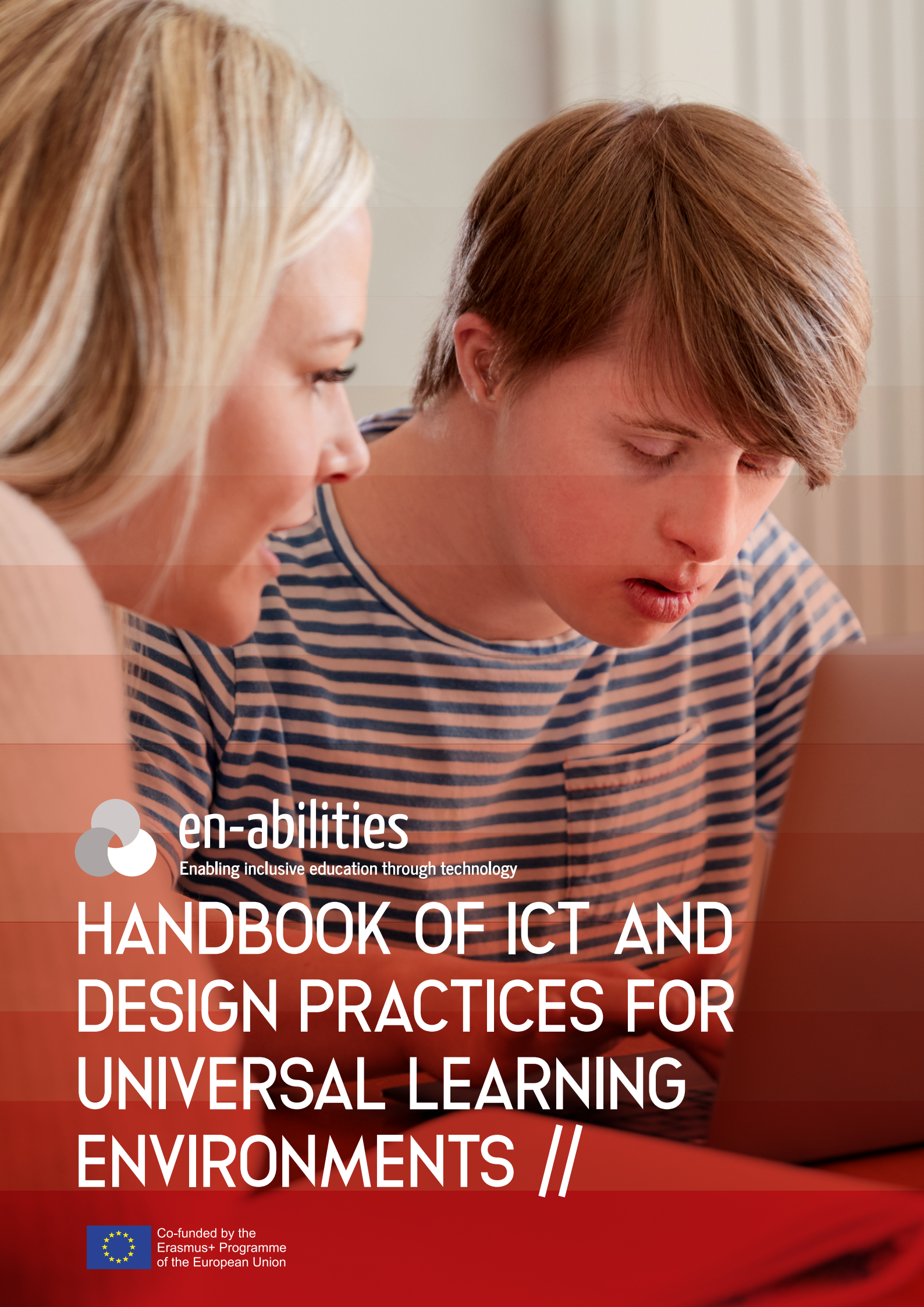

en-abilities

Enabling inclusive education through technology

HANDBOOK OF ICT AND DESIGN PRACTICES FOR UNIVERSAL LEARNING ENVIRONMENTS //

Co-funded by the
Erasmus+ Programme
of the European Union

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Introduction

Digital literacy and access to web content is no longer just a luxury, for a privileged few, it is a necessity for everyone. The evolution of society has led us to new paradigms of socialization, education and work, now based on the global Internet network.

Those who don't know, those who don't surf, those who don't communicate through the Internet run the serious risk of being excluded at social, educational and work level.

We all need to know how to use, to "talk", learn and work in a global society. People with special needs also need to, not least because of their functional conditioning, learning and working needs can be overcome by using a device connected to the Internet.

This handbook is a companion to the two other handbooks (Educational and English) that are also freely available on the project's website. Tries to be a tool of help and "evangelization" for all those who work in web content, regardless of purpose.

It raises awareness for digital literacy for all and outlines a set of factors to consider for a universal design, a design for all. When you design for those who have more difficulties, everyone benefits. It warns of the necessity to think globally, to think universal. It highlights the need to eliminate barriers, considering the diversity of potential users, so that everyone can access the different social, educational and labour contexts.

It focuses particularly on virtual learning environments, on what they should have, what they should be, so that everyone can use them in their learning, particularly those who deviate from pre-established norms. Human diversity is something to be respected, to be valued. There is no better way to design than that which involves the end users as co-designers, because only their participation as testers, evaluators and advisors guarantees the satisfaction of their own needs.

The academic and professional teams from all partners involved in the En-Abilities: Enabling inclusive education through technology Project co-funded by the Erasmus + Programme of the European Union have created this handbook. This output would not have been possible without the help and assistance from the partner institutions (University of Burgos, Sociedad Española de Asistencia Sociosanitaria, Prometeo innovations from Spain; FASPER, University of Belgrade, Serbia; University of Aveiro, Portugal; Dublin City University, Ireland and the Dunarea de Jos, University of Galati from Romania). However, the contributions of educational professionals, and learners with SEN who have taken part in the testing and implementation of this course have been even more important. Without the help of institutions, organizations, ICT and educational professionals, and especially all the participants how have helped us develop the project, it would have been impossible to write this handbook our complete the project. Thank you very much for your support and help!

This project has been funded with support from the European Commission. This publication reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

1. Need for Information and Communication Technologies in the XXIst century.

Nowadays, not many would argue with the assertion that "digital technology is a game changer" (Jones, 2016, p.286) mainly because most things people do, from working on school or work projects to socializing with friends, are inextricably technologically mediated (Jones and Hafner, 2012). However, technology is not just enabling us to do old things in new ways. Rather, digital technologies are actually introducing new practices such as modding – modifying a game either by adding content or by creating a new game (Hancock and Ingram, 2007; Jones and Hafner, 2012), vlogging – video blogging, machinima-making – animated film-making within three dimensional virtual environments (Hancock and Ingram 2007) and so on, that simply did not exist before (Jones and Hafner 2012; Lankshear and Knobel, 2006). These new digital literacy practices involve new abilities and skills such as the ability to record and edit digital photos and videos, the ability to create multimodal documents that combine words, images, video and audio, the ability to interact in virtual environments, but also require from people new ways of thinking, new ways of interacting with others, new ways of making meaning and new understandings of authorship and agency (Gee and Hayes, 2011; Jones and Hafner, 2012; Lankshear and Knobel, 2006). Research studies indicate that our communication practices are "evolving symbiotically with new powerful technical devices flooding the public marketplace" (Lotherington, Fisher, Jenson and Lindo, 2016, p.68).

As a result, communication is becoming increasingly multimodal since multimedia technologies allow the engagement of multiple modes, i.e. linguistic, visual, audio, tactile, spatial and gestural in the meaning-making process. It is possible to argue that the norm in most forms of communication is for multimodality (Cope and Kalantzis, 2000; Cope and Kalantzis, 2009; Jewitt, 2011; Kress, 2003; Lotherington et al., 2016; New London Group, 1996), given that "what it means to mean in the current semiotic climate is something different from what had hitherto been understood" (Nelson 2006, p.56). In this "new landscape of communication" (Kress, 2000a, p.183), digital tools deliver knowledge and language "faster, more widely, more easily, and in a way that allows rapid modification and wider participation" (Gee and Hayes, 2011, p.88).

1.1. New conceptualizations of literacy

Not surprisingly, these rapid developments in the communication environment have radically changed how literacy is viewed. It can no longer be thought of as simply referring to reading, writing, speaking and listening to linguistic resources. On the contrary, literacy "needs to address and acknowledge modes of meaning other than the linguistic one" (Cloonan, 2010, p.3). Therefore, the very concept of literacy in the traditional and narrow sense of the word, the ability to decipher and derive meaning from written language and to use it to convey one's own messages by producing written texts needs to be redefined. It is now viewed as a plural notion and termed "multiliteracies" (Cope and Kalantzis, 2000; New London Group, 1996; New London Group, 2000). The point that literacy is a plural concept with multiple dimensions has taken on added significance in the digital era. While in the preceding decades scholars discussed literacies such as "visual literacy", "media literacy" and "information literacy", with the advent of web 2.0 came an explosion of interest in new—particularly digital—literacies (Jones and Hafner, 2012; Jones, 2016). The term has so far resisted precise definition but it has been broadly characterized by Jones and Hafner (2012, p.13) as the practices of communicating, relating, thinking and being that people engage in using digital technologies (Jones, 2016, p.286). Language learning within a digital literacies framework "is not a matter of mastering an abstract code or set of decontextualized skills, but of becoming competent in particular social practices such as Facebooking, Tweeting, Instagramming and gaming of various kinds" (Jones, 2016, p.287). Digital literacy practices such as social networking, texting, online gaming and micro blogging are fundamentally about communication and represent the main ways in which students communicate with one another outside of the classroom (Jones, 2014, p.5).

"New ways of thinking, new ways of interacting with others, new ways of making meaning and new understandings."

"Multimedia technologies allow the engagement of multiple modes, i.e. linguistic, visual, audio, tactile, spatial and gestural in the meaning-making process."

Literacies that transcend the alphabetic world by utilizing diverse media to represent the audio, visual, spatial, gestural and tactile dimensions of communication will increasingly be required by human beings to communicate, work, and thrive in the digital world of the 21st-century (Lotherington and Jenson, 2011; Alvermann, 2002; Cope and Kalantzis, 2000; Gee, 2004; Kress, 2003; New London Group, 1996)

1.2. Calls for teaching of digital literacies in schools.

Such revolutionary shifts in the forms and functions of our communication practices call for radical adjustments in education (Nelson, 2006, p.56) in general but in the domain of language and literacy education in particular.

