SEVEN
publicações acadêmicas

A TEACHING SEQUENCE BASED ON PROBLEM-BASED LEARNING AND FLIPPED CLASSROOM FOR TEACHING ELECTROCHEMISTRY IN HIGH SCHOOL

UMA SEQUÊNCIA DIDÁTICA BASEADA EM APRENDIZAGEM BASEADA EM PROBLEMAS E SALA DE AULA INVERTIDA PARA O ENSINO DE ELETROQUÍMICA NO ENSINO MÉDIO

UNA SECUENCIA DIDÁCTICA BASADA EN EL APRENDIZAJE BASADO EN PROBLEMAS Y EL AULA INVERTIDA PARA LA ENSEÑANZA DE LA ELECTROQUÍMICA EN LA EDUCACIÓN SECUNDARIA

https://doi.org/10.56238/sevened2025.036-141

Hercília Araújo Santos[1], Ezequiel da Cruz Lima[2]

ABSTRACT
The teaching of Electrochemistry in High School presents challenges related to the abstraction of concepts, the difficulty in articulating theory and practice, and student demotivation, especially when approached through traditional methodologies. Given this scenario, this work aimed to investigate the contributions of Problem-Based Learning and the flipped classroom to the teaching of Electrochemistry in High School. The methodology adopted was characterized as qualitative and bibliographic research, developed from the analysis of academic productions published between 2019 and 2025, located in the SciELO and Google Scholar databases, related to Chemistry teaching, active methodologies, and Electrochemistry. As a result, the literature analysis showed that the integration between Problem-Based Learning and the flipped classroom favors the contextualization of content, student protagonism, and the progressive organization of teaching, aspects relevant to the learning of electrochemical concepts. Based on these results, a theoretical teaching sequence was developed, structured in articulated stages aligned with the learning objectives of secondary education. It was concluded that the proposed approach contributes to lesson planning and reflection on substantial pedagogical practices in the teaching of Electrochemistry.

Keywords: Chemistry Teaching. Electrochemistry. Active Methodologies. Problem-based Learning. Flipped Classroom.

RESUMO
O ensino de Eletroquímica no Ensino Médio apresenta desafios correlatos à abstração dos conceitos, à dificuldade de articulação entre teoria e prática e à desmotivação dos estudantes, sobretudo quando abordado por meio de metodologias tradicionais. Diante desse cenário, este trabalho teve como objetivo geral averiguar as contribuições da Aprendizagem Baseada em Problemas e da sala de aula invertida para o ensino de Eletroquímica no Ensino Médio. A metodologia adotada caracterizou-se como uma pesquisa qualitativa e bibliográfica, desenvolvida a partir da análise de produções acadêmicas publicadas entre 2019 e 2025, localizadas nas bases SciELO e Google

[1] E-mail: herciliacta@outlook.com Lattes: https://lattes.cnpq.br/7868130816577054
[2] E-mail: ezequielclima4@gmail.com Lattes: https://lattes.cnpq.br/5125745612959188

Acadêmico, relacionadas ao ensino de Química, às metodologias ativas e à Eletroquímica. Como resultados, a análise da literatura evidenciou que a integração entre a Aprendizagem Baseada em Problemas e a sala de aula invertida favorece a contextualização dos conteúdos, o protagonismo discente e a organização progressiva do ensino, aspectos relevantes para a aprendizagem de conceitos eletroquímicos. Com base nesses resultados, foi elaborada uma sequência didática de caráter teórico, estruturada em etapas articuladas e alinhadas aos objetivos de aprendizagem do Ensino Médio. Concluiu-se que a proposta apresentada contribui para o planejamento docente e para a reflexão sobre práticas pedagógicas substanciais no ensino de Eletroquímica.

Palavras-chave: Ensino de Química. Eletroquímica. Metodologias Ativas. Aprendizagem Baseada em Problemas. Sala de Aula Invertida.

