Using New Technologies and Mobiles for Students with Disabilities to Build a Sustainable Inclusive Learning and Development Ecosystem

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Abstract—Nowadays, the educational policy, in many countries, promotes equal access for all students, including those with disabilities, to the general school, against all forms of social exclusion. Inclusion, in an innovative sense of the concept of diversity, focuses on the active participation and interaction of a heterogeneous student population in the general classroom. "E-inclusive" pedagogy refers to teachers' decisions about the use of technology in the educational process with a view of compensating their developmental deficits and making functional use of their strengths. The aim of this paper is to propose tech tools and e-services for the access and active participation of students with sensory and motor disabilities in the educational procedures of the mainstream school and examine the role of teachers in realizing their inclusion / e-inclusion, as the main facilitators and modulators of the classroom settings to an open learning and development student-centered ecosystem. The results showed that teachers who accept as equal members of the school community all their students and incorporate flexibly new technologies into their teaching strategies to meet their unique needs, providing them with authentic opportunities for interaction and learning, contribute catalytically to their academic and social achievements, preparing them for substantial employment and integration opportunities in community life.

Keywords—inclusion / e-inclusion, new technologies, students with disabilities, self-regulated learning, socio-emotional development

1 Introduction

Worldwide, one of the greatest challenges for education systems is providing equal educational opportunities to an increasingly heterogeneous student population, including students with disabilities, who broaden the boundaries of traditional schooling [1]. The inclusive approach to education, starting from the USA and Italy, was established by the Universal Declaration of Salamanca (UNESCO, 1994), which promoted the right of all students to receive quality education, equally with their peers [2]. This school reconstruction process also includes the concept of social inclusion and recognition of the value of all children, regardless of their diversity or abilities [3].

Although the heterogeneity initially concerned culture, language and socio-economic level, it is then enlarging, also for students with disabilities and special educational needs, by creating an open education model, where the value of diversity is diffused in the school culture and the curriculum, which according to the US "No Child Left Behind" Act (NCLB, 2001), is required to involve them in all mainstream school activities [1]. The inclusion of these students is legislated internationally, however it is perceived and implemented in a variety of ways, reflecting underlying differences in education policy, socio-economic and political conditions and cultural backgrounds.

On the other hand, the development of effective inclusion practices, in the traditional classroom, requires a universal design with the cooperation of researchers, teachers, parents and students of the class, as well as the respective government policy, which must primarily invest in learning, providing the necessary educational resources and infrastructure, which will ensure them consistent access to information and knowledge [4]. Therefore, in order to achieve the inclusion, which aims at the empowerment and emancipation of students with disabilities [5], a new standard of education that respects the heterogeneity and a new model of educational services in the general classroom, is required, where the teachers invest in educational goals for all their students [6], by implementing beneficial teaching and pedagogical strategies, which incorporate the use of new technologies, based on individual differences. Teachers usually display more positive attitudes to the e-inclusive practices, when they are familiar with using technology and the classroom has access to technology equipment [7]. In addition, a catalytic factor for meaningful inclusion is the appropriate regulation and adaptation of the learning environment and their willingness to use assistive and instructional technology in the educational activities, which bridges the digital gap between children of typical and atypical development [8]. Thus, by making appropriate planning for the use of the tech tools and e-services, students with physical (fine / gross motor) and sensory (vision / hearing) disabilities, gain access to the provision of quality education, aiming to increase and enhance their functionality, for their active engagement in cognitive resources and social interaction experiences within the school environment, which lay the foundations for a sustainable future [7], [9], [10].

Hence, there is no doubt that the role of systematic training, either as initial teacher education (ITE) or as continuous professional development (CPD), for a deeper understanding of the substance and results of inclusion [2], but also for the effective implementation of the e-inclusive pedagogy, in the everyday life of the classroom, is considered crucial [11] [12].

2 Inclusion / E-Inclusion

"Inclusion" is a multidimensional conceptual construct, which adopts the model of diversity as a natural state of the individual [13]. It is based on socio-cognitive theory and concerns the equal access and participation of all students, including those with disabilities, in the local school community [14].

This concept has emerged in the 1990s, replacing the previous terms "incorporation" and "integration", ending social discrimination and providing equal opportunities to all

children in the educational programs of mainstream schools, in terms of maximizing their potential, in important areas of human development. Therefore, inclusion, as a multifaceted process, means not just placing students with disabilities in the general classroom, but mainly the active participation in a wide range of activities of a coherent curriculum, providing them with a sense of social acceptance and allowing them to develop new academic skills and dynamic interactions, which promote their socialization and reinforce their cognitive development [15], [16]. Therefore, this new approach, through the radical restructuring of educational structures, focuses on the social and environmental characteristics of educational settings [17].

