PRÁTICAS EDUCATIVAS, MEMÓRIAS E ORALIDADES

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Digital learning objects for the teaching of chemistry in an inclusive perspective: scientific productions (2019-2023)

ARTICLE

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Abstract
Digital Technologies, when directed to teaching, are considered Digital Learning Objects (DLO), and can help teachers in classes, making them more interactive and attractive to students. In this sense, the present study aimed to map the scientific productions that address the development and/or use of digital learning objects for the inclusive teaching of chemistry. This is a bibliographic research, with a qualitative approach, which used the Systematic Literature Review as a research methodology. The search was carried out on the Periódicos Capes platform with descriptors “Digital learning objects”, years 2019 to 2023. 14 articles were selected, nine of which involved DLO with chemistry and five that involved DLO and special or inclusive education. Unfortunately, no article was observed that related the use of DLO for the teaching of chemistry from an inclusive perspective.
Keywords: Special Education. Assistive Technologies. Digital Technologies.

Objetos digitais de aprendizagem para o ensino da Química na perspectiva inclusiva: produções científicas (2019-2023)

Resumo
As Tecnologias Digitais (TD), quando direcionadas para o ensino, são consideradas como Objetos Digitais de Aprendizagem (ODA), e podem auxiliar os professores nas aulas, tornando-as mais interativas e atrativas aos estudantes. Nesse sentido, o presente estudo teve como objetivo realizar o mapeamento das produções científicas que abordam o desenvolvimento e/ou uso dos objetos digitais de aprendizagem para o ensino inclusivo de Química. Trata-se de uma pesquisa bibliográfica, de abordagem qualitativa, que utilizou como metodologia de pesquisa a Revisão Sistemática de Literatura (RSL). A busca foi realizada na plataforma de Periódicos Capes com descritores “Objetos digitais de aprendizagem”, nos anos de 2019 até 2023. Foram selecionados 14 artigos, sendo que nove envolviam os ODA com a Química e cinco que envolviam os ODA e a educação especial ou inclusiva. Infelizmente, não foi observado nenhum artigo que relacionasse o uso dos ODA para o ensino de Química na perspectiva inclusiva.
Palavras-chave: Educação Especial. Tecnologias Assistivas. Tecnologias Digitais.

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1 Introduction

During the inclusion process, it is important to meet the individual educational needs of students with disabilities and to simultaneously take into account the diversity that permeates everyone in the classroom. Consequently, strategies need to be adopted that are capable of encompassing all spheres of human learning (Mantoan, 2006).

The process of school education, in addition to promoting the learning of content related to curricular components, needs to foster an environment that favors human coexistence, which allows the uniqueness of each individual present in the classroom to emerge. In this sense, inclusive education has emerged as a challenge to ensure that any student has access to a school education. To this end, specialized strategies need to be devised to enable the educational promotion of all students, without only traditional teaching being approached (Aguiar; Rodrigues, 2021; Santos, 2012).

In chemistry teaching, it is common for students to be disinterested because they are unable to directly relate what is covered in theory to activities carried out in everyday life. Thus, the use of experimental activities as a way of replacing technical, theoretical and traditional classes is a major challenge for education professionals (Gonçalves; Goi, 2020).

The Brazilian educational guidelines for teaching chemistry in high school state that the components of the Natural Sciences area should be taught based on students' daily situations and on the process of investigation using experimentation, always with a focus on contextualized and interdisciplinary teaching (Brasil, 2002).

Along these lines, as discussed by Santos and Menezes (2020), the use of experimental activities in a ludic way is considered a possible way to improve the process of teaching and learning chemistry content, making it possible to relate theory to practice.

However, there are still some gaps in science teaching, including chemistry, with only the reproduction of content without the development of scientific knowledge by students due to the lack of conditions and physical spaces for experimentation (Santos; Menezes, 2020).

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In what is considered a digital age, it is important for education professionals to keep up with the development of technologies, using the tools developed as support for teaching, adopting them as teaching resources (Leal *et al*., 2020).

Digital Information and Communication Technologies (DICT) can help teachers with various types of technological tools, such as videos, games, software, among other digital products that can be used to develop lessons (Alexandre; Tezani, 2019), including the effective inclusion of students with disabilities.

According to the research carried out by Batistella and Leão (2021), technological tools aimed directly at the teaching and learning of students are considered Digital Learning Objects (DLO), such as “animations, mobile applications, multimedia presentations, audios, digital classes, simulations and software” (Batistella; Leão, 2021, p. 8).