RESUMEN
Los accidentes de tránsito se encuentran entre las principales causas de muerte por causas externas y constituyen un problema prioritario de salud pública. Tradicionalmente clasificados como eventos no intencionales, estas muertes suelen atribuirse a errores humanos, condiciones ambientales o deficiencias en la infraestructura vial. Sin embargo, la evidencia científica indica que una parte de estas muertes puede involucrar indicios de intencionalidad autolesiva, los cuales permanecen ampliamente subregistrados y suelen clasificarse como accidentes de causa indeterminada. Ante esta laguna, el presente estudio tiene como objetivo presentar la autopsia psicosocial de tránsito como una estrategia metodológica innovadora para la evaluación de la intencionalidad en accidentes viales con resultado fatal. Se trata de un estudio de desarrollo metodológico, de naturaleza cualitativa y aplicada, que sistematiza un proceso integrado de investigación retrospectiva de muertes en el tránsito. La metodología adapta los supuestos de la autopsia psicológica y psicosocial clásica, incorporando de manera ampliada datos técnico-periciales, psicosociales, epidemiológicos, ambientales e institucionales. El proceso se organiza en seis etapas secuenciales: identificación del caso, integración de fuentes de datos, investigación psicosocial retrospectiva, análisis técnico y contextual de la vía, sesión intersectorial de integración e inferencia, y elaboración de informe técnico con recomendaciones. Se concluye que la autopsia psicosocial de tránsito amplía la capacidad analítica de la investigación de muertes en accidentes de tránsito, contribuye a la mejora de la vigilancia epidemiológica y respalda políticas públicas intersectoriales orientadas a la prevención de muertes evitables.

Palabras clave: Autopsia Psicosocial. Seguridad Vial. Accidentes de Tránsito. Intencionalidad. Mortalidad por Causas Externas. Vigilancia Epidemiológica.

1 INTRODUCTION

The teaching of Chemistry in High School is elementary in the scientific training of students, corroborating the development of critical thinking, the understanding of natural phenomena and the relationship between science, technology and society. However, the literature points out that, historically, the teaching of this discipline has been marked by traditional practices centered on the transmission of content, which makes it difficult to build meaningful and contextualized learning, especially when it comes to abstract concepts and high conceptual complexity (LINHARES, 2024).

In this context, Electrochemistry stands out as one of the contents that most present obstacles to the teaching and learning process in High School. It should be noted that the difficulties are mainly related to the abstraction of the microscopic processes involved in oxidation-reduction reactions, the need for articulation between chemical, physical and mathematical concepts, as well as the recurrent use of calculations, which can generate demotivation and low engagement of students (INOCÊNCIO et al., 2019). In fact, the dissociation between theoretical content and everyday situations contributes to the perception that Electrochemistry is a topic far from the students' reality (ARAUJO, 2021).

Given this scenario, it becomes evident the need to rethink the pedagogical strategies adopted in the teaching of Science, in order to favor the active participation of students in the learning process (LINHARES, 2024). Active methodologies emerge as alternatives capable of promoting greater student involvement, intellectual autonomy and significant construction of knowledge, by moving the student to the center of the educational process and redefining the role of the teacher as a mediator of learning (VIANA et al., 2020).

Among the active methodologies discussed in the literature, Problem-Based Learning (PBL) stands out for proposing contextualized problem-situations that stimulate investigation, reasoning and decision-making by students, favoring conceptual understanding and the development of cognitive and collaborative skills (INOCÊNCIO et al., 2019). In a complementary way, the flipped classroom proposes the reorganization of learning time and spaces, allowing the initial contact with the contents to occur outside the classroom, through previously available materials, while the face-to-face time is intended for discussion, problem solving and conceptual deepening (NACHTIGALL; ABRAHÃO, 2021).

In this context, the articulation between Problem-Based Learning and the flipped classroom presents itself as a promising pedagogical possibility for the teaching of

Electrochemistry in High School, since both approaches value the active participation of the student, the contextualization of the contents and the progressive construction of knowledge. Thus, the following research problem arises: how to make the teaching of Electrochemistry in High School more meaningful from the proposition of a didactic sequence based on Problem-Based Learning and the flipped classroom?

In view of this problem, this work has as its general objective to investigate the contributions of Problem-Based Learning and the flipped classroom to the teaching of Electrochemistry in High School. The specific objectives are: to discuss the main difficulties related to the teaching and learning of Electrochemistry in High School, to analyze the potentialities of Problem-Based Learning and the flipped classroom as pedagogical strategies for the teaching of Chemistry and to propose, based on the literature analyzed, a didactic sequence for the teaching of Electrochemistry in High School based on Problem-Based Learning and the flipped classroom.

2 PROBLEM-BASED LEARNING AND FLIPPED CLASSROOM IN ELECTROCHEMISTRY EDUCATION

2.1 TEACHING OF ELECTROCHEMISTRY IN THE SCHOOL CONTEXT

The teaching of Chemistry in High School plays a central role in the scientific training of students, as it contributes to the understanding of natural phenomena, technological processes and transformations that occur in everyday life, favoring the construction of a critical view of science and its relationship with society. By enabling the interpretation of physical and chemical phenomena present in real situations, the discipline helps in the development of scientific thinking, argumentation, and reasoned decision-making, essential aspects for the integral formation of the student in basic education (LINHARES, 2024).

