# PEDAGOGICAL PRACTICES IN SCIENCE AND BIOLOGY FOR STUDENTS WITH AUTISTIC SPECTRUM DISORDER: TOOLS FOR INCLUSIVE EDUCATION

## *PRÁTICAS PEDAGÓGICAS EM CIÊNCIAS E BIOLOGIA PARA ESTUDANTES COM TRANSTORNO DO ESPECTRO AUTISTA: FERRAMENTAS PARA A EDUCAÇÃO INCLUSIVA*

## *PRÁCTICAS PEDAGÓGICAS EN CIENCIAS Y BIOLOGÍA PARA ESTUDIANTES CON TRASTORNO DEL ESPECTRO AUTISTA: HERRAMIENTAS PARA UNA EDUCACIÓN INCLUSIVA*


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**ABSTRACT**: Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized by socio-communicative deficits and restricted and repetitive patterns of behavior, interests or activities. There are different degrees of severity of ASD, which will directly influence the individual's responses to environmental stimuli and the level of support needed. These peculiarities need to be considered to establish an inclusive educational scenario. Considering that teaching science/biology involves handling different materials and using environments outside the classroom, this work aimed to carry out a bibliographic review on inclusive pedagogical practices already described in the literature and, based on the results found and on the cognitive profile of hypothetical autistic students, develop activities that address both the student's specificities and their interests. This work is expected to stimulate debates and inspire educators to know their students better in order to develop inclusive science/biology teaching activities.

**KEYWORDS**: Autism Spectrum Disorder. Inclusion. Science teaching. Biology teaching. Pedagogical practices.

***RESUMO***: *O Transtorno do Espectro Autista (TEA) é um transtorno do neurodesenvolvimento caracterizado por déficits sociocomunicativos e padrões restritos e repetitivos de comportamento, interesses ou atividades. Há diferentes graus de severidade do TEA, que influenciarão diretamente nas respostas do indivíduo a estímulos ambientais e no nível de apoio necessário. Essas peculiaridades precisam ser levadas em conta para o estabelecimento de um cenário educacional inclusivo. Considerando que o ensino de ciências/Biologia envolve manuseio de diferentes materiais e uso de ambientes externos à sala de aula, este trabalho objetivou realizar uma revisão bibliográfica sobre práticas pedagógicas inclusivas já descritas na literatura e, com base nos resultados encontrados e a partir do perfil cognitivo de estudantes autistas hipotéticos, elaborar atividades que contemplem tanto as especificidades do estudante quanto seus interesses pessoais. Espera-se com este trabalho estimular o debate e inspirar educadores a conhecerem melhor seus estudantes para desenvolverem atividades inclusivas no ensino de ciências/Biologia.*

***PALAVRAS-CHAVE***: *Transtorno do Espectro Autista. Inclusão. Ensino de ciências. Ensino de Biologia. Práticas pedagógicas.*

***RESUMEN***: *El Trastorno del Espectro Autista (TEA) es un trastorno del neurodesarrollo caracterizado por déficits sociocomunicativos y patrones de comportamiento, intereses o actividades restringidos y repetitivos. Existen diferentes grados de gravedad del TEA, que influirán directamente en las respuestas del individuo a los estímulos ambientales y en el nivel de apoyo necesario. Estas peculiaridades deben ser tenidas en cuenta para el establecimiento de un escenario educativo inclusivo. Teniendo en cuenta que la enseñanza de las ciencias/biología implica el manejo de diferentes materiales y el uso de ambientes fuera del aula, este estudio tuvo como objetivo realizar una revisión bibliográfica sobre prácticas pedagógicas inclusivas ya descritas en la literatura y, a partir de los resultados encontrados y a partir del perfil cognitivo de hipotéticos estudiantes autistas, desarrollar actividades que contemplen tanto las especificidades del estudiante como sus intereses personales. Se espera que este trabajo estimule el debate e inspire a los educadores a conocer mejor a sus estudiantes para desarrollar actividades inclusivas en la enseñanza de las ciencias/biología.*

***PALABRAS CLAVE***: *Trastorno del espectro autista. Inclusión. Enseñanza de las ciencias. Enseñanza de la Biología. Prácticas pedagógicas.*

## Introduction

Autism Spectrum Disorder (ASD) is characterized as a neurodevelopmental disorder whose diagnostic criteria are deficits in communication and social interaction, as well as the presence of restricted and repetitive patterns of behaviors, interests or activities (American Psychiatric Association, 2014). The first clinical description of autism was made in 1941 by the American psychiatrist Leo Kanner, whose reports still correspond to the clinical manifestations observed in people with ASD to this day (Eisenberg, 1981).