It is therefore possible to use DLO to create possibilities for integrating chemistry curricular components, helping students to understand theoretical content, such as the use of computer simulators or virtual laboratories.

Thinking in the area of education and in an inclusive process, the characteristics of DLOs can help teaching, with a more pleasant and concentration-friendly aspect when compared to the technical explanation of content. The “[...] colors, platform, icons, images and instructions contained in the DLO as well as other characteristics should contribute to access and ease of use” (Alexandre; Tezani, 2020, p. 2).

Despite the development of DLOs for teaching chemistry, little has been said about the development of technological tools in an inclusive way. In this context, two research questions were defined: how are DLOs being used in chemistry teaching? Does research with DLOs relate to chemistry from an inclusive teaching perspective?

Therefore, it is important to verify the current use of DLOs for teaching chemistry, thinking about the aspect of inclusion, to ensure that all students are taught. The biggest problem lies in the scarcity of research investigating the application of these resources, especially from the perspective of inclusion, considering the specificities of students with disabilities and the barriers they face in accessing knowledge of chemistry.

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The use of DLOs in chemistry teaching can become a response to the growing need to diversify teaching practices and make them more inclusive, meeting the demands of an increasingly heterogeneous educational scenario (Alexandre; Tezani, 2020). Furthermore, considering the complex nature of chemical concepts, which are often abstract and difficult for students to understand, combined with the need to make learning more attractive and meaningful, the use of DLOs is justified as a way of aiding the teaching process (Finger; Bedin, 2019).

Therefore, this study becomes relevant by analyzing the current panorama of scientific production on the use of DLOs in chemistry teaching, seeking to identify gaps and potentials with regard to inclusion and contributing to the development of more equitable and accessible pedagogical practices for all students.

In view of this, the aim of this research was to map scientific productions that deal with the development and/or use of DLOs for inclusive chemistry teaching.

2 Methodology

In order to survey scientific production over the last five years (2019-2023) on DLOs used for teaching chemistry from an inclusive perspective, the proposal used a qualitative approach and, as a research methodology, used the Systematic Literature Review (SLR).

According to Galvão and Pereira (2014, p. 183), SLR consists of a process "[...] of investigation focused on a well-defined question, which aims to identify, select, evaluate and synthesize the relevant evidence available". Thus, systematic reviews need to be comprehensive, with systematic and pre-defined methods, so that other researchers can reproduce them. In addition, for them to be considered of quality, they need to present categorized evidence for decision-making when evaluating the work.

Bardin's (2016) content method was used to analyze the works found in the search. In the words of Oenning and Fagundes (2022), this method of analysis should be carried out in three stages:

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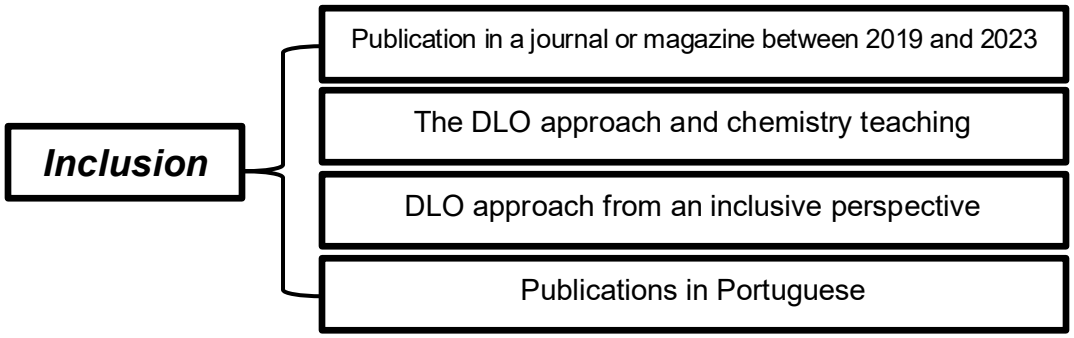
> Pre-analysis, which is the organization of the collected material; Exploring the material, in this stage the researcher must take a careful look at each piece of data collected, together with some theoretical input, select excerpts or words and group them together, called coding and registration units, and from similarities and differences emerge categories of analysis; the last stage is the treatment of the results, which is the interpretation of the results found in the categories of analysis (Oenning; Fagundes, 2022, p. 47).

