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# Educational accessibility in mathematics education under the principles of Universal Design for Learning

## Accesibilidad educativa en educación matemática bajo los principios del diseño universal para el aprendizaje

## Accessibilité de l'enseignement des mathématiques selon les principes de la conception universelle de l'apprentissage)

## Acessibilidade educacional na educação matemática sob princípios do desenho universal para a aprendizagem

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**Abstract**

This article reflects issues related to mathematics education and educational accessibility and refers to part of a post-doctoral research project characterized as collaborative research. The aim of this article is to show the possibilities of developing methodological strategies, resources and teaching materials to support teaching activities related to learning mathematics, based on the assumptions of inclusive and bilingual education and on the principles of the UDL. In this regard, a Formative Action was carried out as part of the initial training of mathematics teachers, in two subjects on a mathematics degree course. Concerning the formative action, in this article we analyze a lesson plan which, re-elaborated by undergraduate students, sought to include resources and methodological strategies for accessible teaching, considering the specificities of students with disabilities and neurodivergent conditions. The results point out that in view of the diversity present in the educational settings, training experiences carried out during initial teacher training courses, with an emphasis on internship disciplines, through active methodologies, research and articulation of knowledge related to special and bilingual education and universal strategies, such as UDL, with the collaboration of a special education

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professional support initial training for issues of this theme due to the understanding, reflection and mobilization of strategies for the provision of more accessible teaching.

***Keywords:*** Mathematics education, Educational inclusion, Universal design for learning, Teacher training.

**Resumen**

Este artículo refleja cuestiones relacionadas con la educación matemática y la accesibilidad educativa y se refiere a parte de un proyecto de investigación postdoctoral caracterizado como investigación colaborativa. El objetivo de este artículo es mostrar las posibilidades de desarrollo de estrategias metodológicas, recursos y materiales didácticos de apoyo a la actividad docente relacionados con el aprendizaje de las matemáticas, partiendo de los supuestos de la educación inclusiva y bilingüe y de los princípios del DUA. Con este objetivo, se llevó a cabo una Acción Formativa en el contexto de la formación inicial de profesores de matemáticas, en dos asignaturas de una carrera de matemáticas. En referencia a la acción formativa, en este artículo analizamos un plan de clase que, reelaborado por estudiantes de grado, buscaba incluir recursos y estratégias metodológicas para una enseñanza accesible, teniendo en cuenta las especificidades de estudiantes con discapacidad y condiciones neurodivergentes. Los resultados muestran que, en vista de la diversidad presente en el contexto educativo, las experiencias de formación realizadas durante los cursos de formación inicial de profesores, con énfasis en los temas de prácticas, a través de metodologías activas, la investigación y la articulación de los conocimientos relativos a la educación especial y bilingüe y estrategias universales, como el DUA, con la colaboración de un profesional de la educación especial, subsidiar la formación inicial para cuestiones relacionadas con este tema a través de la comprensión, la reflexión y la movilización de estrategias para proporcionar una enseñanza más accesible.

***Palabras clave***: Educación matemática, Inclusión educativa, Diseño universal del aprendizaje, Formación del profesorado.

**Résumé**

Cet article reflete les questions liées à l'enseignement des mathématiques et à l'accessibilité de l'éducation et se réfère à une partie d'un projet de recherche post-doctorale caractérisé par une recherche collaborative. L'objectif de cet article est de montrer les possibilités de développer des stratégies méthodologiques, des ressources et du matériel pédagogique pour soutenir les activités d'enseignement liées à l'apprentissage des mathématiques, sur la base des postulats de l'éducation inclusive et bilingue et des principes de la conceptión universelle pour

l’apprentissage, CUA. Dans cette optique, une action formative a été menée dans le contexte de la formation initiale des professeurs de mathématiques, impliquant deux sujets d'un cours de mathématiques. Em référence à l'action de formation, nous analysons dans cet article un plan de cours qui, réélaboré par des étudiants universitaires, a cherché à inclure des ressources et des stratégies méthodologiques pour un enseignement accessible, en tenant compte des spécificités des étudiants handicapés et des personnes atteintes de troubles neurodivergents. Les résultats montrent que, compte tenu de la diversité présente dans le contexte éducatif, les expériences de formation réalisées pendant les cours de formation initiale des enseignants, en mettant l'accent sur les sujets de stage, à travers des méthodologies actives, la recherche et l'articulation des connaissances relatives à l'éducation spéciale et bilingue et les stratégies universelles, telles que le CUA, avec la collaboration d'un professionnel de l'éducation spéciale, subventionnent la formation initiale pour les questions liées à ce thème à travers la compréhension, la réflexion et la mobilisation de stratégies pour fournir un enseignement plus accessible.

***Mots-clés*** : Enseignement des mathématiques, Inclusion éducative, Conception universelle de l'apprentissage, Formation des enseignants.

**Resumo**

Este artigo reflete questões atinentes à educação matemática e acessibilidade educacional e se refere à parte de uma pesquisa de pós-doutorado caracterizada como pesquisa colaborativa. O objetivo deste artigo é o de mostrar as possibilidades de desenvolvimento junto a alunos de licenciatura de estratégias metodológicas, recursos e materiais didáticos para apoio a atividades de ensino atinentes à aprendizagem da matemática, pautando-se nos pressupostos da educação inclusiva e bilíngue e nos princípios do DUA. Nessa direção, foi realizada uma Ação Formativa no âmbito da formação inicial de professores de matemática envolvendo duas disciplinas de um curso de licenciatura em matemática. Referente à Ação Formativa, neste artigo, analisamos um plano de aulas que, reelaborado por licenciandos, buscou contemplar recursos e estratégias metodológicas para um ensino acessível, considerando especificidades de estudantes com deficiência e condições neurodivergentes. Os resultados apontam que, diante da diversidade presente no contexto educacional, experiências formativas realizadas ao longo dos cursos de formação inicial para a docência, com ênfase em disciplinas de estágio, por meio de metodologias ativas, pesquisa e articulação do conhecimento atinente a educação especial e bilíngue e estratégias universais, como o DUA, com a colaboração de profissional da educação especial subsidiam a formação inicial para questões dessa temática pela compreensão, reflexão e mobilização de estratégias para a previsão de um ensino mais acessível.

