UNIVERSAL DESIGN FOR LEARNING AND ASSISTIVE TECHNOLOGY: COMPLEMENTARY OR EXCLUDING?

DESENHO UNIVERSAL PARA APRENDIZAGEM E TECNOLOGIA ASSISTIVA: COMPLEMENTARES OU EXCLUDENTES?

DISEÑO UNIVERSAL PARA EL APRENDIZAJE Y TECNOLOGÍA DE ASISTENCIA: ¿COMPLEMENTARES O EXCLUYENTES?

Amália Rebouças de Paiva e OLIVEIRA[1]
Adriana Garcia GONÇALVES[2]
Lígia Maria Presumido BRACCIALI[3]

ABSTRACT: With the advances in researches and legislation about educational inclusion a lot of theories and actions have emerged in order to support the inclusion of students with disabillitis in the school context, among them we highlight the Universall Design for Learning (UDL) and the use of Assistive Technology (AT). This article presents a theoretical discussion based on the principles of Universal Design for Learning and Assistive Technology, to this end we discuss how the literature has pointed out that these perspectives, although they seem incompatible at first sight, they can favor and be complementary in the process of educational inclusion.

KEYWORDS: Universal design for learning. Assistive tecnology. School inclusion.

***RESUMO**: Com os avanços de pesquisas e legislações sobre a inclusão educacional surgiram inúmeras teorias e ações com o objetivo de favorecer a inclusão dos alunos com deficiência no contexto escolar, entre elas destacamos o Desenho Universal para Aprendizagem (DUA) e o uso da Tecnologia Assistiva (TA). Esse artigo apresenta uma discussão teórica pautada nos princípios que compõem o DUA e a TA, para tanto dissertamos como a literatura tem apontado que essas perspectivas, apesar de a priori parecerem incompatíveis, podem favorecer e ser complementares no processo de inclusão educacional.*

***PALAVRAS-CHAVE**: Desenho universal para aprendizagem. Tecnologia assistiva. Inclusão escolar.*

[1] Federal University of São Carlos (UFSCAR), São Carlos – SP – Brazil. Doctoral student at the Graduate Program in Special Education (PPGEES). ORCID: https://orcid.org/0000-0002-8190-812X. E-mail: amaliareboucas@gmail.com.
[2] Federal University of São Carlos (UFSCAR), São Carlos – SP – Brazil. Professor at the Department of Psychology (DPsi) and at the Graduate Program in Special Education (PPGEES). ORCID: https://orcid.org/0000-0002-5725-2001. E-mail: adrigarcia@ufscar.br
[3] São Paulo State State University (UNESP), Marília – SP – Brazil. Doctor in Physical Education. ORCID: https://orcid.org/0000-0002-2540-3725. E-mail: ligia.bracciali@unesp.br

***RESUMEN**: Con los avanzos de las encuestas y legislaciones sobre la inclusión educacional surgieron muchas teorías y acciones con el objetivo de favorecer la inclusión de los alumnos con discapacidad en el contexto escolar, entre ellas destacamos el Diseño Universal para el Aprendizaje (DUA) y el uso de la Tecnología de Asistencia (TA). Ese artigo presenta una discusión teórica con base en los principios que componen el DUA y la TA, para tanto disertamos como la literatura hay apuntado que esas perspectivas, a pesar de a priori parecer incompatibles, pueden favorecer y ser complementares en el proceso de inclusión educacional.*

***PALABRAS CLAVE**: Diseño universal para el aprendizaje. Tecnología de asistencia. Inclusión escolar.*

Introduction

From the 1990s onwards the social and educational inclusion movement gained consistency in the Brazilian scenario. Driven mainly by international documents such as the Salamanca Declaration (1994), to which Brazil was a signatory, and national documents such as the Constitution of the Federative Republic of Brazil (BRAZIL, 1988) and the Law of Directives and Bases of National Education (BRAZIL, 1988; 1996).

The inclusion of special students movement arose from scholars, congresses, conventions, and the legislation itself, especially after the promulgation of the National Education Policy from the perspective of Inclusive Education (BRAZIL, 2008), and had a direct impact on the increase in the number of Special Education Students (SES) in the regular education system (VALENTINE; GOMES; BISOL, 2016).

Although this increase in enrollment is significant and has contributed to SES gaining visibility in the school context, it is necessary to think that access to regular schools itself does not promote the inclusion of these students and does not guarantee that they will actually have effective learning. Recent data from UNESCO (2018) warn that when dealing with school inclusion, the vast majority of countries only address the access of these students to regular schools.

