Universal Design for Learning and Assistive Technology: a Literature Review on the Inclusion of People with Disabilities in Higher Education

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ABSTRACT

The study presents an integrative review of the literature on the use of Universal Design for Learning - UDL and Assistive Technology - AT in Higher Education, especially in the field of Inclusive Education. The main objective of the study was to carry out a survey of national research, referring to the use of UDL and assistive technology in higher education that facilitate the inclusion of students with disabilities. The studies were collected in the Scientific Electronic Library Online - Scielo, Brazilian Digital Library of Theses and Dissertations - BDTD from 2015 to 2021. The consultation initially resulted in 13 studies, but after applying exclusion criteria referring to studies that were not specific to higher education, five studies were considered relevant to compose the final sample. The publications were analyzed with the aim of evaluating the following aspects of production: i) objective; ii) theoretical perspective; iii) methodology; and iv) results and evidence found. After analyzing the collected data, and verifying the detailed results in the researched studies, as result of the research, the integration of UDL with AT can be considered as an inclusive interdisciplinary practice in the context of higher education. Thus, UDL associated with AT in the construction of content for Higher Education presents results that facilitate the promotion of the inclusion and permanence of students with disabilities.

KEYWORDS: Inclusive Education. Accessibility. School Inclusion. Pedagogical Practices.

INTRODUCTION

This article is part of the work presented in the VII SINECT – Simpósio Nacional de Ensino de Ciência e Tecnologia (National Symposium on Science and Technology Teaching) in 2022. We analyzed results of studies addressing the use of Universal Design for Learning (UDL) and Assistive Technology (AT) for disabled individuals in higher education.

Technological and scientific productions have promoted changes in society, where the use of computing, its services and products, occurs in most of the everyday activities. This can be considered an important resource in the promotion of access to information and inclusion.

The Brazilian Law for the Inclusion of Disabled Persons (Statute of the Disabled Persons) (BRASIL, 2015) secures in equal conditions, the exercise of fundamental rights and freedom by disabled people, aiming at their social inclusion and citizenship. Thus, thinking technology as a resource for inclusion means thinking about promoting access to information to every individual, mainly in the education field and, more than that, to provide appropriation of scientific knowledge. This includes considering learners who are inserted in the education system and how they develop their experiences in the education context.

The Salamanca Statement of 1994 (UNITED NATIONS, 1994), marked the start of discussions in the inclusive education perspective, defending that everyone should attend regular schools, have access and appropriate the knowledge taught in them. It motivated the reformulation of the Brazilian Law of Guidelines and Bases for Education (LDBEN, Brazilian Portuguese for Lei Brasileira de Diretrizes e Bases), Law nº 9,394 of 1996 (BRASIL, 1996), which confirmed what had been proposed by the Federal Constitution (BRASIL, 2016) currently, with a perspective closer to inclusion. The LDBEN 9.394/96 (BRASIL, 1996) proposes that disabled people must have access to regular schools and, therefore, the institutions must adjust their action by means of a pedagogy focusing individuals and catering for their needs. It places Special Education in the category of school education modality, pursuant to Art. 58, whose wording was amended by Law nº 12,796/2013:

> Art. 58. Special education, for the purposes of this Law, is the school education modality that is preferably offered by the regular education network, to disabled learners, those who present global development disorders, and high abilities or gifted individuals (BRASIL, 1996).

With the appearance of the inclusion movement, regular schools were ascribed the function of teaching scientific knowledge and promoting access and appropriation of such knowledge by disabled students. In this way, Special Education started to be a modality of complementary and supplementary service to that of the regular teaching, thus reaching all levels of schooling, including higher education (BRASIL, 1996).

In the evolution of legal norms and broadening the conception of Inclusive Education, in 2008, the National Policy for Special Education in the Inclusive Education Perspective (BRASIL, 2008) was approved. This policy aims at "securing school inclusion to students with disabilities, global development disorders, and high abilities/gifted individuals" (BRASIL, 2008, p. 14).