***palavras-chave:*** Educação matemática, Inclusão educacional, Desenho universal para a aprendizagem, Formação de professores.

**Educational accessibility in mathematics education under the principles of universal design for learning**

Teacher training for the inclusion of students with disabilities and neurodivergent conditions is increasingly necessary, considering the right to education under principles of accessibility and human functioning (Lei nº 9.394, 1996; Lei nº 13.146, 2015). Considering this diversity, formative experiences are needed that enable more equitable practices from the teaching planning stage. In mathematics, according to the Brazilian National Curricular Guidelines for courses in this area, a vision of mathematical knowledge accessible to all is recommended as an expected characteristic for undergraduates (Conselho Nacional de Educação, 2001).

In the context of initial teacher training, can the supervised curricular internship be a relevant experience for understanding educational accessibility? According to Rodrigues, Quaresma, and Ponte (2024), the internship is a theoretical and methodological field that, under a collaborative and reflective principle, helps identify training challenges and overcoming preconceptions that influence practice. For Meneghetti and Oliveira (2019), although undergraduates may feel unprepared for the job, the internship is essential for connecting with the school and for experiencing the practice through mandatory teaching, which fosters theoretical and practical contributions and professional identity. In this sense, we believe that the supervised internship courses can serve as a locus for reflecting on and applying concepts related to educational accessibility.

The objective of this article is to present the possibilities for developing methodological strategies, resources, and teaching materials in collaboration with undergraduate teaching students to support instructional activities related to mathematics learning, based on the premises of inclusive and bilingual education and the principles of Universal Design for Learning (UDL).

Given the above, this study, which is part of a collaborative research project, reflects on issues related to mathematics education and educational accessibility based on a lesson plan developed by undergraduate Mathematics Teaching students at a public university in the state of São Paulo. The plan was revised based on the premises of special education and the principles of Universal Design for Learning (UDL), which were addressed in a Training Initiative developed by the authors of this study with students from two courses in the aforementioned program, one of which was a supervised internship.

To this end, we will contextualize aspects related to more universal teaching practices considering diversity in the educational context, presenting the methodological approach that

supports this study, and then provide a summary of the initial lesson plan, seeking to understand and analyze the strategies outlined by the students in the lesson plan revised under the principles of UDL and assumptions of special education, finally bringing some final considerations.

## Diversity in the educational context and universal teaching practices

In Brazil, students with physical, intellectual, hearing, and visual disabilities, high abilities, and giftedness, and those with autism spectrum disorder are legally considered target groups for special education (Lei nº 9.394, 1996; Secretaria de Educação Especial, 2008). The Brazilian Law of Guidelines and Bases for National Education (LDB) establish, in Article 59, item I, that specific curricula, methods, techniques, educational resources, and organization structures must be provided to meet their needs (Lei nº 9.394, 1996). However, other conditions, such as attention deficit hyperactivity disorder (ADHD) and dyslexia, now also covered by law, have gained a different perspective in education (Lei nº 14.191, 2021).

In the school environment, demands are made to promote accessibility in different areas and to improve access to the curriculum (Lourenço, 2022; Alecrim & Santana; 2022). In this aspect, the Brazilian Inclusion Law (LBI, 2015) establishes criteria for physical accessibility, as well as accessibility within the environment, which is assumed to include, among others, didactic and pedagogical resources, and for communication and information, based, for example, on assistive technology, which refers to "products, instruments, equipment or technology adapted or specially designed to improve the functionality of people with disabilities or reduced mobility, favoring personal autonomy, whether total or assisted" (Decreto nº 5.296, 2004).

In this regard, UDL seeks to expand teaching for all, serving as a teaching tool. It is a universal strategy, that is, a universalist pedagogical practice, that promotes broad access to the curriculum. In an approach that guides professor choices, UDL seeks to create flexible learning pathways so that everyone can progress, although it also advocates personalizing instruction to meet individual needs (Cast, 2024; Mendoza & Gonçalves, 2023; Silva & Mendes, 2022; Zerbato & Mendes, 2021).

UDL corresponds to a set of three principles: engagement, representation, and action and expression, based on neuroscience studies for curriculum differentiation and transformation of learning processes. According to the principle of representation, access to content should be achieved through distinct means through the different senses. The principle of action and expression emphasises the importance of ensuring multiple ways of demonstrating what has been learned. In relation to the principle of engagement, it is necessary to find ways of engaging

in students that awaken their interest, attention, and cognitive activity. (Cast, 2024; Sebastián-Heredero, 2020).

According to Mendoza and Gonçalves (2023), universalist pedagogical practices are relevant to inclusive educational processes and correspond to teachers' response to diversity regarding "choices between the varieties of resources and services, pedagogical strategies, and teaching materials accessible to all students" (Mendoza & Gonçalves, 2023, p. 7). As Zerbato and Mendes (2021) state, this involves valuing different ways of learning, proposing accessibility for all in which strategies are developed "both in the structural-physical, pedagogical, and classroom management spheres, as well as in terms of services and support focused on the general class, with a view to minimizing and eliminating all barriers to learning" (Silva & Mendes, 2022, p. 64).