In this sense, the need for theories and practices that support the teacher to promote inclusion in the educational context emerges, thinking not only about access, but also about the permanence and learning of the SES student at school. Researchers and theorists begin to study, then, through evidence-based practices, how to guarantee SES students their right to education. Among various theories and practices are studies on Assistive Technology (AT) and Universal Design for Learning (UDL).

In short, these two aspects are concerned with promoting teaching, accessibility and inclusion of people with disabilities in the educational and/or social field. However, these are two proposals that developed in parallel, and because of this, some scholars began to question whether the AT field contradicts the principles established by the UDL.

This article aims to analyze the characteristics of the UDL and the AT through a theoretical discussion, and to compile their similarities and differences for the educational context. Therefore, this manuscript is divided into four parts, namely: considerations about the UDL; AT considerations; UDL and AT: conceptual and practical approximations and distances; and Final considerations.

Considerations about the UDL

The concept of Universal Design for Learning emerged in 1999 in the United States, proposed by David Rose and Anne Meyer, researchers who were part of the "Center for applied special technology" (NELSON, 2014). In short, the concept of the UDL consists of designing accessibility strategies that are easy for everyone, with regard to physical structures, services, products and educational solutions. In this way, multiple ways of offering learning are thought of, thus reducing the barriers imposed by the traditional educational environment (CAST, 2013).

Nelson (2014) emphasizes that the concept of the UDL was not designed specifically for people with disabilities, but rather as a way of offering education to all students. The author also points out that this concept is based on neuroscience, based on the assumption that each individual learns differently, that is, what may be a significant experience for one may not be effective in providing learning for another. Alves, Ribeiro, Simões (2013) corroborate when stating that the UDL is an alternative to think about different ways of teaching the same curriculum to all students.

The UDL theory then meets the learning sciences, thinking about planning and applying different strategies that reach all students, so that each one with their specificity processes learning in the most effective way. After all, "the greater the possibilities of presenting new knowledge, the greater the possibilities of learning it" (ZERBATO, 2018, p. 58).

Rose and Meyer (2014) address that the UDL is composed of three main principles; they are: principle of engagement; principle of representation; principle of action and

expression. These principles guide the development of planning and strategies that lead to an inclusive activity.

The principle of engagement should guide the teacher to think about how to engage students in the activity, that is: How to challenge these students and keep them interested? What strategies can the teacher use to motivate students to participate in learning? It is related to the affective networks of students, in assimilating the reason for learning (NELSON, 2014).

In the second principle, one should think about how to present information to students (ROSE; MEYER, 2014). This is the principle of representation, in which the student must recognize the "what" of learning. It is important in planning to think about how to present the same information and content in different ways (NELSON, 2014).

Nelson (2014) also exemplifies that the third and final principle, entitled Action and Expression, guides teachers to help students process and organize what has been learned. In this way, the student will be able to express in their own way the knowledge acquired in a certain task. It refers to the "how" of learning. The author also emphasizes that flexibility is essential for the student to be able to express and re-signify their learning.

In view of all the above, it is clear that the UDL is a theoretical approach that aims to offer subsidies to teachers to think about activities for everyone. It is not about specific activities or teaching adaptations, but about providing different ways for the teacher to think about student learning. It is a way to break with the traditional plastered, standardized curriculum called by Rose and Meyer (2014) a one-size-fits-all curriculum.

The solid theory constituted by the UDL promises to assist in inclusion, making education more accessible to all (NELSON, 2014; NUNES; MADUREIRA, 2015; RIBEIRO; AMATO, 2018; ROSE; MEYER, 2014). Accordingly, practical research has demonstrated the effectiveness of UDL principles in planning inclusive classes and activities in various disciplines (ZERBATO, 2018). However, it is necessary to emphasize that although it is a concept created in 1999 and widely studied in North America (OLIVEIRA; MUNSTER; GONÇALVES, 2019), in Brazil research on this topic has gained strength in the last 10 years (PRAIS; ROSA, 2017).

Considerations about Assistive Technology

Assistive Technology is characterized as a multidisciplinary area of knowledge, which, through resources, methodologies, strategies, practices and services, aims to promote independence, autonomy, quality of life and social inclusion for people with disabilities and/or reduced mobility (BRAZIL, 2015). Manzini and Deliberato (2007) list three elements that help to understand the concept of AT: 1) it is a technology at the service of people with disabilities; 2) it must promote functionality; 3) must serve for social inclusion.