Regarding normative and legal acts related to accessibility and inclusion in higher education, Cantorani *et al.* (2020) pointed out that in 2004, by means of Decree nº 5,296/2004 (BRASIL, 2004), the Ministry of Education - MEC provided for the need for architectural accessibility in all environments and to all academic community, and since 2006, MEC seeks to standardize ways of making higher education institutions suitable to cater for the rights of disabled persons.

The law comprises a set of definitions about different types of accessibility (BRASIL, 2015), as follows:

• **Architectural accessibility**: no physical barriers in homes, buildings, urban spaces, urban equipment, and individual or collective means of transportation;

• **Attitudinal accessibility**: absence of barriers imposed by prejudice, stigma, stereotypes and discrimination;

• **Communication accessibility**: absence of barriers for interpersonal communication, written communication, and virtual communication (digital accessibility);

• **Instrumental accessibility**: absence of barrier instruments, utensils, and tools used to work, study, leisure, recreation and activities of daily life;

• **Program accessibility**: aiming to eliminate existing barriers in the law, ordinances, decrees, regulations and norms that prevent access to information, knowledge, and the application of actions and public policies promoting the inclusion of disabled students;

• **Methodological accessibility**: absence of barriers in teaching/learning methods, theories, and techniques of work and community action (social, cultural, and artistic, among others);

• **Transport accessibility**: aims to promote easier and safe access to public means of transportation;

• **Digital accessibility**: aims to eliminate barriers that might prevent access to digital communication, either physical access difficulties in certain places, and in relation to equipment and programs, as well as the presentation of content and information in inaccessible formats.

Both inclusion and accessibility in higher education can be considered recent themes, that is, they are translated in equal opportunities, via interaction between individuals with and without disabilities, with full access to the resources available, as described by Silva and Nascimento (2021). This means that the curricula offered must promote conditions for the access and appropriation of knowledge taught in universities, and the progression in studies must occur in the same pedagogical process. However, such actions appear as great weaknesses in the teaching practice, since they require different teaching methods, different resources, time organization, pedagogical support, and specific knowledge, among others.

For this reason, rethinking the actions developed in higher education is necessary to secure the inclusion of individuals with disabilities at this level of education. It requires rethinking models, objectives, teaching methodologies, curriculum flexibilization, inserting and using technologies to help disabled students' learning, and developing new designs to foster their learning.

Thus, to develop subjects that promote learning, teaching must be meaningful for the students, as emphasized by Vigotski (2001), to develop higher psychic functions such as the abstract thinking, concept formation, free will, and logic memory. When considering disabled people, the focus is not exclusively on the organic origin of their disability, but rather on their cultural development process, with appropriation of abilities such as oral and written communication.

In the cultural-historical or social-interactionist perspective defended by Vigotski in his work Defectology (VIGOTSKY, 2011), the disabled people's development and education, in the perspective of biological limitation, might impose limits to the adaptation of the individuals to the environment. However, the same limits might be self-motivating so that the functional limitation can be overcome with sensorial stimuli coming from the disability, or via external social stimuli, called "social compensations" (VIGOTSKI, 2011, p. 863).

Taking that into consideration, creating differentiated resources and methodologies that enable students with disabilities to have access and appropriate the knowledge taught in higher education can be considered inclusion.

In such perspective, inclusion

> [...] represents the advancement towards equality of rights among individuals in society. It entails the extension, to all, of the right to integrate and take part in all dimensions of social environments, without suffering any kind of discrimination or prejudice (CANTORANI et al., 2020, p. 3).

Facing the challenge of transforming the classroom into an inclusive environment, LUD principles can be considered a possibility to provide more meaningful and equal learning among higher education students.

LUD originated from the UD (universal design), a concept developed by architects in 1970 aiming to making people's lives simpler by means of designing environments and products targeting the largest number of people, without the need for future adjustments (SEBASTIÁN-HEREDERO, 2020). Years later, in 1984, this conception influenced a group of researcher professors at the newly created *Center for Applied Special Technology* (CAST), led by Anne Meyer and David Rose, in the investigation of a possible answer to the challenge faced by professors dealing with more and more heterogeneous classes, with high learning expectations, and resulted in the UDL conception (MENDES, 2017).