Despite repeated calls for attention to the growing importance of digital literacies for a generation of students for whom these literacies are required for successful participation in a globalised, digitally mediated society (Lotherington et al., 2016, p.68), people are not always aware that these new literacy practices alter not just the way they communicate but also the identities they can enact and the types of relationships they can have with others (Jones and Hafner 2012, p.1). As a result, the study of digital literacies and the ways they affect language learning and language use often take a back seat in the classroom. In fact, educators need to identify, understand and teach the competencies required for the communicative realities and needs of digitally mediated communication, such as knowing how to express meaning effectively by choosing and combining different meaning-making modes, work in collaborative author partnerships, learn by doing and so on (Lotherington et al., 2016, p.68). To successfully face rigorous higher education coursework, career challenges and a globally competitive workforce students of the 21st century and, perhaps more importantly, their teachers need to develop these new literacies and multimodal learning strategies so as to take advantage of the diverse modes of communication made possible by new technologies and to participate in global learning communities (Miller, 2007).
A practical example of why students need knowledge of digital technologies and digital literacies is discussed in Jones and Hafner's (2012, pp.77-78) book on digital literacies. In 2011, the University of Iowa Tipple School of Business invited applicants to submit their admissions essays as "tweets". According to the director of admissions, the purpose of this was to gauge how imaginative applicants could be when required to express themselves concisely, a key demand of business writing. The winning applicant who received a scholarship for the most creative effort chose to write his tweet in the form of a haiku, thus, combining one of the newest forms of communication with one of the oldest forms (ibid).

Some theorists and researchers stress the importance of teaching digital literacies, the literacies that "digital natives" (Prensky, 2001) need as citizens of a fast-changing world. Prensky's (2001) "digital nativism" refers to those who "have spent their entire lives surrounded by and using computers, videogames, digital music players, video cams, cell phones, and all the other toys and tools of the digital age" (p.1). The researchers agree that the ease of understanding and designing digital multimodal literacies, lliteracies that "transcend the alphabetic world" (Lotherington and Jenson, 2011, p.226) by utilizing diverse media to represent the audio, visual, spatial, gestural and tactile dimensions of communication (Cope and Kalantzis, 2009) will increasingly be required by human beings to communicate, work, and thrive in the digital world of the 21st century (Alvermann, 2002; Cope and Kalantzis, 2000; Gee, 2004; Kress, 2003; New London Group, 1996). In today's world of multimodal texts, both teachers and learners need to be able to interpret and represent meaning across and within modes (Cloonan, 2010). Therefore, students and teachers urgently need opportunities in schools and in teaching preparation programs and professional development courses to acquire multimodal learning strategies and digital literacy practices that are reflective of the society in which they live and are in fact required for new times and social futures (Gee and Hayes, 2011; Miller, 2007).

However, formal education has not really kept up with the rapid rate of change in digital communication practices (Lotherington et al. 2016, p.65) and the literacy practices of school usually differ from the digital multimodal literacy practices needed to enter and succeed at various levels of the academic hierarchy and subsequently in the highly competitive workforce (Miller, 2010). Some researchers put this point quite harshly by stating that modern schooling is rooted in 19th century industrialization and "intended to run as a tide assembly-line process where children are batched into classes and grades and processed in a monitored learning environment" (Lotherington et al. 2016, p.65) whilst learning in this paradigm is narrated to learners by teachers and the deposited knowledge is then measured quantitatively in examinations (ibid). Thus, in many cases, the way students are educated today is based on 19th century ideas and methods, elements of the standard transmission model are used frequently in schools (Saavedra and Opfer, 2012, p.7) and, moreover,

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schooling continues to be based on paper based literacy instead of practices that allow students to explore and utilize the multimodal, non-linear literacies available in digital environments" (Rhodes and Robnolt, 2009, p.158). Skills such as producing multimodal texts, however central their role in contemporary society, are, in fact, not taught in schools (Kress and van Leeuwen, 2006, pp.17-18). In the words of Kress and van Leeuwen (2006), "institutional education (...) produces illiterates" (p.18). Lotherington and Jenson (2011) also point out that in today's classrooms "the interactive screen-based media of the 21st century have taken a back seat" (p.227) and print literacies continue to dominate. However, the old logics of literacy and teaching on which school literacy is based are profoundly and continuously challenged by the new media environment (Cope and Kalantzis, 2009). Moreover, they are bound to disappoint the Millennial Generation, i.e. those born after 1981 (Hagood, Stevens and Reinking, 2002), whose expectations of engagement are greater and are also likely to fail to direct them towards developing the kinds of knowledge and skills required for "the new domains of work, citizenship and personality" (Yelland, 2006). As a consequence, scholars such as Gee and Hayes (2011) warn, today's school is in a crisis since much of what students learn "does not lead to the ability to solve problems or innovate" (p.64). They illustrate their argument with an example of college physics students who could pass a pencil and paper test on Newton's laws of motion but could not in fact explain how many forces are impinging on a coin thrown in the air even though this could be deduced from Newton's laws (Gee and Hayes 2011, p.117).

1.3. The disconnect between students' lifeworlds and school curricula.

Many research studies suggest that various digital literacy practices such as designing multimodal texts already play a large role in learners' lifeworlds, i.e. their personal lives (NLG, 2000, p.10), as they engage in multimodal composing and producing in their everyday lives outside of school according to their personal and private contexts (Cope and Kalantzis, 2000; Cope and Kalantzis, 2009; Jewitt, 2011; Kress, 2003; New London Group, 1996; Nallaya, 2010). The Millennial Generation has been surrounded and shaped by practices related to computers; for them digital technologies, the Internet, and hand-held devices are increasingly ubiquitous.

Consequently, Millennials think of messages and meanings multimodally—not just in terms of printed words, but also in terms of moving and still images and music (Miller, 2007, p.62). Moreover, some research studies point out that "we are moving away from a world in which some produce and many consume media, toward one in which everyone has a more active stake in the culture that is produced" (Jenkins 2006). A majority of youth are already active producers thanks to user-friendly production possibilities in digitally mediated spaces (Sheridan and Rowsell, 2010, p.12). Besides being active producers of meaning thanks to modern technology, young people today are often engaged outside of school in "processes of learning that are deeper and richer than the forms of learning to which they are exposed in schools" (Gee, 2004, p.107). Gee (2004) takes modern first- and third-person shooter games as an example and identifies a few of the learning principles

"Familiarity with technology would transfer so as to significantly impact their ability to know how to more intuitively use these tools effectively" (Hubbard 2008, p.179).

that the player is (however tacitly) exposed to in learning to play these games, i.e. learning is based on situated practice, learning is a form of extended engagement of self as an extension of an identity to which the player is committed, the learner can customize the game to suit his or her style of learning, the meaning of texts and symbols is situated in what one does, and is thus never purely verbal or textual; meaning is built up through various modalities (images, texts, symbols, interaction, abstract design, sound) and so on (pp. 198 - 199). Unfortunately, too often, these people's digital literacy practices in spaces such as online games, Facebook, Instagram, YouTube, and wikis have been largely ignored in school-based curricula (Sheridan and Rowsell, 2010, p.5).

The disconnect between students' experiences in digitally mediated spaces where they frequently participate in knowledge production activities and their literacy experiences in the classroom where students generally only engage in fact and information consumption can make schooling feel out of sync and irrelevant to the interests and issues that affect them (Gee and Hayes, 2011, p.67; Scott, 2015; Sheridan and Rowsell, 2010, p.5). Therefore, as a consequence of schools being unresponsive to today's changing conditions and not recognising nor exploiting the affordances of digital environments, students are becoming less engaged in this "old-style instruction" which is only marginally helpful as they tackle 21st century challenges (Sheridan and Rowsell, 2010, p.69).

Gee and Hayes (2011) warn that schools risk eventually becoming relic institutions (p.64) because they undermine what students already bring to the classroom, i.e. out-of-school sites of creativity and innovation. Education is failing to prepare learners for the challenges ahead by not taking account of digital literacies and their implicit multimodality and, instead, heavily focusing on print literacies. Students are not learning relevant practices and skills under the current system of education and are thus being de-privileged and short-changed on their present and future needs (Dudeney, Hockly and Pegrum, 2013; Scott, 2015). They are missing experiences that will prepare them for more satisfying lives and productive work (Scott, 2015).

Although the advantages of rethinking the curriculum to take digital literacies into account for the benefit of the current generation of students are becoming increasingly clear, it is important not to romanticize concepts such as the one coined by Prensky, i.e. digital natives. While the bulk of the literature in language and literacy education indicates that today's students are digital natives whose "thinking patterns have changed" (Prensky, 2001, p.1) and these changes require a radical shift across today's classrooms which do not match the changes in the way digital natives' minds process information (ibid), researchers such as Hubbard question whether the concept of digital natives has any real value. He points out that while there is indeed consensus that learners today are more technologically advanced in certain ways from those of a generation ago (Hubbard, 2013, p.165), it is important to note that "a mere exposure to technology in everyday life" does not automatically mean that they can effectively make use of technology for educational purposes (Karabulut, Levelle, Li and Suvurov, 2012). While it is, therefore, unquestionable that some of the current generation of students will have grown up with technology as an integral part of their lives and may feel more comfortable with technology such as hand-held digital devices for entertainment and communication, researchers (Hubbard, 2008; Jones, 2014) caution against assuming that exposure to technology has indeed changed digital natives' thinking patterns. Moreover, they question the extent to which students' "familiarity with technology would transfer so as to significantly impact their ability to know how to more intuitively use these tools effectively" (Hubbard 2008, p.179) for learning.

1.4. Digital natives vs. digital immigrants.

Jones (2014) identifies Prensky's distinction between digital natives and digital immigrants as one of the most damaging discourses for teacher identities in the digital age. Digital natives are described as native speakers of the digital language of computers, video games and the internet while "digital immigrants" is the label given to most teachers who are portrayed as clumsy "second language learners", unfamiliar with new digital environments. One reason why Jones considers the distinction to be mostly unhelpful is because it exaggerates the "generation gap" between teachers and learners. According to Fieldhouse and Nicholas (2008), "the digital generation gap represents something of a dichotomy, with digital natives and digital immigrants using different language" (p.60). More specifically, digital natives have no experience of pre-digital life, computers are not technology but part of life and, consequently, they do not describe things in terms of them being digital, since to them they have always been. The language of digital immigrants, on the other hand, reflects their experience of pre-digital life, therefore, they describe things as digital in order to differentiate between electronic and traditional versions (ibid). The literature reviewed by Fieldhouse and Nicholas also suggests that digital natives and digital immigrants have different learning styles with the former favoring instant information, animations, audio, and video to text, and naturally interacting with others while multitasking. For digital natives, doing is more important than knowing, and learning has to be fun and instantly relevant. The latter opt to handle knowledge systematically, logically and to inform discrete activities (ibid). The other reason why Jones and other researchers consider the distinction between natives and immigrants problematic is that it tends to romanticize the everyday digital literacies of learners while also implying that teachers have nothing to add to these literacies. In other words, students are seen as adept at dealing with digital media and teachers as "fumbling, hopelessly out-of-touch without much meaningful to say" (Jenkins, 2007). Consequently, the distinction is likely to disempower teachers, encouraging them to feel helpless, and thus justifying their decision not to know nor care about what happens to young people as they move into the online world (ibid).