Despite this relevance, the teaching of Chemistry still faces significant challenges when predominantly based on traditional methodologies. The centrality of oral exposition, the emphasis on memorizing concepts and formulas, and the dissociation between theory and context contribute to a teaching-learning process that is not very significant, in which the student assumes a passive posture. This scenario tends to hinder conceptual understanding and generate disinterest in the discipline, especially in content that requires a higher level of abstraction and articulation of knowledge, such as those covered in High School (SAMPAIO, 2022).

In view of these limitations, it is necessary to adopt pedagogical strategies that favor meaningful learning, promoting greater involvement of students in the educational process. Methodologies that value active participation, problematization and contextualization of content enable students to establish relationships between scientific knowledge and their reality, favoring the construction of meanings and intellectual autonomy. In the meantime, the literature points out that innovative pedagogical approaches in the teaching of Chemistry can contribute to overcoming the challenges of the traditional model, by stimulating student protagonism and critical reflection on the contents worked on in the classroom (LINHARES, 2024).

The content of Electrochemistry occupies a relevant position in the High School Chemistry curriculum because it articulates fundamental concepts related to chemical transformations, electron transfer and the conversion between chemical and electrical energy. Such knowledge is essential for the understanding of various technological and natural processes, such as the operation of batteries, the corrosion of metals and industrial applications, which reinforces its formative and contextualizing potential when properly worked in the school environment (INOCÊNCIO et al., 2019).

However, the way Electrochemistry is traditionally approached in the classroom does not always favor conceptual understanding by students. The fragmented presentation of content and the excessive emphasis on algorithmic procedures tend to hinder the construction of meanings, making this topic one of the most complex within the discipline of Chemistry in High School (ARAUJO, 2021).

In high school, the study of Electrochemistry generally begins with the concepts of oxidation and reduction, which describe the loss and gain of electrons during chemical reactions. Understanding these processes is fundamental for understanding oxidation-reduction reactions, but it requires the student to move between different levels of representation, such as the symbolic, the microscopic, and the macroscopic, which can generate difficulties when there is no adequate pedagogical mediation (RODRIGUES, 2023).

Electrochemical batteries constitute another central axis of this content, being used as an example of the conversion of chemical energy into electrical energy. In the school context, the study of batteries involves the identification of electrodes, electron flow, and the function of the salt bridge, in addition to the interpretation of the semi-reactions involved. Despite their potential for contextualization, these concepts are often presented in an excessively theoretical way, which compromises students' understanding of the global functioning of the electrochemical system (INOCÊNCIO et al., 2019).

Electrolysis, in turn, introduces the idea of non-spontaneous processes, in which electrical energy is used to promote chemical reactions. This content demands from the student the ability to differentiate spontaneous and non-spontaneous electrochemical processes, in addition to understanding the inversion of the direction of reactions in relation to batteries. The literature points out that the lack of articulation between these concepts contributes to recurrent conceptual confusion in the teaching of this topic (ARAUJO, 2021; LINHARES, 2024).

Another relevant concept addressed in high school is the electrochemical potential, used to predict the spontaneity of reactions and compare the tendency of oxidation or reduction of chemical species. The interpretation of the standard potential tables and their application in problem solving require mathematical and conceptual skills that are not always consolidated in students, which reinforces the complexity of this content in the school context (INOCÊNCIO et al., 2019).

Several studies point out that one of the main difficulties in teaching and learning Electrochemistry is related to the abstraction of the concepts involved. Electrochemical processes occur at the microscopic level, requiring the student to be able to imagine phenomena that are not directly observable, such as the movement of electrons and ions, which can compromise understanding when teaching does not favor the construction of adequate mental models (RODRIGUES, 2023).

In addition to conceptual abstraction, the mathematical difficulties associated with electrochemical potential calculations and the interpretation of chemical equations also pose a significant obstacle. The need to integrate knowledge of Chemistry, Physics, and Mathematics makes the content challenging, especially when the student does not have previous mastery of these areas, which can result in low performance and demotivation in relation to the topic (LINHARES, 2024).

When concepts are presented in a decontextualized way, without explicit relationship with real situations or practical applications, students tend to perceive the content as abstract and not very relevant. The distance corroborates the loss of interest and hinders the construction of meaningful learning, reinforcing the need for pedagogical approaches that promote greater contextualization and student engagement (SAMPAIO, 2022).