Therefore, UDL is a set of principles (multiple means of engagement, multiple means of representation, and multiple means of action and expression) and strategies that involve curricular development, thus reducing barriers in the teaching-learning process by means of professors' actions in the creation of teaching aims, materials and suitable assessment for all students, focusing on the pedagogical dimension of the activity (NUNES; MADUREIRA, 2015).

When allied to the inclusion concept, UDL offers conceptual and concrete material with possibilities of new ways of teaching, with real benefits to the teaching practice and its inclusive constitution (PLETSCH; SOUZA; ORLEANS, 2017).

In the same perspective, Bersch (2017) advocated that the term Assistive Technology - AT should be employed to describe a broad set of resources and services that play a fundamental role in the increased functional abilities of

disabled individuals. Thus, becoming an essential contribution to favor the inclusion of those people in society since AT make several activities possible.

For this reason, in the AT evolution, fundamental principles such as UDL, accessibility and usability must be considered since those concepts are vital to secure that AT is inclusive and accessible to all users, regardless of their abilities or needs.

According to Zerbato and Mendes (2018, p. 150), studies carried out by Meyer and Rose based on the investigation of "the three large brain cortical systems involved in learning, namely, knowledge, strategies, and affective networks", corresponded to the principles of Vigotski's (2001) theory on the recognition of the information to be learned, the use of strategies to process such information, and the engagement with the learning task.

Following this reasoning, the Brazilian Law for the inclusion of Disabled Persons (BRASIL, 2015) considers UDL as the conception of products, environments, and services to be used by all persons, without needs for accessibility, or specific projects, including AT resources.

Therefore, UDL use enables everybody's access to curriculum, regardless of their conditions, respecting students' particularities, from the use of differentiated pedagogical/teaching and or technological strategies, including AT (PLETSCH, 2020). LUD expresses a concern with the development of education practices and strategies aiming at the plurality of subjects, so that both disabled students and the community as a whole can benefit from the UDL use.

As regards access, permanence, accessibility, and success of persons with disabilities in higher education, inclusive practices such as recognition and appreciation of differences to promote access to its spaces and the construction and socialization of knowledge can be considered delayed (VIGENTIM, 2014).

Considering these characteristics, the challenge posed to the current higher education, includes the articulation of access democratization, mainly for disabled persons, thus guaranteeing appropriation of knowledge desired for their professional future.

Zerbato and Mendes (2018) proposed that when education inclusion is aimed at, curriculum adjustments and flexibilization are needed, to properly cater for the needs of the group of people that requires differentiated teaching support.

Therefore, higher education institutions must become more inclusive, which implies not only securing access, but also full conditions of participation and learning to all students (SANTOS; FUMES, 2012, p. 122). An inclusive university respects the human rights issue and secures the right to education to young people enabling access to all.

Taking all that into consideration, this research aimed to analyze, by means of an integrative review of national research, UDL and AT contributions to the processes of access, permanence, and inclusion of disabled people in higher education.

MATERIAL AND METHODS

The survey and cataloguing of the scientific production have become essential tools for research in the most diverse areas of knowledge as elements that seek to identify, know, and understand what is being produced by researchers in the country. Integrative review is a research method that aims at synthesizing and integrating the existing knowledge on certain theme, by combining data of experimental and non-experimental studies, both theoretical and empirical. (Souza *et.* al, 2010, p. 103).

To understand how UDL favors the inclusion of disabled people in higher education, an integrative survey was carried out referring to the use of LUD along with AT resources. This aimed to assimilate the contributions of the UDL and AT use as promoters of accessibility and inclusion in higher education.