Although AT belongs to an extremely broad multidisciplinary field, this text will focus on AT in the educational setting. This is because the purpose of this article focuses on a specific look at the UDL and AT as facilitators for educational inclusion.

Toyoda and Lourenço (2008) point out that interest in the field of AT in Brazil emerged in the mid-70s, however its connection with the educational context began to be studied in the 90s (CALHEIROS; MENDES; LOURENÇO, 2018). AT is found in the school universe in two ways: the first are the AT resources that make up the multifunctional rooms (which is called high-cost AT resource), and the low-cost AT resources, here understood as "prefabricated and low-cost products and adaptations made with alternative material" (HOHMANN; CASSAPIAN (2011, p. 10), which most of the time are presented in the form of adaptations carried out by teachers, occupational therapists and physical therapists.

Thus, Calheiros, Mendes and Lourenço (2018, p. 231) point out that:

> In the educational space, with emphasis on the practices carried out directly with the target population of Special Education, still strongly in institutional contexts, the practice of differentiating materials and using adaptations to carry out activities was also present, for example, in the education of visually impaired people.

These adaptations made at school happen, most of the time, in the activity, and/or in the resource, and/or in the strategies used by the teacher. It is therefore necessary to review the conception of teaching strategies and pedagogical resources. The term teaching strategy is conceived as the teacher's action itself and the pedagogical resource is characterized by being concrete, manipulable and having a pedagogical purpose (MANZINI; DELIBERATO, 2007). Both concepts are part of the multidisciplinary field of AT and have been widely investigated in research, as they function as elements that facilitate the SES student's access to an activity in the school environment (FIORINI, 2011).

In other words, the teaching strategy used by the teacher to pass on certain content may change, according to the student's needs, as well as the pedagogical resource. After all,

any adaptation must always be carried out thinking about promoting greater functionality to the student, whether the adaptation in the resource itself, and/or in teaching (SEABRA JUNIOR, 2008). In this sense, several studies have pointed to the benefits of using AT within the school, whether to promote accessibility for those who have some motor limitation (ALVES; MATSUKURA, 2011), to collaborate with alternative communication in the school context (MASSARO; DELIBERATO, 2013), and also in the use of teaching strategies and pedagogical resources that help the learning and/or inclusion of these students (FIORINI, 2011).

It is extremely important that the implementation of a resource in the school is accompanied by the student himself, after all, it is he who will enjoy the benefits of this technology, and who will be able to say if the resource is functional or not to his needs (ALVES; MATSUKURA, 2011; LOURENÇO, 2012). In addition, "understanding the context and situation of students with disabilities at school is fundamental for the prescription, construction, adaptation and implementation of assistive technology resources" (ROCHA; DELIBERATO; LAMÔNICA, 2012, p. 87).

Finally, some studies have pointed out obstacles that make it difficult to use AT in the school context. Calheiros, Mendes and Lourenço (2018) point out that a major barrier concerns the training of human resources to work with this technology, that is, teachers undergo ineffective initial training that does not qualify them for this universe. The authors also point out the vast proliferation of continuing education that seek to alleviate this gap. Psychological, motivational, aesthetic, social, environmental, economic and other factors are considered by Galvão Filho (2009) as limiting factors for the operationalization of AT at school. Fachinetti, Gonçalves, Lourenço (2015) emphasize that professional training can be an obstacle to the implementation of AT in the school context, and suggest that the collaborative partnership between the teacher and the researcher contributed to the implementation of AT resources in the school.

UDL and AT: conceptual and practical approximations and distances

The considerations made in the previous items allow us to conclude that the UDL is a theoretical approach that, through pre-established principles, seeks to provide subsidies to teachers so that teaching and curriculum are planned with all students in mind, while AT in the educational context seeks to promote individual solutions for a given student to have access to learning, either through the adaptation of a resource and/or a service.

It can be seen then that it is in this sense that a possible incompatibility between these two conceptions is speculated, after all, if the UDL starts from the premise that the same curriculum should be accessible to all, how to reconcile it with the AT, which will promote specific adaptations to each student?

The beginning of this discussion takes us back to the United States, where the Office of Special Education Programs (OSEP) financed the creation of two technology-focused study centers. The first is called the National Institute for Research in Assistive Technology (NATRI), at the University of Kentucky, and the second is called the National Center for Access to the General Curriculum (NCAC), in CAST (ROSE; ZABALA; HASSELBRING, 2005).