2.2 FLIPPED CLASSROOM IN SCIENCE TEACHING

Active methodologies have gained prominence in the teaching of Chemistry because they propose a reorganization of the teaching-learning process, shifting the focus from the transmission of content to the effective participation of the student in the construction of knowledge. In the context of basic education, these approaches seek to overcome limitations of traditional teaching, promoting greater student involvement, intellectual autonomy, and the development of cognitive and socio-emotional skills, aspects widely discussed in recent academic production on the teaching of Science (LINHARES, 2024).

By considering the challenges inherent to the learning of abstract and complex contents, such as those addressed in Chemistry, the adoption of active methodologies presents itself as a strategy capable of favoring conceptual understanding and contextualization of knowledge. It is emphasized that these methodologies contribute to making the educational process more dynamic and meaningful, especially when articulated with problem situations and contexts close to the students' reality (VIANA et al., 2020).

Active methodologies can be understood as pedagogical approaches that place the student at the center of the learning process, attributing to him an active role in the construction of knowledge. Unlike traditional models, these methodologies value problematization, investigation, and reflection, encouraging the student to mobilize previous knowledge, formulate hypotheses, and seek solutions to proposed situations, as discussed in the literature on the teaching of Chemistry (LINHARES, 2024).

In this context, the role of the teacher is redefined, moving from a transmitter of content to a mediator and facilitator of learning. It is up to the teacher to organize the pedagogical environment, propose cognitive challenges and guide the students' research process, while they assume a more autonomous and responsible posture for their learning. This change in roles favors the construction of a collaborative environment, in which dialogue and the exchange of experiences become central elements of the educational process (SAMPAIO, 2022).

The relationship between active methodologies and meaningful learning is widely highlighted in the literature, since these approaches allow students to establish connections between new knowledge and their previous experiences. By promoting the contextualization of content and the active participation of students, active methodologies favor the attribution of meaning to scientific knowledge, contributing to a more lasting and integrated learning, especially in the teaching of Chemistry (LINHARES, 2024).

Problem-Based Learning (PBL) originates from educational proposals that seek to articulate theory and practice through the presentation of contextualized problem situations, capable of instigating students' curiosity and reasoning. This methodology is based on the idea that knowledge is built more effectively when the student is challenged to investigate, discuss and propose solutions to problems that make sense in their learning context (VIANA et al., 2020).

Among the central characteristics of PBL, the use of problems as a starting point for the study, collaborative work in groups, and the valorization of the investigative process stand out. In this approach, students are encouraged to identify what they already know, what they need to learn, and what strategies can be used to solve the proposed problem, promoting the development of cognitive, communicative, and social skills (INOCÊNCIO et al., 2019).

In the teaching of Chemistry, the literature points out that PBL contributes to the contextualization of contents and to the understanding of complex concepts, by allowing students to relate scientific knowledge to real or simulated situations. Studies indicate that this methodology favors student engagement, motivation for learning, and the development of critical thinking, and is especially relevant for teaching challenging topics, such as Electrochemistry (ARAUJO, 2021).

The flipped classroom has been consolidated as a relevant pedagogical approach in the teaching of Science by proposing the reorganization of the teaching-learning process, breaking with the traditional logic of centralization of the exposure of contents in the classroom space. From this perspective, the student's initial contact with the contents occurs previously, through guided materials, while the face-to-face time is intended for conceptual deepening, problem solving and interaction between teacher and students, favoring a more active and reflective learning (NACHTIGALL; ABRAHÃO, 2021).

In the teaching of Chemistry, this methodology has significant potential by allowing complex concepts to be explored in a more dynamic and contextualized way. It is noted that the flipped classroom contributes to the expansion of opportunities for pedagogical interaction and to the more efficient use of time in the classroom, aspects considered fundamental for working with content that requires greater teacher mediation, such as those present in science teaching (RODRIGUES, 2023).

The flipped classroom can be understood as a methodology that reorganizes the pedagogical process by transferring the initial exposure of the contents to moments prior to the face-to-face class. In this approach, students access previously available materials, such as texts, videos and other digital resources, allowing them to arrive at the classroom with an initial contact with the content to be worked on. Thus, it is possible for the face-to-face space to be used for activities that promote interaction, problematization and the collective construction of knowledge (NACHTIGALL; ABRAHÃO, 2021).

The organization of the pedagogical process in the flipped classroom requires careful planning on the part of the teacher, who must select and produce materials appropriate to the students' level of understanding, as well as structure face-to-face activities consistent with the learning objectives. Such reorganization favors a more active posture of the student, who starts to assume greater responsibility for his learning process, while expanding the possibilities of monitoring and mediation by the teacher (SAMPAIO, 2022).