"E-inclusive" pedagogy is a sub-field of inclusive education and includes the decisions of the teaching staff, which reflect their beliefs and attitudes towards diversity and the functional incorporation of ICTs in educational processes and activities, as tools to remove digital inequality, with the support of which the inclusion is essentially implemented in a holistic way. The digital divide in education, which according to Miller (2007) should be considered as an inability to make digital decisions of access, learning, motivation and skills, with a negative impact on every area of human development [11] is a result of: a. the lack of sufficient digital resources that motivate teachers to implement innovative educational strategies b. the inadequacy of their knowledge for the effective use of technology in order to differentiate their teaching and c. the absence of the students' physical access to them [8].

E-inclusive pedagogy involves adapting the content of the common curriculum, and personalizing it, so that it becomes meaningful for each student, but also the modification of the inclusive classroom environment by introduction, on a consistent, non-disruptive basis, of educational technology tools and services, designed to compensate for the absence or deficient presence of some skills, allowing students with disabilities to become participants in authentic situations of self-regulated learning and development [4]. The level of commitment of the educational community to their use in teaching practices, differentiating flexibly the curriculum, is related to their perceptions as reliable learning and development skills tools and to their knowledge about their effective use in the educational procedure [11].

3 Bridging the digital gap for students with disabilities

The critical role of technology is recognized, on a global scale, with the perspectives it provides, through a wide range of digital tools and e-services, integrated into a universally designed learning environment, to maximize the academic learning and social-emotional development of all students, including those with disabilities, providing differentiated ways of teaching and learning, aligned to the different functional requirements of each child, with a view to upgrading their quality of life indicators [9], [18]. Highlighting the functionality of technology in inclusive education, Abbott (2007) points out that a. provides access to learning b. supports educational process and practice opportunities and c. using it makes learning possible for all students [5].

According to the European Agency (2013a), the educational policy and legislation of each country must promote the digital access and inclusion of each student. In recent

decades, European education policy, in the context of Sustainable Development, has been steadily oriented towards facilitating the universal accessibility of children with disabilities in the Information Society, aiming to provide quality education and equal opportunities for lifelong learning, eliminating any inequality, with access to the suitable technology tools, digital hardware and software, to support personalized learning and maximize each child's potential. In this direction, Universal Design for Learning (UDL), which envisages the proactive design by the teacher of an open learning and development ecosystem, provides the supporting framework that allows the differentiation of the curriculum, with an emphasis on the use of technology, as an integral part of educational strategies, which provides innovative and intuitive means of representing information, engaging and expressing students [9], [18]. Moreover, it also provides the possibility of adjustments, such as the accessibility settings in the computer operating systems of Apple, Macintosh and Microsoft Windows, which aim at flexible approaches to self-regulated learning by offering the educational material in digital format, [5] to maintain their effort and commitment to completing their assignments [18].

More specifically, the assistive technology for students with sensory and physical disabilities, provides medical-type aids, such as hearing amplifiers and devices that boost motor functionality, but also educational-type equipment, such as touch screens, alternative keyboards and mice, alternative and augmentative technology devices, speech-to-text devices, word processors, scanners and a wide range of digital applications and services [4], [5].

For the suitable selection of the appropriate technological equipment, ease of use and transport, safety and reliability in its use, technical characteristics and adaptation to different environments must be taken into account. Above all, however, the support of their functional incorporation in carefully designed student-centered activities, guided by educational goals, their previous experiences and unique characteristics [4], [18], [19], [20]. At the same time, by providing students with the opportunity to participate in the selection of the necessary tools and to reflect on their usefulness and the type of support provided, the cultivation of their self-awareness, regarding their capabilities, is enhanced, increasing the prospects of a self-regulated learning [18]. The determination and use of technological equipment must be individualized by assessing, on a regular basis, the changing needs of students [20]. It is vital, however, its integration as part of an interactive educational procedure, in the students' daily schedule and the regularity of the classroom, while it is considered appropriate to model its correct use [19], as well as the establishment and implementation of rules and realistic performance expectations [20]. In this planning, some models and projects can guide teachers, which provide them with strategy instructions for the proper use of resources, environment and technology and monitoring their impact on the progress of their students, such as SETT (Student, Environment, Task, Tool), MPT (Matching Person and Technology) [9], [20], WRITE (Writing Strategies for Instructional Technology in Education), GPAT (Georgia Project for Assistive Technology), TECH, TAM (Technology Acceptance Model) and TPACK (Technological Pedagogical Content Knowledge) [20].