For the data analysis, the articles were pre-selected according to the inclusion and exclusion criteria (organization of the materials), an in-depth reading of the themes was carried out (exploration of the material) and the data separated into two main categories: works that carried out an analysis of the use and/or application of existing DLOs and works that developed a new DLO.

Research involving a Systematic Literature Review presents a large amount of data, which needs to be organized. In this work, they were used to discuss the use of DLOs in chemistry teaching from an inclusive perspective. To this end, two research questions were defined to address the proposed objective: how are DLOs being used in chemistry teaching? Does research using DLOs relate chemistry from an inclusive teaching perspective?

In the stage of analyzing the materials, some inclusion and exclusion criteria were applied in order to direct and guide the data collection, so that it would be possible to answer the research questions. The criteria defined are shown in figure 1.

Figure 1 – Inclusion and exclusion criteria defined when searching for journals



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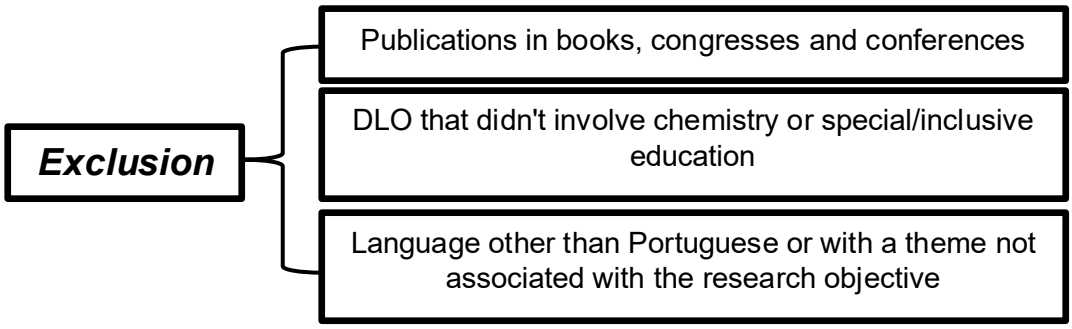

Source: Authors (2024).

In order to find out about the work produced in recent years, the years 2019 to 2023 were used as a time frame, excluding 2024 as it was not yet a complete year (during the research).

The Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Coordination for the Improvement of Higher Education Personnel – Capes) has an active portal called Periódicos Capes, where one of the largest virtual scientific collections in Brazil is available to researchers and the Brazilian academic community. Currently, the portal provides "[...] more than 38,000 full-text journals and 396 databases with various contents, such as references, patents, statistics, audiovisual material, technical standards, theses, dissertations, books and reference works" (Periódico Capes, 2024, website[1]). The collection is accessed remotely via the Comunidade Acadêmica Federada (Federated Academic Community – CAFe), by selecting the institution and the corresponding login and password.

In this research, we opted to use descriptors and not just keywords. According to Brandau, Monteiro and Braile (2005), keywords can be random, freely taken from texts, and descriptors need to have a high degree of control of meaning and importance to the subject to be addressed, which is why we chose to use descriptors in the research.

[1] The Periódico Capes Portal can be accessed via the following link: https://www-periodicos-capes-gov-br.ezl.periodicos.capes.gov.br/.

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The first part of the search was carried out on the Periódicos Capes[2] platform with the descriptors “Digital Learning Objects”. We chose not to add the word “chemistry” to the descriptors in order to individually evaluate all the works selected by the system involving DLOs.

During the search, 484 scientific papers were found between 1969 and 2024. Of this total, 439 are open access, i.e. they are available for everyone to read, without having to pay for the magazine. In this same search, it was observed that more than 80% of the articles (388 files) available in the Periódico Capes search database are of Brazilian origin.

In order to refine the search and adapt it to the recent time frame of publications (last five years), a filter was applied to publications from 2019 to 2023, and 2024 was not included as it is an incomplete year. The search obtained a total of 243 articles, more than 84% of which were of national origin (205 in total).

After this initial selection, a careful reading of the titles, abstracts and keywords of the 243 articles was carried out to check that the objectives of the studies met the inclusion criteria defined and shown in figure 1. In the end, 14 articles were selected for individual evaluation, with nine articles involving DLOs with chemistry and five involving DLOs and special or inclusive education.

From this selection, a floating reading of the articles was carried out, with the aim of organizing the information relevant to the research.