The research question was "What are the UDL and AT contributions to the process of including disabled persons in higher education"? To answer this question, an integrative review of the national literature was carried out by accessing academic productions, theses and dissertations, made available in the Catalogue of Theses and Dissertations by Capes and the Brazilian Digital Library of Theses and Dissertations – BDTD (Brazilian Portuguese, Biblioteca Digital Brasileira de Teses e Dissertações) between 2015 and 2021. The period was based on the date of publication of the Brazilian Law for the Inclusion of Disabled Persons (BRASIL, 2015), approved in 2015.

The following keywords were used: "Universal Design for Learning - UDL", "Higher Education", "Inclusive Education", and "Assistive Technology", and the following textual aspects were adopted to evaluate the studies found in the search: 1) Objective; 2) Theoretical Background; 3) Methodology; and 4) Results and Evidence found.

Aiming to validate the search keywords, each one was searched in isolation, which resulted in 9,030 articles in the Capes webpage and in the Digital Library of Theses and Dissertations – BDTD. The validation was carried out to verify the existence of studies including the keywords selected for the research question.

Next, using the connector *AND*, and all the descriptors, 13 studies were found for analysis for meeting the requirements of our proposal. The exclusion criterion was the absence of the keywords according to the descriptors.

After reading the abstracts of the thirteen publications, eight articles were excluded for not matching the objective of this study since they focused on basic education. Therefore, five articles were analyzed for addressing the research question focusing on higher education (Chart 1):

Chart 1 – Articles analyzed according to the research proposal

Title	Author (Year)	Category	HEI
Inclusive education for undergraduates in the education course: pedagogical actions based on universal design for learning	Prais (2016)	Human, Social and Natural Sciences Teaching Professional	Federal Technological University of Paraná – Londrina

Title	Author (Year)	Category	HEI
		Master's Program.	
Validation of teaching material for visually impaired individuals: joint construction between users and designers	Turino (2019)	Production Engineering Master's Program	Federal University of São Carlos
Anatome: Modeled anatomy teaching and learning for all	Ferreira (2019)	Computing Doctoral Program	Federal University of Paraná
So that everyone can see through words: elaboration of assistive technology and database of audio-description digital objects following the universal design principle (boca-rep)	Silva (2018)	Education Master's Program	Federal University of Grande Dourados
Good accessibility practices in higher education: assistive technology and universal design	Ricardo (2017)	Education Master's Program	Federal University of juiz de Fora

Source: Research data (2022).

The next section presents the analysis of the articles regarding their objectives, theoretical background, methodology, results and the evidence found.

RESULTS AND DISCUSSIONS

The studies found included bibliographic, field and applied research. First, the articles were analyzed regarding their objectives (Chart 2).

The review carried out in this study reinforced the UDL and AT integration as an inclusive practice in higher education, thus promoting greater interaction, communication, adaptability, and integration in the teaching-learning process.

Chart 2 – Objectives of the studies analyzed

Author (Year)	General Objective	Study Object
Prais (2016)	To interpret the contributions from the application of a teaching unit (aiming at qualifying professors for inclusion related to planning teaching activities based on the Principles of Universal Design – education product) in a university outreach course with 40 students of the education undergraduate course.	A university outreach course aimed at the qualification of professors in the education course, focusing on planning inclusive teaching activities.
Turino (2019)	To validate prototypes of teaching	Implementation of inclusive

Author (Year)	General Objective	Study Object
	material for visually impaired individuals, aiming at improving the students' development.	teaching practices in public and private schools, using Assistive Technologies as the main resource.
Ferreira (2019)	To identify and model Technologies to favor disabled students' autonomy in anatomy learning, using the same technology as those used by other students.	The impact of Assistive Technologies on inclusive teaching practices in a Brazilian University.
Silva (2018)	To develop free digital and social technology to disseminate the practice of using universal design principles, whose products must be affordable to individuals with disabilities and those without them. To elaborate a prototype of a database of audio-description production and collaboration, to multiply this production capacity by means of pedagogical processes and materials and make available for free the contents produced in a database of a portal (BOCA-web) and an App for Smartphones (BOCA-app)	The development and implementation of a database and an audio-description application based on the Universal Design principles.
Ricardo (2017)	To provide proposals of good accessibility practices based on Assistive Technology and Universal Design, aiming to support professors' work on the students' education and engagement in a contemporary university.	The professors' and students' perceptions of the efficacy of inclusive practices mediated by Assistive Technologies in a higher education institution.