However, the very real problem of educators not having grown up in an environment where digital literacy practices were necessary (Belshaw,

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Teachers need to negotiate the call to make learning more creative, innovative and collaborative while also being held accountable for student learning and their performance on mandatory standardised assessments (Lotherington et al. 2016)

2012, p.177) cannot be ignored particularly because many research studies have frequently identified teachers as the strongest influence on learner achievement (Knobel and Kalman 2016). Even more, it is the teachers who, according to Halliday (1978), "exert the most influence on the social environment" (...) "by playing a major part in the process whereby a human being becomes social man" (Halliday, 1978, p.10). While many factors contribute to a learner's academic performance, including individual background, family experiences, class size and other variables, research consistently suggests that, among school-related factors, teachers matter most (Knobel and Kalman 2016). Knobel and Kalman (2016) cite several research papers whose authors go so far as to claim that an "education system is only as good as its teachers" (Bokova 2014, p1) and problematize unsatisfactory student test scores in terms of the quality of teachers and their teaching thus placing much of the responsibility for how students do at school squarely on teachers' shoulders (Knobel and Kalman 2016, p.2). There is then a very real conundrum teachers themselves are faced with.

According to Lotherington et al. (2016) teachers need to negotiate the call to make learning more creative, innovative and collaborative while also being held accountable for student learning and their performance on mandatory standardised assessments which have remained largely unchanged and measure knowledge quantitatively (p.65). The teachers' dilemma is summarized by Lotherington et al. (2016) in terms of learning approaches and aims that collide over assessment ideals with examinations limiting technological facilitation in spite of learning in the context of everyday practice being frequently technologically mediated (p.67). Cloonan (2010) discusses the pervasive

power of assessments that only measure print literacies thus determining what is taught in schools. She identifies assessments as one of the most important reasons why literacies continue to refer only to traditional print literacies (ibid). This is most often the case in the language classroom, where the linguistic mode is considered essential to assessment. Not surprisingly, it is this mode that attracts teaching emphases leading to the neglect and sometimes exclusion of visual, audio, gestural, spatial and tactile meaning-making modes. According to Hafner et al. (2015, p.5), this is why students' participation in innovative multimodal digital practices such as video-making remains problematic as far as language- dominant assessment is concerned. If such high-stakes examinations are not altered, many teachers will continue to view digital literacies as mostly an add-on than an integral part of the language curriculum (ibid). It becomes, therefore, evident that transforming 21st century instruction cannot be addressed without also addressing current assessment paradigms (ibid).

Teaching towards digital multimodal literacies within educational frameworks based on past models, principles and ideas is extremely challenging (Lotherington et al. 2016, p.67). Many, if not most teachers admit to being ill-prepared for the current generation of students not only because of a lack of digital literacies but also because the teacher-centred pedagogical practices they are familiar with focus on print-based literacy and are inadequate preparation for the exploratory, student-centred, constructivist learning facilitated by digital tools that encourage collaborative and creative thinking and enable the design and production of multimodal ensembles (Lotherington et al. 2016, p.72).

Therefore, in spite of a global push for the adoption of 21st century learning models that support the development of digital literacies in educational institutions, the majority of teachers are unprepared to integrate them into their classrooms (Lotherington et al. 2016, p.74). Further compounding the issue, "teachers who are not tech-savvy or feel unsupported when integrating digital tools can be overwhelmed and easily discouraged when something goes awry, and they are unsure of the value of what they are doing" (ibid). This constitutes yet another issue besides problematic assessment paradigms and "the digital divide and disconnect" (O'Brien and Bauer 2005, p.126), that has been signaled in a considerable number of studies, i.e. the lack of digital literacy among educators.

Garrett (2009) asserts that, even though, nowadays, there are perhaps not many postsecondary language teachers who make no use of technology, there are still many—especially those whose teaching preparation did not include mention of technology—who use it only to a limited extent. They may use email, word processing, and digital audio; they may find authentic materials on the Web to use in class or to make available to students, and they may use their institutions' course management systems to post syllabi and assignments and to manage their grading. (p.719)

Technology use often limited to PowerPoint presentations, word processing, emails and Web searches (Ware, 2008) is predominantly framed by a traditional view of technology as a tool to improve language skills rather than to engage students in new digital literacies which can support language speakers in their authentic uses of technologies in target languages. These uses of technology, Garrett continues, do not support the full integration of technology into learning which involves "a dynamic complex in which technology, theory, and pedagogy are inseparably interwove" (p.719). Even though there is nothing wrong with viewing technology as a tool to support learning, in the view of digital literacies scholars, this perspective is limiting and can impede the development of students' digital literacies capabilities (Kalantzis et al. 2016; Tour, 2015). This seems to be the case in second and foreign language teaching contexts in particular.

According to Valdes (2004), teachers have been hesitant to acknowledge and engage with the new dimensions of literacy primarily because of their "tendency to conceptualize language in their teaching as an abstract linguistic system, detached from a broader socially constructed multimodal perspective" (p.79). She goes on to argue that:

The view that there are multiple literacies rather than a single literacy and that these literacies depend on the context of the situation, the activity itself, the interactions between participants, and the knowledge and experiences that these various participants bring to these interactions, is distant from the view held by most L2 educators who still embrace a technocratic notion of literacy and emphasise the development of decontextualized skills. (p.79)

Her insight chimes with that of Kress (2000b) who in his discussion of TESOL (Teaching English to Speakers of Other Languages) educators points out that:

TESOL professionals continue to act as though language fully represented the meanings they wish to encode and communicate. Yes, they admit that other features are important, but if pressed, the linguist and the applied linguist would maintain that their business was language, after all, and these other things were someone else's to look after. (p.337)

This finding might help explain teachers' inattention to multimodal design and new ways of knowing (Leu, Kinzer, Coiro and Cammack, 2004, p. 1600), being and doing (Hafner et al. 2015; Jones and Hafner 2012) afforded by digital literacy practices. However, reducing second and foreign language teaching to print-based literacies by spending most of the classroom time developing students' reading and writing skills poses many challenges for the language learner as mentioned above. According to Lotherington and Jenson (2011), this practice raises questions of authenticity, as it is not reflective of the society about which the language student learns (p.228). Although becoming digitally literate is not an easy task for any student, it is especially difficult for foreign and second language students. In their attempts to become digitally literate, these students must acquire linguistic competence in a new language and at the same time develop the sociocultural skills required to gain access into the 21st century social, academic, and workforce environments (Kasper, 2000, pp.105-106). Therefore, since "language is no longer the carrier of all meaning" (Kress 2000b, p.339), education in general and language education in particular need to reconsider the traditional, almost exclusive focus on print-based literacies. Integrating the dramatic broadening of the concept of literacy to include multimodal meaning-making beyond print-only texts for all students and their teachers becomes the essential task for schools and schools of education in the 21st century (Miller and Borrowicz, 2007). For education to remain relevant it must "account for the assumption that literacy is indeed multiple" (Stewart, 2014) and this can be achieved only if educators consciously deploy multimodality in learning and teaching (Cope and Kalantzis, 2009, p.182).

1.5. The role of professional development.

Professional development opportunities that fundamentally incorporate new digital tools and literacy practices are sorely needed. Research studies frequently suggest that most teacher education programs do not offer anything more than superficial preparation for and in digital tools and technology-enhanced learning (Lotherington et al. 2016, p.73). Consequently, teachers are inadequately prepared to use digital technologies in meaningful ways (ibid)—this inadequate teacher preparation has been identified as yet another disconnect between the needs and expectations of 21st century learners and the unsatisfactory preparation of teachers where the focus is often on using digital tools for instructional practice, not facilitating the practice of multimodal digital literacies. Not surprisingly, then, many critics believe that teacher education has "failed to keep pace with the profound socio-political changes in society" (Imig and Switzer, 1996, p.213) precisely because, as Vélez-Rendón (2002) argues, the knowledge and skills that a teacher needed two decades ago are no longer sufficient in today's highly wired and rapidly changing world (p.461). While knowledge of the subject matter and pedagogy was all that was needed twenty years ago, today's language teachers face challenges that demand a wider array of competencies and skills (ibid).

In this context, providing teachers with opportunities to experiment with emerging literacies and use digital learning tools in the classroom is an obvious but complex solution. Consequently, efforts have to be made to renew teaching practices through teacher education. Moreover, teacher educators need to provide preservice and in-service teachers with opportunities to learn new multimodal literacies for their own authentic purposes before they can effectively use them as student learning tools in their classrooms (Lankshear and Knobel 2003, p.67). Albers, Vasquez and Harste (2008) also point out that it is essential for teacher education to be reconceptualized so as to allow for activities that engage teachers in discovering on their own the relationship between digital technologies and multiple literacies learning. Teachers, they conclude, can only do for students what they have experienced for themselves (p.12).

Jones (2014) points out that only by engaging teachers in digital literacy practices and allowing them to experience the transformative effect of digital technologies, can they be in a position to

guide their students' collaboration and creation online into sensible learning outcomes as well as increase their understanding of how to help students participate successfully in these practices (pp.12-13). In other words, "teachers need to spend more time understanding how the language and communication skills learners will need in the future differ' from those they are currently teaching them, and "to explore the ways learners are already engaging in effective learning in the context of digital networks and affinity groups outside the classroom" (Jones 2014, p.17). Equally importantly, Blake (2009) and Egbert, Huff, McNeil, Preuss and Sellen (2009) point out that often educators are only willing to implement new technologies with which they are already familiar from use in other contexts. Also, teachers will only integrate technologies into their curriculum after they have been convinced of their usefulness (Lafford, 2009, p.687).

This makes imperative a change in the professional development of pre-service and in-service teachers (Knobel and Kalman 2016; Miller, 2007; Miller, 2008; Pianfetti, 2001).

However, despite the prevalence of arguments for transforming professional development for teachers to better support the acquisition of 21st century skills, the question of how best to purposefully and explicitly integrate digital literacies into teacher education remains largely overlooked. This calls for professional development that is directly aimed at increasing teachers' awareness of digital literacies and broadening their teaching repertoires in relation to multimodality by involving them in hands-on experiences. Cloonan (2010) makes the point that "professional learning directly affects student achievement by improving the quality of teaching practice, fostering those improved teacher pedagogical and content practices which lead to student achievement" (p. 31). Therefore, she continues, "we must turn our attention to the major impact of teachers in affecting student achievement and the strong influence of professional learning on teacher knowledge, and subsequently, student knowledge" (ibid).

2. Information and Communications Technology tools.

After having carefully reviewed the need for using Information and Communications Technology (hereafter ICT) tools and creating new learning interactions with students in the 21st century, the next section will look at how these tools must be adapted for learners with disabilities or SEN in order to further enhance their social inclusion and implicitly increase their participation in their own learning and society as a whole.