3 Results and Discussion

Although 243 articles were found, only nine directly addressed DLOs in chemistry teaching. After analyzing the pre-selected papers, they were analyzed in terms of the purpose of the DLO, categorizing them into papers that analyzed the use (application) of the software as an DLO and papers that developed a new DLO. Table 1 shows the basic information on the selected articles.

[2] Survey conducted on June 5, 2024.

Table 1 – Articles on Digital Learning Objects and the teaching of chemistry

Title	Authors	ODA application
Objeto digital de aprendizagem como proposta pedagógica para o ensino de química	Pascoin; Carvalho (2020)	Analysis of software use.
Objetos Digitais de Aprendizagem como Recurso Mediador do Ensino de Química	Oliveira; Carvalho; Kapitango-a-Samba (2019)	Analysis of software use.
Desafios enfrentados no desenvolvimento de objetos digitais de aprendizagem e o QuiLegAl	Paiva; Alves; Oliveira; Lorim; Silva; Carvalho (2020)	Software development.
QuiLegAl application as a teaching resource from the perception of undergraduate Chemistry students	Oliveira; Carvalho (2018)	Analysis of software use.
Uso de aplicativos no ensino de Química orgânica na percepção de discentes	Oliveira; Milani Júnior; Carvalho (2020)	Analysis of software use.
A perspectiva dos estudantes do Ensino Superior de Química sobre a contribuição dos objetos de aprendizagem	Alves; Silva; Dantas (2020)	Analysis of software use.
A didática de Ciências e o uso de recursos tecnopedagógicos: estratégias para o ensino de Química	Machado; Silva; Almeida (2022)	Analysis of software use.
Potencialidades do uso de museus virtuais no ensino de Química	Simomukay; Perez (2020)	Software development.
Estudo da Química por meio da cultura digital do anime Dr. Stone: uma proposta pedagógica	Fiori; Goi (2022)	Analysis of software use.

Source: Authors (2024).

In the research carried out by Pascoin and Carvalho (2019, p. 438), it was assessed how the use of the digital simulator “The Greenhouse Effect”, available on the Phet Interative Simulation Portal, a DLO, could contribute to the pedagogical practices of chemistry teachers based on continuing education. The authors emphasized that the

training allowed reflection on the pedagogical practices adopted and made it possible to indicate a technological tool capable of breaking down the physical and structural limitations of traditional teaching and without the availability of experimental laboratories.

One of the advantages presented by Guaita and Gonçalves (2020, p. 181) is the use of activities mediated by Digital Technologies (DT), including DLOs, which allow experiments to be carried out without the need for a laboratory. Among these tools, the authors highlight "simulations with various levels of interaction, remote experimentation activities or even the use of software to build graphs or visualize explanatory models". Of course, the use of technology does not eliminate the need for practical activities in laboratory spaces with workbenches, but it does reduce the damage to learning in school environments that do not have these materials.

In the same vein, Oliveira, Carvalho and Kapitango-a-Samba (2020, p. 1005) evaluated the use of DLOs as mediators of chemistry teaching from the point of view of high school students. Three applications were used in the research: "Balancing chemical equations", "Reagents, products and excesses" and "Chemical balance". Among the main results found was the DLO's ability to:

> [...] motivate and mobilize knowledge, make teaching more dynamic and aid learning, exemplify content, offer feedback, allow visualization of content, improve the understanding of content and simplify learning, and, limitations of not allowing feedback, presenting incomplete content and limited interface, are difficult to use and do not offer all the help needed to solve the activities, which can influence the teaching of chemistry (Oliveira; Carvalho; Kapitango-a-Samba, 2020, p. 1005).

It is interesting to note that the authors found only one of the apps available in the Play Store, the last two being available on the University of Colorado's website. Another advantage of DLOs is that, as they are DTs, they can be made available in different databases, with easy access for users from different parts of the world and, therefore, the possibility for students to access them without needing to be in the same physical space.

The work carried out by Paiva *et al*. (2020, p. 6) consisted of developing a DLO (software) called QuiLegAl, which presents chemistry and natural sciences content in an

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interactive way. The DLO developed offers an interface with subjects relating to "[...] chemical elements and chemical bonds, chemical substances and their representations, chemical equations and reactions and a molecule-building function for the student's school", with playful activities (such as games), writing chemical equations and also solving questions such as Quiz.

