ISEC - ADE

FOCUS GROUP DISCUSSION REPORT

ACCESSIBLE DIGITAL LEARNING

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Recommendations and Outputs for Learners with Autism and Intellectual Disabilities

ISEC - ADE

ISEC-ADE Accessible digital education for learners with autism and intellectual disabilities: Innovating solutions and enhancing educators' competences 2021-1-CY01-KA220-SCH-000027701

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KEY TERMS

Throughout this report, we use the following definitions:

Digital learning	Digital learning comprises the technology and teaching practices that use technology to enhance learning. It includes a broad range of content and communication tools, curricular models, design strategies, and services that personalize instruction for students across all learning modalities: in face-to-face, blended, and e-learning environments. Online courses, conducting internet research, even watching online videos, or using digital tools and devices face-to-face with their teacher in a traditional classroom are all considered digital learning.
Online learning	Online learning is digital learning that uses the internet as a form of communication and learning. This means that students and the teacher can all be in the same room together and still adopt online learning.
E-learning	E-Learning is a type of learning that happens virtually – the students and the teacher do not have face-to-face interaction at all. As a "fully" online learning experience, e-Learning involves all materials, course work, and communication that take place online. This means that this virtual learning requires emails, forums, chat, online group discussions, or video conferencing as primary means of learning and communication.
ASC	Autism Spectrum Condition - complex neuro-developmental condition involving persistent challenges with social communication, restricted interests, and repetitive behaviour. While autism is considered a lifelong disorder, the degree of impairment in functioning because of these challenges varies between individuals with autism.
ID	Intellectual disability – condition that involves challenges with general mental abilities that affect intellectual functioning (such as learning, problem solving, judgement) and adaptive functioning (activities of daily life such as communication and independent living).

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UDL	Universal design for learning is an educational framework based on research in the learning sciences, including cognitive neuroscience, that guides the development of flexible learning environments and learning spaces that can accommodate individual learning differences.
Errorless Teaching	An instructional strategy used widely with individuals with intellectual and developmental disabilities. It has advantages to a more typical teaching style which allows errors and then provides prompting as a correction procedure. Here prompting is being paired with correct responding and faster reinforcement. This in turn conditions prompting to be pleasant for the child. When prompting is done as part of a correction procedure, the opposite effect can occur and prompting can become aversive to the child. Prompting ensures accuracy and a history of reinforcement for correct responding. This in turn reduces errors and the possibility of accidently reinforcing errors or inappropriate behaviour that may occur to avoid or escape the task demands.
Reinforcement	The provision of verbal, symbolic, tangible or other rewards for desirable performance or effort at the classroom level. This definition includes such things as: Praise (and other verbal reinforcement) - for correct responses during class, discussions, accurate homework, improved test scores, etc.; Symbolic rewards - such as gold stars, having one's picture on a bulletin board or name in a newsletter, etc.; Token rewards - such as points or chips, which are valueless in themselves, but which can be redeemed for things of value; Tangible rewards - such as edibles, toys, or school related items (pencils, notebooks, etc.); Activity rewards - such as free time, being leader of an activity, going on a field trip.
Prompts	Prompting is an instructional strategy in which any one of several different cues (e.g., gestures, illustrations, photographs, modelling) is used to help a student learn a new skill or behaviour. The prompt is given before or right as a student is getting ready to perform an ability to prevent student error.
Gamification	Gamification in education refers to the introduction of game design elements and gameful experiences in the design of learning processes.

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EXECUTIVE SUMMARY

Using an exploratory and participatory descriptive approach, this study presents information elicited from a series of stakeholder Focus Group Discussions (FGDs) to understand existing practices, needs, barriers, and goals for the use of digital education tools and content for learners with ASC and ID. The main conclusions of the study centre upon digital education issues of direct and immediate relevance to learners and their teachers that need to be addressed. These issues include: accessibility; acceptability and cultural appropriateness; technology infrastructure and affordability; quality individualized digital content and benefits of digital learning.

Digital education and digital content use provide opportunities to increase learning access and reduce barriers for students with ASC and ID. However, they can also maintain or increase existing inequalities in education and even create new ones. Vulnerability to digital exclusion can arise from unavailable or poor technical infrastructures or in digitally marginalized groups and communities. Financial subsidies for development of digital infrastructure are seen as a facilitator of accessibility in this sense. In addition, open source technologies for teaching and learning, as well as open educational resources can help to bridge the current gap in digital education. Another significant exclusion factor is the perceived fit, relevance, or compatibility of the technology to a particular user, provider, community or setting. The findings imply that design and development of digital education tools and content needs to consider acceptability and cultural appropriateness. Access to digital tools that meets both teachers' and learners' particular needs is a key area of concern. Teachers are also concerned with access to high quality educational resources and opportunities to easily design and develop their own material.

The priority in supporting digital learning is developing software that can be adapted to diverse cognitive and sensory styles of learners with ASC and ID. In addition, digital tools and content should fit in with the curriculum and individual learning goals, and with effective methods of teaching and learning. In this sense, the selection, design and use of digital technologies and media should exclusively follow the requirements of inclusive and SEN pedagogy and not vice versa. Digital learning needs to incorporate principles of evidence based teaching practices for learners with autism and ID.

By grounding information brought forth by stakeholders in relevant concepts of web content accessibility inclusive design, we propose recommendations and guiding principles for the development of interfaces accessible to learners with ASC and ID. Recommendations address the physical, intellectual and social dimensions of web accessibility, as well as the development of accessible digital learning tools and content

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that allow for integration of inclusive and SEN teaching practices. Along with allowing the developers to know what they should consider when developing appropriate solutions for learners and teachers, design recommendations can contribute to raise the awareness of these professionals about the characteristics of persons with ASC and ID and how technology can be valuable to them. Following recommended guidelines for proper software design, designers and developers can increase learning access and reduce barriers for learners.

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BACKGROUND

Autism Spectrum condition (ASC) and Intellectual disability (ID) are the most common developmental conditions. Combined, they affect between 3-5% of the population. Each, individually, have a rather high prevalence, with ID affecting 1-3% of the population and ASCs is found in 1/50 school age children (Perou et al., 2013). Additionally, they can be found together in the same individual as comorbid conditions. Seventy percent of individuals with ASCs have some level of ID while conversely, at least 10% of individuals with ID have ASCs, with some ID conditions exhibiting a much higher level of co-morbidity (Srivastava & Schwartz, 2014).

Both conditions are complex heterogeneous neurological conditions, under the umbrella of invisible disability, or hidden disability. This term captures a whole spectrum of challenges in the lives of both those who have the condition and their caregivers, that are not immediately apparent and can be difficult to grasp and thus, to be appropriately addressed.

This is particularly evident in education, were the provision of new opportunities to maximize learning is a fundamental right for all students. The Covid-19 pandemic pushed the development of digital teaching and learning, while access to learning opportunities offered by digital technology for learners with ASC and ID is very limited. This is widening the education gap and exacerbating inequalities for learners with invisible disabilities across Europe (EASPD, 2020). There is an urgent need for fully accessible digital tools or educational content, and enhancing teacher competence on disability and accessibility matters, outlined in the Digital Education Action Plan (EC, 2020). In order to provide high-quality, inclusive and accessible digital education in Europe, it is imperative, that the educational needs of autistic learners are adequately addressed during the digital transformation in education.

In the past 20 years, computer technology is recognized to increase learning access and reduce barriers for students. Previous works in research and collaboration projects showed that students with ASC and ID are interested in technology and that technology is beneficial to their learning and skills development, independent of age (Weber et al., 2022). Nowadays, devices exploring natural interactions and direct manipulation with touch screens, increase the acceptance of technology by these users. In spite of these developments, there still are very limited possibilities for teachers to apply outcomes of research in their everyday teaching practice. This is especially relevant to non-English speaking countries were accessible digital education tools and content is scarcest.

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In addition to accessible instructional design, equally important facet of accessible digital education is web content accessibility. The needs of people living with invisible disabilities are often not considered in accessible web design, as much as the needs of visibly (physically, visually or hearing) impaired people. There are many accessibility concerns that affect people with cognitive disabilities. These include issues about design, context, structure, language, and usability. Each of these issues can affect a person's cognitive load, defined here as the amount of working memory or short-term memory someone is using while interacting with a website or application. When a person's cognitive load is overwhelmed it can result in their being fatigued and unable to successfully interact with a digital experience.