2.1. Co-design and involvement

End-users should be involved in all stages of the project or program: design, development and evaluation. Therefore, co-design seems to be a suitable approach for the context discussed here (Design for Europe, 2015):

This approach goes beyond consultation by building and deepening equal collaboration between citizens affected by, or attempting to, resolve a particular challenge. A key tenet of co-design is that users, as "experts" of their own experience, become central to the design process.

Co-design allows developers to generate innovative ideas founded on deep knowledge of learners' needs. It also affords a more efficient decision-making process as well as the validation of the IT departments' ideas. As a result, higher quality products could be developed at a lower cost and reduced time .Real co-creation leads to higher degrees of engagement, support and satisfaction of end-users (Design for Europe, 2015; Torrington, 2009).

Co-design is a participatory approach which involves the planning, development, testing and implementation of technological solutions. This widely used approach originated in the 1970s in the Scandinavian region. Core concepts (Ventura and Talamo, 2016) are:

End-users should be involved in all stages of the project or program: design, development and evaluation.

Photo by Rodion Kutsaev on Unsplash

- The centrality of end-users' and stakeholders' involvement: all participants contribute to the definition of interfaces and functionalities with his/her own skills
- Engagement: the involvement of end-users is far beyond simply stating requirements or mere validation. In fact, new methods for designing software are specifically linked to the co-creation process, such as design-by-play or design-by-doing, among others
- Mutual learning as a direct consequence of end-users' and stakeholders' involvement: it implies viewing the co-design process as an investigation and reflection, establishment, joint development and mutual support by all participants, including the IT developers, in a collective reflection-to-action.

However, and regardless of the participatory approaches used and the consideration given to end-users, the use of ICT tools implies a series of considerations at an ethical and societal level: that is why the engagement of end-users is needed, especially if these are vulnerable persons. For instance, the adults with special educational needs that participated in EN-Abilities were involved in the project from the start and asked about their opinions and necessities.

The main ethical concerns in developing IT platforms for learners with special educational needs (SEN) are:

- **Isolation**: interacting with IT platforms instead of regular classrooms, even interacting with peers but online, might increase the risk of segregation in a group particularly susceptible to be socially excluded or, to some extent, isolated. This ethical risk can be mitigated by designing online tools but considering these as an instrument for face-to-face interaction, or pondering the development of tools jointly with more in-depth interventions in the "real world" (e.g. labor inclusion programs, etc.).
- **Dependence on prompts**: prompts, tokens or badges can be addictive. Gamified platforms could generate dependence in some individuals. The co-design would mitigate this risk, affording the design of a safe but engaging platform thanks to the participation of all stakeholders, including education professionals.
- **Data and security**: to be a user of a platform specifically devoted to persons with disabilities implies some degree of self-disclosure of confidential data, i.e. data on social and health related aspects. At the EU level, these are considered "particularly sensitive" data: in particular, information on disabilities and SEN is considered both social and health data. Similarly, collecting information on "migrants" or "refugees" involves social data as well as data on ethnicity, racialization and health data in the vast majority of cases
- **Top- down approaches**: these approaches would reproduce social inequalities through technologies. The major problem is that vulnerable users are also vulnerable in technological environments due to their life-long trajectory at the academic and labour levels, the traditional approaches that undermine their active participation as citizens, etc.

By considering the diverse needs and abilities of all throughout the design process, universal design creates products, services and environments that meet peoples'needs.

2.2. Universal design.

When discussing the use of ICT in education, there are a range of steps that must be considered. Firstly, we should define the goals of our platform, that is, the contents we want the students to acquire through the learning process. Moreover, and as in any other educational process, we must know and take into account the barriers our target group faces when learning. In other words, we must consider the individual differences that may influence the interaction with the technical interfaces (e.g. levels of literacy, mastery of the language in the destination country, type of disabilities, functionality, etc.) especially when using a web environment. On the other hand, we must also consider the testing or evaluation process that we will design for our platform.

Secondly, regardless of individual and group particularities, the overall aim of the development of tools is to overcome the barriers that every individual may experience when navigating or interacting with the platform Since physical and cognitive abilities differ for everyone, independently of diagnosis and categorizations, there is also a broad range of difficulties to be addressed in the use of digital resources. Therefore, in the past decades, there has been a growth in the so-called heuristic evaluation methods, where discount methods are used to find broad usability problems and strategies (heuristics) to solve them. After analyzing a set of these methods, Nielsen (1994) found that 10 heuristics could solve most usability issues encountered by users when using digital platforms that prevented them from achieving their tasks, for example, causing delays or discouraging them from using the system.; Some usability heuristics highlighted by Nielsen are: the visibility of the system status (the user is informed of what is going on) , the match with the real world (using phrases, icons familiar to the user), the consistency of standards (avoiding the use of different words or actions that mean the same thing), the prevention of errors in the interfaces, or the minimalist design. These heuristics are included in the Universal Design (hereafter UD) principles.

UD is a relatively new term that contributes to the design of IT tools but is not restricted to it. UD can also guide the design of furniture, homes or cars, among others, to ensure these products are accessible to all persons (Rose, 2009). The concept combines the efforts of the design industry to remove barriers for disabled people, inspired by the social movements of the 20th century, with the inception of assistive technologies aimed at providing specialized solutions for people with specific requirements, and the growing influence of user-centred design approaches.

The Centre for Excellence in Universal Design defines UD (Centre for Excellence in Universal Design, 2014b) as:

[...] the design and composition of an environment so that it can be accessed, understood and used to the greatest extent possible by all people regardless of their age, size, ability or disability. An environment (or any building, product, or service in that environment) should be designed to meet the needs of all people who wish to use it. This is not a special requirement, for the benefit of only a minority of the population. It is a fundamental condition of good design. If an environment is accessible, usable, convenient and a pleasure to use everyone benefits. By considering the diverse needs and abilities of all throughout the design process, universal design creates products, services and environments that meet peoples' needs. Simply put, universal design is good design.

The UD follows 7 principles reproduced on Table 1 (Centre for Excellence in Universal Design, 2014a).

Table 1. Principles of UD and their guidelines by Centre for Excellence in Universal Design (2014a) (Continue).

Principles	**1. Equitable Use** The design is useful and marketable to people with diverse abilities.	**2. Flexibility in Use** The design accommodates a wide range of individual preferences and abilities.	**3. Simple and Intuitive Use** Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.	**4. Perceptible Information** The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
Guidelines	- Provide the same means of use for all users: identical whenever possible; equivalent when not. - Avoid segregating or stigmatizing any users. - Ensure privacy, security, and safety to all users. - Make the design appealing to all users.	- Provide choice in methods of use. - Accommodate right- or left-handed access and use. - Facilitate the user's accuracy and precision. - Provide adaptability to the user's pace.	- Eliminate unnecessary complexity. - Be consistent with user expectations and intuition. - Accommodate a wide range of literacy and language skills. - Arrange information consistent with its importance. - Provide effective prompting and feedback during and after task completion.	- Use different modes for redundant presentation of essential information. - Maximize legibility of essential information. - Differentiate elements in ways that can be described (i.e., make it easy to give instructions). - Provide compatibility with a variety of techniques or devices used by people with sensory limitations.

Table 1. Principles of UD and their guidelines by Centre for Excellence in Universal Design (2014a) (Continue).

Principles	**5. Tolerance for Error** The design minimizes hazards and the adverse consequences of accidental or unintended actions.	**6. Low Physical Effort** The design can be used efficiently and comfortably and with a minimum of fatigue.	**7. Size and Space for Approach and Use** Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.
Guidelines	- Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded. - Provide warnings of hazards and errors. - Provide fail-safe features. - Discourage unconscious action in tasks that require vigilance.	- Allow user to maintain a neutral body position. - Use reasonable operating forces. - Minimize repetitive actions. - Minimize sustained physical effort.	- Provide a clear line of sight to important elements for any seated or standing user. - Make reach to all components comfortable for any seated or standing user. - Accommodate variations in hand and grip size. - Provide adequate space for the use of assistive devices or personal assistance.

2.3. General considerations and the W3C checklist.

While UD is not about accessibility for persons with special needs, a website designed following these principles should consider the key guidelines in order to ensure better accessibility for all potential audiences, including, among others, persons with physical or cognitive disabilities.

The W3C states:

The Web is fundamentally designed to work for all people, whatever their hardware, software, language, location, or ability. When the Web meets this goal, it is accessible to people with a diverse range of hearing, movement, sight, and cognitive ability.

Thus, the impact of disability or SEN is radically changed on the Web because the Web removes barriers to communication and interaction that many people face in the physical world. However, when web sites, applications, technologies, or tools are badly designed, they can create barriers that exclude people from using the Web.

There are a broad variety of tools for checking the accessibility of a website, and using several tools, at least 2 or 3, is strongly recommended in order to better fine-tune an online platform. To this end, guidelines are provided in a variety of formats:

- The official W3C website offers the full checklist of checkpoints organized by concept for Web content developers. These may be used to review a page or site indicating whether each point has been satisfied or not, or is not applicable. [1]
- Cheat sheets are also available, offering summarized checkpoints that can be evaluated at a glance. Explanations are offered as links for each point. [2]
- For the evaluation of websites, codes and html files, an online tool (in Spanish) allows the automatic check using as reference the Web Content Accessibility Guidelines 2.0 (WCAG 2.0), assigning as an index a score between 1 and 10 and delivering a detailed report of the points checked. [3]
- The checklist in the Framework for Accessibility in the Specification of Technologies (FAST) [4] prepared by the Accessible Platform Architectures Working Group [5] offers a collection of features that a given technology may provide organized by types, summarizing a comprehensive collection of references and guidelines. [6]
- Chrome also allows performing accessibility audits through the developer tools functions. Checking the "accessibility" option will run an audit and provide a score and a report with the features to be improved. [7] Also, the browser Mozilla offers a similar tool to analyze accessibility in the developer tools. This is available in the options menu.

2.4. Definition, features and platforms.

Learning Management Systems (LMS) are applications for creating learning environments. These allow a person to create courses or learning environments (even the most complex ones) without needing to create the full platform from scratch and, usually, supported by the community of IT developers. Most of them have accessibility issues but also specific modules, add-ons/widgets or features for allowing a more user-friendly design.

These types of applications afford documentation management, tracking, reporting and, also, the delivery of training. The most popular system is Moodle: it is open source, well-supported by an international community of developers, even

1 For more information, see https://www.w3.org/TR/WAI-WEBCONTENT/full-checklist.html
2 For more information, see https://www.w3.org/2009/cheatsheet/
3 For more information, see http://examinator.ws/
4 For more information, see https://w3c.github.io/
5 For more information, see https://www.w3.org/WAI/APA/
6 For more information, see https://w3c.github.io/apa/fast/checklist.html
7 For more information, see https://developers.google.com/web/tools/chrome-devtools/accessibility/reference.

specialized companies, and contains additional features. Furthermore, Moodle supports the vast majority of contents (SCORM packages, videos, PDFs and other documents, popular plugins for creating interactive tests such as H5P, etc.)