Rose, Zabala, Hasselbring (2005), in an article entitled "Universal Design for Learning and Assistive Technology: the two sides of the same coin", discuss that despite being different concepts, they do not compete with each other, and they do not need to be opposites, after all, both strands study ways to make education accessible to students with disabilities.

This means that the use of UDL precepts will not exclude TA support. We rescue here that the UDL concept inspires us to think about the curriculum, the environment, professionals and ways to make all knowledge accessible to all students (ROSE; MEYER, 2014). In other words, the focus is not on the student itself, but on the favorable environment to their learning. However, although at certain times the adaptations under the premises of the UDL can meet the educational needs of all students, it may be that, in another situation, it is necessary to use a specific AT to include a student in an activity.

An example of this is the use of a ball with a rattle for a visually impaired student to participate in an activity in physical education. From the UDL perspective, we think about how to adapt the environment, how to plan the class, provide multiple means of expression, as well as various strategies for all students to understand that task (ROSE; MEYER, 2014). However, even though we have planned all the items meticulously, it is essential that this student participates with a ball with a rattle, after all, he is deprived of visual information, and will be guided by auditory information. At that moment, the AT comes up with an adaptation so that the ball has a sound when rolling, for example, the ball is wrapped in a plastic bag, allowing the student to be guided by the noise. Although this adaptation arose from an individual need, it can be used by all students, therefore, it does not exclude the principles of the DUA, it only complements it.

Rose, Zabala and Hasselbring (2005) created a figure to exemplify the relationship between AT and UDL (Figure 1). It is noticed that both aspects aim to reduce barriers and can be used alone or together, which makes them complementary and not exclusive.

Figure 1 – Relationship between Assistive Technology and Universal Design for Learning

Tecnologia Assistiva = Assistive Technology / Desenho Universal para Aprendizagem = UDL / Reduzir barreiras = Reduce barriers
Source: Prepared by the authors – adapted from Rose, Zabala and Hasselbring (2005)

In this same perspective, Messinger-Willman and Marino (2010) discuss how the UDL can be used in conjunction with AT to increase educational opportunities for students with learning difficulties:

> TA and UDL rely on technology to improve the education of students with disabilities. However, TA is individual-specific, while UDL focuses on a holistic approach to curriculum development. Consider an example where a language arts teacher has a ninth grader in her class. When she sees the student's learning difficulties from the TA perspective, she considers how word prediction software can help that particular student respond to a written request. Looking through the UDL lens, she recognizes that barriers to learning reside in a curriculum that forces students to write responses by hand. She then changes the assessment so that the barrier no longer exists for any student, allowing all students to use the technology during their responses (MESSINGER-WILMAN; MARINO, 2010, p. 9).

Both adaptations made by the teacher, in this fictitious case, would be effective, both using the software individually and changing the way all students are evaluated. By concluding the study, the authors state that the use of AT within the precepts of the UDL contributed to improve the academic and social results of students with disabilities, but

emphasize that it is necessary for the teacher to be well oriented and instrumented to govern these adaptations (MESSINGER-WILMAN; MARINO, 2010).

For Alnahdi (2014), the development of AT, from the perspective of the DUA, makes it more functional in the school context. The author points to the UDL on the one hand as an alternative to modify the curriculum, making it more accessible to all, and the AT as a complement to this curriculum, with more specific adaptations.

Research recently published by Munster, Lieberman and Grenier (2019) aimed, through a case study, to describe the different approaches used by teachers to include students with disabilities in an early childhood school in New York. The thematic analysis identified three main approaches: (a) standardized instruction; (b) differentiated instruction; and (c) instruction based on UDL principles. The strategies most used by teachers were differentiated instruction (that adapted specifically for a student) and strategies based on the UDL. The authors concluded that both approaches are effective in accommodating students with disabilities in physical education classes.

Differentiated instruction (DI) addressed by the study explained in the previous paragraph, as well as AT, is a specific adaptation for each individual. However, Cast (2013) himself states that the UDL and differentiated instruction understand and recognize that each student is unique and variable, therefore, it offers the flexibility of a learning process that considers the needs of all (UDL) and all (DI) student. In this sense, the UDL would be a theory that offers subsidies to think about universal access to learning in a flexible way, that is, when necessary, differentiated instructions and assistive technology are welcome to collaborate with this learning.

