted complexity, student A7 highlighted that the table was useful in the complex calculations necessary to determine the atomic mass, stating that *"it was not that easy, but it helped a lot, which made the calculations easier, as the calculations are a little complex"* .

Finally, student A8 evaluated the use of the Interactive Periodic Table as a positive experience, stating that *"it was really cool, I learned a lot of different things, but I found the calculations a little difficult"* , highlighting the challenges faced in the calculations. On the other hand, student A12 highlighted that the table facilitated the learning process, expressing that *"I thought it was really cool and it's easier to learn".*

The Periodic Table is an important instrument in the field of Chemistry, as it allows us to understand different aspects of chemical elements including atomic mass, which is essential for chemical analyses. Scerri (2007) reaffirms that the Periodic Table plays an indispensable role in the study of Chemistry, since it is through it that all chemical elements are found, organized in a way that allows the observation of their properties and similarities.

At this stage of the Didactic Sequence, students used *Scratch Software* to build an Interactive Periodic Table to work with activities related to the Periodic Table and atomic mass calculations. In this sense, the students were asked: What improved your understanding of the concepts of the Periodic Table and its atomic mass calculations when using *Scratch Software* for construction and interaction during activities?

According to the students' responses, using *Scratch Software* to construct and interact with the Interactive Periodic Table was beneficial in relation to understanding the concepts of the Periodic Table and atomic mass calculations. As evidenced by student A4, *"I was able to understand better thanks to the interactive table, as it is easy to use and learning becomes more enjoyable".*

Student A7 highlighted that *"through the construction of the periodic table, I learned more about the elements and I am also learning about how to calculate atomic mass".* Student A6 mentioned that *"Scratch helps a lot with certain activities"* , while student A11 stated that *"well, I still didn't know the periodic table, but the little I learned was enough for me to learn more about it, in my understanding was the calculations of atomic mass".*

Finally, A12 highlighted that *"Before classes I didn't know anything, now I know".* Using *Scratch Software* allowed him to gain knowledge and understanding regarding the Periodic Table and its calculations.

Based on the answers provided by students, using the Interactive Periodic Table to perform atomic mass calculations proved to be a useful and beneficial resource, even though some students mentioned that this approach was a bit complex and challenging.

However, they noticed an improvement in solving activities and understanding concepts. These results corroborate the idea of Marcondes and Peixoto (2012), who advocate contextualized Chemistry teaching, which involves both procedural and attitudinal knowledge, allowing students to construct knowledge instead of just absorbing it.

In this context, the use of *Scratch* as a teaching resource provided students with the opportunity to explore *software* that encourages the creation, protagonism and sharing of ideas and information. Specifically, when teaching the Periodic Table and calculating atomic mass, *Scratch* favored the development of essential skills, such as basic notions of programming.

In the conversation circle, students were able to share their experiences and opinions about the meeting and the knowledge provided. Initially, some students had difficulty understanding the topic, but with the researcher's explanations, they were able to understand it better. According to A1's report, *"it was difficult to understand but after the explanation everything became easier to understand!!"* , demonstrating that the interdisciplinary approach was fundamental to knowledge.

Although it was a little challenging for some students, as mentioned by A4, *" I thought it was really cool, but it was a little complicated and had some difficulties",* overall, the meeting was seen as an interesting and useful opportunity for improvement. As A8 stated, *"it was a very good meeting and a lot of learning, we saw that mathematics is related to various subjects and in everyday life".*