The term "spectrum" reflects the heterogeneity of characteristics presented by autistic individuals (Lord *et al*., 2018). Thus, an autistic individual may have great difficulty dealing with changes and be very attached to routine, while being able to maintain fluid conversations and even establish eye contact. Likewise, another individual may have more difficulty maintaining eye contact and flowing conversations, but tolerate loud noises well. Therefore, just like neurotypical people, each autistic individual has their own particularities and none are the same. It is also important to note that it is possible to have comorbidities associated with ASD, such as intellectual disability and Attention Deficit Hyperactivity Disorder (ADHD), among others (American Psychiatric Association, 2014).

In addition to the heterogeneity of characteristics, different degrees of severity exist within ASD, which can range from milder to more severe degrees. The perception of these degrees of severity implies the level of support that must be provided to the individual. Therefore, support must be personalized and targeted to the specific demands of each individual.

## ASD, school inclusion and science teaching

The school routine of children and adolescents is of great importance not only for the student's academic development, but for their personal and social development. Considering that a large part of childhood and adolescence takes place at school, it is essential that this period is well used and that reflection and discussion on the inclusion scenario in schools for students with ASD is intensified.

For a long time, the education of people with disabilities took place in parallel to the regular education system, in specialized institutions or workshops (Silva; Dore, 2016), having a welfare and normalizing character. In the second half of the 20th century, there was a paradigm shift in access to education for autistic people. From a legal point of view, following

the National Education Guidelines and Bases Law (Brazil, 1996), there was an increase in the availability of specialized help for children who require this work. Law 12,764, which established the National Policy for the Protection of the Rights of People with Autism Spectrum Disorder (Brazil, 2012), ensures rights for individuals with ASD, such as access to education and a specialized companion in the classroom. It is also a guideline of this Law to encourage the training and qualification of professionals specialized in caring for people with ASD.

Unfortunately, even with such rights and guidelines, there is still a long way to go to achieve an ideal inclusion scenario for students with ASD (Gomes *et al.,* 2018; Heckler *et al.,* 2021; Martins; Chacon, 2022). Among the difficulties encountered, the one that stands out most is the lack of adequate teacher training. The complaint is that many teachers do not understand the disorder well and are not prepared to make the necessary adjustments in the classroom for true inclusion (Balbino *et al.,* 2021, Barbosa, 2018, Couto *et al.,* 2019), which it will require the implementation of systematized and individualized teaching strategies. Thus, we can see the potential for formal and widely offered training, both in courses/workshops and through the inclusion of the theme in the curriculum in university teacher training courses, complemented with the daily study of books and articles and a continuous interaction between the entire pedagogical team can play a role in the school environment in terms of inclusion.

Science is present in students' daily lives and teaching basic notions of different areas of scientific knowledge allows the establishment of its correlation with reality, influencing their actions in society (Laugksch, 2000). From this perspective, scientific literacy must be worked on during the school period, when the student is becoming an individual and citizen. Furthermore, learning science develops skills that can be taken beyond scientific themes. Qualities linked to scientific thinking, for example, can be applied in different everyday scenarios. Science is directly related to curiosity, the formulation of hypotheses, discussion and the search for evidence. These skills are important for the development of the individual and promote an increase in critical sense, research and argumentation (Hart Barnett *et al*., 2017).

Biology is the branch of science that studies the different forms of life that surround us and the different processes that influence them. Issues related to Biology are always on the agenda in the media and in our daily lives. Among the most recent, it is possible to mention the Covid-19 pandemic, anti-vaccine movements and climate change. A pertinent question for teachers is how to ensure that these and other topics are attractive to their students. Furthermore, many topics require a certain degree of abstraction, such as biochemistry and embryology, while others encompass a large amount of detail and specific names, such as cytology. In this

sense, Biology can be considered an arduous subject, especially for students with learning difficulties. Therefore, making the content more tangible and facilitating its understanding is a constant challenge and, to this end, a variety of teaching resources and methodologies can be used.

This work sought to raise and discuss didactic resources and educational strategies already described in the literature for teaching science and biology to students with ASD and present, based on hypothetical profiles of two students with ASD, pedagogical practices that can be carried out in science classes and Basic Education Biology.

## Methodological procedures

The first stage of this research constituted a narrative bibliographic review that sought to present and discuss teaching resources and educational strategies that have been used in science and biology classes for students with ASD. The bibliographic review was divided into three moments, the first being a basic reading, to explore the available materials and the different elements involved in the research. The second was research and selective reading, aiming at an analysis focused on the resources and strategies used and applicable in similar scenarios. The third moment consisted of an analysis of the collected data, as well as a reflection on the praxis of working with resources and strategies.