2.4.1. Advantages and disadvantages using LMS.

Advantages of choosing to use an existing LMS:

- Wide variety of supported contents, regardless of format
- Online availability
- End-user friendly, even for teachers and instructors: similar to CMS (Content Management Systems), the major advantage is that end-users can easily modify the contents
- If you choose a well-supported LMS, there are many plug-ins and documentation for supporting your development
- If you choose Moodle or a similar LMS, it is free and open-source. However, you should carefully evaluate if the needed time for developing the course is actually balanced. Nevertheless, we must remember that LMS does not mean "open source" or "free". In fact, most learning management systems are proprietary software.

Disadvantages of choosing to use an existing LMS:

- The DB and hosting infrastructure (PHP versions, etc.) should be well-built and compatible with the LMS version you want to install
- While it is pre-developed, these are complex platforms and usually require time human resources for their set-up and personalization

2.4.2. Steps in the definition of the LMS to be used:

In case of using an existing LMS such as Moodle, these are some suggestions for guiding the development project:

- Gather all usability requirements from your partners and, if possible, end-users. As has been mentioned before, the views and needs of end-users should be carefully explored and integrated within the design.
- Research different LMSs and their features. This may involve making decisions on which types of contents you need to use (only videos and documents, documents and H5P quizzes, SCORM, etc.) as these will determine if the system is feasible for your project.
- Design the mock-up of your site.
- Show the mock-up to end-users.
- Integrate all changes and suggestions (as possible and practicable) in the mock-up.
- Start developing the site: iterative cycles and periodic assessment with end-users would be useful for reaching optimal results in terms of usability. Perhaps, your colleagues may also bring a very valuable perspective into the project, but if you are developing software for persons with special educational needs, you will need their own views and, most importantly, the interaction patterns observed within the user interface. Adding a single short course, two or three modules would be sufficient for testing purposes. .

2.4.3. Most popular LMSs:

There are a wide variety of comparative tools for choosing your most convenient LMS. [8]

We highly recommend Moodle, mainly because of its personalization features, the open-source and free character of the application, the international and vast community of IT developers and amateurs around the platform, the variety of plug-ins and widgets, the broad range of available templates, periodic stable updates and, of course, the technical documentation at your disposal. However, Moodle is a complex LMS and to implement a course built on this Open Source application might be time- consuming and costly.

While there are a lot of tools, even proprietary and professionally supported ones, choices must depend on your aim and objectives. Then, target users, features needed and materials to be included should be primarily addressed for selecting the best LMS for your project.For example, another LMS is open EdX [9] which was

8 For more information, see https://blog.capterra.com/top-8-freeopen-source-lmss/ or https://www.pcmag.com/roundup/336308/the-best-lms-learning-management-systems
9 For more infomration, see https://open.edx.org/

founded by MIT and Harvard in 2012 and the learning platform of choice for organizations all along the world comprising academic institutions, non-profit institutions, national governments, non-governmental organizations (NGOs), and multinational corporations. Some courses offered in EdX can be found on his website. [10]

Besides, Canvas [11] is an open source LMS developed by Instructure Inc. circa 2010. It offers a Cloud solution free for teachers to get started, without the need for installing. It is also widely used in academic institutions, from schools to universities. Some examples of courses offered in Canvas can be found on his website. [12]

Another example of LMS is TalentLMS [13] used by a variety of companies to train their teams in different areas. A free version, with basic features, is offered in the cloud, with the option to upgrade for more customized features.

10 For more information, see https://www.edx.org/course
11 For more information, see https://www.instructure.com/canvas/
12 For more infomation, see https://www.canvas.net/
13 For more information, see https://www.talentlms.com.

3. Technical solutions aimed towards including universal design within an online course.

Our aim in this text is to talk about the technical issues included in the development of the EN-Abilities' Virtual Learning Environment. But before digging into the technical concerns, it is important to go back a little to see how ICT is a tool for people with learning needs, but above all, to observe what it can offer and how it must be used for it not to become just another barrier towards social inclusion.

"**If the essence of ICT is its ability to dissolve boundaries, whether between countries or between subject, teacher and learner, then inclusion can be said to be its defining characteristic"** (Adams and Brindley, p.11).

We know that there are learners who need permanent help, i.e. learners with sensory, intellectual and motor disabilities, autism, among others) and others who have milder and even temporary learning problems with reading and

writing, difficulties getting their ideas across, school failure or even lack of interest (Ribeiro, 2014).

The use of traditional "paper" educational resources can cause barriers for those who struggle to handle or are even unable to use them, such as flipping through a page or reading printed material. Examples highlighting the power of technology for individuals with disabilities are not hard to come by. The answer comes through the use of ICT-supported educational resources, potentially increasing learner engagement with the availability of different formats of presentation and manipulation of information. Technologies, as several authors testify, are exceedingly and successfully transforming the education of people with SEN. They can provide a range of different opportunities, especially for those whose learning patterns do not follow typical development. ICT allows diversified and differentiated teaching and learning strategies and its use as assistive technology (AT) enables learners with motor, cognitive, sensory/perceptive disabilities, individually or in a group, to access and interact with available information from a computer. For people with motor disabilities (who may not have the fine motor skills required to handle a pencil, keyboard or conventional mouse), the advantages of expanded keyboards, switch devices, pointing devices through head or eye movements, speech recognition and word prediction software are obvious. Similarly, braille devices, speech-synthesized word processors, screen readers and screen magnifiers, text recognition and embossing can offer clear advantages for blind or low-vision people. The resources offered by digital technologies make it possible to create and use educational materials that can stimulate the learner, potentially making them an accomplice to the learning process and actively involving them in the process of their development. The use of digital materials and educational strategies provide opportunities for adapting to individual learning needs within a broad spectrum of areas of competence (perceptive, cognitive, academic, etc.). We must keep in mind that today's world lives immersed in technology and that educating with technology is educating for technology (Ribeiro, 2014).

Indeed, European and international studies are already demonstrating the benefits of technology and education, with compelling evidence of improvements in performance and participation (Ribeiro, 2014). At this juncture, the statement by Florian and Hegarty is relevant.

"Technology can be used to overcome barriers to learning for all learners, but particularly those with disabilities, wherever learning takes place" (Florian and Hegarty, 2004, p.6)

From the above mentioned ideas, it is clear that technology is an asset for people who need special attention in their learning. But, how to do it? What care, what strategies to adopt?

These questions lead us to the Universal Design for Learning (hereafter UDL) and the importance of ICT in the educational context, which we value. With UDL we have ICT tools at our disposal that adapt perfectly to the demands of this electronic and computer revolution that highlights our society.

Also, our answer comes in the form of implementation of UDL, which requires crucial aspects such as the usability and accessibility of digital tools.

3.1. When usability and accessibility are not an option... Are mandatory!

Usability is the degree of ease of use of a product, even when you first come into contact with it. It is defined by the efficiency, effectiveness and satisfaction with which users of a product can achieve their goals in specific environments. It is related to the ability of a product to be understood and used, and yet be enjoyable to the user in unique contexts of use. In the case of digital learning resources, usability is of great importance as the degree of effort and resources needed to achieve a given goal, product efficiency and user satisfaction are key to fostering a conducive teaching and learning dynamic for success. Although the value of the content and activities to be performed is paramount, usability is crucial. It does not matter to have content of great value and educational potential when the use of the product is uncomfortable and/or causes unnecessary cognitive efforts, making it unavailable for learning. The usability of an educational product cannot be neglected in order to promote effective and efficient use and exploration.

In the particular case of people with SEN, poor usability can exacerbate the obstacles that may arise for these learners with possible constraints on participation at the sensory, cognitive and motor levels.

For example, reading problems may condition the use of systems that rely on complex textual commands. To this end, the coexistence of highly transparent (easy and quick understanding) and intuitive icons can help individuals with cognitive problems (Ribeiro, Almeida and Moreira, 2011).

Closely related to usability arises the idea of accessibility. In fact, the criteria for good usability are often merged with the accessibility criteria in search of an accessible and easy use of a particular product. Most accessibility features benefit all users by providing increased usability.

Considering the accessibility of a product means weighing the diversity of its potential users and the peculiarities of their interaction with a particular product, which can be manifested either in user preferences (preference for visual or auditory information), restrictions on the quality of the product, equipment used and the existence of SEN that cannot be ignored by the product designer. In the universe of different users there may be cases of individuals who do not have access to visual or auditory information and users with motor and cognitive disabilities that make it difficult or incapable to interact with the product, and there may also be cases where all of the above or several coexist (Ribeiro et al., 2011).

As we can read on the W3C (2019) website "The Web is fundamentally designed to work for all people, whatever their hardware, software, language, location, or ability. When the Web meets this goal, it is accessible to people with a diverse range of hearing, movement, sight, and cognitive ability".

This statement is reinforced by the following that dazzles us and leads us to start digital to reach more people.

"The power of the Web is in its universality. Access by everyone regardless of disability is an essential aspect" (Tim Berners-Lee, W3C Director and inventor of the World Wide Web).

People with disabilities benefit most from web accessibility because, in its absence, their access may be impaired or even impeded by barriers imposed by inaccessibility. But when sites are truly accessible, people with disabilities can take advantage of all the information and services available on the web.

Thus, when access and use are made available for people with disabilities everyone will benefit in some way. In the same way, implementing accessibility guidelines can also provide several benefits for nondisabled users (Schmutz, Sonderegger and Sauer, 2016).

It is easy to conclude that accessibility and, later in this chapter, Universal Design are a win-win situation for all. However, we must always bear in mind, that, when resorting to digital environments, understanding and studying users, their context and simplifying the complexity of information, making it visible to all learners are fundamental objectives of research and the creation of virtual learning environments (Luís, Rocha and Marcelino, 2017).

Table 2 identifies the major problems inherent to the most frequent disabilities and includes some of the more used options to promote accessibility. However, it is advisable to consult the W3C guidelines[14] for web accessibility.

14 https://www.w3.org/TR/WCAG21/

Table 2. More frequent limitations and more commonly used accessibility strategies (Adapted from Ribeiro et al., 2011; Mariger, 2006).

Physical disability	Motor problems have implications for accuracy and speed of movements affecting the use of common computer peripherals. It becomes necessary to use alternative methods of interaction, such as the activation of the accessibility options of OS, keyboard navigation and the combination with AT. Websites must have larger spaces and clickable items.
Hearing Disability	Prevents the input of sound stimuli, which should, where possible, be compensated by visual information (e.g. through the subtitling of sound content or availability of alternative text). Auditory feedback must have alternate visual feedback such as page blinking. The hearing impaired do not use specific AT but may use the accessibility options of the OS.
Visual Disability	People with visual disability often use screen reading software for sound and/or refreshable Braille displays or a Braille terminal. However, this software requires that the non-textual information is complemented by textual descriptions. The functions of the magnification and high contrast of the OS/webpages are often used by people with sight problems. Sequential line by line navigation and skip to content (with shortcut keys) must be enabled.
Intellectual Disability/ Cognitive disability	In intellectual disability, the main issues arise from problems to understand and adapt to instructions and processes. Comprehension, planning, reasoning and learning can be affected. Disorientation can happen in website navigation, one may not remember or identify the next steps to proceed. Page structure/organization, cleanness, navigation aids, clear commands, different formats of the same information, speaking text/narration for users with low-literacy or processing impairments must be available. There is a need for succinct, clear and concise instructions. Information and aids must be repeated. Controls, features and navigation within a website must be standardized. Navigation must be simplified and aided: forward step-by-step navigation; short and understandable menus; ways to backtrack or start over in navigation; prompts and feedback to identify correct choices or errors.