The Web Content Accessibility Guidelines (WCAG), developed by the Web Accessibility Initiative (WAI) (W3C, 2008), address concerns of various aspects of web accessibility features. However, they are largely created by and for individuals with physical and sensory (i.e., vision and hearing) disabilities, not by individuals with other sensory processing, communication, or cognitive disabilities, such as people on the autism spectrum and intellectual disabilities. Although WCAG 2 incrementally advances web content accessibility not all user needs are met by these guidelines. Aware of this, the WAI convened a Cognitive and Learning Disabilities Task Force (COGA) to provide guidance around cognitive accessibility. The Working Group reports that some cognitive accessibility user needs are not addressed in existing W3C standards. Currently W3C is actively working to provide additional guidance on cognitive accessibility, including: updating "supplemental guidance" beyond what fits into accessibility standards now, developing additional requirements to be included in future versions of WCAG, developing standards for personalization, which is a key aspect of cognitive accessibility (W3C, 2021).

Digital accessibility in education seeks to increase learning access and reduce barriers for students. As such, digitalization serves to improve learning for all and is not justified by itself. The primacy of pedagogy is essential to ensure accessible digital education, and the selection, design and use of digital technologies and media exclusively follow the requirements of SEN and inclusive pedagogy and not vice versa. The Universal Design for Learning (UDL) as a framework that can guide the development of inclusive learning environments, may tentatively be interpreted as having the potential to be an overarching preventive strategy for inclusive digital education. However, further research on this idea is needed (Weber et al., 2022). In this sense, there is little guidance for developers and teacher alike, to produce tools and resources for learners with ASC and ID.

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Clear guidelines, informed by end users and developed through a systematic process, are needed. Our aim was to use an exploratory and participatory descriptive study approach to create a set of recommendations for developing accessible digital education tools targeting learners with ASC and ID.

This study evaluates information elicited from a series of stakeholder focus groups to understand existing practices, needs, barriers, and goals for the use of the digital education tools and content by learners with ASC and ID, educators and support staff and parents. In order to increase learning access and reduce barriers for learners and to inform the development of accessible tool for digital education, we will present recommendation based on the evaluated information and considering current web content accessibility guidance for people with autism and ID.

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METHODOLOGY

STUDY DESIGN

An exploratory and participatory descriptive study was carried out using focus group discussion (FGD) with a diverse sample selected using the principle of maximum diversity on the basis of different socio-demographic parameters such as age, gender, socio-economic and education status. The following stakeholder categories represented the focus group participants:

- Educators and other school based staff working with learners with autism and/or ID in inclusive or specialized settings in elementary education (grade 1 to 9): general education teachers, special educators, teaching assistants, psychologists, occupational therapists.
- Parents of learners with autism and/or ID in regular and special schools.
- Learners with autism and/or ID in regular and special schools.

Purposive sampling technique was used to identify the participants. The recruitment was done through several sites in five different geographical regions, that included regular and special schools, as well as nongovernmental organizations in the education sector supporting learners with autism and ID. Information sheet for school professionals and parents was send out to provide a brief summary of the research project and its aims, clearly outlining the entire research process in a language accessible for a non-expert audience. Participants were enrolled on a voluntary basis. A diverse sample was selected using the principle of maximum diversity on the basis of different socio-demographic parameters such as age, gender, socio-economic and education status.

Selection criteria:

- Include educators that have experience working with learners with ASC/ID and used some kind of digital apps/content with students with ASC and/or ID in their practice. This can be in the form of e-learning in the classroom, or remote synchronous of asynchronous learning.

- Include learners with ASC and learners with ID that have been exposed to some kind of e-learning, have used digital apps/content in their classroom or remotely.

- Make sure that a balanced representation of ASC vs. ID exists in the groups.

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- The number of participants 6-10, having more than 12 participants is not recommended.

- If possible, make sure that participants don't know each other from other contexts.

- Consider gender balance within the groups.

A series of ten FGD (five educators' groups and five parents and learners' groups) were conducted in the period of April and May 2022. Two FGD were conducted in each region: in Bulgaria, Cyprus, Greece (Eastern Macedonia and Trace, and Western Greece) and North Macedonia. The FGDs were conducted with educators and parents separately, while learners' participants were accompanied by their parents in the parents' groups. This separation helped ensure that members of both stakeholder groups would feel more comfortable in freely sharing information about their experiences.

In total, sixty (60) participants were enrolled. Five educators FGDs included a total of twenty-eight (28) educators' participants, and five (5) parents and learners FGDs included (thirty-two) 32 participants, twenty-six (26) parents and six (6) learners. Each FGD included between five (5) and seven (7) participants. Demographic characteristics of educators-participants are shown in Table 1. Parents data is shown in Table 2 and includes information on their children.

Six learners, age twelve (12) to seventeen (17) years, participated in the parents and learners FGDs. The gender ratio of learners-participants was five (5) male to one (1) female learner, of whom four (4) had been diagnosed with ASC, and two (2) with ID. The learners participated in the discussion to the best of their abilities. Some were very interested and always ready to answer a question, while other rarely spoke during the sessions. They were free to stand up, walk around, make movement with his hands and sounds with his mouth during the meeting.

In-person interviews were the primary method of data collection, while 2 sessions were conducted via Zoom to accommodate to the availability of participants. The discussions, led by a team of investigators with the role of moderator and assistant moderator, followed the structure of the focus group guides (annex 1). based upon a set amount of open-ended questions and asked to elaborate on certain points when necessary. In all sessions, verbal permission was gained to both participate in, and have sound recording of, the FGDs. Each FGD was audio recorded. Thematic analysis was undertaken by the lead researcher.

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Table 1. Demographics of educators - participants

		# of respondents	% of total (N=28)
Country of residence	Bulgaria	7	25.0
	Cyprus	5	17.9
	Greece, Eastern Macedonia and Trace	5	17.9
	Greece, Western Greece	5	17.9
	North Macedonia	6	21.4
Gender	Male	8	28.6
	Female	20	71.4
Type of respondent	Teacher	5	17.8
	Special educator	14	50.0
	Teaching assistant	1	3.6
	Psychologist	2	7.1
	Occupational therapist	6	21.5
Highest degree completed	Bachelor's degree	10	35.7
	Master's degree	17	60.7
	Doctorate degree	1	3.6
Age group	30 or less	8	28.6
	31-40	10	35.7
	41-50	5	17.9
	51-60	4	14.3
	over 60	1	3.6
Years in practice	Less than 5	4	14.3
	5-10 years	8	28.6
	11-20 years	9	32.1
	over 20 years	7	25.0
Type of practice	Public	18	64.3
	Private	1	3.6
	Public and Private	9	32.1
Students' type of SEN	ASC	4	14.3
	ID	3	10.7
	Both	21	75.0

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Table 2. Demographics of parents - participants

		# of respondents	% of total (N=26)
Country of residence	Bulgaria	6	23.1
	Cyprus	6	23.1
	Greece, Eastern Macedonia and Trace	5	19.2
	Greece, Western Greece	3	11.5
	North Macedonia	6	23.1
Gender	Male	5	19.2
	Female	21	80.8
Age	30 or less	1	3.8
	31-40	5	19.2
	41-50	14	53.8
	51-60	6	23.1
Employment status	Full-time job	11	42.3
	Part-time job	4	15.4
	Fully responsible for housework	5	19.2
	Unemployed	3	11.5
	Retired	1	3.8
	Volunteer	2	7.7
Highest degree completed	Some high school, no diploma	3	11.5
	High school graduate, diploma or the equivalent	8	30.8
	Some college credit, no degree	3	11.5
	Trade/technical/vocational training	2	7.7
	Bachelor's degree	4	15.4
	Master's degree	6	23.1
Area of living	Urban area	12	46.2
	Semi urban area	10	38.5
	Rural area (remote areas included)	4	15.4
Child's gender	Male	19	73.1
	Female	6	23.1
Child's age	5-7 years	2	8.0
	8-10 years	4	16.0

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	11-13 years	6	24.0
	14-16 years	6	24.0
	17+ years	7	28.0
Child's diagnosis	ASC	20	80.0
	ID	1	4.0
	ASC and ID (concurrent)	4	16.0

METHOD

For the analysis we used transcription of recorded FGDs and detailed observers' field notes. All sessions were transcribed verbatim and anonymized before analysis. The method of thematic analysis was used to evaluate the data (Krueger, 2014). We used the most widely adopted approach for thematic analysis outlined by Braun and Clark (Braun & Clarke, 2006) consisting of 6 steps: (1) familiarization with the data, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes, (6) producing the manuscript. Notably, this method of analysis is recursive, whereby each interpretation and finding is compared with existing findings as it emerges from the data analysis. Frequencies are used only in the broadest terms (e.g. many, some, a few).