A search was carried out using the terms "Autism Spectrum Disorder", "autism", "educational strategies", "teaching", "science", "school", "instruction" and "inclusion", both in Portuguese and English, in the ERIC, Scielo, and Google Scholar platform databases. Work that specifically dealt with subjects other than science and biology, in addition to those carried out with higher education students, was excluded. The data from each work was organized for comparison purposes, considering the type of study, the degree of ASD manifested (along with the presence of comorbidities) and which teaching resource or educational strategy was used.

The articles selected in the first stage served as a theoretical foundation for the second stage, proposing teaching resources and educational strategies that address the needs of students with ASD, in order to inspire other teachers and professionals in the field. For this stage of the research, two cognitive profiles of hypothetical autistic students developed by a psychologist and master of the Professional Master's Course in Diversity and Inclusion (UFF) were used as a starting point, based on her experience working with children with ASD. Two models of pedagogical practices were created for each student, totaling four practices. In the profiles, there

is both information found in reports and anamnesis, as well as private observations of the child that could be perceived with direct contact in the classroom.

## Results

Nine works were selected during the bibliographic review (Hart; Whalon, 2012; Knight *et al.,* 2012; Knight *et al.,* 2013; Smith *et al.,* 2013; Carter *et al.,* 2017; Hart Barnett *et al.,* 2017; Gomes *et al.,* 2018; Knight *et al.,* 2018; McKissick *et al.,* 2018), after applying the indicated filters. The vast majority were experimental studies with a predominance of elementary school students or equivalent. The degree of severity of ASD was rarely reported, however, in more than 50% of the works there were students with intellectual disabilities (ID). The teaching resources and educational strategies presented in the articles will be described and discussed. Educational strategies are techniques or actions that facilitate the teaching-learning process and teaching resources are the materials that will be used to carry out this act.

### *Didactic resources*

Hart Barnett *et al*. (2017) conceptualize three types of visual resources, namely scripts, *checklists* and graphic organizers. The work presents examples of these resources applied to science classes, which aim to develop scientific discussions, although none of these resources have been applied in the classroom. Scripts detail an activity to be carried out and can be used to prepare the student for a classroom discussion with peers. Because it is a scenario that involves social interaction and communicative skills, which are often challenges for autistic individuals, this type of situation is likely to cause feelings of anxiety in the student. Therefore, the script allows the student to anticipate the stages of the discussion and organize themselves accordingly. Checklists have a similar proposal, in which the aim is to reduce anxiety-provoking situations and prepare the student for activities *to* be carried out, presenting the situations explicitly. They can be presented through images or text. Both scripts and *checklists* can be used beyond the school environment, even in everyday activities. The difference between the two is that the *checklist* details each step of an activity, while the script provides a general overview of what will be accomplished.

When thinking about the subjects of science and Biology, interesting applications could involve *checklists* for an experiment in a practical class or a script for a dynamic (Hart Barnett *et al*., 2017). Furthermore, it is possible to use these resources for classroom activities that

require discussions. Considering that knowing how to argue and share information with colleagues are important personal and interpersonal skills, in addition to promoting the fixation of topics already studied, it is interesting for autistic students to be able to take advantage of scenarios like this. These are activities that require greater communicative effort, which tends to be a challenge for students with ASD. Therefore, making use of resources like these is very useful and facilitates the path for the student to develop these skills.

Graphic organizers consist of visual materials that provide concrete representations of ideas and content and can be of different formats, such as models, graphs, tables, diagrams, concept maps, among others. Therefore, it is possible to use these organizers both for the presentation of new content, so that it can be presented in a more concrete and clear way, and for fixing previously covered content. Additionally, you can take advantage of the tactile sense by adding different textures to the organizer when possible.

Knight *et al*. (2013) used graphic organizers to work on the theme of the water cycle with elementary school students with ASD and ID. These students participated in classes in a regular classroom, but interventions with the organizers were carried out in the resource room with the Specialized Educational Service teacher. The graphic organizers were diagrams indicating the different stages of the cycle in different environments, such as a beach and a forest. The steps, however, were not included in the diagrams, and it was up to the student to place a piece of paper with the name of each one in the corresponding place.

The interventions were designed in sessions of approximately 15 minutes, four to five times a week, totaling eight sessions. At the end of the period, they realized that the students managed to master the content, answering most of the questions correctly. It should be noted that in addition to the use of visual teaching resources, a learning strategy was also used, called systematic instruction, which will be better discussed later in this work. Finally, at the end of the interventions, the authors stated that this set of resources and strategies contributed to student learning and that it can be considered and suitable for application in regular classrooms.