The authors describe the difficulties encountered in the programming process, which, because it involves DT, requires knowledge in this area. At the same time, activities to develop new DLOs become a multidisciplinary action that requires different expertise, as it requires programmers who are usually unfamiliar with teaching-related content and education professionals who select what should be covered in the tool developed in accordance with the Base Nacional Comum Curricular (Common National Curriculum Base – BNCC)[3].

As a way of evaluating the potential of QuiLegAl DLO, the authors Oliveira and Carvalho (2020, p.1) identified and discussed the main contributions of the application in the teaching and learning processes of students on the chemistry degree course at Unemat. Among the results obtained, the DLO aimed at teaching chemistry met aspects such as "integration between visual, sound and interactive resources that are associated with possibilities for building molecular structures". In this way, it demonstrated that it is possible to use the developed DLO as a didactic resource for teaching chemistry.

It is important to emphasize that, in addition to developing teaching material, it is essential to evaluate with potential users the applicability and efficiency of the material produced, verifying that this material can have an effective influence on the teaching and learning process (Alexandre; Tezani, 2019).

Oliveira, Milani Júnior and Carvalho (2020) researched the perception of undergraduate students (higher education) about the DLOs "Organic Nomenclature" and "Hydrocarbons" in relation to hydrocarbon content. During the research, the students

[3] The Base Nacional Comum Curricular (Common National Curriculum Base) is a normative document that defines the organic and progressive set of essential learning that all students should develop throughout the stages and modalities of basic education.

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recognized the importance of apps for the process of learning content, but stressed that the application "[...] must be accompanied by activities that direct the approach and the objectives that are intended to be achieved" (Oliveira; Milani Júnior; Carvalho, 2020, p. 86). With this in mind, it is understood that DLOs can be used as teaching materials, but thought must be given to how they will be added to school activities.

In this line of thinking, it is important that the teacher aligns the selected technological tools with the classroom activities. Alexandre and Tezani (2019) describe that DLOs are only really important if they offer flexibility to education professionals and students. Thus, just knowing how to use technological tools may not be enough to develop pedagogical knowledge. It is essential to develop teaching strategies and monitor the teacher so that the process of teaching and learning the content covered is effective.

In the research carried out by Alves, Silva and Dantas (2020), a reflection was made on DLOs in chemistry teaching, with the main emphasis on the use of computers and media. During the research, the authors evaluated the use of computers and social media, usually using tools to animate three-dimensional (3D) molecules, as well as digital books and video lessons.

DLOs don't necessarily have to be a content-specific application. As defined by Alexandre and Tezani (2019, p. 140), DLOs "are resources that can be used in education in all areas of teaching, which are easily accessible and attractive nowadays when Digital Information and Communication Technologies (DICTs) are present". In this way, any technology tool, be it video lessons, software, websites or even social media, can be considered DLO if it is applied to the teaching and learning process of students.

In an analysis of the abstract, the authors Simomukay and Perez (2020) present a pedagogical strategy for setting up a virtual museum that addresses chemistry content and can be used as a DLO in the classroom. In their results, they highlight the ease of construction and application of the product in chemistry teaching.

Machado, Silva and Almeida (2022) carried out a systematic review of the literature on the use of Open Educational Resources, Educational Software and Learning Objects for teaching chemistry between 2005 and 2021. The results obtained by the authors show

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that the use of technological resources can be considered as a support strategy for teachers to favor the teaching and learning process, improving the understanding of chemistry.

Researchers Fiori and Goi (2022) developed strategies for the use and development of educational objects using the anime Dr. Stone, an anime whose protagonist is the student and young scientist Senku, who uses the teaching of chemistry curricula in the episodes. The researchers demonstrated that the proposal could be implemented by high school teachers using problem-based methodology, since the anime addresses everyday scientific knowledge in line with the content of textbooks.

Finger and Bedin (2019) point out that, in order to truly understand the content, especially involving chemistry, there must be contextualization with the student's reality, and the theoretical concept must be connected to everyday practice. It is often difficult for teachers to get students to pay attention to the content, since chemistry is a subject that involves a lot of calculations, which ends up causing blockages in the learning process. With the use of DLOs, this blockage can be broken and, as a result, students can become more interested in the subject, as the evaluated articles propose.

Despite this need, the search found only nine articles on the subject, two of which dealt with the development of new DLOs and seven involved their evaluation by education professionals and/or students, demonstrating the need for further research in the area. It is also noteworthy that no DLO for teaching chemistry was found that has an inclusion perspective, a fact that hinders the learning of students with special needs, and this gap needs to be filled.