We see that the UDL perspective advocates expanding learning opportunities, from planning to assessment, as a "strategy or support system that aims to promote the elimination of physical, sensory, affective, and cognitive barriers, facilitating and guaranteeing access to learning and student participation" (Mendoza & Gonçalves, 2023, p. 10). Thus, considering contexts constituted by diversity, including students with disabilities and neurodivergent conditions, it becomes clear why teaching considers the specific needs and characteristics of students from their initial training.

## Methodological path

This study forms part of a collaborative research project (Ibiapina, Bandeira & Araújo, 2016) in mathematics education which seeks to connect knowledge production and teacher training. This postdoctoral research was designed as a collaborative effort, intended to be conceived and carried out through a process of joint, dialogical, and reflective collaboration. The overall objective of this research was to develop a proposal for methodological strategies, resources, and teaching materials to support teaching activities related to mathematics learning, with an emphasis on the condition of deafness. One of the specific objectives was to develop a proposal for methodological strategies, resources, and teaching materials based on the premises of inclusive and bilingual education and the principles of UDL.

To pursue these objectives, a Training Initiative was held in the first semester of 2023 in a mathematics undergraduate program at a public university in the state of São Paulo. The programme included two courses: a supervised internship in mathematics, hereinafter referred to as Internship 1, and a course related to the inclusion of students with disabilities and neurodivergent conditions, hereinafter referred to as Inclusive Education. Both courses were

taught by the second author of this study and supervised by the first author, who is a professional in special education and a postdoctoral researcher at the same institution under the supervision of the second author, investigating issues of mathematics education and educational accessibility.

As part of the research, a Training Initiative was conducted in these two courses, based on the UDL and the principles of special education and bilingual education, with the aim of reflecting on legal, conceptual, theoretical, and practical issues related to accessibility in mathematics education. The Training Initiative included collaboration and reflection between the researcher and the study supervisor, who, coordinated the mathematics course and taught both courses at the time this training was proposed. The Initiative was offered to all students in these courses, and the joint collaboration in study and reflection also involved students who agreed to participate in the study.

The Training Initiative was led by the researcher but designed in collaboration with the professor. The proposal was revisited as necessary, considering demands that emerged from the meetings and joint reflections with the students and study participants. The Training Initiative, which took place during class time in both courses, with extracurricular meetings also taking place, when necessary, included lectures, discussion groups, and debates on topics related to the types, characteristics, and specificities of disabilities and specific neurodivergent conditions, such as autism spectrum disorder, giftedness, attention deficit hyperactivity disorder, dyslexia, and dyscalculia, with a view to the educational process and learning.

Teacher training is always challenging, particularly for mathematics teaching. As Zuffi, Meneghetti, and Netto (2022) have shown, an enriched environment favors learning, and initial training must ensure time for planning and developing a teaching sequence with the application of alternative teaching methodologies. Thus, the teacher developed training regarding the use of active approaches to mathematics teaching, focusing, more specifically, in the Internship 1 course, on problem-solving (Onuchic & Allevato, 2004; Cavalheiro & Meneghetti, 2016) and mathematical inquiry (Ponte, 2003; Meneghetti & Redling, 2012) teaching methodologies, in which students had the opportunity to learn about and apply these approaches in their teaching plans. One of the activities of Internship 1 was the elaboration of a lesson plan for teaching, which could be re-elaborated as an activity in Inclusive Education (since there were students in common), in which we sought to create, with the participation of the researcher, special education professional, conditions for collaborative reflection on aspects necessary for more accessible practices in planning mathematics teaching.

In the Inclusive Education course in addition to the Training Initiative, a workshop on UDL was developed, led by the researcher in collaboration with the professor. This workshop aimed to delve deeper into aspects related to teaching practices in mathematics education and school inclusion previously addressed in the Training Initiative. Thus, the workshop focused on deepening the topics studied and reflecting on the development of methodological strategies, resources, and teaching materials based on teaching plans already developed by the undergraduate students for use in Internship 1 classes, aiming for accessibility considering UDL.

The development of both the Training Initiative and the Workshop on UDL was possible without compromising the syllabus and workload of the course. This was because the themes were related to the objectives of the study and were also linked to the proposition of the Inclusive Education course. Considering the post-doctoral study, joint planning took place between the professor and researcher for a conduction that would enhance the proposed training.

Based on the collaborative research presented, we present this excerpt from a qualitative documentary study (Ludke & Andre, 1986), which reflects on accessibility issues in mathematics education, focusing on a lesson plan reworked by students on the aforementioned mathematics degree course, seeking to outline resources and methodological strategies for accessible teaching.

To develop the lesson plan created in Stage 1, the internships were to be carried out in the final years of elementary school, and the plan was also considered valid for youth and adult education (EJA), respectively, in the same grades. The planning of didactic sequences was considered, which, according to Zabala (1998), involves didactic units that are coordinated and outlined based on ideas and intentions regarding educational practice. These units consist of content related to facts, procedures, and attitudes, as well as activities based on methods that support the proposed teaching. According to Ausubel (1982), this can be configured as significant learning when the student's existing knowledge relates to the new knowledge.

For the revised lesson plan for the Inclusive Education course, the curricular activity required undergraduate students to observe the application of UDL principles, assuming they were teaching a 2nd grade elementary school class with students with disabilities and/or neurodivergent conditions, about potential barriers and solutions for school inclusion. For purposes of illustration, we present here the lesson plan of a group we will refer to as the *Algebra Team*, consisting of three students. Two of these students participated in the

development of the first version in Internship 1, and the three, students of both courses, agreed to revise the plan for the Inclusive Education course.