Source: Research data (2022).

In general, the objectives described by the researchers showed similarities since they all sought to introduce products developed with the use of UDL and AT.

The study by Prais (2016) analyzed the contributions of applying a teaching unit according to UDL, while the work put forward by Ricardo (2017) identified good practices developed by accessibility centers in higher education that could contribute to the professors' work.

The studies developed by Turino (2019), Silva (2018) and de Ferreira (2019) aimed to create a product, either a prototype, digital resource, or application, based on UDL to improve teaching the possibilities of education inclusion. Those

articles agree with the premises of the systemic survey of relevant works to be included in this study, that is, those focusing on higher education.

The studies dedicated to the promotion of inclusion and accessibility in the higher education environment addressing from the educators' qualification to apply inclusive principles in teaching to the development of specific assistive technologies. They reported valuable points and practical strategies to overcome the challenges of inclusive education, emphasizing the importance of accessibility and inclusion as the fundamental pillars for the development of that kind of education.

Next, the studies were analyzed regarding the theoretical background as follows (Chart 3):

Chart 3 – Theoretical background of the productions analyzed

Author (Year)	Theoretical Background
Prais (2016)	Several authors supporting the investigation axes including Rodrigues (2006) and Mantoan (2011; 2015) for a better understanding of inclusion; Glat; Pletsch, 2010, Vitaliano, 2010 and Soares, 2010 for inclusive educators' qualification; Cast (2011), Meyer, Rose and Gordon (2002) and Bersch (2013) for Universal Design for Learning
Turino (2019)	Cultural-Historical Activity Theory (CHAT) (VIGOTSKI, 1997); Cerqueira and Ferreira (2000) Medeiros (2007) for inclusion; Bersch (2013) for Assistive Technology; Cast (2014), Nunes and Madureira (2015) for Universal Design for Learning
Ferreira (2019)	MEYER; ROSE; GORDON (2014), CAST (2011), for Universal Design for Learning. Scholars discussing visual impairment, virtual and augmented reality technologies (MÉNDEZ et al., 2014, 2016).
Silva (2018)	Mueller (1973) for Theory of Blocked Communication, Campos and Mello (2015), Rose (2005) for Universal Design for Learning, Montoan (2010) for Inclusive Education, Sartoretto and Bersch (2017) for Assistive Technology
Ricardo (2017)	Several authors discussing accessibility and inclusion - Cunha, Sassaki, Silva, Mazzotta, Manzini, Montoan, etc. Galvão Filho, Bersch, Sassaki, etc. for Assistive Technology; Rose and Meyer, Burgstahler, Davies, and Gordon, among others for Universal Design.

Source: Research data (2022).

In addition, considering the theoretical background analysis, the studies adopted epistemological pluralism to explain the complex nature of teaching and education, seeking in several areas, a substantial body of knowledge to answer the problems addressed. The articles by Prais (2016), Ricardo (2017) and Ferreira (2019) used the following research descriptors: Inclusive education/Special education, Assistive Technology and Universal Design for Learning. The works by Turino (2019) and Silva (2018) were supported by other epistemological conceptions since Turino (2019) based his research on the Cultural-Historical Activity Theory – CHAT by Vigotski; while Silva (2018) sought support in the Theory of Blocked Communication by Müeller.

Therefore, the articles included show commitment to inclusive education, accessibility and the use of innovative technologies and teaching practices to cater for the needs of all students. The UDL use as a guiding line in several studies confirms its relevance as a fundamental strategy to promote effective inclusion in educational practices.

All studies addressed inclusive education as the central theme, highlighting the importance of creating accessible and inclusive learning environments for all students, mainly those with disabilities.