3.1 Digital Learning Object for inclusion

In the analyses carried out on articles involving chemistry teaching, no material was found that considers the perspective of inclusion. Therefore, when selecting the papers, we chose to select those that involved DLOs with the characteristics of inclusive

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teaching materials. Four articles were selected for analysis and the information is shown in table 2.

Table 2 – Articles on DLO from an inclusive education perspective

Article title	Authors
Realidades aumentada e virtual no ensino de Ciências para alunos com necessidades educacionais específicas em uma escola pública de Barreirinhas-MA	Sousa; Lima; Melo; Novaes; Teles (2021)
Utilização de realidade aumentada e virtual por professores do ensino especial: uma análise de usabilidade e experiência do usuário	Lima; Sousa; Melo; Novaes; Viana; Teles (2021)
Contribuição do objeto de aprendizagem "órgãos do sentido" para alunos com deficiência intelectual	Schmengler; Pavão; Pavão (2019)
Jogo educacional para apoiar a aprendizagem de crianças com transtorno do Espectro Autista / Educational game to support the learning of children with Autistic Spectrum disorder	Pena; Lima; Almeida; Magalhães; Almeida (2022)

Source: Authors (2024).

From an inclusive education perspective, the authors Sousa *et al*. (2021) looked at how Augmented Reality (AR) and Virtual Reality (VR) could contribute to teaching science to students with Special Educational Needs (SEN). To work with AR, the researchers selected the "Solar System AR" application, which presents colorful and attractive images, with reproduction of the characteristic sounds of space. To work with VR, VR BOX glasses and smartphones were used to transmit 360º photos of Maranhão's local ecosystems.

During the research, the authors verified aspects such as "attractiveness, perspicuity, efficiency, reliability, stimulation and novelty of the Digital Learning Objects used", concluding that AR and VR were favorable in the teaching and learning process of the students in the Atendimento Educacional Especializado (Specialized Educational Assistance – AEE) room, with interactive participation of the students (Sousa *et al*., 2021, p. 1).

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For Costa and Souza (2017), DTs, which include DLOs, have become indispensable in the school environment, as they are capable of arousing interest and stimulating the development of student learning by making content more attractive, dynamic and interactive, as well as providing opportunities to engage with local reality.

The research carried out by Lima *et al*. (2021) analyzed teachers' perceptions of Augmented Reality and Virtual Reality as an educational tool, as well as checking teachers' knowledge of the use of DLOs. The results showed that the teachers surveyed use DT, but do not use AR and VR. After training on the use of these DLOs, the teachers indicated that the tools are viable for teaching students in AEE classrooms.

It is extremely important that technological tools such as DLOs are not only available to teachers and in the school environment, but are effectively used as a way of helping the learning process of students with disabilities (Lima *et al*., 2021).

For Onzi *et al*. (2023), DT can be considered as tools capable of helping in the process of inclusion of students with SEN and helping special education teachers to make their classes more attractive and interactive, effectively contributing to the production and assimilation of knowledge.

Schmengler, Pavão and Pavão (2019) in their research verified how the DLO called “Organs of sense” would contribute to the learning of students with intellectual disabilities (ID). The main results include student motivation through the attractiveness of the images provided, interactivity with the app and accessibility of the content through explanatory audios with objective texts, making it easier for the user to understand.

For the DLO to be considered inclusive, the resources provided need to be valid and accessible to all students. In this sense, Barbosa and Silva (2010) point out that the accessibility of technological tools is linked to the ability of the person who will use the system to access and interact with it, without the interfaces providing obstacles.

The work carried out by Pena *et al*. (2022) consisted of developing a DLO for the Android platform in the form of a digital game called “Letrinhas”. The game was structured in two activities, to stimulate the students' language (“Letters” activity) and to stimulate logical thinking by associating the objectives with the environments provided in the images

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("Cards" activity). The authors also validated the application developed by psychologists who work in therapy with students with autism spectrum disorder (ASD). The game developed was considered satisfactory in the process of cognitive and oral development.

ASD is a neurodevelopmental disorder characterized by impairment in the areas of sociocommunication, at different levels of severity (Rosa; Matsukurab; Squassoni, 2019). Technology in education provides resources that can be customized for the development of students with ASD, promoting a more inclusive, personalized and effective education.