One way to ensure the accessibility of the resources we put online is to ensure that we comply with the four accessibility principles and their thirteen guidelines. With these procedures, we can reduce or even prevent anyone from being deprived of them. Table 3 shows the principles and, subsequently, Table 4, Table 5, Table 6 and Table 7 show heir guidelines.

These principles should be follow conformance requirements, which are divided in three levels:

- For **Level A** conformance (the minimum level of conformance), the Web page satisfies all the Level A Success Criteria, or a conforming alternate version is provided.
- For **Level AA** conformance, the Web page satisfies all the Level A and Level AA Success Criteria, or a Level AA conforming alternate version is provided.
- For **Level AAA** conformance, the Web page satisfies all the Level A, Level AA and Level AAA Success Criteria, or a Level AAA conforming alternate version is provided.

Table 3. Principles of Accesibility by W3C (WCAG 2.1.). [15]

		Guidelines
1 - Perceivable	Information and user interface components must be presentable to users in ways they can perceive. This means that users must be able to perceive the information being presented.	1. Text alternatives 2. Time-based media 3. Adaptable 4. Distinguishable
2 - Operable	Use interface components and navigation must be operable. This means that the interface cannot require interaction that a user cannot perform.	5. Keyboard accessible 6. Enough time 7. Seizures and Physical reactions 8. Navigable 9. Input Modalities
3 - Understandable	Information and the operation of user interface must be understandable. This means that users must be able to understand the information as well as the operation of the user interface.	10. Readable 11. Predictable 12. Input Assitance
4 - Robust	Content must be robust enough that it can be interpreted by a wide variety of user agents, including assistive technologies. This means that users must be able to access the content as technologies advance (as technologies and user agents evolve, the content should remain accessible).	13. Compatible

Table 4. Guidelines of Principle of Perceivable by W3C (WCAG 2.1.) (Continue).

1. PERCEIVABLE	
1.1. Text alternatives	**1.1.1. Non-text content**: All non-text content that is presented to the user has a text alternative that serves the equivalent purpose, except for the situations listed below. (Level A)
1.2. Times-based media	**1.2.1. Audio-only and Video-only (Prerecorded)**: An alternative for time-based media or an audio track is provided that presents equivalent information for audio-only or video-only content. (Level A).
	1.2.2. Captions (Prerecorded): Captions are provided for all audio content in synchronized media. (Level A)
	1.2.3. Audio Description or Media Alternative (Prerecorded): An alternative for time-based media or audio description of the prerecorded video content is provided for synchronized media. (Level A)
	1.2.4. Captions (Live): Captions are provided for all live audio content in synchronized media. (Level AA)
	1.2.5. Audio Description (Prerecorded): Audio description is provided for all video content in synchronized media. (Level AA)
	1.2.6. Sign Language (Prerecorded): Sign language interpretation is provided for all audio content in synchronized media. (Level AAA)
	1.2.7. Extended Audio Description (Prerecorded): Where pauses in foreground audio are insufficient to allow audio descriptions to convey the sense of the video, extended audio description is provided for all video content in synchronized media. (Level AAA)
	1.2.8. Media Alternative (Prerecorded): An alternative for time-based media is provided for all prerecorded synchronized media and for all video-only media. (Level AAA)
	1.2.9. Audio-only (Live): An alternative for time-based media that presents equivalent information for live audio-only content is provided. (Level AAA)
1.3. Adaptable Create content that can be presented in different ways (for example simpler layout) without losing information or structure.	**1.3.1. Info and Relationships:** Information, structure, and relationships conveyed through presentation can be programmatically determined or are available in text. (Level A)
	1.3.2. Meaningful Sequence: When the sequence in which content is presented affects its meaning, a correct reading sequence can be programmatically determined. (Level A)
	1.3.3. Sensory Characteristics: Instructions provided for understanding and operating content do not rely solely on sensory characteristics of components such as shape, colour, size, visual location, orientation, or sound. (Level A)
	1.3.4. Orientation: Content does not restrict its view and operation to a single display orientation, such as portrait or landscape, unless a specific display orientation is essential. (Level AA)
	1.3.5. Identify Input Purpose: The purpose of each input field collecting information about the user can be programmatically determined when: (Level AA) • The input field serves a purpose identified in the Input Purposes for User Interface Components section; and • The content is implemented using technologies with support for identifying the expected meaning for form input data.
	1.3.6. Identify Purpose: In content implemented using mark-up languages, the purpose of User Interface Components, icons, and regions can be programmatically determined. (Level AAA)

15 For more information, see https://www.w3.org/TR/WCAG21/

1. PERCEIVABLE	
1.4. Distinguishable Make it easier for users to see and hear content including separating foreground from background.	**1.4.1. Use of Colour:** Colour is not used as the only visual means of conveying information, indicating an action, prompting a response, or distinguishing a visual element. (Level A)
	1.4.2. Audio Control: If any audio on a Web page plays automatically for more than 3 seconds, either a mechanism is available to pause or stop the audio, or a mechanism is available to control audio volume independently from the overall system volume level. (Level A)
	1.4.3. Contrast (Minimum): The visual presentation of text and images of text has a contrast ratio of at least 4.5:1, except for the following: (Level AA) • Large Text: Large-scale text and images of large-scale text have a contrast ratio of at least 3:1. • Incidental: Text or images of text that are part of an inactive user interface component, that are pure decoration, that are not visible to anyone, or that are part of a picture that contains significant other visual content, have no contrast requirement. • Logotypes: Text that is part of a logo or brand name has no contrast requirement.
	1.4.4. Resize text: Except for captions and images of text, text can be resized without assistive technology up to 200 percent without loss of content or functionality. (Level AA)
	1.4.5. Images of Text: If the technologies being used can achieve the visual presentation, text is used to convey information rather than images of text except for the following: (Level AA) • Customizable: The image of text can be visually customized to the user's requirements. • Essential: A particular presentation of text is essential to the information being conveyed.
	1.4.6. Contrast (Enhanced): The visual presentation of text and images of text has a contrast ratio of at least 7:1, except for the following: (Level AAA) • Large Text: Large-scale text and images of large-scale text have a contrast ratio of at least 4.5:1; • Incidental: Text or images of text that are part of an inactive user interface component, that are pure decoration, that are not visible to anyone, or that are part of a picture that contains significant other visual content, have no contrast requirement. • Logotypes: Text that is part of a logo or brand name has no contrast requirement.
	1.4.7. Low or No Background Audio: For pre-recorded audio-only content that (1) contains primarily speech in the foreground, (2) is not an audio CAPTCHA or audio logo, and (3) is not vocalization intended to be primarily musical expression such as singing or rapping, at least one of the following is true: (Level AAA)
	1.4.8. Visual Presentation: For the visual presentation of blocks of text, a mechanism is available to achieve the following: (Level AAA) • Foreground and background colours can be selected by the user. • Width is no more than 80 characters or glyphs (40 if CJK). • Text is not justified (aligned to both the left and the right margins). • Line spacing (leading) is at least space-and-a-half within paragraphs, and paragraph spacing is at least 1.5 times larger than the line spacing. • Text can be resized without assistive technology up to 200 percent in a way that does not require the user to scroll horizontally to read a line of text on a full-screen window.
	1.4.9. Images of Text (No Exception): Images of text are only used for pure decoration or where a particular presentation of text is essential to the information being conveyed. (Level AAA)
	1.4.10. Reflow: Content can be presented without loss of information or functionality, and without requiring scrolling in two dimensions for: (Level AA) • Vertical scrolling content at a width equivalent to 320 CSS pixels. • Horizontal scrolling content at a height equivalent to 256 CSS pixels. Except for parts of the content which require two-dimensional layout for usage or meaning.
	1.4.11. Non-text Contrast: The visual presentation of the following has a contrast ratio of at least 3:1 against adjacent colour(s): (Level AA) • User Interface Components: Visual information required to identify user interface components and states, except for inactive components or where the appearance of the component is determined by the user agent and not modified by the author; • Graphical Objects: Parts of graphics required to understand the content, except when a particular presentation of graphics is essential to the information being conveyed.
	1.4.12. Text Spacing: In content implemented using mark-up languages that support the following text style properties, no loss of content or functionality occurs by setting all of the following and by changing no other style property: (Level AA) • Line height (line spacing) to at least 1.5 times the font size. • Spacing following paragraphs to at least 2 times the font size. • Letter spacing (tracking) to at least 0.12 times the font size. • Word spacing to at least 0.16 times the font size.

1. PERCEIVABLE	
1.4. Distinguishable Make it easier for users to see and hear content including separating foreground from background.	**1.4.13. Content on Hover or Focus:** Where receiving and then removing pointer hover or keyboard focus triggers additional content to become visible and then hidden, the following are true: (Level AA) • Dismissable: A mechanism is available to dismiss the additional content without moving pointer hover or keyboard focus. • Hoverable: If pointer hover can trigger the additional content, then the pointer can be moved over the additional content without the additional content disappearing. • Persistent: The additional content remains visible until the hover or focus trigger is removed, the user dismisses it, or its information is no longer valid.

Table 5. Guidelines of Principle of Operable by W3C (WCAG 2.1.) (Continue).