The Inclusive Education course forms part of the course curriculum, and the plan was revised follwing a UDL workshop to encourage broader reflection. For this revision of the plan, students considered fictitious cases with disabilities and/or neurodivergent conditions, based on their acquired knowledge. As fictitious cases, the *Algebra Team* considered students with the characteristics shown in Table 1, Fictitious Cases of Specificities in the Context of Diversity.

Table 1.

*Fictious cases of specificities in the context of diversity (by the authors based on the descriptions of the fictitious cases by the Algebra Team)*

| Condition | Specifics |
|---|---|
| Physical Disability | Difficulty moving – Wheelchair user |
| ADHD | Inattention with agitation and impulsivity |
| Dyslexia | Difficulty at reading and writing, from word recognition to fluent reading, and difficulty at learning and using reading and writing skills |
| Primary Dyscalculia | Difficulty handling and interpreting numbers [Moderate] |

Physical disability, whether congenital or acquired, refers to the "complete or partial alteration of one or more segments of the human body, leading to impairment of physical function" (Decreto nº 5.296, 2004). This condition affects the musculoskeletal system and can arise from the central nervous system, causing sensory, vision and hearing, cognitive, behavioral, language and communication impairments, as well as epilepsy and seizures (Lourenço, 2022).

ADHD is a neurodevelopmental disorder characterized by unique conditions related to attention, concentration, and behavior. It can manifest in three types: one with a predominance of hyperactivity symptoms, another with a predominance of inattention symptoms, and a type that combines both. These symptoms imply functional impairment in different contexts (Lei nº 14.191, 2021; Costa, 2023; Sousa et al., 2020). Regarding education, as demonstrated by Borges and Machado (2021), it is important to create daily routines for time management, schedule planning, and the development or adaptation of programs guided by systematic thematic teaching. For this purpose, it is important to consider clarity of information, which should be brief and visual.

According to Buzetti (2021), dyslexia and dyscalculia are understood as specific learning disorders of skills that impact and compromise educational performance. Dyslexia is related to reading and writing, for example, comprehension and fluency, which are linked to the understanding of mathematics, languages, and statements. Dyscalculia involves difficulties in understanding numerical aspects, "impaired knowledge of number sense, memorization of arithmetic facts, accuracy or fluency of calculation, and precision of mathematical reasoning" (Buzetti, 2021, p. 147). These conditions can have an emotional impact, affecting self-esteem. For Bernardi and Stobaus (2011), playful intervention is relevant in issues involving emotions and mathematical skills.

Considering the specificities and possible methodological alternatives for teaching is essential considering this diversity. Initial teacher training serves as a potential locus for developing more accessible practices for teaching practices. In this systematic training experience, within the undergraduate program, this study was facilitated by the profesor and the special education professional, fostering joint training and reflection on more equitable processes in teaching mathematics. Thus, in our qualitative analysis of the *Algebra Team*'s plan, we focused on the methodological strategies, resources, and/or teaching materials suggested by the team. We considered the principles of UDL, and sought to identify and interpret the approaches outlined by the graduates as alternatives for more accessible teaching.

## Teaching mathematics: summary of the didactic sequence proposal

The initial plan consisted of a five-lesson (5-hour) instructional sequence on functions for a 9th-grade class, based on the skills and competencies outlined in the National Common Curricular Base (BNCC) and the São Paulo State Curriculum. The *Algebra Team* presented both the initial and the revised plans as appropriate curricular activity descriptions for the subjects. Table 2, Summary of the lesson plans proposal, provides a summary of the initial proposal in terms of objectives, content, and methodology, as well as information on the topic and school year.

Table 2.

*Summary of the lesson plan proposal (The authors, based on the Algebra Team's plan developed in Internship I)*

| | |
|---|---|
| Plan Title | Sequence of Fun Activities for Teaching Functions |
| School Year | 9th Grade of Elementary School |
| Initial Curriculum Content | Functions: Numerical, Algebraic, and Graphical Representations of Functions<br>Cognitive Interpretation of the Topic |
| Duration | 5 class hours |
| General Objective | To develop the following BNCC skills:<br>a) (EF09MA06): Understand functions as relationships of univocal dependence between two variables and their numerical, algebraic, and graphical representations, and use this concept to analyze situations involving functional relationships between two variables.<br>b) (EF09MA22): Choose and construct the most appropriate graph (columns, sectors, lines), with or without the use of spreadsheets, to present a given set of data, highlighting aspects such as measures of central tendency. |
| Specific Objectives | Implement a teaching sequence on functions and their representations, with student participation and protagonism in the learning process. |
| Organization | 30-45 minutes per class hour |
| Teaching Methodology | Problem Solving and Mathematical Investigation; Collaborative teaching-learning methodology |

As described in the initial plan above, for classes 1 and 2, aimed at fostering student development, responsibility, and autonomy, through a problem-solving and mathematical investigation methodology, the *Algebra Team* proposed to discuss with the Internship class how the classes work and how the activities are carried out. To introduce the content, the proposal involved preseting an example of the relationship between two variables based on a practical situation, establishing a connection between car sales and time. Using the interactive whiteboard, the plan suggested creating a table showing car sales over a given period, prompting reflection on the existence of a pattern in the sales volume of two brands. Through this table, the law of formation of functions and the univocal dependence relationship between sets were introduced, if the students had an algebraic perception of the common difference between the values of different brands.