The use of digital resources is a central element in the implementation of the flipped classroom, since it enables access to content outside the school environment. Video classes, virtual platforms, and multimodal materials are widely used as support for this methodology, contributing to the diversification of teaching strategies and to the flexibility of the learning pace. Nevertheless, the use of these resources can favor the understanding of the contents and expand access to information, as long as it is accompanied by adequate pedagogical guidance (RODRIGUES, 2023).

In the teaching of Chemistry, the flipped classroom presents relevant contributions by favoring the development of student autonomy. With access to content in advance, students are encouraged to organize their study time, identify doubts, and take a more active stance in the learning process, which contributes to the construction of more meaningful and lasting knowledge (SAMPAIO, 2022).

In addition to autonomy, the literature points out that this methodology promotes greater engagement and protagonism of students during face-to-face classes. By reserving this moment for discussions, problem-solving, and collaborative activities, the flipped classroom favors active participation and dialogue, creating an environment conducive to the collective construction of knowledge and conceptual deepening in Chemistry (SCHUINA, 2024).

Despite the contributions pointed out, some studies also highlight limitations associated with the implementation of the flipped classroom. Among them, the dependence on access to technological resources, the differences in student engagement in extra-class moments, and the need for greater teacher preparation for the planning and mediation of activities stand out (SAMPAIO, 2022). The limitations in question indicate that the effectiveness of the methodology is directly related to the institutional conditions and the pedagogical follow-up offered to students (NACHTIGALL; ABRAHÃO, 2021).

2.3 PBL AND FLIPPED CLASSROOM IN ELECTROCHEMISTRY TEACHING

The analysis of the literature shows that Problem-Based Learning and the flipped classroom present conceptual and methodological convergences relevant to the teaching of Electrochemistry in High School. Both approaches break with the traditional model centered on the exposure of contents, by prioritizing the active participation of the student, the problematization and the construction of knowledge based on contextualized situations (LINHARES, 2024). Such convergence favors the reorganization of the pedagogical process, allowing the student to assume a central role in learning, while the teacher acts as a mediator and advisor of the proposed activities (VIANA et al., 2020).

From a theoretical point of view, the literature points out that the integration between PBL and the flipped classroom enhances the learning of complex contents, such as those of Electrochemistry, by articulating investigation, previous study and conceptual deepening. PBL contributes by presenting contextualized problems that instigate scientific reasoning, while the flipped classroom reorganizes pedagogical time, allowing the face-to-face space to be used for discussions, clarification of doubts and consolidation of concepts. This articulation favors meaningful learning, by allowing students to relate electrochemical content to real situations and build more consistent conceptual models (ARAUJO, 2021; RODRIGUES, 2023).

Despite the contributions evidenced, the literature also points out gaps related to the integrated approach of these methodologies in the teaching of Electrochemistry. It is observed that many studies analyze PBL and the flipped classroom in isolation or applied to other Science contents, with a smaller number of productions that discuss, in a systematized way, the combination of these strategies specifically for the teaching of Electrochemistry in High School. In addition, limitations are identified regarding the detailed description of the pedagogical proposals and the reflection on the challenges faced in the implementation of these methodologies in different school contexts (LINHARES, 2024; SCHUINA, 2024).

In the meantime, the literature indicates future pedagogical possibilities that involve the elaboration of didactic sequences that integrate, in a planned way, Problem-Based Learning and the flipped classroom for the teaching of Electrochemistry. These proposals can contribute to overcoming conceptual difficulties, promoting greater student engagement and favoring the contextualization of contents, as long as they consider institutional conditions, access to technological resources and the pedagogical training of teachers. Thus, the articulation between these methodologies presents itself as a promising field for the development of innovative pedagogical practices and for the expansion of theoretical discussions in the teaching of Chemistry (ROSA, 2025).

2.4 DIDACTIC SEQUENCE PROPOSED FOR THE TEACHING OF ELECTROCHEMISTRY

The proposition of a didactic sequence based on Problem-Based Learning and the flipped classroom emerges as a pedagogical strategy coherent with contemporary discussions on the teaching of Chemistry, especially with regard to overcoming the difficulties associated with learning Electrochemistry. It is noteworthy that the sequence presented in this research has an exclusively theoretical character, being elaborated from the analysis of the literature, without practical application in a school context, with the objective of contributing to teacher planning and pedagogical reflection in High School.

