# Social Inclusion for Children with Disabilities: The Role of ICT in Play and Entertainment Activities

Paolo Lucattini[1], Sara Jayousi[2], Alessio Martinelli[2], Lorenzo Mucchi[2(✉)], and Grazia Lombardi[3]

[1] Agazzi Rehabilitation Centre "Madre Divina Provvidenza" of Passionisti, 52100 Arezzo, Italy
plucattini@istitutoagazzi.it
[2] Department of Information Engineering, University of Florence, 50139 Florence, Italy
{sara.jayousi,alessio.martinelli, lorenzo.mucchi}@unifi.it
[3] Department of Primary Educational Science, University of Campobasso, Campobasso, Italy
Grazia.lombardi@unimol.it

**Abstract.** Family associations, educational and university institutions, political and health systems, companies and local agencies, and third sector organizations are involved in and committed to consolidate the historical and cultural path of children's right to play, including children with disabilities. The objective of this paper is to explore the potential role of Information and Communication Technologies (ICT) and in particular of the digital games to create opportunities for social inclusion through playful and entertainment activities for children with disabilities. Starting from the analysis on the role of "play" in the life of children, the main goals and requirements of entertainment are presented with the aim to highlight how the adoption of digital technological solutions can enable social inclusion for disabled children. Guidelines for digital game design are presented together with advanced digital solutions for engaging children with disabilities and increasing their participation and communication capabilities. Robotics, interactive platforms and devices and artificial intelligence algorithms are considered in this analysis. Finally, ICT challenges, innovative approaches and future applications in the context of social inclusion are reported.

**Keywords:** Information and Communication Technologies · ICT · Play · Children with disabilities · Social inclusion · Digital games · Rights

## 1 Introduction

Globally, more than 1,000 million people with disabilities (15% of the world population) live worldwide, including around 93 million children (moderate or severe disability). 80% of people with disabilities live in developing countries where, compared


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to people without disabilities, they encounter more difficulties in accessing education, employment and services [1].

As an example, [2] provided an in-depth assessment of epilepsy, intellectual disability, hearing loss, vision loss, autism spectrum disorder, attention deficit disorder and hyperactivity in 195 countries. In particular, the total number of children under the age of 5 with one of the abovementioned conditions is approximately 53 million. It should be emphasized that 95% of those children live in low and middle-income countries and that vision loss is the most common type of disability, followed by hearing loss, intellectual disability and autism spectrum disorder.

It is worth highlighting that estimation of data on children with disabilities is strongly influenced by adopted assessment methods, as well as cultural and linguistic difficulties [3].

On the other hand, considering the need of extending particular care to the rights of children, several documents testify this constantly evolving historical process. In this framework, the *Geneva Declaration of the Rights of the Child* (1924) [4], the *Universal Declaration of Human Rights* (1948) [5], the *Declaration of the Rights of the Child adopted by the General Assembly* (1959) [6], the *International Covenant on Civil and Political Rights* (1966) [7], the *International Covenant on Economic, Social and Cultural Rights* (1966) [8] and the *Convention on the Rights of the Child* (1989) [9] represent significant achievements. In particular, issues connected to play and entertainment activities receive notable attention in [9]. Children have the right to rest, to engage in leisure and recreational activities appropriate to their age, to participate freely and fully in cultural life and the arts. States must "encourage the provision of appropriate and equal opportunities for cultural, artistic, recreational and leisure activities" (Article 31).

Moreover, considering children with disabilities, [9], in addition to emphasizing the importance of active community participation of disabled children, invites the States to ensure that children have access to recreational activities to achieve full "social integration and individual development" (Article 23). The *Convention on the Rights of Persons with Disabilities* (2006) [10], besides underlining "that children with disabilities have the right to express their views freely on all matters affecting them, their views being given due weight in accordance with their age and maturity, on an equal basis with other children" (Article 7), dedicates a detailed article to questions related to participation in cultural life, recreation, leisure and sport (Article 30). The concepts of equality with others, accessibility of communication formats, participation in leisure time within as well as outside educational institutions, represent commitments recognized by the States and at the same time serve as an enrichment of the society.

Starting from these considerations and focusing on the need of providing new opportunities to facilitate social inclusion, particularly, for children with disabilities, the adoption of ICT in this context shall be analyzed.