First, the lead researcher familiarized herself with the data by examining and re-examining the transcripts and audiotapes. Second, initial codes were generated to organize the data on potential items of interest. One focus group discussion was coded; thereafter, the researcher defined a coding framework for the remaining dataset while denoting possible patterns or discrepancies between the codes. Open coding was used to ensure flexibility to incorporate themes outside the questioning route. Third, the identified codes from all focus groups were organized in preliminary themes. The final themes were constructed by reviewing the preliminary themes for commonness and coherency, and as well as for their sufficient distinctiveness to justify separation. Lastly, they were modified with adequately clear and descriptive denominators.

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FINDINGS

Ten groups of relevant exemplars were interviewed and responded to data requests that culminated in this report. They shared experiences, challenges, and successes using digital learning to address equity gaps in their context. The presentation of results is organized in five themes that emerged from the data.

The first theme addresses accessibility as the concept of whether a product or service can be used by everyone—however they encounter it. It reflects the ease or difficulty for users to access a particular educational technology, tool or digital content.

The second theme concerns acceptability and cultural appropriateness, understood as the perceived fit, relevance, or compatibility of the technology to a particular user, provider, community or setting.

The third theme looks at the issue of access to appropriate IT resources at the school level – hardware, software, internet access and affordability as the true cost of implementing a particular technology. The construct of affordability depends on the costs of the particular technology, the cost of implementation, and the cost of accessing the technology in a particular location.

The fourth theme concerns creation of digital content that is of high quality, and individualized, designed for the needs of the learner.

The fifth theme reflects benefits of digital learning and teaching as perceived by the relevant stakeholders.

In each of these themes, key points are identified and illustrated with respondents' own voices.

ACCESSIBILITY

Educators generally agree that most apps and tools available to them are not accessible to students with cognitive challenges including ASC and ID. Their experience illustrates the extremely limited number of specialized apps and digital content designed to meet the needs of students with ASC and/or ID. These challenges were experienced both in class as well as during distant education.

During school lockdowns teachers report that parental involvement and support was curtail to student success as the majority of tools and platforms used for teaching were

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difficult to manage for their students. Remote education required that a parent is constantly present by the child during classes.

With the help and guidance from someone at home, digital tools can be accessible for these children. Nevertheless, in my experience, distance learning was more of a trouble for the kids than a help, if I may say so. (ID#5, Special Educator)

With regards to technical accessibility, it is easy to press two buttons and enter the virtual classroom. But, if we're talking about non-technical aspects, then I think they [e-learning platforms] were not accessible (reduced accessibility, a virtual environment that does not attract or hold the attention, hyper-stimulation of sound and image). All these do not give a calm tone that a digital educational space must have. (ID# 2, Parent)

Many of the apps used in class, on the other hand, also required support from an adult, usually the teacher, who needed to provide additional instructions and help for students with ASC and/or ID. Their experience shows that very often students are not able to interact independently with content or software due to several aspects of the user interface design.

One special educator made a reference to the intellectual accessibility, noting that interfaces usually are not accommodated for diverse ways of understanding information, characteristic for learners with ASC and/or ID. The concept of universal design, a set of principles that can facilitate accessibility for all, is not integrated in the design of most digital educational tools currently available. Most commonly mentioned challenges for users with ASC and/or ID include over-complicated language, extensive menus, or nested menus, that make understanding, navigation and orientation difficult.

On the other hand, it can be noted that a higher percentage of those educational games and applications that are available and can be used for free are not adapted to their mother tongue and as a barrier also occurs and does not respect universal design when games and applications are created. (ID#15, Special Educator)

It should be simple; it shouldn't be too complicated… It shouldn't try to show it can do everything! It should be clear, plain, easy to use, easy in its language because, sometimes, you see a tool in English and then in Greek, some tools, their Greek is a bit...bad. Or of a too high standard, or badly translated from English... Let me give you an example, in e-class, there is a menu option "internet links" (υπερσύνδεσμοι διαδικτύου). No child can understand what "Hypersyndesmoi diadiktiou" is! Even if they want to find it, there would be a blockage in communication, with the information (laughs). Whereas, if it was only written as "link" can it be perhaps easier to understand? I am not sure if the child with autism would understand better the term

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"link", but "hypersyndesmoi diadiktiou" is a level of speech that, even for me, is a bit... unnecessarily difficult! Or, instead of letters, it could have a symbol, the symbol of a link. They may be more at home with this... Or perhaps, instead of having written "Document files" it could have the image of a file... such kind of simple things... (ID#1, Teacher)

... It's the setup of tools sometimes that is a bit complicated and I assume that this can also have a function disorientating a student with ID or ASC... (ID#1, Teacher)

It is agreed that the appropriate digital tools should have a clear and simple interface having in mind users with ASC and/or ID and teachers likewise and to support the users' native language. Respondents acknowledge that learners with ASC and/or ID learn well from visual media because "pictures are their first language – while words are their second language". In this sense, they recommend using clear and simple visuals to clarify information. However, visual and audio modalities have to be carefully designed to support focus and concentration on the task at hand, by avoiding distractions such as loud colours, background graphic and audio details that don't convey information.

The usual use of colours and high contrast are not favourable for a student with sensitive vision and colour and contrast sensitivities. Visual distractions such as textured backgrounds, moving images, decorative elements that do not convey information, and other visual and/or sonic ''clutter''; these types of elements may make the site difficult or impossible to comprehend as it requires extensive mental effort from the learner to focus on task at hand.

Tools and platforms that are more complex, like 'e-class'[1] and especially 'e-me'[2] where there are too many things, many colours, many pictures, too extensive menus are not so attractive because students get lost in them... and I imagine that if neurotypical students lose themselves, then even more for the others... they would say "Where is that Mrs, I cannot find it", "I enter in there, I cannot find what I was writing" "here it says this..."... it was a bit difficult to organise oneself in an environment having so many options... Many information, many options, maybe more than necessary, we need something more simple and easy to use... (ID#8, Teacher)

Atypical sensory sensitivities are common among learners with autism and/or ID and they present in various ways across a spectrum of hipper to hypo sensitivities in all

[1] https://eclass.sch.gr/ Electronic School Classroom (e-class) is an educational platform for students and teachers, and is used daily in schools throughout Greece.

[2] https://e-me.edu.gr/ Digital Educational Platform e-me is a modern, collaborative, social and scalable digital platform for students and teachers available from the Ministry of Education & Religion (YPAITH) as an asynchronous education platform for Greek schools.

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sensory modalities. For an accessible digital tool, visual and auditory sensitivity profiles of learners are particularly relevant. It is suggested that the tool design can accommodate the needs of the learner in this sense, by offering customization in concordance with the user's sensory profile.

Also, it would also be possible to make a sensory profile, the sensor profile should be entered, because it is very important how to combine what needs to be done. Loud music - no/yes, movement - no/yes. So that anyone can make an adequate sensor profile. (ID#13, parent)

The efficient digital tool is expected to empower educators to easily create custom, interactive, digital activities from their own original materials or by adapting a teacher-created resource. It is perceived important that the tools can seamlessly integrate with how teachers already teach, and moreover how learners learn. This means to pair technology with instructional content to differentiate for all students' needs, so that no learner is left behind, with activities that are individualized, self-paced and engaging. This is particularly important, for the learners perceived as "low functioning".