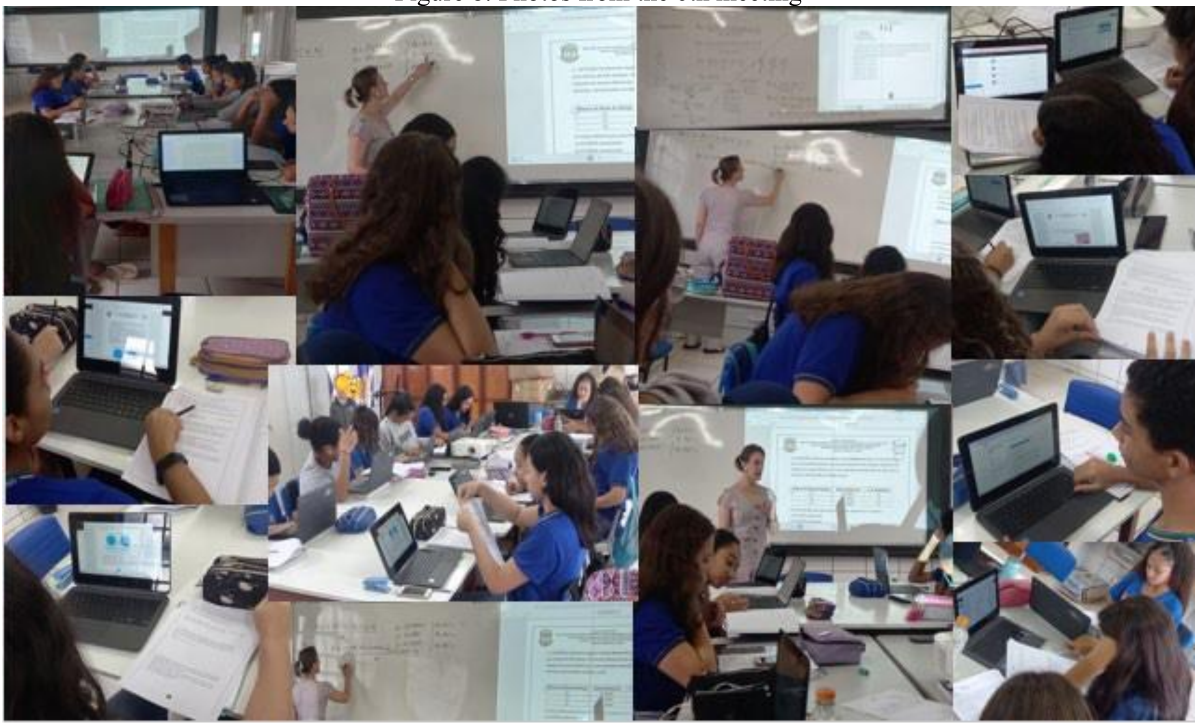
The reports of A9 and A10 point to a positive experience in relation to interdisciplinary teaching about atomic mass. From this same point of view, the National Curricular Parameters (2002, p. 89) consider that "interdisciplinarity must start from the need felt by schools, teachers and students to explain, understand, intervene, change, predict, something that challenges a discipline isolated and attracts the attention of more than one look, perhaps several". A9 highlighted the importance of acquiring knowledge in the areas of Science and Mathematics, expressing his satisfaction by saying *"I found it rewarding to learn new content related to science and mathematics, I believe I managed to assimilate the material in a certain way".* In a similar way, A10 demonstrated his interest in learning new calculations associated with atomic mass by stating *"It was very intriguing to acquire knowledge about these new calculations related to atomic mass."* These reports show that students not only understood the relevance of the topic addressed, but also engaged positively in the context of interdisciplinary teaching.

Despite having encountered some challenges during the mathematical calculations, A11 evaluated the meeting positively, considering it very cool. He expressed his appreciation for the experience, mentioning *"I really enjoyed it!!! Today was really cool, removing some difficulties regarding the MATHEMATICAL accounts."*

By analyzing the results and students' perceptions, we can see the effectiveness of the interdisciplinary approach between Chemistry and Mathematics, using the Interactive Periodic Table in *Scratch Software* . This integration allowed students to visualize and interact with chemical elements, understand the structure of the Periodic Table and perform atomic mass calculations in a practical and contextualized way. From this perspective, the adoption of interdisciplinary practice emerges as one of the viable solutions to overcome the fragmentation and lack of contextualization of knowledge, in addition to contributing to the search for solutions to complex problems (Morin, 2000; BRASIL, 2017; Fernandes, 2007) .

Furthermore, during the conversation circles, students were able to express their opinions and share their experiences. These discussions provided a greater understanding of the challenges faced by students, as well as their achievements and development throughout the knowledge process. In Figure 8, we can see some images from the 6th meeting.