"ICT" is defined as all the technologies that enable the transmission, reception and processing of data and information. It primarily focuses on communication technologies (such us Internet, wireless communication networks and systems, etc.) and includes all the mechanisms to access information (communication access technologies, protocols and interfaces), but also digital technological solutions.

In the framework of digital solutions, *digital games* defined as any interactive electronically mediated game, either online or stand-alone, are considered part of ICT.

The objective of this paper is to explore the potential role of ICT and in particular of the digital games to create opportunities for social inclusion through playful and entertainment activities for children with disabilities.

To introduce the application context of this study and identify the benefits of ICT for improving inclusion of people with disabilities trough entertainment experience, it is important: (i) to clarify the meaning of *social inclusion* and to know what results are linked to *inclusive education* and (ii) to highlight the need of technological tools for supporting play activities by creating different opportunities of social inclusion.

### 1.1 Social Inclusion

As proposed by Simplican, Leader, Kosciulek and Leahy [11] "[…] social inclusion is a broad term which includes social interaction and community participation". With social interaction, the authors refer to relatives, colleagues, friends, acquaintances and intimate partners (with or without disability). With community participation, they refer to leisure activities (hobbies, art and sport), productive activities (employment or education, consumption or access to goods and services, etc.).

Research conducted by the *European Agency for Special Needs and Inclusive Education* [12] highlights that Inclusive Education facilitates significant friendships between students, with and without disabilities, promoting social interactions and supporting networks both throughout the school period and immediately after obtaining the diploma. However, with the passing of time and the subsequent aging of a person with disability, these positive tendencies, together with the sustainability of the previous results, gradually diminish. This underlines a need to encourage projects that further explore the experiences of students during their school life, paying particular attention to those activities, contexts and programs that ensure functional transitions between Inclusive Education and employment as well as between Inclusive Education and community living.

### 1.2 Play for Children with Disabilities: The Need of Technological Support

In the last decades, the theme of play and entertainment activities for children with disabilities has been the focus of many studies. Most works are focused on single topics, on specific disabilities, or seem to address defined actors engaged in educational activities, rehabilitation services and/or research.

Among the reviewed material, the *COST Action TD1309—Play for Children with Disabilities* (LUDI) [13] is one of the clearest example of a project born with an inclusive perspective. It is a joint effort of researchers, professionals and users, with the aim of creating a new and autonomous field of research and application on play for children with disabilities. In addition to collecting and systematizing all existing educational research, clinical initiatives, and know-how on resource centers and users' associations, in order to develop new knowledge related to contexts, tools and methodologies associated with the play of children with disabilities, LUDI (2014–

2018) is also an important cultural and scientific milestone thanks to the numerous information dissemination activities (participation in international conferences, organization of two annual plenary meetings, exchanges between over 100 researchers and professional operators in the sector from 32 countries and involved in different scientific areas) and the production of 7 books, 1 special publication and 2 Training Schools.

LUDI adopts as a central scientific issue the crossing of three autonomous research areas [14]. The first relates to the types and functioning characteristics of the disability. The second focuses on features, development and evaluation of play and on the right to play. The third observes environmental factors, such as technologies, contexts, and game situations.

Among the 7 books produced, [15] provides guidelines for supporting children with disabilities' play. It highlights the importance of play for every child, and furthermore includes a detailed analysis on the importance of play for children with disabilities, on the barriers that children must overcome in order to play and on the possible roles of the adult as a facilitator. These guidelines host references on the different types of assistive technologies needed for children with disabilities to take part in the game. Finally, insights on various types of games (including digital games), environments, contexts and toys most appropriate for children with disabilities are reported.

Through cultural references and application examples, it emerges how ICT allows children with disabilities to participate in play. ICT generally contribute to the reduction of the gap between the requirements of the game (including relationships with other children and environmental characteristics) and the skills of children, providing support to their functional areas or adapting the proposed activity.

### 1.3 Our Contribution

This paper is the result of an interdisciplinary work that gathered the knowledge and skills of various professionals (university professors, researchers and third sector operators), engaged in the areas of Information Engineering, Special Education and Physical Education.

It is motivated by these professionals' recognition of the need to conceptualize, design and create products and services with an inclusive perspective, understood as discovery, enhancement and promotion of the meaning of diversity and of acting together to build together products and services useful to all [16].