These tools must focus more on children who have lack of verbal expression and seem more "seriously" autistic. Existing materials and programs, as well as educators focus more on this side of the spectrum which is already well functioning, on the children that used to fall under the title of Asperger's Syndrome because results are more rapid and easy. However, there is a great number of children who remain non- verbal and there are no tools or therapists that bother with them because "they are difficult" and "who wants to bother himself trying to find a solution for such complex cases". I don't want to diminish the importance and severity of problems that people with high functionality are facing, it's just that many times, the parents of the other, the "difficult" children do not find the tools they need and remain in despair without the possibility to communicate even the simplest things to their children. *(ID# 3, Parent)*

…What I would like to pay attention to, is for all of it [the digital tool] to be determined by the age of the children, and to include the methods, techniques, methodology of working with such a child, ideas on how to capture something the child needs to know… (ID#15, Parent)

Many learners with autism and/or ID really struggle with making mistakes. The cognitive style that involves inflexibility, proclivity towards perfectionism and strong focused on details, makes errors in their work particularly frustrating and can be barrier to learning as learners are prevented from learning from their mistakes. Parents and teachers often shared the following phrases: "he doesn't like making mistakes," or "If

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he gets it wrong, he stops work", "he will cry/scream/tantrum when they get something wrong", "apologize for the error over and over (and over and over)". When asked what they find particularly frustrating about the digital tools, one learner highlighted himself:

"I don't like making mistakes." (ID# 5, learner with autism)

Thus, it is important that the design of tools supports errorless learning by providing prompts and immediate feedback to the learner.

Reinforcement is another important aspect in educational support for learners with ASC and/or ID, thus it is necessary that the design of the tool provides opportunities for individualized and meaningful reinforcement, by incorporating gamification features, the use of badges, rewards, points and similar token systems.

Moreover, something I forgot to tell and is good, I mean it works in a positive way, is to have feedback... towards the child with different forms. Meaning, I write an exercise, can I see the result instantly? Can I see the correct answers instantly? Can I see an instant reward if I have done something correct? It is my impression that this works positively, even for children with autism, E.g. "look! My score got higher! It was 50% and now it is 60%!" or "Now that I have answered correctly, a firework pops out!" Silly things that. I think that in education, in general, they play a role, I need instant feedback, not wait for the teacher to check on my exercise and tell me whether it is correct or wrong after a week. And if digital tools are meant to be used in order to enhance students' autonomy, they should be given this feedback in an automatic way (laughs), it should not depend on my own intervention. (ID#1, Teacher)

Respondents noted that it is helpful to have an open access, single platform for versatile activities around many different skills: across all academic subjects, but also communication and social skills. Instead of juggling multiple tools at once, educators can go from searching to prepping to assigning interactive lessons, all in one place.

They should be cheerful, with soft colours so that students do not get tired, it should have the possibility to adjust the time of completion of every exercise, the possibility to use many different types and ways of exercises or methods, possibility to practice, possibility to explain errors, reminder of techniques or rules during exercise completion if students tarry in finding the correct answer, praise, verbal and maybe even visual instructions on software use, meaning how can you make or play this game/activity, etc... (ID#3, Special Educator)

I also think that should be easy and have fast connection also be free, also have a single platform for everything about study and education. To be systematized by ages and

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school subjects or have some resource that can help and increase student's skills. (ID#23, Special Educator)

Educators stressed that a digital tool/app should also support parental involvement, and should be designed having in mind simple and practical options for parent users. Expectedly, similar idea was found across the parents' groups. Parents agree that their involvement in digital learning and better positioning to help with kids' schoolwork can drive better student engagement and performance.

Parents are really important for us for students' education which mean they also should have access for digital tools and use it in home with kids. (ID#4, Speech and Language Therapist)

Some parents don't have enough competences about digital tools and they don't have way how to help to their own kids. (ID#21, Special Educator)

The parent must, the parent is 90% the one who should capture the things for that child, we cannot turn only to special educators and speech therapists, the whole thing, 90%, I will say again, of the work is up to us. (ID#15, Parent)

While participants' experience to date with digital learning is that learners are interested and motivated to use digital tools, it is evident from the discussion that learners with cognitive differences face barriers in accessibility to digital learning. There is an urgent need for fully accessible digital infrastructure, tools and content, designed to take into account the learner's particular needs, that will provide quality educational opportunities on equal basis for all learners.

I think we [in North Macedonia] are still very far behind in a world where children with autism do online things, games and everything. I think we are far behind, that we can still improve a lot. (ID#17, parent)

ACCEPTABILITY AND CULTURAL APPROPRIATENESS

Another significant barrier is the lack of native language localization of most popular and widely used apps. The majority of participants across all groups accented the fact that there is a very limited number of tools available in native languages.

I need a tool that will be free i.e. accessible to everyone, in Macedonian language and in which in a simple way and with pictures will be processed all the contents of all school subjects in primary and secondary school that the child learns. (ID#13, Educational Assistant)

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It's difficult for me, because the language is English. (ID#24, learner with ID)

The language barrier renders those apps not acceptable for users, nor culturally appropriate, but also can have a negative effect on language development, especially in learners who are still mastering the native language and communication skills.

I think that [in North Macedonia] there are very few applications compared to another speaking area, for example the English speaking area, which can only confuse the child. At least I think so, speech therapists say so. (ID#15, Parent)

The same observation was shared for other multimedia content, available in digital format, that significantly limits the selection of most appropriate tools for learners with autism and/or ID.

Some of the videos available on YouTube are very helpful (for instance the series "learning otherwise" is very good) and digital exercises with school content (interactive) which, unfortunately do not exist in Greek language. (ID# 3, Parent)

Because we have for example one or two platforms and they are not the best for my child, we don't have many options to choose between platforms and online tools. (ID#22, Parent)

TECHNOLOGY INFRASTRUCTURE AND AFFORDABILITY

Of course, provision of infrastructure is a basic requirement for digital learning, that is still missing in some communities. In the discussions, it was highlighted that often the school or home infrastructure is not conducive to digital learning.

…in all the schools I have served in, there was no infrastructure to make use of digital tools… (ID#8, Special Educator)

Many respondents shared challenges with the school infrastructure, such as outdated technology in schools and week internet connections. A Learner with autism, who is very interested in technology and likes to talk a lot about that, described his experience with digital learning in school as difficult and annoying:

…I have difficulties because of hardware… I am annoyed by the bad internet connection… (ID#10, Learner)

Also, majority of respondents across groups agreed that the cost of specialized digital tools and platforms is a significant impediment to accessible digital learning.

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… everyone has free access [to the app], but there is a limit to how many different things you can make for free… (ID#10, Special Educator)

From the point of view of having access easily (finding them), they are all accessible. Unfortunately, most means of assistive tools for learning that have a good quality are expensive. (ID# 3, Parent)

In the context of on-line teaching, as most specialized tools and platforms are not affordable to teachers, as they are not provided by the schools, or education authorities, and present a financial burden for teachers themselves, respondents reported using popular conferencing platforms (free or provided by education authorities) that are too complex for users with autism and/or ID.

Disappointing is that not every kids and students can use the normal online platform, on this point of view, should create a special platform and website for learn students with Special Needs. (ID#18, Occupational Therapist)

I do not have [access to] a tool for proper digital lessons for students with Special Needs and on this way I need to use different website and platforms. A lot of this platforms are paid and this increases the problem. (ID#21, Special Educator)

QUALITY INDIVIDUALIZED DIGITAL CONTENT

Most respondents first started using digital technologies during the Covid-19 crisis, when they had no choice but to adapt quickly to the imposed circumstances of distant or blended education. Faced with a steep learning curve, they reported rapid progression in digital skills and competences over a short period of time.

It was something new… perhaps, at the beginning, it had seemed difficult but afterwards I enjoyed it so much… especially when I saw the response of my students. I have had many possibilities to adapt and create the content I wanted and for a particular objective. I consider it to be easy, it's always the fact that starting something new and unknown can be, maybe, stressful but after putting it into practice, it becomes easy. (ID#3, Special Educator)

Creating or adapting digital teaching and learning content is easier for many respondents compared to the paper-based alternatives. They reported that digital tools were an easy and time-saving way to present teaching material. Notably, this was experienced by respondents that were creating some type of interactive content using

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specialized software and apps, whereas the opposite was reported by educators that don't have access to specialized digital tools and platforms. In this context, the latter group report challenges in preparing for a quality lesson.

Because I use the content of live sheet work most often I do not need to adapt anything, there are many different materials there and can be found for the needs and interests of each child. Therefore, with these tools today my work is much easier and I am preparing faster (ID#14, Special Educator)

Easy way to present study material and save a lot of time. (ID#17, Teacher)

The difficult for create online education lessons is coming from the fact that there is no united platform because you need to spend a lot of time for searching proper materials and lessons, also almost you need to remake to be practically for our students. A lot of time almost in every website for registration. (ID#23, Special Educator)

Careful considerations are called for when designing an accessible lesson with the help of digital technology, in line with the learner – centred pedagogy approach in inclusive settings.