However, it is pointed out that the effective development of learning through technology must be based on the assessment of the children's educational needs [21] and requires systematic planning at the level of the classroom and school unit [22]. In any

case, the use of technology should motivate these students to focus on their own unique abilities and become more efficient, in order to prepare themselves socially and professionally for the job market of the future [20]. Furthermore, the incorporation of digital tools and e-services in the educational process for the planning of teaching and learning activities, record keeping, student monitoring and assessment procedures, in order to surpass the barriers to their development, contributes to the acquisition of literacy, decision-making and problem-solving skills. But mainly, aims at the cultivation of balanced relationships with the other members of the classroom, so that they are dynamically engaged in the interactive processes of a cooperative learning, which highlights the unique value of each student, increasing their self-esteem, acceptance by their peers and the sense of equal member of the classroom [9], [23], [24]. Thus, the use of digital resources in the inclusive classroom should not be an end in itself, but be used purposefully, multiplying the opportunities to communicate information and knowledge, providing motivation and encouragement to students with disabilities to develop a sense of co-responsibility in their learning and promote a self-directed model of work [4], [18].

4 Students with physical (motor) disabilities

To enter information, while performing a task on the computer, students with physical disabilities need an input device adapted to their reduced motor functionality, due to their difficulty with the size and position of the keys on common keyboards [22].

- "Intellikeys™" are alternative keyboards on which custom overlays are placed, containing a portion of the keyboard or specialized graphics, depending on the nature of the user's work.
- "BAT Personal Keyboard" belongs to the category of chording keyboards, with fewer keys that must be pressed in combination to enter text, while in addition, they can be configured to display frequently used words.
- "WinMini" and "MacMini" are miniature keyboards, easy to carry and require less finger movements on the keys.
- "On-screen keyboards" have the above features, such as "Discover: Screen", and the keystrokes are directed by a mouse or other clicking device [22].
- Input devices with virtual manipulatives, such as alternative keyboards and specialized mice, controlled with head pointers, eye-gaze systems, large buttons, switches and joysticks.
- Keyboards computers, where the keys are controlled with a stick fitted to the child's mouth or head, or computers where track balls, head trackers and touch screens replace the traditional mouse, and other keyboards with specially adapted key layouts for children where their functionality is limited in one of their hands [4], [9], [19], [22].
- "Touch screens", where the computer monitor is overlaid with a touch sensitive grid, which presents the graphics and characters of the screen, while a touch of the screen is enough for the desired command of the user.

- Alternative input systems such as speech input and recognition systems, using specialized software and sound cards. With the speech recognition program (SR), students enter into the computer written tasks or texts that they produce only with their voice - provided that the words are pronounced correctly and intelligibly [22].
- "Graph paper" and "Number Navigator" software help students with fine mobility limitations to perform arithmetic operations that require placing numbers in rows and columns.
- The graphical interface of the "Graph Calc" calculator on Windows is indicated for students, who have difficulty using the common calculator [18], [21].
- Using a joystick on a common computer, equipped with audio cards and "Axe" software (Harmonix Co.), they can explore music files or produce their own musical patterns [22].
- Children with severe motor deficits are provided with the emulation of a keyboard with a scanner and the input of Morse code, which operates with specialized switches that are controlled by the voluntary movement of a muscle of the head or mouth or knee. During scan input letters are scanned by lights and cursors and symbols appear on the computer screen or other external device. The users can take control of their computer as they speak letters or words using specific speech recognition (SR) software. Word prediction and abbreviation extension software work are useful to text input and typing, while on-screen keyboards move the user to the next or previous page [4].
- For younger students with motor impairment and mild to severe learning disabilities, an innovative intuitive tabletop using a "tangible user interface" (TUI) has been designed to develop an interactive game in a simple and friendly environment, allowing them to understand physical objects while interacting with them. At the same time, however, it allows e-accessibility, as the activities performed, based on the educational objectives, which involve the students physically and cognitively, are transferred as commands to the screen of a connected computer, through the "Trackmate" platform. Thus, the TUI interface, through physical manipulations that represent abstract concepts, interconnects the physical and digital worlds, as users monitor the progress of their work. Additionally, cooperative learning is enhanced, as two children can work together on the computer, using their right or left hand. In the same direction is the interactive tabletop of the TUI interface, since many students can simultaneously move, monitor and interact sequentially, including students in wheelchairs [25].