Figure 8: Photos from the 6th meeting



Source: Prepared by the Authors (2024)

Regarding the Didactic Sequence developed with the teacher using Digital Technologies, it can be said that it was very well accepted by the students, and contributed to more efficient and interesting learning. A4 highlighted that the project helped a lot in understanding the content studied in the classroom, as mentioned *"I really liked it because I was able to understand the content much better with the project, before I had more difficulties"* .

Furthermore, the students also highlighted that the Didactic Sequence was a fun way of learning. *"I really liked it, because it's been a fun way and I'm learning a lot from our meetings. And they are useful topics in our daily lives"* as A7 said. A8 mentioned that Digital Technologies can be very useful for learning, facilitating the understanding of the content studied, according to his statement *"my assessment is 10, digital technologies make learning a lot easier"* .

Thus, the students' responses indicate that the Didactic Sequence was successful in achieving its objective of supporting and integrating Digital Technologies in the knowledge process, making it more interesting and stimulating for students. Some students also highlighted that the Didactic Sequence was essential to help in Science classes, as mentioned in this answer by A13 *"It's a lot of fun and helps a lot in science classes".* Finally, it is clear that the teacher played an essential role in the success of the project, according to A2 *"she helped a lot with studying in the classroom".*

Regarding *Scratch Software* , students gave it a positive evaluation and shared their experiences enthusiastically. A1 described the experience as "incredible", giving the maximum score of 10/10 and praising the teacher's good explanation. According to the excerpt of his speech *"it was incredible 10\10, and the teacher also explained it well"*. Student A4 mentioned that *"it was a little tiring to do, but it wasn't difficult. In the end, using Scratch was an interesting experience."* He acknowledged that it was a little tiring, but using *Scratch* was not difficult and that the experience was interesting and allowed him to explore new study approaches.

A8 expressed his satisfaction with the project, emphasizing that using *Scratch* helped a lot in learning chemical elements. For her, using this technological resource was an engaging and effective way to understand the concepts, providing a positive and beneficial experience. *"I thought it was cool that Scratch helped a lot in learning about chemical elements"*.

Finally, the A10 *"was cool, I really liked it and my experience with it was great"* describing his experience with *Scratch* as cool and highlighting how much he liked the project. For him, using the *Software* was an enriching teaching opportunity and his overall evaluation was very positive.

These responses reflect the positive impact of the Didactic Sequence using *Scratch Software* on students' understanding. Involvement with this technological resource sparked enthusiasm, improved understanding of concepts and made the teaching process more interesting and engaging. Positive feedback from students highlights the potential of *Scratch as an* educational resource and demonstrates the success of the Didactic Sequence in providing an enriching experience of studying and exploring content.

CONCLUSION

This didactic sequence contributed to the acquisition of conceptual content and attitudes, values, facts and procedures. And it allowed us to verify that the *Scratch Software* at the teaching in Chemical showed up one important resource, allowing an interdisciplinary and technological approach that can favor both the school context and the understanding of important concepts in the area of Chemistry and Mathematics. It is also important to highlight that the practical classes held in the computer laboratory, within this interdisciplinary approach, became enjoyable and motivating for the students. They demonstrated an interest in solving problems, formulating hypotheses, testing them, and adjusting their ideas based on experimental results. This approach aroused curiosity and interest in teaching Science, enabling the construction of new knowledge and providing students with a new way of thinking about Chemistry through the connection between reality and practice.

As a suggestion for future studies, it is recommended that teachers apply the investigative didactic sequence and carry out similar research to verify the results obtained and compare them with those of this research. Furthermore, it is important that investigations are carried out in different classes in order to develop a more comprehensive approach in terms of analyzing and understanding the results. Another relevant aspect is starting the teaching process based on the students' prior knowledge, seeking to rebuild their understanding of the topics to be covered. This approach can contribute to a more enriching and effective educational process, taking into account the particularities and experiences of students. In this way, it will be possible to expand knowledge about the effectiveness of teaching sequences and improve the teaching strategies used.

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