It is not easy to create such [digital] content because the main emphasis in creating such content is the principle of accessibility in order for the content we create to be able to suit the abilities of persons with ASC and ID. When creating content, it needs to be creative, it takes time and an idea where an educational access game can meet the needs of all persons. When creating such content, it is also necessary to consider and define the topic, which is the purpose of the activity, age, images we will use, their size and colour, sounds. (ID#15, Special Educator)

There is a shared awareness among participants that accessibility can mean different thing for different students and their experience shows a strong need for programs and tools that can easily accommodate individual student's strengths, needs and educational goals. In lack of such resources, special educators from Bulgaria and North Macedonia noted that adapting digital materials for their students is a cumbersome and frustrating job, but crucial for student success. Their experience with digital teaching and learning shows that most of the available tools and app can't be used to create individualized exercises, adapted to the particular student and the specific learning goals.

In my opinion, digital tools are difficult to access. Not enough websites or material that can be used for our children. We need to do it ourselves for every student who follows a personal program different from the main plan. (ID#17, Special Educator)

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I think that is not enough websites and tools for students with Autism and Special Needs. There needs to be a proper application or website. Without that, as my college said before me: we need to remake a regular lesson to a lesson for the special needs student. (ID#21, Special Educator)

A noteworthy observation across groups is that some educators discussed accessibility only in terms of provision of devices and platforms/tools, stating that nowadays digital technology (devices) is easily available and daily internet access is common globally. This perception highlights the need for more education for teachers and school professionals on the concept of accessibility and the different dimensions of accessibility specifically for learners with cognitive differences.

I think e-learning tools and content are available and accessible to any child who has a computer or tablet (ID#13, Educational Assistant)

Next, our respondents shared a need for further enhancement of teacher competences related to digital skills, and equally important, competences in methodological approaches for digital teaching for students with ASC and/or ID.

The problem is that we don't have enough explanation how to use digital tools and in this point of view I think it's a problem also for parents and students. (ID#18, Occupational Therapist)

…the teacher must increasingly be able to reflect on what and how to transmit information to the new generations. In a world that is constantly changing, I believe it is essential that teachers mark specific paths to learn the best about the use of information technology because we cannot teach what we have not first assimilated… (ID#23, Occupational Therapist)

BENEFITS OF DIGITAL LEARNING

In spite of the challenges reflected above, many respondents shared positive experiences with digital learning tools and continuously use digital tools in class. As a main benefit from using technology for teaching and learning majority of respondents reported increased interest and motivation in learners, that positively influences their concentration and memory as well as comprehension of the content and independent work. Simple but interactive materials were seen as the most rewarding in terms of sustaining interest and focus on the task.

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I think it is quite helpful and useful for students as it arouses their interest, a motivation for learning and practice, it is something more pleasant than classic, with workbook and pencil, teaching… especially for students who are not extremely fond of writing... It is easy to work, so they can work on it on their own sometimes, without a parent's supervision... You have the possibility to do an exercise as many times as you want, whenever you want.... There is the possibility for the teacher to see a student's error and explanation of this so as to make understanding better. Also, the educator can adjust time for an exercise or for different ways of exercises, and so on... (ID#3, Special Educator)

Most parents also agree that for their children, digital learning is easier compared to traditional pen and paper approach to learning.

In general, they [digital tools] arouse more interest, because everything is cartoon, everything is coloured and because he has this desire to use it, and because of everything [learning] is more easy. (ID#19, parent)

Learners also shared that they find digital learning easy, appealing and motivating, describing why they like using digital tools in the following way:

…You can do few task one by one and everything is at one place. (ID#23, learner with ID)

Everything is coloured and cartoon and because it's not on a paper. (ID#24, Learner with ID)

Technology enables students to access the curriculum and enhance academic skills, and provide disability specific support so that they can participate in inclusive school settings in a number of different ways. Multimedia, or presenting information through a variety of methods– using images, sound, text and video, can be combined in a variety of ways to more effectively reach all students in a classroom situation. Majority of respondents supported the notion that the multimedia embedded in digital learning can be a very powerful teaching tool.

I think all the tools and applications I use are very useful, I can't only point out one. I think they are useful because they are multimedia, i.e. they have sound, image, if it is with a touchscreen they also use motor skills, i.e. encouraged to use all senses and through these applications and tools combine different learning styles (ID#14, Special Educator)

From my experience as a teacher [and a parent] I have seen the benefits of visualised audio lessons. Such a lesson gives more stimulation to my son. (ID# 11, parent)

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Educational support of children with autism and ID often include the use of visual supports, cognitive tools to promote independent work and transitions, facilitate learning, communication, social and emotional skills. Although visual supports are effective in helping to diminish many of the challenges of cognitive and learning disabilities, they are difficult and time-consuming to create, distribute, and use. Technology allows for interactive visual supports that would address the many challenges inherent to current paper-based tools and practices, and makes visual images more accessible to the individual with ASC. A big advantage of digital visuals is that they don't require cutting, printing, laminating and storing, while at the same time they provide a larger variety of options for students to practice skills.

I am currently using a visual schedule app in a mainstream class and it's been great. This is his [student's] first year in class and him staying on track in a less restrictive class was a concern for the parents. He used it since the 1st day of this school year and most of the summer. It's a part of his IEP and his parents are totally on board. It's working. (ID #17, Teacher)

With that application [Buzzy the Knowledge Bug[3]], he learned, let's say, all those aspects that are taught by a special educator, front-above, up-down, inside-outside. He easily learned those mostly through the game, because it was created to emphasize those aspects anyway. We learned those that are quite important in that period. (ID#13, Parent)

Learners, parents and teachers alike reported the effectiveness of keyboards or touchscreen technology as facilitators of communication and social interaction in the classroom environment, for non-speaking learners or learners overwhelmed by social anxiety.

It was easier for me to adapt digital education for students with autism than the "normal", the typical education… At least, as far as I am concerned (laughs)! I am saying this as I have a specific case in mind, for I have told you, having a student who is non-verbal, digital interaction has helped us find a communication channel... Or, as I knew that in the real classroom this particular student would not answer verbally my question, or it would have taken him ages to write it down on a paper, in the digital class he would do it ... and he would do it with more diligence that the other kids because... perhaps he found more easy to press the choices or drag the photos rather than writing the exercise on the workbook... No, for me, adapting content was not more

[3] Buzzy the Knowledge Bug is a series of children's games made by Humongous Entertainment.

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difficult... It was more difficult for me to adjust to the needs of this student in the real class than in the digital one. (ID#1, Teacher)

My son has done WebEx while he was in mainstream school. Using WebEx was very enjoyable as despite his selective mutism, he was not nervous to answer and could talk through the chat. He was particularly involved in the activities because he communicated from the keyboard. (ID# 7, Parent)

I prefer remote, especially since we switched providers. I liked the interaction with WebEx because I'm the comfort of my own home. My chair at home is very comfortable and convenient. At home I have very good equipment. (ID# 10, Learner with autism)

Notably, digital tools can provide alternative ways of engagement and expression for students that have challenges with the grapho-motor skills needed for using a pen/pencil.

...maybe because they [learners] have a problem with motor skills and fine motor skills, they do not know how to write with a pencil or pen, but specifically mine [my son] knows how to write on a computer, it is much simpler. You click on a letter and it pops up in front of you. He also knows how to write his name on a computer, and he does not know how to write it with a pen or pencil. It is much simpler for them, they like simple things. Probably it is the problem with fine motor skills, although we have worked hard. He is great with his rough motor skills. He is literate through a computer, and he does not know how to use a pen. (ID#18, Parent)

Further, the integration of synthetized speech technology with digital learning tools provides the necessary assistance in language development, literacy and communication, necessary for many learners who can thrive with the right support.

As far as any PC in general is concerned, this is easier to use, familiar [to the learner] and offers solutions, such as voice typing. When it comes to reading, my child recognizes more easily words seen on a monitor than on the paper… (ID# 1, Parent)

When using the digital tool 'Govorko[4]', intended for AAC, it was of great benefit to me. I used it daily with children who face some difficulties in speech and communication. By applying the tool, the person was very easily involved in the activity we applied. Through the use of synthesized speech, users were able to express themselves more easily and share what they currently need (ID#15, Special Educator)

[4] Govorko (Говорко) AAC mobile app than enables a smartphone to be used as a communication device.