Technological resources are being increasingly used. Hart and Whalon (2012), for example, used model videos to develop the communicative skills of a 16-year-old student in the 2nd year of high school, with ASD and ID. This student had difficulty maintaining dialogues and asking short, direct questions, hence the idea of developing these skills so that he could participate in classroom discussions.

Thus, they used self-modeling, in which the student himself would be recorded performing the activity which, in this case, was answering questions asked by the teacher. When

recording, the teacher explained a topic that the class would have in the future and encouraged dialogue with the student. Then, in the video editing stage, cuts were made so that, when the student watched it, it gave the impression that he alone had the initiative to speak out and answer questions during the class. They carried out three interventions with the student, showing him the video and then there was the class with the class.

They noticed that he spoke more easily and that the time taken to speak was reduced, but he still needed encouragement to do so. The authors stated that the result was positive, but emphasize that, next time, it would be interesting to carry out a greater number of interventions before class in a regular classroom. They also state that this type of model video, in which the student observes themselves performing an activity, promotes self-confidence and increases their independence to reproduce it.

Smith *et al*. (2013) and McKissick *et al*. (2018) used technological resources in a similar way. Both worked with interactive slide presentations on science-related content. Smith *et al*. (2013) worked with three elementary school students, one with ID and the other with ADHD, covering topics such as cells and organs. McKissick *et al*. (2018) worked with three elementary school students with ID, addressing the topic of amoebas. In this work, the authors included videos and images of contexts familiar to the students in the slide presentation, such as a celebration scene of a series character that one of the students liked. Both works made use of an educational strategy, called explicit instruction, which will be discussed later in this work.

McKissick *et al*. (2018) argue that technological resources such as *slide* presentations allow content to be presented by eliminating distracting elements, as well as highlighting those that are of interest. Smith *et al*. (2013) also comment that neurotypical students in the class who participated in the activity helping students with ASD in solving the questions stated that they were interested in greater implementation of similar resources in the classroom. In other words, technological resources are very attractive not only for autistic students, but also for neurotypical students. However, there are limitations to this type of resource that must be taken into consideration. Smith *et al*. (2013) state that access to digital materials, such as tablets and editing platforms, in addition to the professional's ability to prepare digital activities can represent obstacles.

Games and dynamics can also be playful teaching resources that bring benefits not only to students with ASD, but to the entire class, a fact that further promotes the connection between neurotypical and autistic students. Gomes *et al*. (2018) applied two games and a dynamic to a

class in a regular classroom in the 8th year of elementary school II at a municipal school, with the aim of fixing content previously discussed about the digestive and cardiovascular systems.

The first game concerned the journey that food takes through the digestive system after ingestion. Plates were produced with images of each organ, along with tapes that explained the functions of each one. Thus, as they walked the route, questions were asked to the students, who were divided into groups. Whoever got the most hits would win the game.

The second consisted of questions projected on slides with answers such as "True" and "False" about the cardiovascular system. The students were divided into groups and the one who answered the most questions correctly would win. As a last activity, it was proposed that students produce a parody on one of the topics discussed during the day and bring it to the next class. The authors reported that students with ASD were previously more isolated from their classmates and classroom activities, but realized that during games, although they preserved some of their characteristics, they were now more integrated.

## Educational strategies

As previously mentioned, some works made use of teaching resources associated with educational strategies. This combination is interesting because, as the teaching resource is the material used to facilitate the teaching-learning process, it is necessary to have a technique to guide its use.

A widely discussed strategy is explicit instruction, especially when dealing with students with more severe degrees of ASD or associated comorbidities, such as ID. It consists of simple, objective, and clear instructional behaviors in language and purpose (Hughes *et al.,* 2017).

Knight *et al*. (2012) used it to teach science-related descriptors, such as "dry/wet", to three elementary school students. They were presented with objects that had the characteristics, such as a dry towel and a wet towel. Interventions with the teacher began with him presenting the objects and their descriptors, through statements of examples and non-examples, such as “This is dry. This is not dry.”, while pointing at the objects. Then, the teacher asked the student to perform the statements with him, either speaking or pointing to the objects. Finally, the last step was to ask the student to make the statements alone, answering possible questions from the teacher. In case of a student error, the teacher guided them to the correct answer and repeated the steps as necessary.

Another aspect of this strategy is the possibility of building knowledge by adding questions, such as "why?" and "how do you know?", which can increase the level of abstraction. The authors noticed that, as the interventions progressed, the number of correct answers by students increased, indicating the success of this educational strategy.