The studies were also analyzed regarding the research methodology employed to collect data, as follows (Chart 4):

Chart 4 – Methodology of the studies analyzed

Author (Year)	Methodology
Prais (2016)	Collaborative field research, development and use of an education product, data collection and analysis.
Turino (2019)	Bibliographic and participant research, identifying necessary characteristics, exploratory visits, 3D material elaboration, teaching, technical, and final validations.
Ferreira (2019)	Applied research. Elaboration of models and requirements for accessible technology, evaluation of models and requirements, and implementation and assessment of prototypes. Modeling of the anatomy teaching and learning process supported by accessible interactive technologies and the Anatome architecture, thus integrating the technologies identified for the subject teaching and learning.
Silva (2018)	Applied research supported by social research, inclusive education, and democratic access technology methodologies. The dissertation proposed, by means of collaborative networks, to elaborate a prototype of a database of audio-description production and collaboration, to multiply the production capacity by means of pedagogical processes and subjects, and make it available for free in a database using the portal (BOCA-web) and a smartphone App (BOCA-app).
Ricardo (2017)	Supported by the French Discourse Analysis, references were built up based on dissemination corpus, objectives and action of the universities' accessibility center, to compare with disabled students' reports. The aim was to obtain a broader view to identify ways for the good practices and the need for heterogeneous education from a curriculum change.

Source: Research data (2022).

Regarding the methodology employed, the studies revealed the use of field and/or applied research. The works by Prais (2016), Silva (2018) and de Ferreira (2019) included the development of a product, its application and assessment of its contribution to the learning process of disabled students. The studies by Ricardo (2017) and Turino (2019), also highlighted the importance of elaborating a product. However, its application was not directly tested with students since it occurred via assessment of the prototype by an evaluation team or by the members responsible for the higher education institution accessibility center.

The analysis of the methodologies employed in the studies mentioned revealed a convergence toward inclusive education and accessibility, based on diversified and complementary approaches. Synergy between collaboration and

participation was observed, evidencing the importance of the direct involvement of all participants in the creation and evaluation of the education solutions. The incorporation of technology and innovation in the projects confirms the role of technology in overcoming educational barriers and thus paves the way for inclusive and accessible education.

All studies used qualitative methodologies such as interviews, questionnaires, participant observation, and document analysis to collect and analyze the data. This indicates that the approach used focused on the understanding of the participants' experiences and perceptions.

Finally, the reports were analyzed regarding the results found (Chart 5) as follows:

Chart 5 – Results reported in the studies analyzed

Author (Year)	Results found
Prais (2016)	The adaptability of the resources used favored sharing and discussions between the participants and the professor, as well as learning access, to enable the organization of a formative teaching action in an inclusive perspective. It also led the participants to use such knowledge in an inclusive teaching practice. Allied to the teaching strategies based on the UDL principles, we identified that the use of technological teaching resources - such as ICT – favored the access to learning and optimized the possibilities of the teaching of contents proposed throughout the course.
Turino (2019)	The resources assessed were considered by users, who were learning mediators, offering by means of touch, the concretization of the teaching objectives proposed. Future studies should be carried out to develop and project a reliable and validated assessment instrument, which enable professors to implement quality teaching in their daily practices, thus achieving the central aim of inclusive teaching.
Ferreira (2019)	The result of the prototype assessment was positive and suggested improvements in further studies. The implemented prototypes can already support learning of visually impaired and blind students, as well as those without disabilities. If the research is furthered, they might favor the autonomy of students with other disabilities or specific needs, with the implementation of modules focusing the accessibility of other groups of users.
Silva (2018)	The elaboration of a strategy of insertion of the universal design principle in the development of information and communication technologies in the phases of elaboration and development, and the development of a database of audio-description digital objects, incorporating the principle of universal design in formatting objects and in the database architecture were the results of the study.
Ricardo (2017)	The proposals showed that although Assistive Technology and Universal Design are different, they are also complementary and present some similarities. They are both important for accessibility since they convey the conception that all realities, all environments, and all resources in

| | society must be created, and designed aiming at participation, and all individuals' use and access. |

Source: Research data (2022).