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DISCUSSION

The role of technology in providing support to students with special needs is widely recognised, and there is evidence for the effectiveness of both particular hardware platforms, such as mobile devices, as well as numerous specialised software and apps. Educational technologies are likely to play an increasingly pervasive role for students with special needs, with educators called to keep abreast of technology developments so as to make informed decisions on the use of such technologies in the classroom (Good, 2021). Finding form stakeholders experience are in line with research that digital technologies have the potential to enhance the learning experience for learners with ASC and ID when used appropriately.

There are a number of ways in which technology can enable students to access the curriculum, enhance academic skills, and provide disability specific support so that they can participate in inclusive school settings. As a main benefit from using technology for teaching and learning we found increased interest and motivation in learners, that positively influences their concentration and memory as well as comprehension of the content and independent work. As perceived by stakeholders, for some children, digital learning is easier compared to traditional pen and paper approach to learning. Educational support of children with ASC and ID often include the use of visual supports, cognitive tools to promote independent work and transitions, facilitate learning, communication, social and emotional skills. Technology has the potential to overcome challenges inherent to current paper-based visual supports and makes visual images more accessible to the individual with ASC. Multimedia, or presenting information through a variety of methods– using images, sound, text and video, can be a can be a very powerful teaching tool to reach all students in a classroom situation. Further, for some learners (non-speaking learners, learners overwhelmed by social anxiety, or challenges with the grapho-motor skills needed for using a pen/pencil) keyboards or touchscreen technology are seen as facilitators of communication and social interaction in the classroom environment. The recent development of synthetized speech technology can provide the necessary assistance in language development, literacy and communication, necessary for many learners who can thrive with the right support.

As shown above, digital education and digital content use provide opportunities to increase learning access and reduce barriers for students with ASC and ID. However, they can also maintain or increase existing inequalities in education and even create new ones.

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Vulnerability to digital exclusion can arise from unavailable or poor technical infrastructures or in digitally marginalised groups and communities. The third theme looks at the issue of access to appropriate IT resources at the school level – hardware, software, internet access and affordability as the true cost of implementing a particular technology. The construct of affordability depends on the costs of the particular technology, the cost of implementation, and the cost of accessing the technology in a particular location. Financial subsidies for development of digital infrastructure are seen as a facilitator of accessibility in this sense. In addition, open source technologies for teaching and learning, as well as open educational resources can help to bridge the current gap in digital education.

Another significant exclusion factor is the perceived fit, relevance, or compatibility of the technology to a particular user, provider, community or setting. The second theme concerns the lack of native language localization of most popular and widely used apps as well as digital multimedia content that significantly limits the selection of appropriate tools for learners with autism and/or ID. The language barrier renders those apps not acceptable for users, nor culturally appropriate, but also can have a negative effect on language development, especially in learners facing challenges in language and communication skills. The findings imply that design and development of digital education tools and content needs to consider acceptability and cultural appropriateness.

Access to digital tools that meets both teachers' and learners' particular needs is a key area of concern. Teachers are also concerned with access to high quality educational resources and easily designing and developing their own material. We look at accessibility as ease or difficulty for users to access a particular educational technology, tool or digital content concerns software (tools, such as web applications) and content (educational resources in the form of digital media).

The priority in supporting digital learning is developing software that can be adapted to diverse cognitive and sensory styles of learners with ASC and ID. Learning styles can vary between visual, auditory or a learning style that is tactile or kinaesthetic in nature. While many children learn through multiple means of input, most children with ASC and ID have one preferred primary learning style. This is also true for children who demonstrate atypical sensory processing symptoms. Sensory differences are seen to negatively affect school life, can cause anxiety, distress and distraction for learners and teachers, and disrupt learning and school participation for learners (Jones, 2021). The negative effect of sensory sensitivities on learning demonstrated in research and

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stakeholders experience implies that digital tools and content should account for the sensory profile of each learner.

In addition, digital tools and content should fit in with the curriculum and individual learning goals, and with effective methods of teaching and learning. Primacy of pedagogy is essential to ensure accessible digital education (Weber et al., 2022). The selection, design and use of digital technologies and media exclusively follow the requirements of inclusive and SEN pedagogy and not vice versa. Digital learning needs to incorporate principles of evidence based teaching practices for learners with autism and ID. For instance, considering teaching practices based on the principles of ABA, such as breaking skills into very small steps, errorless teaching, prompting, reinforcement, and implementation of token economy have implications for software development as well as content design and development. Software developers need to have increased awareness of these requirements and provide teachers with tools to design content that can incorporate ABA, visual support, video-modelling, social stories, scripting or other evidence-based practices.

Engagement and motivation of the learners is another key consideration in designing digital tools and content. Building on the traditional success-oriented strategies in SEN pedagogy is also instrumental in increasing learners interest and maximising engagement and achievement satisfaction. Although, classroom technology by itself has shown it can support school practitioners to motivate and encourage positive behaviour among students inside and outside the classroom, one particularly effective method of learning that has arisen with digital technology is gamification—adding typical elements of gameplay to school lessons to make them more engaging, and effective, for students. Gamification elements appear to align well with principles and concepts within ABA (Morford et al., 2014). Manu authors maintain that effective gamification comes down to effective use of behaviour principles such as errorless learning, prompting, token economies, positive reinforcement in general and immediate feedback (Valencia et al., 2019).

The fourth theme addresses concerns regarding quality individualized digital content. When looking at accessibility in digital content, the most influential concept is Universal Design (UD). At its most basic, UD is the principle that all products and the “built environment” are designed to be usable by everyone, regardless of age, ability, or status. The phrase “built environment” refers to human-made physical spaces for working, playing, living, and learning. Universal design for learning (UDL) applies those design principles to the science of how people learn, promoting the creation of materials that work for all learners, rather than a single, one-size-fits-all solution. This

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entails taking a flexible approach to learning design using tools that can be customized, personalized, and adjusted for variable learning needs (Meyer et al., 2014). A key understanding of UD is that accessible and inclusive design benefits everyone, not just users with disabilities. For example, closed captions have been shown to: improve reading ability, word recognition, vocabulary, and comprehension, and support language learning (Bowe & Kaufman, 2001; Evmenova, 2008; Linebarger, 2001). It is regarded as a proactive and hence preventive approach towards accessibility, rather than reactive when problems arise, in the context of digitally enhanced face-to-face learning, as well as distance education and pedagogical use of digital technologies (Brusca-Vega & Trekles, 2019; Dazzeo & Rao, 2020; Smith & De Arment, 2019). In the literature, the aim for implementing UDL can be summarized as creating equity and support for learning in digital educational settings (Dalton & Khurana, 2020; Dazzeo & Rao, 2020; Green & Tolman, 2019). This emphasizes the importance of considering UDL together with issues of didactics.

Software development is greatly influenced by the World Wide Web Consortium's (W3C) Web Accessibility Initiative (WAI), which developed de-facto standards and support materials to help online content developers understand and implement accessibility. One of the central elements developed in the WAI are the Web Content Accessibility Guidelines (WCAG). Although they are non-binding, they have had, and continue to have, an immense influence on the design of websites and web content and on corresponding legislation on accessible internet worldwide. The WCAG aim to make web content perceivable, operable, understandable and robust (with regard to compatibility with other tools and technologies). WCAG guidelines include accommodations for blindness and low vision, deafness and hearing loss, limited movement, speech disabilities, photosensitivity, and combinations of these, and only some accommodation for learning disabilities and cognitive limitations; but will not address every user need for people with these disabilities (W3C, 2021). These guidelines address accessibility of web content on desktops, laptops, tablets, and mobile devices. Following these guidelines will also often make Web content more usable not just for people with disabilities, but to users in general.

The two concepts (UD and WCAG) are compatible as they are both perceived as proactive and preventable approaches to accessibility and diversity. They can guide the development of inclusive learning environments and may tentatively be interpreted as having the potential to be an overarching preventive strategy for inclusive digital education. The project consortium recognizes that this idea merits consideration in our subsequent efforts to facilitate accessible digital education for learners with ASC an ID, by empowering teachers and other education professionals to create learning

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environment and digital content that is accessible, quality, and individualized - designed for the needs of the learner.