Smith *et al*. (2013) and McKissick *et al*. (2018) also made use of explicit instruction associated with a teaching resource, in this case, technological resources. Both works noticed positive results regarding the student's abstraction on the topics. Another study that made use of the association between resources and strategies was that of Knight *et al*. (2013), when they worked with graphic organizers associated with systematic instruction. This is similar to explicit instruction, although it breaks down and separates class activities into simple steps, which progressively increase their level of difficulty (Sedita, 2022).

In addition to systematic instruction, Knight *et al*. (2013) also used explicit instruction and a procedure called Constant Time Delay (CTD), which is a strategy used to teach images, vocabulary and definitions to individuals with special needs. In it, the teacher's prompts are given with a certain delay at different stages of the intervention. This is interesting because it gives time for the student to prepare to give their answer, ensuring support from the teacher in cases of difficulty. This feat promotes greater independence on the part of the student (Pennington *et al.,* 2022).

Another relevant educational strategy is peer-mediated intervention (PMI), which aims to develop social and academic skills through the involvement and participation of peers. This strategy may be appropriate according to the goals set for the student (Carter *et al.,* 2017). Sperry *et al*. (2010) formulate the specific objectives of the IMP: Teaching ways of talking and interacting with children and young people with ASD; Increase the frequency with which children and young people with ASD interact with neurotypical peers; Expand the social initiations of students with ASD in classroom activities; Minimize support from teachers and adults; Promote interactions between neurotypical peers and students with ASD that are positive and natural in quality.

Some criteria must be adopted within the IMP regarding its organization and planning. One aspect is precisely the selection of pairs. It is interesting to choose colleagues who are socially resourceful, liked by the colleague with ASD, who have time available for interventions, as well as adequate attendance at school and who are willing to participate in interventions (Sperry *et al.,* 2010).

Furthermore, it is interesting that a group of colleagues is selected so that there is a rotation between them, not consuming too much of the pairs' time and, consequently, not becoming an activity that overloads them. Another reason is to have a certain level of variation during interventions. Although it is important that interventions are always at the same time and that they preserve routine characteristics, the exchange of peers provides different social responses, which enriches the development of social skills that students with ASD seek to develop (Sperry *et al.,* 2010).

As previously mentioned, interventions can be modified according to the objectives for each student. In this sense, the planning of interventions can vary not only with specific development goals, but also with the age group of the students, according to the milestones expected for each one. Therefore, the responsibilities of peers may vary. For young children, it would be interesting for peers to be instructed to facilitate play moments, such as organizing them, sharing toys, in addition to helping them carry out activities. However, these instructions may vary when dealing with adolescents, for example, in which activities that promote the initiation and maintenance of dialogues are encouraged (Carter *et al.,* 2017, Sperry *et al.,* 2010).

Carter *et al*. (2017) used IMP with four high school students with ASD, from different classes and subjects, with only one student participating in the interventions in science classes. The pairs were selected through recommendations from teachers and autistic students themselves and they acted as partners during activities in the regular classroom. Students with ASD, as they were older, had a participatory role in developing the goals to be worked on. The students' social skills were recorded before the interventions began, in order to serve as a basis for subsequent analyses. Peers were instructed about ASD and how they should mediate activities with the student, following an action plan. Their responsibilities consisted of following common classes, encouraging conversation between colleagues and including the student with ASD in group discussions, in addition to sharing materials and notes, working together on activities, as well as helping to organize them.

It is noteworthy that the student in the study who carried out the interventions in science classes did not want to expose his condition to other classmates. For this reason, instead of selecting specific pairs and guiding them on how to carry out the interventions, the leading teacher carried out the dynamics with the entire class, without mentioning ASD. Therefore, topics such as “what skills can we improve in the school environment”, “ways we learn from our colleagues” and “how can we help our colleagues in science classes, so that they can achieve their goals” were discussed with all colleagues.

At the end of the intervention period, there was an increase or maintenance in the students' grades, with the exception of one, who had a worsening in his performance and had participated in the interventions in a subject other than science. According to the authors, this occurred because their partner had low attendance in classes and, therefore, did not provide the necessary support. In terms of the development of social skills, it was noticed that there was an increase on the part of the students. However, most social interactions occurred more with peers than with other classmates. The authors also emphasize that in the presence of mediators they would expect more satisfactory results.

The peer experience was also positive, according to their reports. They stated that, due to the responsibilities of the interventions, they studied the content more and made friends that they might not have been able to do without the opportunity. Furthermore, some commented that the experience made them value the importance of patience towards others. The teachers emphasize that the interventions were positive, since there were no losses for neurotypical students but there were benefits for everyone, highlighting the greater inclusion of students with ASD.