Based on this theoretical scenario explained, in which research in the AT area shows technology as a functional educational tool to promote inclusion, as well as the principles of the UDL as functional for an education accessible to all, a table was prepared (Table 1) composed of the two strands for comparative purposes.

Table 1 – Comparison between UDL and TA precepts

	Universal Design for Learning	*Assistive Technology as an educational tool*
Goals	To promote universal access to curriculum and content; offer theoretical subsidies for the teacher to plan an education accessible to all.	To promote access to the school context, and specific activities, through adaptations that increase the functionality of students with some disability and/or limitation.
Proposal	It is assumed that the whole must adapt to the needs of students since each one learns differently..	It is concerned with promoting individual adaptations so that the student with difficulties can have access to content, curriculum and learning.
Adaptation	It parts from adapting the general to the specific.	It parts from adapting the specific to the general.
Considerations	The use of UDL does not exclude the use of AT, and vice versa. Just as there are times when no adaptation will be necessary, there are times when adaptations by the precepts of the UDL will be sufficient. In other activities, the AT adaptations will be complementary. Just as TA can be used alone successfully, or have the UDL theory as its precursor.	

Source: Prepared by the authors

Another alternative to think about and to be discussed is when the use of AT gains a universal character; this is a view defended by Almeida (2018, p. 31):

> The AT resource is designed for a specific need of the person with a disability and in a certain situation, but often, when used by other people, this resource can guarantee greater access in carrying out the activity, gaining a universal character.

The author developed a study whose objective was to analyze the implementation of AT resources for a student with cerebral palsy in the common class and its universal use. For this, a collaborative research was carried out, which was subdivided into four stages: initial interview with the teacher of the common class and educational agent, implementation/intervention with the AT resource through the universal design in the common classroom, evaluation of AT resources implemented in the common class and final interview to close the research with the common class teacher and educational agent. After performing a content analysis, the author indicated that:

> [...] the AT resources, along the lines of the universal design, were used in the common class and, in the opinion of the teacher and the educational agent, contributed to greater dynamics in the classroom and learning for all students (ALMEIDA, 2018, p. 8).

In line with this, Cizoto and Francisco (2017) carried out a systematic review of the literature with the objective of seeking AT resources that favor the DUA, "emphasizing where

they can have a concrete and beneficial intersection for the teaching-learning process" (CIZOTO; FRANCISCO, 2017). 2017, p. 7The authors searched the Scielo database combining the descriptors: Assistive Technology; Universal design for learning; School for all; Students with disabilities, and articles that dealt with AT in the educational context and that were written between the years 2010-2016 were selected. After analyzing the use of AT resources in the educational context in the selected articles, the authors concluded that:

> Finally, this research highlights that AT resources must be based on the premises of the DUA. The intersection of TA and DUA lies in the transformation of the entire school context (methodology, materials, assessments, among others), encouraging and promoting its transformation in a way that optimizes the inclusion of quality for all students, thus optimizing the process of teaching-learning, reducing school dropout and, effectively, contributing to the consolidation of the school with all, in a concrete way. This is the most effective way of enabling democracy and social justice in its broadest and most irreversible concept (CIZOTO; FRANCISCO, 2017, p. 17).

It is noticed that, although there is speculation of incompatibility between the concepts of the UDL and the AT, both can be used separately and also together to promote educational inclusion, because there is no "recipe" to promote inclusion, but rather it is necessary to look at the student, at his/her needs, and at the school context, in order to make possible the best theory to support the teacher's practice at a given moment.

Final considerations

Theoretical subsidies point out that both the UDL and the AT have been used within the school to favor access to the traditional curriculum, the proposed activities and learning. Although they are different approaches, both have consonant objectives: to promote educational inclusion. The fact of thinking about adaptations in different ways, with the UDL from the general to the specific, and the AT from the specific to the general, does not make the two aspects distinct or competitors, they only present teachers and professionals with different ways of promoting inclusion at school.

It is important to emphasize that both concepts can be used together to achieve the same goals, as well as they can be used separately and be effective: this is because each student will present a demand, which will be remedied according to their specificities. For example, a student who demands a flexible curriculum may benefit from the principles of the UDL, however, a student who needs a functional adaptation, such as an adapted pencil, will have his demand met by the AT.

It is suggested that practical research are carried out using these two precepts to promote educational inclusion; in this way it will be possible to verify how the two approaches can be used in consonance to reach the same final objective.