The initial plan stated that the relationship "between the number of cars sold and time is called a 'function,' and that functions are a way of studying two sets of objects that relate to

each other through values associated with each of these sets" (*Algebra Team*, 2023). In Class 2, using tables and taking into account students' prior school experience, two problem situations would be proposed: organizing a birthday party and the purchasing customized t-shirts. In the birthday party context, it was assumed that each student had eaten one piece of cake (130 grams), and the task was to identify the formation law of the table, filled with different numbers of students. In the situation related to the purchase of t-shirts, another table would be filled in with values that respected a different formation law for each store.

For classes 3 and 4, still based on the initial proposal, the *Algebra Team* would revisit the problem situations, seeking to foster a discussion on the formation law based on the relationship between sets from the previous activity. From this, they would explain the relationships established through a set language under the context of a function between sets, namely "QC: set of quantities of t-shirts"; "P: set of t-shirt prices per unit"; and "f: function that relates quantity of t-shirts to price per unit, respecting a formation law" (*Algebra Team*, 2023).

The proposition in the t-shirt problem situation would be to introduce the conceptualization of the objects covered by a function (domain, codomain, and image), in which, through the explanation, a function would be compared to a machine that labels each collection of t-shirts. To this end, the interactive whiteboard would be used to write the definitions, as described by the *Algebra Team*, in the format presented in Table 3. Definitions:

Table 3.

*Definitions* (*Algebra Team*)

| |
|---|
| 1) The initial set of values is called the **Function's Domain**. Example: The set QC;<br>2) The final set of values is called the **Function's Codomain**. Example: The set P;<br>3) The set of elements that the function encompasses through the formation law is called the **Function's Image**. Example: The set of prices associated with each quantity of T-shirts. |

Subsequently, the definitions the team defined on the interactive whiteboard would be associated with the drawing of the set and its elements, commenting on what constitutes the domain, namely, the size of the collections; that labeling would correspond to the function; and that the prices received for the quantities of T-shirts would correspond to the function's image. To clarify conceptual doubts, drawings of the sets would be made on the board to show the elements of each object, differentiating domain and image. Function, at this point, would be presented formally, regarding the relationship between each element of a domain set and elements of the codomain set through a formation law, recording the characteristics of the function on the board, as seen in Table 4, Characteristics of a Function.

Table 4.

*Characteristics of a Function (Algebra Team)*

| |
|---|
| a) A function associates every element of the domain with only one element of the codomain. |
| b) Not every element of the codomain is associated. |
| c) There may be some element of the image that is associated with two (or more) elements of the domain. |

The *Algebra Team* considered that adapting the example of the price of t-shirts would be important to clarify the characteristics of a function. Thus, it would be said that every quantity of t-shirts has only one price, and that values that do not correspond to the quantity of t-shirts could also exist, but that two values could correspond to different quantities.

Finally, regarding class 5, the initial moments would be dedicated for questions and group formation, in which students would be guided to develop a problem-solving situation, not with the goal of solving it, but of creating the problem statement. The proposed activity would be a creative and collaborative activity, with an assessment that would seek to determine to what extent the proposed situation, considering conceptual notions, could be solved based on what was learned.

## (Re)thinking mathematics teaching: new elements for the didactic sequence from the perspective of accessibility

Based on the synthesis presented, we reflect on aspects redefined by the *Algebra Team* for accessible practices in mathematics teaching based on the assumptions of Special Education and UDL, which "refers to the process by which a curriculum (i.e., objectives, methods, materials, and assessment) is designed from the outset, intentionally, and systematically, to address individual differences" (Sebastián-Heredero, 2020, p. 740). However, educational planning and practice can be improved, and we will conduct the analysis considering the reflections of the undergraduate students expressed in the revised plan. This is justified by the fact that the Training Initiative was carried out during an initial teacher training course and because "teaching strategies based on universal learning principles do not negate or ignore the experiences of previous teaching plans; on the contrary, they can expand and reframe them to enable access to knowledge for the entire class" (Silva & Mendes, 2022, p. 70). Table 5, Revised Proposals, presents a summary of the revised proposals in relation to objectives, content, resources and pedagogical tendency, as well as theme and school year.

Table 5.

*Revised proposals (The authors based on the description of the Algebra Team's fictitious cases)*

| Plan Title | Sequence of Fun Activities for Teaching Functions |
|---|---|
| School Year | 9th Grade of Elementary School |
| Initial Curricular Content | Functions: Numerical, Algebraic, and Graphical Representations of Functions<br>Cognitive Interpretation of the Topic |
| General Objective defined for the revised plan | To work on skill EF09MA06 without using numerical, algebraic, and graphical representations. Here, skill EF09MA22, also initially defined in the teaching plan for Stage 1 Mathematics Internship, was reduced. |
| Initial Curricular Content | Functions: Numerical, Algebraic, and Graphical Representations Cognitive Interpretation of the Topic |
| Resources and Materials | Fruit, mixer, cups, printed images, cardstock, string, candy, projector, paper, and printed activities. |
| Pedagogical Trend: Revised Plan | Constructivism<br>Cognitivism (Mizukami, 1986) |

In the revised plan, assuming fictitious cases, the interns proposed a constructivist and cognitivist-based approach, with class dynamics based on debates and problem-posing and analysis for conceptual development. From the perspective of the cognitivist approach, knowledge is a continuous construction, built through the interaction between subject and object of knowledge. The professor, in a reciprocal manner, attentive to development, leads the student to new levels of reflection, considering them active in the process (Mizukami, 1986).