The didactic sequence can be defined as an organized and progressive set of teaching activities, planned with the aim of favoring the gradual construction of knowledge by students. This organization presupposes the articulation between learning objectives, contents, pedagogical strategies and forms of monitoring the educational process, allowing teaching to occur in a systematic and coherent way (ROSA, 2025).

The progressive organization of teaching is one of the central elements of the didactic sequence, since it enables the resumption of previous knowledge, conceptual deepening and consolidation of contents throughout the proposed stages. In the teaching of Electrochemistry, this progression is especially relevant, considering the complexity and level of abstraction of the concepts involved, which require careful and articulated planning (ARAUJO, 2021).

From the point of view of teacher planning, the didactic sequence corroborates the organization of pedagogical work by guiding the selection of contents, methodologies and didactic resources in an integrated way. The literature points out that the elaboration of theoretically based didactic sequences favors pedagogical intentionality and expands the possibilities of teacher mediation, especially when associated with active methodologies in the teaching of Chemistry (SCHUINA, 2024).

The proposed didactic sequence is based on the articulation between Problem-Based Learning and the flipped classroom, integrating principles common to these methodologies, such as the centrality of the student, the problematization of the contents and the valorization of the investigative process. This articulation seeks to enhance the learning of Electrochemistry by promoting study situations that stimulate scientific reasoning and the active construction of knowledge (INOCÊNCIO et al., 2019).

The alignment with the learning objectives is another guiding principle of the proposal, ensuring that the suggested activities are in line with the Electrochemistry contents planned for High School. The clear definition of these objectives allows us to guide the progression of the stages of the didactic sequence, favoring conceptual understanding and integration between the different topics addressed, as indicated by the literature on pedagogical planning in science teaching (LINHARES, 2024).

Regarding the roles of the subjects involved, the proposal attributes to the student an active and investigative posture, stimulating autonomy, reflection and collaborative work. The teacher has the role of mediator of the learning process, responsible for guiding activities, proposing cognitive challenges and promoting the articulation between previous knowledge and new concepts. This redefinition of roles is in line with the principles of active methodologies discussed in the literature on the teaching of Chemistry (SAMPAIO, 2022).

Coherence with the curricular guidelines also guides the elaboration of the proposed didactic sequence, ensuring that the contents and suggested strategies are aligned with the guidelines for High School. This concern reinforces the pedagogical character of the proposal, which seeks to contribute to teaching practice without detaching itself from the curricular and formative requirements of basic education (LINHARES, 2024).

The proposed didactic sequence has as its central theme Electrochemistry in High School, with emphasis on oxidation and reduction processes, the operation of electrochemical batteries, electrolysis and electrochemical potential. These contents are organized in an articulated way, considering their conceptual interdependence and the need for progression in teaching, as indicated by the specialized literature (INOCÊNCIO et al., 2019).

The guiding problem-situation is the initial element of the sequence, being elaborated in order to contextualize the electrochemical contents from situations close to the students' reality, such as the use of batteries and corrosion processes. This initial problematization has a theoretical character and seeks to stimulate the raising of hypotheses and conceptual investigation, in line with the principles of Problem-Based Learning discussed in the literature (VIANA et al., 2020).

The contents covered throughout the sequence include fundamental concepts of Electrochemistry, articulated from the proposed problem-situation. As suggested didactic resources, digital materials, guiding texts and video classes stand out, used mainly in moments of previous study, according to the assumptions of the flipped classroom. It should be noted that these resources are indicated in a theoretical way, without description of practical application (NACHTIGALL; ABRAHÃO, 2021).

As for the temporal organization, the didactic sequence is structured in stages, distributed throughout classes or pedagogical moments, respecting the conceptual progression of the contents. This temporal organization has a flexible and adaptable character, being presented as a theoretical proposal that can be adjusted by the teacher according to the school context and the needs of the students (SCHUINA, 2024).

The initial stage of the didactic sequence corresponds to the problematization and activation of the students' previous knowledge, based on the presentation of the guiding problem-situation. In this phase, it seeks to stimulate the initial reflection on electrochemical phenomena, promoting the raising of ideas, questions and hypotheses, according to the assumptions of Problem-Based Learning discussed in the literature (VIANA et al., 2020).

The investigative stage encompasses the guided study of the contents of Electrochemistry, based on previously available materials, in line with the logic of the flipped classroom. In this phase, students are encouraged to deepen their conceptual understanding, identify relationships between contents, and review their initial hypotheses, always under the theoretical mediation of the teacher (RODRIGUES, 2023).