## Proposals for pedagogical practices

The hypothetical profiles of the two hypothetical students are found in Tables 1 and 2. The first cognitive profile is that of Pedro (fictitious name), eight years old, a student in the 3rd year of elementary school I with suspected intellectual disability. Pedro cannot read and write yet, although this is expected for his age group. Due to his hyperactivity and low engagement in activities, it is interesting to use more dynamic elements that are of interest to him in activities that he has difficulty with, to benefit the teaching-learning process and promote inclusion.

**Table 1 –** Hypothetical profile of Pedro, 8 years old (3rd year of elementary school II)

| Verbal communication | Non-verbal communication | Socialization | Restricted and repetitive patterns | Sensitivity | Tastes and preferences |
|---|---|---|---|---|---|
| He is verbal, but his speech is not very coherent, he makes sentences without much logic, he is unable to give long arguments coherently. | Eye contact is rare | See your parents or teacher only when you need something or to share something of interest to you | Stereotypy: Rocking (swinging the body back and forth) more frequently and Flapping (swinging the hands close to the shoulders) less frequently. | Bites the shirt and smells and licks objects | He was not completely literate, but he knows how to write some words in simple letters and use everyday objects such as |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | remote controls, cell phones and tablets. |
| Speaks with little intonation | Pointing gesture is used frequently | He often seems not to hear what the teacher is saying. | Humor is irritable. Presents meltdown crises (difficulty controlling impulses – outbursts of anger) in response to frustration. At these moments, hit your head with your hands | Doesn't like handling paint or sand with his hands | Interested in colors, animals and numbers |
| Responds when asked and with few words | Has difficulty using and reading facial expressions, has strange facial expressions and recognizes only basic emotions (such as fear, anger, happiness and sadness) | Sit close to other children, but do not seek to interact socially with them; smiles when tickled or played with exaggeratedly | At school, it takes a lot of effort from the teacher and the mediator for him to engage in a few activities and always do them his way; He feeds and goes to the bathroom alone, but needs help getting dressed and bathing. Difficulty keeping him in the room. | Has food selectivity, does not eat green foods | Engages, without much effort from the teacher, in more bodily activities and with music |

Source: Prepared by the authors

The themes chosen for the practices were available in the parameters of the 3rd year of elementary education I of the National Common Curricular Base (Brazil, 2018). For the theme "BUILDING KNOWLEDGE ABOUT ANIMALS", images printed on cards can be used as visual resources and, since the student is interested in this topic, it is considered using them to present different types of animals and their characteristics. As autistic individuals have difficulty abstracting information about elements that they do not know in a concrete way, we chose animals that are frequently found in everyday life, with which it is assumed that Pedro has had previous contact: cat, dog, fish, ant and bird. It is suggested to print the images on A4 paper, cut them out and laminate them, as students tend to lick objects. The cards can be used to present the theme, in addition to being able to establish relationships between the animals, such as the place where they can be found and group them by their common characteristics. They can also be useful as fixation exercises. Due to the suspicion of ID and hyperactivity, explicit instruction should be used at the time of the activity, which can be worked on with the class and/or with the mediator.

For the theme "BUILDING KNOWLEDGE ABOUT PLANET EARTH AND ITS REPRESENTATIONS", we suggest the use of music and dance to understand and retain the

content, especially due to Pedro's preference for bodily and dynamic activities. Children's songs themed around planet Earth and its representations, such as "O Nosso Relevo" (Mundo Bita), "A Terra e a Lua" (JunyTony) and "O Meu Planeta" (Toobys) or songs created by the teacher himself, composed by simple verses, they allow the accompaniment of dance steps. This way, the student can work on their motor coordination in conjunction with the science content. He can also practice this activity with his colleagues, which develops his social skills.

It should be noted that in the process of developing these pedagogical practices, in addition to being important to think about and incorporate the student's tastes and preferences, their difficulties and things they have an aversion to were considered. In this sense, since the student has a possible hypersensitivity to touch as they do not like dealing with paint and sand, artistic activities of this type are not interesting and can even be harmful.

For the second hypothetical student, Luiza, 16 years old, in the 2nd year of high school (Table 2), activities were designed to develop her social skills with her classmates, maintaining respect for her preferences, such as practical classes. In this scenario, a practical class was chosen to study the alcoholic fermentation process in tubes with water, yeast and sugar. It is suggested to divide the class into groups to carry out the experiment. During the time the reaction is occurring, students must discuss and formulate hypotheses and justifications about the results of the experiments. At the end of the reaction, the process that occurred will be discussed, explaining the results.