2. OPERABLE	
GUIDELINES	
2.1 Keyboard Accessible. Make all functionality available from a keyboard.	**2.1.1. Keyboard**: All functionality of the content is operable through a keyboard interface without requiring specific timings for individual keystrokes, except where the underlying function requires input that depends on the path of the user's movement and not just the endpoints. (Level A)
	2.1.2. No Keyboard Trap: If keyboard focus can be moved to a component of the page using a keyboard interface, then focus can be moved away from that component using only a keyboard interface, and, if it requires more than unmodified arrow or tab keys or other standard exit methods, the user is advised of the method for moving focus away. (Level A)
	2.1.3. Keyboard (No Exception): All functionality of the content is operable through a keyboard interface without requiring specific timings for individual keystrokes. (Level AAA)
	2.1.4. Character Key Shortcuts: If a keyboard shortcut is implemented in content using only letter (including upper- and lower-case letters), punctuation, number, or symbol characters, then at least one of the following is true: (Level A) • Turn off: A mechanism is available to turn the shortcut off. • Remap: A mechanism is available to remap the shortcut to use one or more non-printable keyboard characters (e.g. Ctrl, Alt, etc). • Active only on focus: The keyboard shortcut for a user interface component is only active when that component has focus
2.2. Enough Time. Provide users enough time to read and use content.	**2.2.1. Timing Adjustable:** For each time limit that is set by the content, at least one of the following is true: (Level A) • Turn off: The user is allowed to turn off the time limit before encountering it. • Adjust: The user is allowed to adjust the time limit before encountering it over a wide range that is at least ten times the length of the default setting. • Extend: The user is warned before time expires and given at least 20 seconds to extend the time limit with a simple action (for example, "press the space bar"), and the user is allowed to extend the time limit at least ten times. • Real-time Exception: The time limit is a required part of a real-time event (for example, an auction), and no alternative to the time limit is possible. • Essential Exception: The time limit is essential and extending it would invalidate the activity; or • 20 Hour Exception: The time limit is longer than 20 hours.
	2.2.2. Pause, stop, hide: For moving, blinking, scrolling, or auto-updating information, all of the following are true: (Level A) • Moving, blinking, scrolling: For any moving, blinking or scrolling information that (1) starts automatically, (2) lasts more than five seconds, and (3) is presented in parallel with other content, there is a mechanism for the user to pause, stop, or hide it unless the movement, blinking, or scrolling is part of an activity where it is essential; and • Auto-updating: For any auto-updating information that (1) starts automatically and (2) is presented in parallel with other content, there is a mechanism for the user to pause, stop, or hide it or to control the frequency of the update unless the auto-updating is part of an activity where it is essential.
	2.2.3. No Timing: Timing is not an essential part of the event or activity presented by the content, except for non-interactive synchronized media and real-time events. (Level AAA)
	2.2.4. Interruptions: Interruptions can be postponed or suppressed by the user, except interruptions involving an emergency. (Level AAA)
	2.2.5. Re-authenticating: When an authenticated session expires, the user can continue the activity without loss of data after re-authenticating. (Level AAA)

2. OPERABLE	
2.2. Enough Time. Provide users enough time to read and use content.	**2.2.6. Timeouts:** Users are warned of the duration of any user inactivity that could cause data loss, unless the data is preserved for more than 20 hours when the user does not take any actions. (Level AAA)
2.3. Seizures and Physical Reactions Do not design content in a way that is known to cause seizures or physical reactions.	**2.3.1. Three Flashes or Below Threshold:** Web pages do not contain anything that flashes more than three times in any one second period, or the flash is below the general flash and red flash thresholds. (Level A)
	2.3.2. Three Flashes: Web pages do not contain anything that flashes more than three times in any one second period. (Level AAA)
	2.3.3. Animation from Interactions: Motion animation triggered by interaction can be disabled, unless the animation is essential to the functionality or the information being conveyed. (Level AAA)
2.4. Navigable Provide ways to help users navigate, find content, and determine where they are.	**2.4.1. Bypass Blocks:** A mechanism is available to bypass blocks of content that are repeated on multiple Web pages. (Level A)
	2.4.2. Page Titled: Web pages have titles that describe topic or purpose. (Level A)
	2.4.3. Focus Order: If a Web page can be navigated sequentially and the navigation sequences affect meaning or operation, focusable components receive focus in an order that preserves meaning and operability. (Level A)
	2.4.4. Link Purpose (In Context): The purpose of each link can be determined from the link text alone or from the link text together with its programmatically determined link context, except where the purpose of the link would be ambiguous to users in general. (Level A)
	2.4.5. Multiple Ways: More than one way is available to locate a Web page within a set of Web pages except where the Web Page is the result of, or a step in, a process. (Level AA)
	2.4.6. Headings and Labels: Headings and labels describe topic or purpose. (Level AA)
	2.4.7. Focus Visible: Any keyboard operable user interface has a mode of operation where the keyboard focus indicator is visible. (Level AA)
	2.4.8. Location: Information about the user's location within a set of Web pages is available. (Level AAA)
	2.4.9. Link Purpose (Link Only): A mechanism is available to allow the purpose of each link to be identified from link text alone. (Level AAA)
	2.4.10. Section Headings: Section headings are used to organize the content. (Level AAA)
2.5. Input Modalities. Make it easier for users to operate functionality through various inputs beyond keyboard.	**2.5.1. Pointer Gestures:** All functionality that uses multipoint or path-based gestures for operation can be operated with a single pointer without a path-based gesture, unless a multipoint or path-based gesture is essential. (Level A)
	2.5.2. Pointer Cancellation: For functionality that can be operated using a single pointer, at least one of the following is true: (Level A) • No Down-Event: The down-event of the pointer is not used to execute any part of the function. • Abort or Undo: Completion of the function is on the up-event, and a mechanism is available to abort the function before completion or to undo the function after completion. • Up Reversal: The up-event reverses any outcome of the preceding down-event. • Essential: Completing the function on the down-event is essential.
	2.5.3. Label in Name: For user interface components with labels that include text or images of text, the name contains the text that is presented visually. (Level A)
	2.5.4. Motion Actuation: Functionality that can be operated by device motion or user motion can also be operated by user interface components and responding to the motion can be disabled to prevent accidental actuation, except when: (Level A) • Supported Interface: The motion is used to operate functionality through an accessibility supported interface; • Essential: The motion is essential for the function and doing so would invalidate the activity.

2. OPERABLE	
2.5. Input Modalities. Make it easier for users to operate functionality through various inputs beyond keyboard.	**2.5.5. Target Size:** The size of the target for pointer inputs is at least 44 by 44 CSS pixels except when: (Level AAA) • Equivalent: The target is available through an equivalent link or control on the same page that is at least 44 by 44 CSS pixels. • Inline: The target is in a sentence or block of text. • User Agent Control: The size of the target is determined by the user agent and is not modified by the author. • Essential: A particular presentation of the target is essential to the information being conveyed.
	2.5.6. Concurrent Input Mechanisms: Web content does not restrict use of input modalities available on a platform except where the restriction is essential, required to ensure the security of the content, or required to respect user settings. (Level AAA)

Table 6. Guidelines of Principle of Understandable by W3C (WCAG 2.1.) (Continue).

3. UNDERSTANDABLE	
GUIDELINES	
3.1. Readable. Make text content readable and understandable.	**3.1.1. Language of Page:** The default human language of each Web page can be programmatically determined. (Level A)
	3.1.2. Language of Parts: The human language of each passage or phrase in the content can be programmatically determined except for proper names, technical terms, words of indeterminate language, and words or phrases that have become part of the vernacular of the immediately surrounding text. (Level AA)
	3.1.3. Unusual Words: A mechanism is available for identifying specific definitions of words or phrases used in an unusual or restricted way, including idioms and jargon. (Level AAA)
	3.1.4. Abbreviations: A mechanism for identifying the expanded form or meaning of abbreviations is available. (Level AAA)
	3.1.5. Reading Level: When text requires reading ability more advanced than the lower secondary education level after removal of proper names and titles, supplemental content, or a version that does not require reading ability more advanced than the lower secondary education level, is available. (Level AAA)
	3.1.6. Pronunciation: A mechanism is available for identifying specific pronunciation of words where meaning of the words, in context, is ambiguous without knowing the pronunciation. (Level AAA)
3.2. Predictable. Make Web pages appear and operate in predictable ways.	**3.2.1. On Focus:** When any user interface component receives focus, it does not initiate a change of context. (Level A)
	3.2.2. On Input: Changing the setting of any user interface component does not automatically cause a change of context unless the user has been advised of the behaviour before using the component. (Level A)
	3.2.3. Consistent Navigation: Navigational mechanisms that are repeated on multiple Web pages within a set of Web pages occur in the same relative order each time they are repeated, unless a change is initiated by the user. (Level AA)
	3.2.4. Consistent Identification: Components that have the same functionality within a set of Web pages are identified consistently. (Level AA)
	3.2.5. Change on Request: Changes of context are initiated only by user request or a mechanism is available to turn off such changes. (Level AAA)
3.3. Input Assistance. Help users avoid and correct mistakes.	**3.3.1. Error Identification:** If an input error is automatically detected, the item that is in error is identified and the error is described to the user in text. (Level A)
	3.3.2. Labels or Instructions: Labels or instructions are provided when content requires user input. (Level A)
	3.3.3. Error Suggestion: If an input error is automatically detected and suggestions for correction are known, then the suggestions are provided to the user, **unless** it would jeopardize the security or purpose of the content. (Level AA)
	3.3.4. Error Prevention: For Web pages that cause legal commitments or financial transactions for the user to occur, that modify or delete user-controllable data in data storage systems, or that submit user test responses, at least one of the following is true: submissions are reversible; data entered by the user is checked for input errors and the user is provided an opportunity to correct them or a mechanism is available for reviewing and confirming information before finalizing the submission.
	3.3.5. Help: Context-sensitive help is available. (Level AAA)

3. UNDERSTANDABLE	
3.3. Input Assistance. Help users avoid and correct mistakes.	**3.3.6. Error Prevention (All):** For Web pages that require the user to submit information, at least one of the following is true: (Level AAA) • Reversible: Submissions are reversible. • Checked: Data entered by the user is checked for input errors and the user is provided an opportunity to correct them. • Confirmed: A mechanism is available for reviewing, confirming, and correcting information before finalizing the submission.

Table 7. Guidelines of Principle of Robust by W3C (WCAG 2.1.).

4. ROBUST	
GUIDELINES	
4.1. Compatible. Maximize compatibility with current and future user agents, including assistive technologies.	**4.1.1. Parsing:** In content implemented using mark-up languages, elements have complete start and end tags, elements are nested according to their specifications, elements do not contain duplicate attributes, and any IDs are unique, except where the specifications allow these features. (Level A)
	4.1.2. Name, Role: For all user interface components the name and role can be programmatically determined; states, properties, and values that can be set by the user can be programmatically set; and notification of changes to these items is available to user agents, including assistive technologies. (Level A)
	4.1.3. Status Messages: Status messages can be programmatically determined through role or properties such that they can be presented to the user by assistive technologies without receiving focus. (Level AA)

3.2. What is UDL? How can it help?

Universal Design for Learning (hereafter UDL) was developed by David Rose, Anne Meyer and other researchers from the Center for Applied Special Technology (hereafter CAST), an initiative supported by the United States Department of Education in 1999 in Wakefield, Massachusetts. It is based on the possibilities that digital technologies offer to design learning environments, with diverse options for learners with specific learning needs, promoting varied learning styles and rhythms, with a variety of possible ways of presenting contents and interacting with students. Digital environments, such as the Internet and its possibilities for communication and interaction, incorporate new skills and opportunities for learners to interact with materials and understand them.

Its origin and inspiration are based on the concept of Universal Design in architecture, whereas it is a framework for the design of living and working spaces and products benefiting the widest possible range of people in the widest range of situations.

Universal Design is accessibility made easy for everyone, both physically and in terms of educational services, products and solutions, so that everyone can have access without barriers, meeting their individual needs and increasing their quality of life. Examples of Universal Design are ramps on sidewalks that assist not only wheelchair users but also strollers, shopping and luggage carts. It is the design for everyone, because when it is designed for those with the most needs, inevitably everyone benefits.