Therefore, DTs, especially DLOs, are support tools that can directly help teaching. Of the four studies analyzed, three evaluated a possible application of an existing technological tool, transforming it into a DLO, and one study dealt with the development of an application to help in the teaching process of students with disabilities.

In a total of 243 papers obtained with the descriptor used (Digital Learning Object), having only approximately 1.65% (4 papers) of the research linked to teaching from an inclusive perspective is worrying given the number of people with disabilities in the country.

According to the Instituto Brasileiro de Geografia e Estatística (Brazilian Institute of Geography and Statistics)[4], Brazil has approximately 8.9 million people, corresponding to 8.9% of the total number of people with some kind of disability, considering only individuals over the age of two.

According to the school census carried out in 2023, there were 1,771,430 enrolments in special education, with the highest concentrations in elementary school (62.90%), followed by kindergarten (16%) and high school (12.6%). Considering the 4 to 17 age group, there was an increase in the number of students in regular classrooms, from 94.2% in 2022 to 95% in 2023. Of the total enrollment, 53.7% are students with intellectual disabilities, followed by students with autism spectrum disorders (35.9%), physical disabilities (9.24%), low vision (4.90%), hearing disabilities (2.34%), high abilities or

4 Available at: https://www.gov.br/mdh/pt-br/navegue-por-temas/pessoa-com-deficiencia/estatisticas.

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giftedness (2.14%), deafness (1.12%), blindness (0.41%) and deafblindness (0.039%). In addition, 88,885 students have two or more disabilities combined[5].

It is therefore essential to develop DLOs or evaluate ways of using them to teach students with disabilities, whether in the regular classroom or in the AEE. The results obtained pointed to a limited number of studies on DLO in chemistry teaching from the perspective of inclusion. This scarcity, identified in this study, reinforces the need to invest in research that explores the inclusive potential of DLOs in chemistry teaching, taking into account the various disabilities and different learning styles. In line with the aim of the research, which was to map scientific production on the subject, an analysis of the selected articles revealed that the majority of research focuses on the technical and pedagogical aspects of using DLOs, without delving into the discussion of inclusion. Although some works mention accessibility as an important factor, few of them present concrete proposals on how to adapt DLOs to the specific needs of students with disabilities. This demonstrates an important gap in research that needs to be filled so that they can be effectively used as inclusion tools.

The low number of papers obtained in the search may be related to the researchers' failure to associate DICT with DLOs and, consequently, possible papers that could have been included in the search ended up being left out because they were not directly related to DLOs.

4 Conclusions

In order to map scientific productions that address the development and/or use of DLOs for inclusive chemistry teaching, the searches found only 243 works on DLOs, and of this total, only 9 were aimed at chemistry teaching and 4 had an inclusive education perspective.

5 Available at: https://www.gov.br/inep/pt-br/assuntos/noticias/censo-escolar/matriculas-na-educacao-especial-chegam-a-mais-de-1-7-milhao.

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This study highlighted the potential of DLOs as innovative tools for teaching chemistry, capable of enriching teaching practices and making learning more attractive, dynamic and interactive. The literature review showed that DLOs can be used in a variety of ways, from simulations of experiments to educational games, contributing to the understanding of complex concepts and the visualization of abstract phenomena. However, the analysis also revealed a significant gap in research related to the application of DLOs from an inclusion perspective.

Unfortunately, we did not find any articles relating the use of DLOs for teaching chemistry from an inclusive perspective, which means that research needs to be carried out in this area and, consequently, help to support students with disabilities in high school in a subject that is considered difficult and abstract.

Despite the potential of DLOs to meet the needs of students with different learning styles, the scarcity of studies on this subject indicates the need to invest in research that explores the possibilities and challenges of inclusion through the use of these technologies in chemistry teaching.

The predominance of studies focused on the technical and pedagogical aspects of DLOs, without considering the inclusive perspective, points to the need to rethink the development and application of these technologies. It is important that accessibility is considered as a central element in the development and implementation of DLOs, ensuring that all students, regardless of their needs, can benefit from their resources.

For DLOs to be consolidated as effective tools for inclusion in chemistry teaching, it is essential that future research investigates the best practices for adapting and using these resources, taking into account the specificities of students with disabilities and promoting equity in access to scientific knowledge. Only in this way will it be possible to fully exploit the transformative potential of DLOs and build a learning environment that is truly inclusive and accessible to all.

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