In the systematization stage, the conceptual organization of the Electrochemistry contents occurs, seeking to integrate the knowledge built throughout the investigative process. The phase in question aims to consolidate concepts such as oxidation, reduction, batteries, electrolysis and electrochemical potential, promoting an integrated view of the content, as suggested in studies on didactic sequences in science teaching (ARAUJO, 2021).

Therefore, the synthesis and reflection stage proposes the consolidation of the acquired knowledge, encouraging students to reflect on the learning process and on the application of electrochemical concepts in different contexts. This final stage reinforces the formative character of the proposed didactic sequence, highlighting again that it is a theoretical construction based on the literature, with the potential to support future practical applications in the teaching of Chemistry (SCHUINA, 2024).

3 METHODOLOGY

This research is characterized as a qualitative and bibliographic study, focusing on the proposition of a didactic sequence based on active methodologies for the teaching of Electrochemistry in High School. The qualitative approach is justified by the intention to understand and analyze, in an interpretative way, the theoretical contributions presented in the literature about the teaching of Chemistry, active methodologies and, specifically, Problem-Based Learning and the flipped classroom, without the use of statistical procedures or quantification of data.

As for the type of research, it is a bibliographic review, carried out from the survey, selection and analysis of relevant academic productions on the subject. Works published in the period from 2019 to 2025 were considered, with the objective of ensuring the theoretical and methodological updating of the study. The searches were carried out in the SciELO and Google Scholar databases, as they are widely recognized as reliable sources of scientific production in the area of Science Education and Teaching. The keywords used in the searches were related to the teaching of Chemistry, Electrochemistry, active methodologies, Problem-Based Learning, flipped classroom and didactic sequence.

The nature of the study is classified as a pedagogical proposal, since, from the analysis of the selected literature, a theoretical didactic sequence is elaborated focused on the teaching of Electrochemistry in High School, without practical application in the classroom. This type of approach allows the articulation of theoretical and methodological foundations discussed by different authors, aiming to contribute to teacher planning and to the reflection on innovative pedagogical practices in the teaching of Chemistry.

The methodological procedures initially involved the exploratory reading of the selected works, followed by an analytical reading, focusing on the identification of concepts, pedagogical strategies and results discussed by the authors. Subsequently, the information was systematized, seeking to establish relationships between the studies analyzed and the research objectives. This process enabled the construction of a consistent theoretical basis for the proposition of the didactic sequence, aligned with contemporary discussions on active methodologies in the teaching of Science.

The criteria used for the elaboration of the didactic sequence included the coherence with the contents of Electrochemistry planned for High School, the articulation between theory and context, the centrality of the student in the learning process and the integration between Problem-Based Learning and the flipped classroom. In fact, the progressive organization of the teaching stages was considered, in order to favor the understanding of electrochemical concepts and the development of scientific reasoning, as pointed out in studies that discuss the elaboration of didactic sequences within the scope of active methodologies.

The choice of active methodologies as the structuring axis of the didactic proposal is based on the literature that shows its potential to promote greater engagement, autonomy and participation of students in the learning process. Problem-Based Learning benefits the contextualization of content and the development of investigative skills, while the flipped classroom favors the reorganization of pedagogical time and conceptual deepening during face-to-face moments, aspects widely discussed in recent research in the teaching of Chemistry and Science.

4 FINAL CONSIDERATIONS

From the analysis of the literature, it was understood the recurrent challenges associated with the learning of this content and to reflect on pedagogical alternatives that favor a more meaningful and contextualized approach in the teaching of Chemistry.

The proposed didactic sequence, of a theoretical nature, presents itself as a relevant instrument for teacher planning, by progressively organizing the contents of Electrochemistry and articulating pedagogical strategies that value the active participation of the student. Its structure highlights the importance of intentional planning, capable of integrating learning objectives, contents and methodologies, contributing to the overcoming of fragmented and excessively transmissive practices in the teaching of this theme.

Regarding the contributions to the teaching of Electrochemistry, the potential of the proposal to favor the understanding of abstract concepts is highlighted, by promoting the problematization, investigation and systematization of knowledge. The articulation between problem-situations and moments of guided study enables a more integrated approach to the contents, bringing scientific knowledge closer to the students' reality and expanding the possibilities of constructing meanings in the learning process.

Active methodologies, especially Problem-Based Learning and the flipped classroom, demonstrate significant potential for the scientific training of students, by stimulating autonomy, critical thinking and student protagonism. By repositioning the student as an active agent of learning and the teacher as a mediator of the educational process, these approaches contribute to the development of cognitive and socio-emotional skills that are fundamental for comprehensive education in high school.