Empowering teachers, specialist teachers, educational assistants to support children with ASC and ID in education needs to bring together competences in the field of digitalization, accessibility, special education and inclusion. Training teachers in the effective use of digital tools and production of content needs to be considered during initial training as well as being a form of on-going in-service training.

In the next section, we describe a set of digital accessibility guidelines for learners with ASC and ID to inform the design accessible web interfaces in the context of educational environments. These guidelines systematize and formalize recommendations and best practices extracted from the lived experiences of stakeholders including learners with ASC and ID, educators and support staff and parents. However, our recommendations take into consideration the most prominent concepts in the field of SEN and inclusive education, and web accessibility as two facets of digital education for learners with ASC and ID.

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GUIDING PRINCIPLES AND RECOMMENDATIONS

As a theoretical foundation for the conceptualization and systematization of the recommendations, we used the Jaeger and Barnett ‘‘information worlds’’ model, that defines three dimensions of information access: physical, intellectual, and social (Jaeger, 2012).

Physical accessibility has received the most focus on the web; examples include image descriptions, forms that are navigable by keyboard, user-controlled font sizes, and other accommodations for sensory disabilities. An example of intellectual (i.e., cognitive) accessibility is translating prose into a simpler and less abstract vocabulary. Examples of social accessibility would be content that explicitly spells out language pragmatics, or content that takes social or cultural context into account; for example, avoiding the use of the jigsaw-puzzle symbol for autism because in autistic and neurodiversity culture, this symbol is considered dehumanizing. As guiding principles for physical accessibility, we used the principles of the WCAG, the most widely used web accessibility standard: sites must be perceivable (can users make it out?), operable (can it be controlled?), understandable (can it be comprehended?), and robust (can it run on current and likely future technologies?). As guiding principles for intellectual and social accessibility, we used the principles of the plain language movement. Plain language is defined behaviourally by the Centre for Plain Language: ‘‘Can the people who are the audience for the material quickly and easily find what they need, understand what they find, [and] act appropriately on that understanding.

In addition, the analysis of the users’ needs and preferences revealed several general recommendations for developing and organizing digital tools and content. They include practices that integrate the methodology of teaching learners with ASC and ID with key principles of UDL.

GENERAL RECOMMENDATIONS

- Provide options to enable provision of prompts and reinforcement.
- Provide options to enable errorless teaching – enabling the wrong answer to become non-tappable/non-clickable.
- Provide options for alternative ways of representation of information (using text, sound, visualization)
- Enable various ways of interaction with the content, user’s actions and expression.

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- Enable personalization and customization for each student, considering learning styles and visual or auditory sensitivities.
- Provide options for creation of diverse forms of content in support of various area of development in addition to academics, such as social and communication skills, and various teaching strategies (social stories, scripts, modelling, communication books, visual schedules etc.)
- Provide an organized and searchable platform for various shared content.
- Provide technical and methodological instructions for teachers and parents.
- Provide different user roles (student, teacher).
- Enable data tracking, for insight in to user's progress

PHYSICAL ACCESSIBILITY

- Provide a selection of colour palettes options, including one with a dark background and one with a light background, again to accommodate colour and contrast sensitivity, or provide at least one low-contrast neutral colour palette option.
- Provide simple consistent navigation and highly consistent site behaviour (similar elements and interaction must produce similar, consistent and predictable results for increased ease of operation.
- Remove or visually tone down horizontal lines as separators and instead increase use of white/blank space between Web page elements to separate different contents or focus the user attention on a specific content.
- Avoid using elements that distract or interfere in focus and attention. In case you use it, provide options to suppress those elements on screen. For example: avoid textured backgrounds, moving images, decorative elements, and other visual or auditory elements that do not convey information.
- Use a plain accessible sans-serif font (e.g., Arial) for ease of readability.
- Provide font size options i.e. smaller font sizes in addition to larger ones as; large font sizes may make the page appear cluttered and difficult to read, and small font sizes may be illegible for some users.

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- Completely avoid using red colour for accents, as well as black for body text. Instead opt for soft pink and darker pink shades and blue/navy.
- Avoid the use of disturbing and explosive sounds, like sirens or fireworks.
- Allow for volume control – options to adjust the volume of audio content being played, including options to turn off the sound altogether, that are separate from the overall system settings.
- Use bigger icons, buttons and form controls that provide appropriate click/tap area and ensure that the elements look clickable.
- Use the simplest interface possible for ease of understanding.
- Provide options to customize the amount of element in the interface, their arrangement and enable features personalization where necessary.
- Avoid automatic page redirects or expiration time for tasks. The user is who should control navigation and time to perform a task.
- Allow critical actions to be reverted, cancelled, undone or confirmed.
- Enable compatibility with touch screen technology, for example avoid the hover action.
- Touch screen interactions should have the appropriate sensibility and prevent errors in selections and accidental touch in interface elements
- Provide easy to use and secure authentication, a simple and secure way to log to increase ease of operation.
- Provide open access - without a fee.
- Provide native language localization.

INTELLECTUAL ACCESSIBILITY

- Use icons or images to communicate redundant information with text, and accommodate multiple ways of understanding information. Provide information in multiple/alternative representation, such as text, video, audio and image for better content and vocabulary understand, also helping users focus on content.

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- Symbols, pictograms and icons should present a textual equivalent near to facilitate symbol understanding and contribute to enrich user's vocabulary.
- Use a simple and concrete visual and textual language, avoid jargons, spelling errors, abbreviations and acronyms, using terms, expressions, names and symbols familiar to users' context.
- Provide concrete examples where applicable to accommodate difficulties in understanding abstractions or generalizations.
- Be succinct, avoid writing long paragraphs, make content as short as possible without sacrificing precision and specificity, to reduce cognitive burden.
- Use mark-ups that facilitate the reading flow such as lists and heading titles.
- Enable a reading or printing mode for activities involving reading and concentration.
- Icons, images and label of menus and actions should be compatible to real world, representing concrete actions and everyday life activities in order to be easily recognized.
- Provide options to customize information visualization with custom images, sound and text according to individual user's preferences (allow uploading images and other pre-prepared digital content, audio files or recording sound).
- Provide a simplified and consistent navigation between pages, use location and progress indicators and present global navigation buttons (Exit, Back to home page, help) on every page. Clearly label site elements with their purpose everywhere on the site, even if it seems redundant, to make navigation and site functionality easier to follow.
- Show all important features and site navigation (as opposed to within combo box drop-down areas) so the user does not need to rely on assumptions to guess whether the item exists and how to access it. For example, completely visible list boxes or radio buttons can be used instead of combo boxes.
- Minimize scrolling so the user does not need to rely on assumptions about content to guess what might be on the page.
- Present appropriate instructions how to interact with interface elements.

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- Provide immediate instructions and feedback over an interaction restriction with the system or a certain interface element
- Provide feedback to confirm correct actions or alerting about potential mistakes and use audio, text and images to represent the message.
- In interactive lessons and educational activities, it is recommended allow up to five attempts before showing the correct answer.

SOCIAL ACCESSIBILITY

- Be specific and precise in language use; avoid colloquialisms, idioms, and ambiguity to accommodate difficulties with language pragmatics.
- Avoid icons with emotions or facial expressions.
- Explain the reason behind any nonstandard instructions or unusual information; provide additional pragmatic context to accommodate difficulties with language pragmatics.
- Use FAQ formats to organize complex information to enhance clarity as to why the information might be useful to the user and how it connects to their life.
- Define terms that might have different meanings depending on social context, or which might be jargon related to a specialized field (e.g., ‘‘drug interactions’’ and ‘‘health care providers’’), to accommodate difficulties with language pragmatics.
- Be mindful of autistic culture and community preferences, including the language used to describe autism and how community-based symbols and history might influence content and perception of site credibility.

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CONCLUSION

Using an exploratory and participatory descriptive approach, this study presents information elicited from a series of stakeholder FGDs to understand existing practices, needs, barriers, and goals for the use of digital education tools and content for learners with ASC and ID.

The main conclusions of the project centre upon digital education issues of direct and immediate relevance to learners and their teachers that must be addressed. These issues include: accessibility; acceptability and cultural appropriateness; technology infrastructure and affordability; quality individualized digital content and benefits of digital learning.