REFERENCES

ALMEIDA, R. C. G. O. **Universal Design for Learning and Assistive Technology:** implementation of pedagogical activities for students with cerebral palsy in regular classrooms. 2018. 208 f. Dissertation (Master in Special Education) – Federal University of São Carlos, São Carlos, 2018. Available at: https://repositorio.ufscar.br/bitstream/handle/ufscar/10449/ALMEIDA_Rita_2018.pdf?sequence=4. Accessed on: 02 Apr. 2021.

ALNAHDI, G. Assistive technology in special education and the universal design for learning. **The Turkish Online Journal Of Educational Technology 18**, Saudi Arabia, v. 13, p. 18-23, Apr. 2014. Available at: https://files.eric.ed.gov/fulltext/EJ1022880.pdf. Accessed on: 11 Jul. 2019

ALVES, A. C. J.; MATSUKURA, T. S. Perception of students with cerebral palsy about the use of assistive technology resources in regular schools.**Rev. Bras. Ed. Esp.**, Marília, v. 17, n. 2, p. 287-304, 2011.

ALVES, M. M.; RIBEIRO, J.; SIMÕES, F. Universal Design for Learning: contributos de uma escola para todos. **Indagatio Didactica**, Aveiro, v. 5, n. 4, p. 121-146, 2013. Available at: https://proa.ua.pt/index.php/id/article/view/4290/3224. Accessed on: 02 Apr. 2021.

BRAZIL. Constitution (1988). Constitution of the Federative Republic of Brazil. Brasília, DF: Federal Senate, 1988.

BRAZIL, **Salamanca Declaration, on principles and practices in the area of special educational needs.** Brasília, DF, 1994. Available at: http://portal.mec.gov.br/seesp/arquivos/pdf/salamanca.pdf. Accessed on: 10 May 2021.

BRAZIL. **Law no. 9,394/96, of December 20, 1996**. Establishes the guidelines and bases of national education. Available at: http://www.planalto.gov.br/ccivil_03/leis/l9394.htm. Accessed on: 10 May 2021.

BRAZIL. Ministry of Education. **National Policy on Special Education from the Perspective of Inclusive Education**. Brasília, DF: MEC, 2008. Available at: http://portal.mec.gov.br/arquivos/pdf/politicaeducespecial.pdf. Accessed on: 10 May 2021.

CALHEIROS, D.S.; MENDES, E. G.; LOURENÇO, G. F. Considerations about assistive technology in the Brazilian educational scenario. **Journal of Special Education**, Santa Maria, v. 31, no. 60, p. 229-244, Mar. 2018. Available at: https://periodicos.ufsm.br/educacaoespecial. Accessed on: 08 Jul. 2019

CAST, **Center for Applied Special Technology**. 2013Available at: http://www.cast.org/udl/. Access on: 15 Apr. 2018

CIZOTO, S.; FRANCISCO, J. Assistive Technology and Universal Design for Learning: where do they intersect**? Academic Journal: Teaching Science and Technology IFSP**, Cubatão, v. 1, no. 1, p. 1-19, Dec. 2017. Available at: https://intranet.cbt.ifsp.edu.br/qualif/volume01/ARTIGO01_15_ABNT.pdf. Accessed on: 02 Apr. 2021.

FIORINI, M. L. S. **Conception of the Physical Education teacher on the inclusion of students with disabilities.** 2011. 143 f. Dissertation (Master in Education) – Faculty of Philosophy and Sciences, São Paulo State University, Marília, 2011.

GALVÃO FILHO, T. A. **Assistive Technology for an Inclusive School:** Appropriation, Demands and Perspectives. 2009. 346 f. Thesis (Doctorate in Education) – School of Education, Federal University of Bahia, Salvador, 2009.

HOHMANN, P.; CASSAPIAN, M. R. Low-cost adaptations: a literature review of use by Brazilian occupational therapists. **Rev. Ter. Ocup. Univ**., Sao Paulo, v. 22, no. 1, p. 10-18, Jan./Apr. 2011.

LOURENÇO, G. F. **Evaluation of a training program on high assistive technology resources and schooling.** 2012. 258 f. Thesis (Doctorate in Special Education) – Center for Human Sciences, Federal University of São Carlos, São Carlos, 2012.