As regards results reported by the authors, Prais (2016) evidenced the importance of proposing an outreach course for professors using UDL to favor discussions and motivate the participants to propose activities to their students following the methodology supported by UDL.

Turino (2019) tested the efficiency of the material developed, elaborated from the UDL propositions and concluded that the product's responses were significant, since they validated the prototypes of teaching material to be used by visually impaired individuals. However, he recommended further studies to design an assessment instrument for the teaching material he introduced and validate its use with a broader group. In addition, he based his analyses on this theoretical perspective, but his study was restricted to testing the teaching materials, without a more consistent implementation.

Ferreira (2019) assessed his prototype and concluded that the product developed and implemented could support visually impaired as well as blind students, and those without disabilities, and that further studies should focus on broadening the group of users. Silva (2018) reported the creation of a database of audio-description digital objects, which can be shared and is at the same time collaborative, thus enabling professors with resources to implement in their classrooms. Finally, Ricardo (2017) pointed out that his study contributed to the identification of solutions by accessibility centers, which might help those working in the inclusive education area.

The results of the studies included in this research highlighted significant advances in the inclusive education and accessibility fields, thus emphasizing the efficacy of adapted teaching and technological strategies. The study by Prais (2016) observed that the adaptability of resources and the use of strategies based on UDL optimized learning access and improved the teaching practice in an inclusive perspective. The study published by Turino (2019) reported that the validation of the teaching material for visually impaired individuals revealed the importance of touch in the learning mediation and suggested the need for the development of reliable evaluation instruments to implement quality inclusive teaching. The study by Ferreira (2019) showed that the prototypes developed to teach anatomy supported effectively the leaning process of visually impaired and blind students, as well as those without disabilities, thus indicating ways to further improvement aiming at the autonomy of learners with varied needs. The elaboration of AT and an audio-description database following the UDL principle, evidenced the viability of incorporating such principles from the initial phase of the development of information and communication technologies. Lastly, the analysis of good practices of accessibility in higher education highlighted the complementarity between AT and UDL and emphasized the importance of both in the creation of accessible and inclusive environments to all individuals.

The studies converged in the inclusive education approach, thus emphasizing the importance of UDL and AT. All studies recognized the need for professors' continuing education for inclusion. They also used qualitative methodologies to explore the participants' experiences.

Despite presenting the same approach, they varied in the application contexts, theoretical background, and results for showing diverse approaches and focus within the inclusive education field.

Therefore, the analysis of the studies selected enabled the understanding that the use of UDL in the preparation of teaching materials promoted a process of inclusion of disabled students, as observed in Prais (2016) and Turino (2019). However, as reported by Turino (2019), the AT use must be consolidated in the context of preparation of teaching material that is essential to the contents taught since this practice is not usual.

CONCLUSION

This literature review reinforced that according to the studies analyzed, the integration of UDL and AT is a possibility to be strongly considered for the inclusive interdisciplinary practice, mainly in the higher education context.

The analysis of the points highlighted in the charts of section 3 reveals the importance of advancements in those fields, thus emphasizing the promotion of inclusion and accessibility, pedagogical and technological innovation, collaboration, the efficacy of adaptive strategies, and opens a path for further research and practices. Such aspects represent the progress and challenges faced in the search for education practices to cater for all needs, thus showing how the application of UDL and AT development are fundamental in this process. Therefore, the emphasis on active participation and collaboration between researchers, educators, and users, and the importance of creative approaches for effective and inclusive solutions becomes clear.

The studies analyzed demonstrated that the use of such technologies strengthened the teaching-learning process for guaranteeing greater interaction, communication, adaptability, and integration. For example, Prais (2106) presented results obtained by using the *webquest* and *podcast* as teaching resources, and that *webquest* provided clarity for the achievement of the tasks proposed. Moreover, the task assessment obtained 94% (ninety-four per cent) of the students reporting to be 'very satisfied' and 'satisfied' with their performance when developing the task.