By grounding information brought forth by stakeholders in relevant concepts of web content accessibility inclusive design, we propose recommendations and guiding principles for the development of interfaces accessible to learners with ASC and ID. Recommendations address the physical, intellectual and social dimensions of web accessibility. Additional recommendations address the development of accessible digital learning tools and content that allow for integration of inclusive and SEN teaching practices. Along with allowing the developers to know what they should consider when developing appropriate solutions for learners and teachers, design recommendations can contribute to raise awareness of these professionals about the characteristics of persons with ASC and ID and how technology can be valuable to them. Following recommended guidelines for proper software design, designers and developers can increase learning access and reduce barriers for learners.

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APPENDIX

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FOCUS GROUP QUESTIONNAIRE - EDUCATORS GROUP

Opening:

1. Tell us your first name and tell us how long you have been working with students with ASC and/or ID?

Introductory:

2. What kind of digital tools have you used with your students? In what circumstances?

Transition:

3. Think about when you first started using digital tools with your students. What was your motivation to start using the tools?

Key questions:

4. How accessible are digital tools and the e-learning content for the learners with ASC/ID?
5. How easy or difficult is it for you to create of adapt content for e-learning?
6. Overall, what was particularly helpful about the digital tools you used?
7. What was particularly frustrating/challenging about the tools?
8. Imagine the ideal digital tool for e-learning. What characteristics/features would it possess?

Ending question:

9. We want you to help us improve the digital tools and make a difference to kids and families. Is there anything we missed? Is there anything that you came wanting to say and didn't get a chance to say?

FOCUS GROUP QUESTIONS - **LEARNERS & PARENTS GROUP**

Opening:

Parent	1.1 Tell us your first name and tell us something about your child with ASC/ID?
Learner	1.2 What is your name? What is your favourite colour/country/game?

Introductory:

Parent	2.1 What kind of digital tools have you used with your child? In what circumstances?
Learner	2.2 What kind of digital tools do you use? When/where do you use them?

Transition:

Parent	3.1 Think about when your child first started using digital tools/e-learning. What was his/her motivation to start using the tools?
Learner	3.2 Why do you like using the digital apps/tools?

Key questions:

Parent	4.1 How accessible are digital tools and the e-learning content for your child with ASC/ID?
Learner	4.2 How easy it is for you to learn using the app? Is there something difficult for you?
Parent	5. How easy or difficult is it for you to support your child in e-learning?
Parent	6.1 Overall, what was particularly helpful about the digital tools they used?
Learner	6.2 What do you like most about the learning with the app/tool?
Parent	7.1 What was particularly frustrating/challenging about the tools?
Learner	7.2 What is it about the app that you don't like?

Parent	8.1 Imagine the ideal digital tool for e-learning. What characteristics /features would it possess?
Learner	8.2 We are going to make a new app/tool for learning. What do you like an app to feature?

Ending question:

Parent	9.1 We want you to help us improve the digital tools and make a difference to kids and families. Is there anything we missed? Is there anything that you came wanting to say and didn't get a chance to say?
Learner	9.2 Is there anything else that you want to say about learning with digital tools?

FOCUS GROUP SESSION PROTOCOL

A. INTRODUCTIONS

Introduce moderator and co-moderator and state your affiliation. Ask participants to introduce themselves using first name only, no last names or other information that would identify them.

Moderator: This focus group is conducted as part of the ISEC- ADE project. ISEC-ADE stands for Accessible digital education for learners with autism and intellectual disabilities: Innovating solutions and enhancing educators' competences, funded by the Erasmus+ program of the EC.

Our purpose today is to obtain data on the needs of teachers (session 1) and persons with ASC and ID and their parent (session 2) on accessible e-learning. We want to know your experience with digital tools and your opinion regarding what e-learning tools should look like in order for it to be accessible. We need your input and want you to share your honest and open thoughts with us so that we can gather actionable data that helps us define the requirements of an accessible digital tool.

Moderator: As part of this study, you are being placed in a group of 6 – 10 individuals. I will ask you several questions while facilitating the discussion. This focus group will be audio-recorded/video-recorded and a note-taker will be present. However, your responses will remain confidential, and no names will be included in the final report. The participation in the focus group is voluntary and you may stop at any time during the course of the study. Thank you for agreeing to take part in this focus group. We appreciate your willingness to participate.

It is important to collect demographic information from participants. Administer the *Demographic data sheet* before the focus group begins.

B. WE HAVE A FEW GUIDELINES AND RULES TO FACILITATE OUR DISCUSSION:

1. We want you to do the talking. We would like everyone to participate. I may call on you if I haven't heard from you in a while.

2. There are no right or wrong answers. Every person's experiences and opinions are important. Speak up whether you agree or disagree. We expect and want to hear a wide range of opinions and we do not anticipate consensus, just sharing.

3. We emphasize that what is said in this room should remain here. You should be comfortable to share anything if sensitive issues come up. Please don't' disparage another participant's remarks and let's have just one speaker at a time.

4. The discussion will last for about one hour. Please silence your mobile phones. Please give everyone the chance to express his/her opinion during the conversation. You can address each other if you like. We are only here to assist in the discussion.

5. We will record this session as we want to capture everything you have to say. We don't identify anyone by name in our findings. When you respond, be sure to not mention your name. You will remain anonymous. Audio recordings will be summarized and the recordings secured by the researcher (add *your organization's principal researcher name).* We can provide summary details once the study is complete.

Are there any questions?

Before asking the first focus group question, an icebreaker can be inserted to increase comfort and level the playing field. Example: "If you had a limitless budget, where would you vacation?"

Let's get started… [see *Focus group questions*]

Debrief after covering the questions – can cover just a brief summary of the purpose, the key ideas in

the discussion and next steps.

MODERATOR AND CO-MODERATOR STRATEGIES TO ADVANCE THE DISCUSSION:

Helpful probes include:

- Can you talk about that more?
- Help me understand what you mean.
- Can you give an example?

Strategies to facilitate the discussion:

- Summarize the main idea of the feedback at the end of each question.
- Reflect the main idea back to the group "Just so I understand, what you are saying is…?"

- Self-appointed experts: “Thank you. What do other people think?” Or, “Does anybody else have
- a different thought/strategy?”
- The dominator: “Let’s have some other comments.” Stand behind the dominator while
- addressing the group to elicit participation from others.
- The rambler: Stop eye contact; look at your watch; jump in at their inhale.
- The shy participant: Make eye contact; call on them; smile at them.
- The participant who talks very quietly: Ask them to repeat their response more loudly.
- If the conversation gets off topic, restate the purpose of the research.

DEMOGRAPHIC DATA SHEET - EDUCATORS GROUP

Place	
Date:	**Time:**
1. Country of residence: o Bulgaria o Cyprus o Greece o North Macedonia	**2. You are a:** o teachers o special educators o teaching assistants o speech and language pathologist o occupational therapists o other_____
3. Your gender: o male o female	**4. Your age:** o less than 30 o 41 to 50 o 51 to 60 o Over 60
5. How long have you been in practice? o Less than 5 years o 5 to 19 years o More than 10 years	**6. Type of practice:** o Public o Private o Other _____
7. Do you work primarily with learners with: o ASC o ID o Both	**8. Education: What is the highest degree or level of school you have completed?** o Bachelor's degree o Master's degree o Doctorate degree

DEMOGRAPHIC DATA SHEET - LEARNERS & PARENTS GROUP

Place	
Date:	**Time:**
A. Information on the parent	
9. Country of residence o Bulgaria o Cyprus o Greece o North Macedonia	**10. Your gender:** o male o female
11. Your age: o 25 to 30 o 41 to 50 o 51 to 60 o Over 60	**12. Employment status (choose all that apply):** o Full-time job o Part-time job o Fully responsible for housework o Unemployed o Other _____
13. Area of living o Urban area o Semi urban area o Rural area (remote areas included) o Other (please describe) _____	**14. Education: What is the highest degree or level of school you have completed?** o Some high school, no diploma o High school graduate, diploma, or Eq. o Some college credit, no degree o Trade/technical/vocational training o Bachelor's degree o Master's degree o Professional degree o Doctorate degree

B. Information on the learner	
15. Gender: o male o female	**16. Age:** o 5 to 7 o 8 to 10 o 11 to 13 o 14 to 16 o 17+
17. Type of difficulty: o Autism spectrum condition o Intellectual disability o Both	**18. Type of setting where the tool is used:** o Public school o Special school o Public centre o Private centre o At home/remotely o Other _____

ISEC - ADE

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