**Table 2** – Hypothetical profile of Luiza, 16 years old (2nd year of high school)

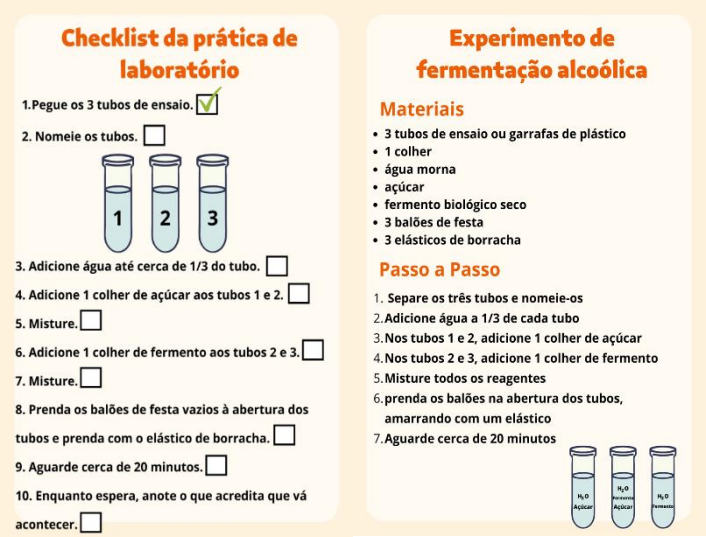
| Verbal communication | Non-verbal communication | Socialization | Restricted and repetitive patterns | Sensitivity | Tastes and preferences |
|---|---|---|---|---|---|
| Difficulty starting a conversation spontaneously and taking turns in a dialogue | Eye contact is slightly altered and routine greetings are not usually performed | Doesn't seem to be very interested in people | Motor stereotypy of hand rubbing. | Noise in the room distracts her and makes her slightly irritated and agitated | Average grades in mathematics and physics, mainly, but likes Portuguese and English, especially grammar rules |
| Sometimes says socially inappropriate things and directs the conversation according to your interest at the time | Difficulty understanding jokes, especially those that depend on understanding gestures | Little seeks others to share internal mental states, interests and desires | Perfectionist and systematic, she needs to organize her material at school and, at home, her belongings are organized into categories. | Does not participate in physical education, because he gets irritated when he sweats and does not like | Enjoy practical laboratory classes |

| | | | | | |
|---|---|---|---|---|---|
| Able to maintain a fluid dialogue. Has difficulty talking about their emotions and cannot understand the emotions of others | | To be socially accepted by her colleagues, she seeks to imitate certain behaviors, such as body postures (walking and running her hands through her hair, for example) and verbal expressions. | | his clumsy appearance | Difficulty following very expository classes, due to low concentration |
| Has mild difficulty answering open-ended questions and organizing thoughts quickly and concisely | | He has a closest friend, his neighbor since childhood | Insists on always doing things the same way. Do you like listening to the same music, watching the same movies, walking around the same places and eating the same snacks, for example? | | Difficulty with fine motor coordination that impacts your handwriting |
| | | Difficulty with abstractions, makes literal interpretations; worries about how she is seen by her colleagues; never had a romantic relationship | | | Good memory for details |

Source: Prepared by the authors

Practical classes are already different from the usual classroom routine and this one, in particular, still involves presence and dialogue with colleagues. All of these factors enhance the teaching-learning process, but can be anxiety-provoking for the student. Thus, the teaching resources to be used in this class will be a *checklist* containing the steps of the experiment and a script for the discussion (Figure 1), which must be made available in advance so that she can prepare for the class.

**Figure 1 –** Script and *checklist* for the practical fermentation class




Source: Prepared by the authors

The last practical activity proposal consists of a debate on gene editing. The idea is to divide the class into groups of around four students, so that half research the positive points of gene editing, while the rest research the negative points. The research would be done at home and, in class, there would be a presentation and discussion about the data collected so that, in the end, the students reach a conclusion about what they think about the possibility of carrying out gene editing (not necessarily needing to be completely against it or in favor). Assuming that this activity may also cause anxiety for the student, it is proposed to prepare a script that explains everything from the research stages at home to spaces for her to fill in with the information she will present to the group (Table 3). Furthermore, the script may contain possible lines to encourage your participation in the discussion of the subject.