Among the limitations of the work, the lack of practical application of the proposed didactic sequence stands out, which prevents the empirical analysis of its impacts on the teaching-learning process. In addition, the study is based exclusively on a literature review, which restricts the conclusions to the theoretical discussions presented in the literature analyzed.

In view of this, it is suggested that future research can apply and empirically evaluate the proposed didactic sequence in real school contexts, investigating its effects on student learning and teaching practice. It is also recommended to carry out studies that explore the integration of active methodologies in other Chemistry contents, expanding reflections on innovative pedagogical practices in basic education.

It is concluded that the proposition of a didactic sequence based on Problem-Based Learning and the flipped classroom constitutes a relevant contribution to the teaching of Electrochemistry in High School, by offering theoretical and methodological subsidies for teacher planning and for reflection on more significant pedagogical practices, aligned with the contemporary demands of Science education.

REFERENCES

Araujo, Y. F. T. de. (2021). Desenvolvimento e avaliação de uma sequência didática ativa baseada em jogos sobre oxirredução dentro de uma metodologia ativa de ensino de Química [Dissertação de mestrado, Universidade Estadual Paulista]. Repositório Institucional UNESP. https://repositorio.unesp.br/bitstreams/95cd7e8a-0e36-4549-9fd5-43336380be9c/download

Inocêncio, R. B. et al. (2019). Aprendizagem baseada em projetos aplicada no ensino de eletroquímica para alunos do ensino médio [Dissertação de mestrado, Universidade Federal Rural do Rio de Janeiro]. Repositório Institucional UFRRJ. https://rima.ufrrj.br/jspui/bitstream/20.500.14407/15741/3/2019%20-%20Ramon%20Batista%20Inoc%C3%AAncio.pdf

Linhares, R. P. de M. (2024). Metodologias ativas no ensino de Química: Uma análise da produção acadêmica brasileira de 2013 a 2023 [Trabalho de conclusão de curso, Instituto Federal de Educação, Ciência e Tecnologia do Espírito Santo]. Repositório Institucional IFES. https://repositorio.ifes.edu.br/bitstream/handle/123456789/4802/TCC_Metodologias_Ativas_Ensino_Quimica.pdf?sequence=1

Nachtigall, C., & Abrahão, M. H. M. B. (2021). Reflexões acerca da produção de vídeos pedagógicos por estudantes de licenciatura: Uma experiência com a metodologia sala de aula invertida adaptada ao ensino remoto. Pleiade, 15(32). https://pleiade.uniamerica.br/index.php/pleiade/article/download/675/778

Rodrigues, A. M. (2023). O papel da sala de aula invertida na construção de modelos mentais sobre conceitos químicos no ensino superior [Dissertação de mestrado, Universidade Estadual Paulista]. Repositório Institucional UNESP. https://repositorio.unesp.br/bitstreams/07bd2992-4ef6-4a75-a318-2462e5d06338/download

Rosa, N. C. dos S. (2025). Sequência didática significativa para o ensino de eletromagnetismo: Uma proposta utilizando a sala de aula invertida e inteligência artificial [Dissertação de mestrado, Universidade Federal do Rio Grande do Norte]. Repositório Institucional UFRN. https://repositorio.ufrn.br/bitstreams/1538ae04-5d0e-4253-94c6-466a36b379b1/download

Sampaio, F. K. A. L. (2022). Sala de aula invertida no ensino de Química aplicada de forma remota: Aspectos socioeconômicos, socioemocionais e ganho de Hake [Dissertação de mestrado, Universidade Federal do Ceará]. Repositório Institucional UFC. https://repositorio.ufc.br/bitstream/riufc/68467/3/2022_dis_fkalsampaio.pdf

Schuina, J. L. (2024). A sala de aula invertida e rotação por estações no ensino médio: Contribuições de uma sequência didática para o ensino do efeito fotoelétrico e da natureza da luz [Dissertação de mestrado, Instituto Federal de Educação, Ciência e Tecnologia do Espírito Santo]. Repositório Institucional IFES. https://repositorio.ifes.edu.br/bitstream/handle/123456789/4716/MNPEF_Disserta%C3%A7%C3%A3o_Produto_Educacional_%20Jhon_Lennon_Schuina_Turma_2022_Vers%C3%A3o_Final.pdf?sequence=1&isAllowed=y

Viana, S. L. da S. et al. (2020). Metodologias ativas: Uma sequência didática sobre probabilidade com enfoque na aprendizagem baseada em problemas no ensino médio. Revista de Educação Matemática, 20. http://educa.fcc.org.br/scielo.php?pid=S2179-426X2023000300109&script=sci_arttext