To revise the plan, the *Algebra Team* assumed that students would be protagonists, encouraged to actively participate under the mediation of the knowledge construction process through guidance, questioning, reflection, and debates for conceptual development, based on the proposition and analysis of an example problem,

> [...] always seeking to achieve the goals of an inclusive education, that is, to contemplate all students in a general way, taking into account their abilities rather than focusing solely on their **special *conditions***[3] [...] trying to take the content to real situations of the

[3] Despite advances, different forms of representation regarding people with disabilities, as well as terminology, can still be seen. This diversity present in the educational context presents distinct specificities. We understand that the "*Algebra Team*," assuming this diverse audience, meant that it would not restrict itself to the condition of disability; that is, that the focus would not be on the organic and/or biological condition.

student's daily life, taking into account the experience of each student (*Algebra Team*, 2023).

Regarding the environment, when reworking the plan, the *Algebra Team* mentioned a special education service, where the school would have a Multifunctional Resource Room (MRR), but this would not be used due to ineffective accessibility for students with physical disabilities. The MRR will not be discussed in depth in this article, but for the sake of explanation, it is characterized as a space where, during after-school hours, specialized educational services are provided to students in the special education target group by a specialist teacher, along with specific communication and learning programs (Secretaria de Educação Especial, 2008).

Regarding accessibility for students with physical disabilities, in the interface with the UDL and its premise of attention to physical and structural aspects (Cast, 2024), with regard to space and furniture, it is necessary to ensure functionality and participation (Lei nº 13.146, 2015). Physical disability can manifest itself in different ways, which presupposes architectural accessibility in the interface with other dimensions of accessibility to ensure safety and autonomy with specific conditions arising from the disability, but also in attention to their unique conditions, characterized by their personal and cultural experiences.

If we consider the concept of disability, which is not limited to the individual's condition, we understand that impediments of various natures arise in interaction with barriers in society, limiting their participation (Lei nº 13.146, 2015). As seen in Alecrim and Santana (2022), for people with physical disabilities, in addition to physical access to space, environmental solutions are necessary for spatial accessibility, such as adapting and positioning furniture, considering the action and participation of students in carrying out activities according to their needs and abilities. As the authors reflect, compliance with accessibility standards involves environmental conditions for movement, use, spatial orientation, and communication.

Regarding the teaching and learning environment conceived in the revised lesson plan, the *Algebra Team* suggested a semicircular classroom layout, in which recreational activities would be developed in the center to promote visualization and interaction. This would allow "all students to participate in the activities and see one another during discussions, while also serving as an integration tool for ***students with physical disabilities***[4] in all classes" (*Algebra Team*, 2023).

[4] The use of the term students with disabilities', adopted by the *Algebra Team*, was previously used in literature and legislation, but is no longer so. Based on reflections and foundations in the area, more current terminology has

From the UDL perspective, the relevance of this reflection by graduates is understood, since this organization of space would encourage interaction and engagement with people, materials, and resources in different formats. This would further enhance what Zabala (1998) refers to as attitudinal content in their categorization of types of knowledge in educational practice, which is related to social values and attitudes. This plan suggests that diversity due to disability conditions could be redefined through interaction, which is encouraged by sharing, collaborative work, and teacher mediation.

Based on the UDL, we understand that this type of classroom would favor different modes of content presentation beyond the whiteboard and allow the teacher to perceive how all students participate. Given the uniqueness of the classroom, this perception would be established through daily practice, highlighting the importance of understanding individual specificities and needs. "By carrying out the activities, we can identify the capabilities of students with physical disabilities and map the barriers and demands for their participation" (Lourenço, 2022, p. 86).

Regarding the conduct of pedagogical practice in the classroom and assuming the presence of students with disabilities and neurodivergent conditions, the *Algebra Team* proposes the presence of a special education professional for the re-elaborated plan. The summary of this plan can be seen in Table 5 (Revised Proposals). The team understands that this professional would work with all students, as seen below:

> It's worth noting that we will have the help of a special education professional working with the entire class so that all students can utilize their resources. During the first two classes, they can help mediate the discussion to engage the class in the activity, and include all students with **special needs**[5]. The specialized professional will accompany ALL classes in the teaching sequence (*Algebra Team*, 2023).

Although this professional's role is briefly described, this analysis suggests that they have specific training. This proposition is valid due to the potential for an inclusive school culture based on the collaboration between a special education professional and a regular classroom teacher. According to Silva and Mendes (2022), this partnership improves the

been adopted, which, in fact, does not understand the term 'person with disabilities' as an understanding of the condition of disability inherent to the subject, and not as something to be carried. See the Brazilian Inclusion Law, Law No. 13,146 of 2015 (https://www.planalto.gov.br/ccivil_03/_ato2015-2018/2015/lei/l13146.htm) for the concept of disability.

[5] "Special needs" is a term that has also been used in the literature in relation to people with disabilities. Currently, however, it is not necessary, as it is understood that needs are specific due to the interaction between the disability and the environment, considering accessibility from the perspective of functionality with participation, safety, and autonomy (Lei nº 13.146, 2015).

schooling of all students and professional development through collaborative work, a relevant process to consider when thinking about teaching collaboratively.

Through training, special education professionals gain more knowledge about the specificities and conditions of disabilities, as well as important information about the teaching and learning processes for this population. Although the UDL process is designed for everyone to maximize learning (Zerbato & Mendes, 2021), it is necessary to value individual needs and personalize instruction. To this end, "it is essential to observe the school environment, especially the classroom, in order to provide support, strategies, and approaches" (Vilaronga, Costa & Piovezan, 2023).

Furthermore, as seen in the systematic review of UDL for inclusive education conducted by Vitalino, Prais, and Santos (2019), the issue of insecurity and lack of training among regular classroom teachers regarding inclusion issues in this context is still evident. The lack of knowledge about these issues hinders reflection on the practice. Therefore, culture and collaborative teaching have much to contribute.