5 Students with sensory disabilities

Students with sensory disabilities face difficulties in typical receiving educational material, completing academic tasks, communicating and sometimes social marginalization [22].

- Using the "Learning Ally Link" app, students with sensory disabilities get access to e-books and audiobooks of "The Learning Ally library" [18].

- "Inastec" (Inclusive Assistive Technology) adaptive technology, based on the Internet of Things (IoT), has been introduced into the educational procedures of the curriculum of Argopuro Jember University of Technology, Indonesia, providing quality education, with positive results in task completion and supporting students with visual and hearing impairments in inclusive environments [26]. IoT refers to global communication networks connecting physical and virtual objects, which are identified through RFID radio frequencies and sensors, integrating modern technology with knowledge and leveraging artificial intelligence perspectives, in the context of inclusive practices, related to the organization of learning and providing the required resources for its implementation [27]. Inastec technology is based on programming languages algorithms and its operation uses the Internet in connection with a hardware system. The algorithm application uses Google's cloud platform as storage for communication services and the Raspberry Pi server to convert text to audio. Using a Raspberry Pi B+ equipped with a sound card, the text is played from the speakers of an RPI Monitor server to blind students. If the RPI Monitor is connected to a computer and LED projector, it converts audio to visual text for deaf students. In addition, teachers are provided with the possibility of remotely monitoring the progress of their students by connecting their smartphones or laptops to the Raspberry Pi server via Bluetooth [26].

5.1 Students with visually impaired / blind

- Asstech (Assistive technology) offers quality learning tools and services that utilize the senses of touch and hearing, as they cannot have the typical access to printed or digital visual materials, in order to perceive and understand the learning objects. These include tangible objects, embossed images and the use of Braille [21].
- Common keyboards can be used with Braille labels on the keys or provide access to Braille input devices. Thus, the ordinary scanner, using "Optical Braille Recognition" (OBR) software, scans documents written in Braille, analyzes the dot pattern, translates the text and displays it on the computer screen. Renewable Braille displays translate computer screen text into this writing, which can then be printed with a Braille printer. OCR scanners scan a printed text and store it in digital form, which can, then, be read by a speech synthesizer or printed in Braille, using the appropriate Braille software and printer. Thus, they can independently have access to the educational materials - printed and digital - of the curriculum and successfully perform their homework [4].
- Speech output systems and "text-to-speech" (TTS) software, such as "Screen Reader", "JAWS" and "Thunder", are used to transcribe the text displayed on the monitor screen into sound, which is then provided audio by a recording device [21].
- The "JAWS" (Job Access with Speech) software provides students with multiple possibilities to adjust the volume, tone, timbre of the voice, as well as the reading pace, while with the use of headphones neutralize sound distractions.
- With "speech synthesis", the text is read by the computer analyzing each word into its phonemes, helping in its identification and understanding of the text [4], [22].

- "Talking books" give them recorded lessons on audio cassettes and operate as recording study material, useful information or even entire lectures, as well as for audio submission of their homework.
- The "descriptive video service" (DVS) describes, automatically, verbally everything that appears on the computer screen, providing them with a complete "picture" of the knowledge offered [4], [22].
- The "VOCAROO" service offers the possibility of recording their voice for free [23].
- "Speech recognition" (SR) systems read the text on the computer's screen. Then, scanners, with "Optical Character Reader" (OCR) software, digitally store the text on the computer so it can be printed in large font for students with low vision or entered into a word processor for editing or read using speech synthesis.
- For students with low vision there are large printed labels for keyboard keys, enlarged symbols and graphics for the computer screen or printer, in order to edit a text, use email or other software. Using an anti-glare screen or adjusting its colors appropriately makes it easier for photosensitive children to read [4], [22].

5.2 Students with hearing and / or speech impairments

Considering that their way of learning is very different and is provided through the sensory pathway of vision, user interfaces use information embedded in videos or include symbols with expressive pictures, photo albums, articulation diagrams, visual elements for practicing or correcting speech and language acquisition.