The concept has also been applied to web page designs, which allow, for example, disabled users to access the Internet. More recently, Universal Design has been applied to education. UDL also intends to integrate this concept into teaching and learning processes because technology is available to make it possible, which we consider to be relevant to this project.

The UDL framework stems from a broad base of research in how the brain learns (as reflected in the affective, recognition, and strategic networks) and a similarly broad base of educational research in the core components of effective teaching (as reflected in optimal techniques for building engagement, knowledge, and skills) (Meyer, Rose and Gordon, 2014).

UDL is governed by three neurophysiological principles that meet learners' needs by providing equal opportunities for learning and improving access to content (CAST, 2018):

1. Provide multiple and flexible presentation methods to enable learners with diverse learning styles to acquire information and knowledge (the "what" of learning);

2. Provide multiple and flexible forms of action and expression to provide students with

alternatives to demonstrate what they have learned (the "how" of learning);

3. Provide multiple and flexible modes of engagement to meet learners' diverse interests and to provide an appropriate challenge to motivate them for learning (the "why" of learning).

UDL does not only apply to people with SEN. It has been designed to make instruction accessible to learners with disabilities, but it provides learning opportunities for all learners by guiding educators to find innovative ways to enhance accessible and appropriate academic content for learners with different educational backgrounds, learning styles, abilities and disabilities in different learning situations and contexts (Rose and Meyer, 2002).

Digital content is incorporated into these principles and can be implemented in various educational contexts. By way of example: (1) different forms of presentation of content may be achieved through multimedia support (e.g. educational websites, digital books and other specific software); (2) multiple forms of expression are achieved through multimedia formats, concept maps, e-portfolios and blogs; (3) The use of interactive virtual learning environments provides other forms of engagement that are typically engaging for learners.

UDL does not only apply to people with SEN. It has been designed to make instruction accessible to learners with disabilities, but it provides learning opportunities for all learners.

3.3. When UDL and Technology come together.

The use of ICT enables varied responses because it allows for different ways of presenting information, diverse ways of expression and learning, and varied ways of engaging to respond to the complexity of facets of learning and teaching (Sancho and Hernández, 2006)

In the EN-Abilities project, UDL is a foundation for the development of the concept and learning materials. Table 8 summarizes UDL strategies in a way that makes it easy to observe how they come in line with the project.

Table 8. UDL strategies aligned with learning networks. Adapted from the original UDL strategies aligned with learning networks (Rose and Meyer, 2002).

Recognition Networks: Strategies that support the recognition of information to be learned.	• Provide multiple examples • Highlight critical features • Use media and other formats that provide basic information
Strategic Networks: Strategies for Processing Information to Be Learned	• Provide flexible models for demonstrating competent performance • Provide supportive practice • Provide continuous relevant feedback • Provide flexible opportunities to demonstrate skills
Affective Networks: Strategies for Promoting Student Engagement	• Offer content options and tools • Provide adjustable levels of challenge • Offer the opportunity to interact in different learning contexts • Provide reinforcement options and learning rewards

The UDL principles outlined above are flexible and personalized, and based on brain and media research to help teachers "reach out" to all students, taking into account their individual differences from the adoption of appropriate learning objectives, choosing and scaling up effective materials and methods, and developing fair and rigorous ways to assess student progress (Rose and Meyer, 2002). These authors argue that the three principles of UDL aim to:

- Provide multiple and flexible presentation/ representation methods to make it possible for students to acquire knowledge with different learning rhythms and styles. Examples of digital options are digital books, specialized software, and site-specific features.
- Provide varied and flexible forms of expression to provide alternatives for students to demonstrate what they have already learned. Digital examples that illustrate this principle are online concept maps, which provide students with a graphical map to highlight learning, text-to-speech programs, graphs with progress data.
- Provide diverse modes of engagement to meet learners' interests and offer an appropriate challenge to motivate them for learning. At the high-tech level, examples of flexible options include interactive software, recorded text and/or books, and visual graphics.

Recognition networks are specialized in the senses, and assign meaning to patterns we see. They allow us to identify, understand and process the concepts, ideas and information obtained through sensory channels. These networks are formed by the information that reaches the brain and represents the "what" of learning. They are located in the visual cortex, in the occipital lobe which processes visual stimuli. They collect visual information, then process it and group it into secondary areas that compare it with existing information. The visual area communicates with other areas of the brain that give meaning to what we see, given our experience and expectations. Therefore, the same object is not perceived in the same way by different subjects.

According to Rose, Meyer and Hitchcock (2005) there is no single teaching method to make each student an expert in recognition, but the proper use of various teaching strategies can support success in this area. A good support for easy recognition is to provide several examples using text, images (visualization) or concrete situations (manipulation). Computer and other media usage can also be a good aid in enriching the illustration with examples and highlighting critical features. Providing alternatives for

presenting information in various formats, enhancing/operationalizing the active processing of students' prior knowledge and maximizing the transfer/generalization of learning are also effective options for fostering recognition, developing diligent and knowledgeable students, which is related to the first principle of UDL.

Strategic networks specialize in producing and overseeing mental and motor patterns. They allow us to plan, execute and monitor actions and skills. In responding to something, we use strategic networks because they correspond to the "how" of learning. They are located in the frontal lobe that covers a large part of the cortex and perform functions of great complexity, such as sensory processing, motor and cognition. They also allow all actions and thoughts to be consciously perceived. The anterior part of the frontal lobe, the prefrontal cortex, is directly related to strategy: deciding which motion sequences to activate, how to order it, and evaluating its outcome. Their functions seem to include abstract and creative thinking, fluency of thought and language, social judgment, will, determination for action, and selective attention.

Teaching methods associated with the second principle of UDL consist of anticipating barriers to strategic learning, as well as choosing materials and practices that are flexible and make it possible to overcome these barriers (Rose et al., 2005). These are option with which digital materials, computer simulations, and virtual reality are inherently compatible, while also enabling student learning feedback, which is crucial to forming strategic and targeted learners. It is also interesting to develop gradual levels of support for student performance/participation and, consequently, facilitate the monitoring of the teaching and learning process by the student, diversifying the response methods and the course. As Rose et al. (2005) stated "computer simulations and virtual reality can provide students with rich, multisensory models [...] and offer a relatively easy means to integrate ongoing feedback into practice and learning" (p.189).

Affective networks are related to interest, motivation, allowing us to evaluate patterns, assign them emotional significance and engage in tasks/learning with the world around us. The mechanisms that control the levels of activity in different parts of the brain and the bases of the impulses of motivation, especially those directed to the learning process, as well as the feelings of pleasure or punishment, are carried out largely by the basal regions of the brain which together form the Limbic System. Affective networks are the "why" of learning, activities and ideas that challenge us, are confined to the limbic system and are fundamentally related to the regulation of emotional processes. It is a continuous cortical ring-shaped system that bypasses interhemispheric formations.

If students are not interested in learning, efforts to support them will have very little return. That is why this third principle is the most valued of all. Affectivity is of utmost importance in the teaching and learning process, as the way students are motivated to learn represents a decisive element, with UDL being at the forefront of this conception. To achieve motivated and determined learners, teachers must know how to educate for autonomy, respect their individual choices, reinforce the sense of collaboration in different learning contexts, promote social participation and a sense of responsibility in the community, and provide adjustable levels, authentic challenges and prizes/rewards, valuing individual capacity to overcome difficulties, self-assessment and reflection. Rose and Meyer (2002) also reiterate the importance of content options and digital tools, as already mentioned.

As said before UDL originates from Universal Design and its seven principles are embedded in UDL. However, when it comes to product development, in our case a VLE, it is important to point out how these seven principles can be embodied into our project (see Table 9).

Table 9. Universal Design Principles. Adapted from Center for Universal Design (2008).

Equitable Use	Is useful and marketable to people with diverse abilities	1a. Provide the same means of use for all users: identical whenever possible; equivalent when not. 1b. Avoid segregating or stigmatizing any users. 1c. Provisions for privacy, security, and safety should be equally available to all users. 1d. Make the design appealing to all users.	• Use High Contrast • Use Alt Texts • Avoid Mouse-Only Interactions • Allow the use of Assistive Technology
Flexibility in Use	Accommodates a wide range of individual preferences and abilities	2a. Provide choice in methods of use. 2b. Accommodate right- or left-handed access and use. 2c. Facilitate the user's accuracy and precision. 2d. Provide adaptability to the user's pace.	• Avoid Scroll-Jacking • Allow accessibility options such as text resizing, colour change
Simple and Intuitive Use	Easy to understand, regardless of users experience, knowledge, language skills, or current concentration level	3a. Eliminate unnecessary complexity. 3b. Be consistent with user expectations and intuition. 3c. Accommodate a wide range of literacy and language skills. 3d. Arrange information consistent with its importance. 3e. Provide effective prompting and feedback during and after task completion.	• Simplify use and navigation
Perceptible Information	Communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities	4a. Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information. 4b. Provide adequate contrast between essential information and its surroundings. 4c. Maximize "legibility" of essential information. 4d. Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions). 4e. Provide compatibility with a variety of techniques or devices used by people with sensory limitations.	• Use short pieces fo information at a time • Use visuals or sound to support textual information • Synthesize information in lists, tables and charts
Tolerance for Error	Minimizes hazards and the adverse consequences of accidental or unintended actions	5a. Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded. 5b. Provide warnings of hazards and errors. 5c. Provide fail-safe features. 5d. Discourage unconscious action in tasks that require vigilance.	• Allow for undo • Avoid accidents • Allow automatic saves to return to previous version
Low Physical Effort	Used effectively and comfortably with a minimum of fatigue	6a. Allow user to maintain a neutral body position. 6b. Use reasonable operating forces. 6c. Minimize repetitive actions. 6d. Minimize sustained physical effort.	• Use action grouping – minimize the amount of mouse dragging or thumb stretching neede • Minimize actions to perform and long tasks.
Size and Space for Approach and Use	Provides appropriate size and space for approach, reach, manipulation, and use regardless of users body size, posture, or mobility	7a. Provide a clear line of sight to important elements for any seated or standing user. 7b. Make reach to all components comfortable for any seated or standing user. 7c. Accommodate variations in hand and grip size. 7d. Provide adequate space for the use of assistive devices or personal assistance.	• Use large enough action targets for tactile • Organize dynamic spaces that don'T hide information

Final Remarks

Accessibility and UDL can provide all users with more equal opportunities for learning, potentially rising awareness of their abilities. However, dreaming is not enough. One needs to know what is possible, what and how technology can help people with special educational needs. Knowing potential users, frameworks and guidelines can help us better develop and harvest the full potential of technology in teaching and learning. Technically, there are many things that are contained within the programming field, yet teachers are fundamental in producing accessible and usable content. In this En-Abilities project, design for all and hence accessibility are a constant concern given the target population of our project.

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