Regarding other aspects of the teaching methodology, when reworking the plan, the *Algebra Team* chose not to suggest the use of writing on the board. Instead, they proposed dictation for conceptual information and carrying out all activities visually. They justified the use of this methodology, explaining that students “abstract mathematical concepts involving functions without the need to work on a robust formalization and systematization involving mathematical symbols” (*Algebra Team*, 2023).

As seen in Sebastián-Heredero (2020), the presentation of concepts and explanation of processes could be limited if the information were predominantly textual. However, presenting information in different modalities not only expands accessibility, but also individual ways of understanding it. For example, when considering the characteristics and demands of students with specific needs regarding writing and understanding symbols, such as those with dyslexia or dyscalculia, the textual mode,

> As a presentation format, it can be somewhat challenging for students with learning disabilities related to written language. Providing alternatives to the text, especially illustrations, simulations, images, or interactive graphics, can make your information more understandable for any student and more accessible to those who find it completely inaccessible in this format (Sebastián-Heredero, 2020, pp. 750).

From the UDL perspective, it is understood that one modality does not need to replace another, whether written, visual, auditory, or manual. Rather, they complement each other. It is understood that "different ways of teaching the curriculum are indispensable prerequisites for

planning that encompasses the diversity of rhythms, styles, and ways of learning" (Silva & Mendes, 2022, p. 64). Therefore, in a professional setting, there is no need to replace the use of the whiteboard with dictation, especially since many students may prefer that format. Instead, it is important to consider different approaches and, if necessary, customize them in specific cases. Customizing for one student can provide insight into understanding others (Sebastián-Heredero, 2020).

As it can be seen, accessibility involves different aspects. For classes 1 and 2, while reworking the plan, the *Algebra Team* suggested approaching the concept of function in a comprehensive and playful way. They proposed a problem-situation based on the relationship between fruits and their juices. To this end, different fruits could be brought to school to produce juices using a blender, which would be the method. The relationship between each fruit and its juice would be based on color and flavor. The method of producing juice with a blender would determine the formation law of the function. In the proposal, the fruits would be arranged on one table, representing the domain of the function. On another table would be glasses representing the range, including a glass of water representing the range minus the image. According to the team, "The idea is to use this discussion to say that 'a function is a rule that relates each element of a set to one and only one element of another set,' explicitly explaining each part of this sentence on the tables" (*Algebra Team*, 2023).

The team also suggested asking questions about what connects the two tables and what the juices have in common during production. They expected this would help learners to understand how the blender crushes the fruit to produce the juice. From this, one could conclude that the juice-making method is a law of formation for the function presented. Another question would be whether it is possible to produce two different juices with just one fruit or a flavorless juice from crushed fruit, which would not be possible in either case. Another suggestion would be to show that the table could also have some content (juice) that is unrelated to any fruit because of the crushing process.

In another activity, mixing juices from two fruits could illustrate that, despite the possibility, the juices would no longer have their original properties. During the discussion, it could be highlighted that a "function is a rule that relates each element of a set to only one element of another set" (*Algebra Team*, 2023). Another activity suggested by the team to explain a formation law is to create a function and ask students to establish a relationship between themselves and the tables.

From a UDL perspective, it is important to present content in different ways, such as in a playful manner or by relating it to elements of the students' realities. Therefore, both plans

developed by the students considered elements of reality, including the tables containing data on car and t-shirt sales, proposed by the undergraduates in the original plan, and the fruit in the revised plan. In a teaching context, these elements relate to how information is presented. In addition to the principle of representation, the principle of engagement could also be considered through dialogue. This would motivate students to ask questions related to the content, fostering their involvement and participation. UDL not only makes curriculum elements more flexible, but also encourages more direct student participation. To this end, alternatives are necessary

> for the teacher to optimize student's autonomy and personal choice, offering them, for example, the maximum possible autonomy and ensuring choices in the following dimensions: activity with different levels of difficulty/complexity or demand – prior knowledge, for example; type of rewards/recognition available; variations in color, designs, layouts, etc. of the materials used – diversifying the sequence or time for completing the activities (and their stages) (Mendoza & Gonçalves, 2023, pp. 11).

We understand that adopting the concrete and visual resources and materials suggested in the plan and the mathematics teaching methodology outlined by the *Algebra Team* would enable significant learning (Ausubel, 1982), by establishing relationships between new knowledge and knowledge already organized by the students. For class 3, the suggestion is to use printed images of fruits, juices, and blenders to construct on the board, write on the blackboard, and dictate to explain the relationship between two sets related to the function and explain Domain and Codomain. In this context,

> we will ‘draw’ students (we will choose those with ADHD) to connect the elements of the images with a string and secure the ends of the strings to the elements with adhesive tape. We will direct this activity, using it to explain more formally the characteristics of functions based on the ideas already briefly described in classes 1 and 2 (*Algebra Team*, 2023).

Regarding students with ADHD, the suggestion of intentionally drawing lots for more active participation in the activity, with oral mediation, could be considered positive in terms of autonomy and confidence. Within the educational context, plurality is further distinguished by the presence of students who may exhibit, under varying circumstances, symptoms of hyperactivity and inattention. The *Algebra Team* emphasizes both ADHD and dyslexia, for which legal advances signal and guide changes in educational practice to address these specificities, as advocated by Law No. 14,254 of 2021.

> Art. 3 Students with dyslexia, ADHD or other learning disorders who present changes in reading and writing development, or instability in attention, which have an impact on learning, must be assured of specific monitoring aimed at their difficulty, as early as

> possible, by their educators within the school in which they are enrolled. They can count on support and guidance from the health area, social assistance, and other public policies existing in the territory (Lei nº 14.254, 2021).