**Table 3** – Proposal for a script for the debate on gene editing

| |
|---|
| 1. First, the teacher will give instructions for the activity. |
| 2. Second, let's divide into groups. If the teacher doesn't divide us, I can ask a classmate if I can be part of their group. |
| 3. Next, I will decide whether I want to argue the positive or negative elements of gene editing. |
| 4. I will do my research at home. If I need to remember concepts about genetics, I can look that up first. It's also important for me to know a little about both sides (positive and negative), so I can predict what my colleagues will argue. I can look for topics such as: What is the difference between a gene and DNA? How is DNA modified? Applications of gene editing; Why is gene editing done?<br>To find out about the positive elements of gene editing, I can research the following topics on the internet: Benefits of gene editing; Gene therapies; Gene editing in agriculture; Gene editing in medicine<br>To find out about the negative elements of gene editing, I can research the following topics on the internet: Risks of gene editing; Difficulties of gene editing; Ethical aspects of gene editing; Gene editing and eugenics |
| 5. I will write down information that I find interesting. |
| 6. I will organize my notes to take to the discussion with my colleagues.<br>I can use the following questions to organize myself: |

| |
|---|
| What advantages/disadvantages have I found about gene editing? Why did I find these things good/bad? What do I think my colleagues who will argue against me might say? How could I counter that? |
| 7. When discussing, we will decide which side will start speaking first. If it's my side, I'll talk about the arguments I wrote down when I did my research. If it's the other side, I'll listen to what they argue and think about whether I have a counterargument.<br>I can start talking in the following ways:<br>"Gene editing is interesting because it allows _____." Or "Gene editing might be bad because _____"<br>"I think gene editing is an important advance in science because _____." Or "I think that gene editing, despite being an advance, poses some dangerous risks like _____." |
| 8. If I have started the argument, I will wait for my colleagues' turn and listen to what they say, thinking of counterarguments. If it is my turn to respond, I can bring my initial arguments and counter-arguments. Some example responses are:<br>"I found what you said about _____ interesting, but in my research, I found _____."<br>"I disagree with what you said about _____ because _____."<br>"I thought what you said about _____ was cool. It really is a good argument."<br>"Where did you find the information about _____?"<br>"When you said _____, I thought it was interesting, but don't you think _____ could be _____?" |
| 9. After talking and discussing the subject, we will reach a final conclusion about what we think and write it down on a piece of paper to give to the teacher. Since it will be one sheet per group, I can see if anyone would mind writing down the answers, but I could write if I feel comfortable.<br>Some example conclusions might start with: "Finally, we conclude that gene editing is a very important advance in science and offers several benefits because _____."<br>"Ultimately, we conclude that, although gene editing offers advances in science, it is bad because _____."<br>"Finally, gene editing has good and bad aspects. We think that _____. |

Source: Prepared by the authors

## Final remarks

The bibliographical review made it possible to observe the existence of a great diversity of teaching resources and educational strategies that can be applied to facilitate the teaching-learning process of students with ASD and lead to a more inclusive scenario within the school environment. Teaching resources can be presented in various ways and it is essential to know the preferences and difficulties of each student. Furthermore, the same type of resource can be modified for this same purpose. Graphic organizers can include specific textures or colors. Scripts can be applied in writing, on an A4 sheet, for high school students, for example, who do not have difficulty with reading. However, for an elementary school student with ID, it is interesting to use images that represent the activities that will be carried out. Different types of assistive technologies can be used with autistic and visually impaired students (Messina *et al.,* 2022). In these cases, it is interesting to take advantage of tactile resources to make such adjustments.

The technological resources are versatile and very attractive to students, which are positive points for their use. However, they often depend on financial resources that are not always available in many primary schools, in addition to requiring time and skill. Furthermore,

screen time should be a factor to consider. Therefore, it is essential to know the student to carry out an assessment of which methodology is most appropriate.

In the literature review, no works were found with practices related to music for students with ASD in science and biology classes, although one of the resources proposed here involved singing and dancing. There are studies that address the benefits of these for the teaching-learning process for students with ASD (Moreira *et al.,* 2014; Heckler; Baumer, 2021). Music therapy can act as a facilitator for expression and communication, being a non-verbal communicative path (Moreira *et al.,* 2014; Sharda *et al.,* 2018). However, in case of auditory hypersensitivity, using music or activities that generate a lot of noise and parallel conversations can be harmful.

Practical classes and tour classes move away from the formal classroom environment and can be very beneficial for the teaching-learning process. Both are attractive, allow reflections and change of perspective, make the content more concrete and stimulate social skills, as the student has fun and even shares the process with their colleagues (Interaminense, 2019; Júnior *et al.,* 2019). However, it is important to be cautious, since breaking out of routine and increasing interaction with colleagues can be anxiety-provoking, and it is worth associating them with resources such as scripts and *checklists* and strategies such as IMP.

In view of the above, the importance of making the most of the period at school is highlighted, with the focus of this study being science and biology subjects. Taking into account the challenges of the teaching profession, we sought to offer ideas and inspirations that can be taken to primary education classrooms and thus move towards an increasingly inclusive educational scenario.

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