The use of UDL along with AT, mainly in higher education, obtained satisfactory results as described in reports by Prais (2016), Silva (1028) and Turino (2019). The review carried out in this study evidenced that the research analyzed suggested that UDL and AT promoted the inclusion of disabled students in higher education. However, some gaps were observed in those studies, mainly, regarding professors' education to teach technological subjects, as for example, the methodological plan and the preparation of teaching resources targeting visually impaired students.

A direct and significant relationship between the results of the studies analyzed and the Brazilian law was observed in relation to inclusion policies. The Brazilian law has evolved to guarantee the rights of disabled individuals, thus promoting inclusion and accessibility at all levels of education, including higher education. The analysis of the studies confirmed that the application of UDL and AT principles agrees with the legal guidelines and national policies.

The studies analyzed explored several theoretical lines to base their investigations on inclusive education and the use of assistive technologies. The study by Silva (2018) is based on the theory of blocked communication by Clauss Mueller, thus emphasizing the importance of assistive technologies and UDL for the inclusion of visually impaired individuals. Ferreira (2019) also supported his studies on UDL and focused on the creation of accessible learning environments and professors' qualification, as discussed by Glat and Pletsch. The study by Turino (2019) adopted the inclusive education and UDL theories and emphasized assistive technologies as teaching mediators. Prais (2016) used the UDL principles to discuss the organization of the education system to cater for the needs of all students. Finally, Ricardo (2017) employed the sociocultural theory by Vigotski to analyze the social interaction and mediation occurring in the learning process of students with special needs. He also supported his discussion on Glat and Pletsch theories about professors' education and the use of assistive technologies.

Furthermore, the existence of a specific research field on professors' education was confirmed. Such qualification would contribute to the learning of assistive methodologies aimed at the inclusion of students, to provide access to academic knowledge in a planned way according to its demands. Therefore, this study confirmed that there is still room for contributions to the consistent depth of this research field, mainly, regarding the promotion of digital competencies in the education of future professors.

DESENHO UNIVERSAL DA APRENDIZAGEM E TECNOLOGIA ASSISTIVA: UMA REVISÃO DE LITERATURA SOBRE A INCLUSÃO DE PESSOAS COM DEFICIÊNCIA NO ENSINO SUPERIOR

RESUMO

O estudo apresenta uma revisão integrativa da literatura sobre o uso do Desenho Universal da Aprendizagem – DUA e da Tecnologia Assistiva - TA no Ensino Superior, em especial, na Educação Inclusiva. O estudo objetivou realizar um levantamento das pesquisas nacionais, referente à utilização do DUA e TA no ensino superior que contribuam para o acesso, permanência e inclusão da pessoa com deficiência. Os dados foram coletados nas bases *Scientific Eletronic Library Online* – Scielo e Biblioteca Digital Brasileira de Teses e Dissertações – BDTD, no recorte temporal compreendido entre e 2015 a 2021. A consulta resultou incialmente em 13 trabalhos, entretanto, após a aplicação de critérios de exclusão, entre eles, trabalhos não específicos para o ensino superior, foram considerados para análise cinco trabalhos para compor a amostra final. Foram avaliados os seguintes aspectos textuais: i) objetivo; ii) perspectiva teórica; iii) metodologia; e iv) resultados e evidências encontradas. Após a análise dos dados coletados e verificação dos resultados detalhados nos trabalhos pesquisados, constatou-se que a integração do DUA com TA pode ser considerada como prática interdisciplinar inclusiva no contexto do ensino superior. Assim, o DUA, associado à TA na construção de conteúdo para o Ensino Superior, apresenta resultados que facilitam a promoção da inclusão e permanência de alunos com deficiência.

PALAVRAS-CHAVE: Educação Inclusiva. Acessibilidade. Inclusão Escolar. Práticas Pedagógicas.

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