As it can be seen, guaranteeing these students' right to education involves not only actions by the teachers, but also a potential support network that enables reflection and decision-making, taking into account their specificities, uniqueness, and learning needs.

For Lesson 4, it is recommended that the teaching sequence should be concluded with a summary of the content through a supportive dialogue. In the Lesson 5 of the revised plan, the suggestion is to select a brief animated film with content related to the topic being discussed and that could be used to reflect on mathematics in everyday life. This strategy uses an interactive and playful approach to encourage students' abstraction of mathematical concepts.

In summary, the team's proposal entails the assessment of understanding without resorting to a formal assessment, seeking to include everyone in this dialogue. The leadership of this discussion is suggested to be led by the Special Education professional. Through joint planning, the aim is to broaden participation and connect students' experiences with the mathematical content. Finally, it should be a resource for consultation and formalization of the content. The definitions and characteristics of the functions would be printed in capital letters and with ample space, considering students with dyslexia.

As this analysis shows, there has been a shift toward lesson planning that seeks to broaden the reflection on teaching practices by considering the plurality of diversity and different elements of the curriculum. According to Sebastián-Heredero (2020), the objective of UDL, regarding the curriculum — which consists of objectives, methods, materials, and assessment — is to lead students to the mastery of learning by focusing on their development.

Considering diversity, objectives, methods, and materials can be outlined in different ways. Methods and materials must be varied and flexible to consider the relationships established in an environment that enhances learning, based on the teacher's creativity. To this end, it is important to consider aspects that promote engagement, content presentation, and assessment in different ways (Sebastián-Heredero, 2020). It aligns with Zuffi, Meneghetti, and Netto (2022) perspective that an enriched environment favors mathematical learning through alternative methodologies, such as the problem-solving methodology.

Regarding assessment, the *Algebra Team* briefly described how it guides planning and results, aiming to promote learning for everyone from a perspective that connects knowledge in a dynamic process and with the prospect of growth, considering the teaching objective. To

this end, the student needs guaranteed opportunities to take the lead, control their learning process, and express knowledge, which are premises of UDL. This is important because

> There are no means of expression that are equally valid for all students or all types of communication. On the contrary, there are means that seem inappropriate for certain forms of expression and for some types of learning. While a student with dyslexia may be an excellent narrator orally, they may have difficulty telling the same story in writing (Sebastián-Heredero, 2020, pp. 755).

This shift by undergraduates toward a more accessible education demonstrates the effectiveness of the collaborative work between teachers and researchers in the courses of Inclusive Education and Supervised Internship during initial training. This collaboration, combined with the proposals of the Training Action on UDL and Special Education, as well as the UDL workshop, provided new ways of thinking about educational accessibility for mathematics teaching and learning processes.

Considering the training demands in this field, conducting training experiences of this nature within the framework of the relationship between theory and practice can be seen as an alternative way to improve training in the context of accessibility. This can be done even before assuming a teaching role, by already reflecting on it in relation to this reality. In this sense, we emphasize the relevance of discussing special education not only in specific courses, but also in other courses of the common curriculum, such as supervised internships.

## Final considerations

Initial teacher training plays a key role in understanding the specific needs of students with disabilities and neurodivergent conditions to develop more accessible educational practices. In this study, we reflect on aspects of mathematics education and educational accessibility based on a lesson plan. These aspects were addressed in two courses, referred to as Internship I and Inclusive Education, in an undergraduate mathematics program at a public university in the state of São Paulo. As part of collaborative postdoctoral research, we conducted a training program based on the principles of UDL and the assumptions of special and bilingual education.

A special education professional and the professor of the courses led the training initiation, engaging with the syllabus proposals and establishing interaction with the proposed curricular activities. The collaborative research, supervised by the second author and led by the first, aimed to expand knowledge about mathematics education and educational accessibility.

The research also proposed a UDL workshop, culminating in the redesign of the lesson plan developed by the undergraduate students.

The undergraduate students initially developed their lesson plans in *Internship I,* a mandatory course, and some were reworked during the *Inclusive Education* course, which had students in common. In this article, we qualitatively analyzed a lesson plan on functions, which was reworked considering fictitious cases of students with physical disabilities, ADHD, dyslexia, and dyscalculia. Based on the principles of UDL and special education, we sought to identify and analyze how undergraduate students and future mathematics teachers outlined teaching strategies, used alternative materials and resources to present content in different ways, and engaged students in the learning process, considering assessment from an accessible perspective.

The principles of UDL and the assumptions of special and bilingual education supported the research, the training program, the workshop, and the redesign of the lesson plan. For this activity, the initially defined curriculum components, such as objectives, materials, methodologies, and assessment, were revised to maximize education for all.

The results of the analysis indicate that formative experiences throughout initial teacher training courses support initial training on issues related to diversity in educational contexts through understanding, reflection, and mobilization of strategies for more accessible teaching. We emphasize the internship courses, through active methodologies, research, and the articulation of knowledge related to special and bilingual education and universal strategies such as UDL, in collaboration with special education professionals.

Training initiatives of this nature can foster experiences that support future teachers' reflection on more equitable educational practices by outlining alternatives that presuppose plurality in planning and curriculum elements. These alternatives aim to provide flexible access to the learning environment and knowledge. Formative experiences for educational accessibility can provide support, foster knowledge construction and reflection, and empower individuals to mobilize what is necessary for teaching in their professional practice.

The results show that formative actions in the initial training of teachers, emphasizing students with disabilities and neurodivergent conditions and carried out in the presence of a special education professional, can support theoretical and practical training. These actions should primarily occur in internship or inclusion courses. Considering the reality in which the internship can take place, these actions can enhance the design of a plan presupposing more equitable teaching practices and actions.

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