MANZINI, E. J; DELIBERATO, D. **Portal of technical aids for education, equipment and pedagogical material for education, training and recreation of people with disabilities adapted pedagogical resources II.** 1. ed. Brasilia, DF: MEC/ABPEE, 2007.

MASSARO, M.; DELIBERATO, D. Use of supplementary and alternative communication systems in Early Childhood Education: teacher's perception. **Journal of Special Education**, Santa Maria, v. 26, no. 46, p. 331-350, May 2013. Available at: https://periodicos.ufsm.br/index.php/educacaoespecial/article/viewFile/4821/pdf. Accessed on: 23 Apr. 2021.

MESSINGER-WILLMAN, J.; MARINO, M. T. Universal Design for Learning and Assistive Technology: Leadership Considerations for Promoting Inclusive Education in Today's Secondary Schools. **Nassp Bulletin**, v. 94, n. 1, p. 5-16, 2010.

MUNSTER, M. A.V.; LIEBERMAN, L. J.; GRENIER, M. A. (Universal Design for Learning and Differentiated Instruction in Physical Education. **Adapted Physical Activity Quarterly**, p. 1-21. jun. 2019.

NELSON, L. L. **Design and deliver**: planning and teaching using universal design for learning. Paul. H. Brookes Publishing Co., 2014. 115 p.

O, A. P. **Universal design for learning from the perspective of school inclusion**: potential and limits of collaborative training. 2018. 298 f. Thesis (Doctorate in special education) – Federal University of São Carlos, São Carlos, 2018.

ROCHA, A. N. D. C.; DELIBERATO, D.; LAMÔNICA, D. A. C. Assistive technology for children with cerebral palsy at school: identification of needs. **Brazilian Journal of Special**

Education, Marília, v. 18, no. 1, p.71-92, Mar. 2012. Available at: https://repositorio.unesp.br/bitstream/handle/11449/117885/S1413-65382012000100006.pdf?sequence=1. Accessed on: 08 Jul. 2019

ROSE, D. H.; MEYER, A. **Teaching every student in the digital age**: Universal design for learning. Alexandria: ASCD, 2014.

ROSE, D.; ZABALA, J.; HASSELBRING, T.S. Assistive Technology and Universal Design for Learning: Two Sides of the Same Coin. **Handbook Of Special Education Technology Research and Practice**, p. 507-518, 2005. Available at: https://www.semanticscholar.org/paper/Assistive-Technology-and-Universal-Design-for-%3A-Two-Rose-Hasselbring/4506ed4fc568cc1640fa48b777a296f730f1c1a1. Accessed on: 08 Jul. 2019

SEABRA JUNIOR, M. O. **Teaching strategies and pedagogical resources for teaching visually impaired students in adapted physical activity.** 2008. Thesis (Doctorate in Education) – School of Philosophy and Sciences, São Paulo State University, Marília, 2008.

TOYODA, C. Y.; LOURENÇO, G. F. Inclusive Education: the context of occupational therapy. In: ALMEIDA, M. A.; MENDES, E.G.; HAYASHI, M.C.P.I. (Org.). **Themes in special education: multiple perspectives**. Araraquara: Junqueira and Marin, 2008. p. 44-52.

UNESCO. **Accountability in education**: meeting our commitments. Paris: 2018. Available at: https://en.unesco.org/gem-report/report/2017/accountability-education. Accessed on: 19 Apr. 2020

VALENTINE, C. B; GOMES, R. B; BISOL, C. A. Inclusion of students with intellectual disabilities: a systematic literature review. **Revista Teias**, v. 17, no. 46, Jul./Sep. 2016. Available at: https://www.e-publicacoes.uerj.br/index.php/revistateias/article/viewFile/25502/18552. Accessed on: 28 May 2019.

How to reference this article

OLIVEIRA, A. R. P.; GONÇALVES, A. G.; BRACCIALI, L. M. P. Universal design for learning and assistive technology: complementary or excluding? **Revista Ibero-Americana de Estudos em Educação**, Araraquara, v. 16, n. esp. 4, p. 3034-3048, Dec. 2021. e-ISSN: 1982-5587. DOI: https://doi.org/10.21723/riaee.v16iesp.4.16066

Submitted on: 08/05/2021
Revisions required on: 10/30/2021
Approved on: 12/10/2021
Published on: 12/30/2021

Management of translations and versions: Editora Ibero-Americana de Educação
Translator: Thiago Faquim Bittencourt Lattes
Translation reviewer: Alexander Vinícius Leite da Silva