- The "Trobosan" application supports many educational activities, in the context of the learning process, while the "I-Chat" (I Can Hear and Talk) application is a language acquisition and / or learning tool for the specific student population.
- For children with speech intelligibility problems, advanced "speech synthesizers" can replace their voices so they can be intelligible, giving them the opportunity to participate in classroom discussions [21].
- Particularly assistive for students with hearing impairment is a personal listening system, consisting of a wireless transmitter with a microphone worn by the speaker and a receiver with an earphone worn by the listener, so that the speaker's voice is transmitted directly to the ear of the user, by eliminating environmental distractions [24].
- Using the "text-telephones" application they can type and read the telephone conversations, while with the computerized speech recognition (SR) software, the computer converts a spoken text into readable written text [4].
- Message switches, telephone amplifiers and image systems are still used for communication needs [19].
- Older school-aged children are motivated by communication and manipulation through "virtual or real robots" in virtual or augmented reality [7].
- Programming languages such as "Logo" or the modern 'Microsoft Visual Basic" are using for teaching basic artificial intelligence concepts to deaf students and contribute to their acquisition of problem-solving skills [22].

6 Discussion

The change in the values and philosophy of education, which implies the transformation of the school ethos, constitutes the driving force for the implementation of the inclusion and wider social integration of students with disabilities, as equal members of the school community. But in order to change society's attitude, teachers need to face diversity as a creative challenge [4] and the national political strategy to provide the required financial support and promote the equal distribution of open educational resources to exploit the potential of technology by all students [5]. Furthermore, it is necessary to update the deficit education model, which focuses on the developmental deficits of students, towards a holistic education culture, which focuses on the possibility, the cultivation of self-esteem, the understanding of each individual need, but also the coordinated cooperation of teachers to the universal design of the learning of all their students. However, even if social prejudices have receded, there are still inherent problems, which incite teacher skepticism and are related to the absence of new curricula that promote the common goals of inclusive education and to the inadequacy of resources and planning time, of necessary technical know-how and their systematic training in technologies that are constantly evolving.

On the other hand, the functional incorporation of new technologies in educational activities lays the foundations for a self-directed way of learning and forms an inclusive framework, which provides strong incentives for experiential learning, which has as a reference point the knowledge and experiences of the students' daily life [27], activating thinking, promoting experimentation (trial-error) and the search for the acquisition of new knowledge and developing decision-making and problem-solving skills [20], [24]. As schools are becoming increasingly open, it is a challenge internationally, for educational policy makers, a more coordinated and participatory effort in the planning and implementation of teacher training programs, as the main contributors to the educational policy of equality, aiming to promote positive attitudes and initiatives for the realization of inclusion and the diffusion of good practices that promote e-accessibility, removing the digital inequality with the cooperation of all education professionals. More importantly, inclusive schools by modeling educational approaches to meet different needs, using technology as a bridge to the learning and development of all students, can be the cornerstone for building a society without discrimination and exclusion [4], [9].

At the same time, it becomes noticeable, due to the enhanced technical know-how that the teachers acquire, they attempt to model the educational design, based on their new knowledge and practical experiences, providing an educational project of high standards for all their students [20], who learn to accept heterogeneity as the regularity of the classroom and develop digital literacy skills, which are among the basic skills of the 21st century, for their dynamic integration in an open, competitive and sustainable knowledge-based society [5]. This is in line with the findings of research that have proven the higher degree of diversity in the learning environment as an important factor that maximizes learning outcomes for all classroom members [28].

Finally, the incorporation of digital technologies, in education domain, is very productive, successful and facilitates and improves the educational procedures via Mobiles

[29-34], various ICTs applications [35-63], AI & STEM [64-68], and games [69-72]. Additionally, various strategies and techniques can be incorporated in educational approaches via IoT and the combination of ICTs with theories and models of metacognition, mindfulness, meditation and emotional intelligence cultivation [73-99] as well as with environmental factors and nutrition [100- 103], accelerates and improves more over the educational practices and results.

In this perspective, further research, observation and evaluation of the findings from the use of technology in inclusive classrooms, is needed, for the design and development of more sophisticated tech tools and e-services, based on these theories and the emerging technologies.

7 Conclusion

To sum up, efforts for an education without restrictive divisions, where teachers with their attitudes and practices facilitate the integration of technology into the classroom routine, include progressive goals, physical, academic, and social inclusion of students with disabilities, with main purpose, the optimization of educational services provided and the willingness of all parties involved to cooperate, in order to successfully build a sustainable learning and development student-centered ecosystem. Within this open ecosystem, students with disabilities must be supported and encouraged to develop not only academic, but mostly, communication, information-seeking, decision-making, problem-solving skills to become potential digital content creators. The open access portal for children with developmental asynchronies to this interactive ecosystem is new technologies, which make even the most challenging educational goals achievable, transforming the ways of learning, in order to synchronize with their changing educational need and paving the way for the acquisition of functional life skills, through living authentic learning experiences, which boost independence, self-esteem, self-regulation, active participation, sociability and provide quality opportunities for achievement and self-realization of all students.

8 References

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