Starting from the review of the state of the art on social inclusion for children, this paper aims at analyzing how ICT can provide advanced solutions to reduce barriers and increase facilitators by creating *inclusive* opportunities through play and entertainment activities for children with disabilities.

The paper is organized as follows: the application context of the proposed study (inclusive entertainment) is introduced in Sect. 2 by providing an overview of the concepts of barriers and facilitators and the benefit of the adoption of ICT in playing activities and social inclusion for children with disabilities; Sect. 3 focuses on ICT solutions for social inclusion, highlighting the requirements in designing digital games based on a specific disability and reporting some achievements in robotics, interactive platforms and artificial intelligence; ICT challenges and future applications for

improving social inclusion are considered in Sect. 4; finally conclusions are drawn in Sect. 5.

## 2 Inclusive Entertainment: Requirements and ICT Role in Contexts, Rights and Goals

### 2.1 Context and Requirements

In 2013, the United Nations Committee on the Rights of the Child examined Article 31 of the Convention on the Rights of the Child (1989) through the General Comment No. 17 (GC17) [17]. In addition to underlining the scarce recognition by the States of the rights contained in the Article, the consequent lack of investments and dedicated legislation, the absence of themes related to children in local and national policies, the Committee expresses a series of concerns for the difficulties faced by particular categories of young people, such as girls, poor children, children with disabilities, indigenous children, children belonging to minorities. Within the GC17, play and recreational experiences are considered fundamental for the health and well-being of children. These experiences increase self-confidence and self-efficacy, and develop cognitive, emotional, physical and social skills. Playing teaches children to negotiate, resolve conflicts and make decisions. Playing allows children to explore and experience the world around them. Playing leads children to experiment with ideas and roles. The concerns expressed in the Introduction are transformed into an invitation to trigger changes to cultures, policies and inclusive practices [18] by the States, organizations, family members and professionals. All children must have the opportunity to realize the rights expressed in Article 31 without discrimination of any kind, including situations of disability (Article 2). Environments and facilities must be accessible and inclusive, to allow also children with disabilities to enjoy the rights set forth in Article 31. The value of inclusive play as a mean of achieving optimal development must be recognized by family members, health professionals, school staff, and in general by all professionals. In this process of enhancing inclusive play, the States must compete by promoting opportunities for children with disabilities, as equal and active participants, through awareness-raising actions in the community and by providing adequate support (Article 23). Programs that are overly structured and decided by adults, such as mandatory sporting activities, rehabilitation activities for children with disabilities, household chores in particular for girls, must be limited because they negatively affect the development of young persons' self-determination skills [19]. Likewise, government investments that focus on recreational activities with predetermined and specific purposes, or the choices of adults relating to youth organizations to be attended by children must be limited.

Starting from the awareness that concentrating all the free time of children in planned or performing activities can be harmful for his physical, emotional, cognitive and social well-being, it is worth highlighting that free time slots, where children have the right also to do nothing (if they wish), must be favored. An absence of activity that becomes functional in activating forms of creativity (Article 42).

The GC17 reveals the presence of multiple barriers that separate children with disabilities from the rights stated in Article 31. These barriers are present in the school as well as in informal and social contexts, in places where friendships are formed, where games and recreational activities are held. Barriers exist in communities, where there are negative and hostile cultural attitudes and stereotypes, and sometimes a source of refusal towards children with disabilities. Further examples include: physical barriers in public spaces, parks, playgrounds with equipment, cinemas, theaters, concert halls, sports facilities; political-decision-making barriers that for security reasons on some occasions exclude children with disabilities from sports or cultural venues; and communication barriers, due to inability to interpret or lack of adaptive technology. Finally, barriers can be witnessed in transport.

## 2.2 Barriers and Facilitators

The concepts of Barriers and Facilitators were introduced by the International Classification of Functioning, Disability and Health (ICF), considered as the "framework for organizing and documenting information on functioning and disability" [20] within which the functioning is perceived as a "dynamic interaction between a person's health condition, environmental factors and personal factors" [21]. In using classifiers and codes, a neutral and standard language, and a conceptual basis for defining disabilities, the ICF has the value of integrating the medical model and the social model, and reaching synthesis with the bio-psycho-social model, in which environmental factors become a dimension that can generate conditions of disability. "Functioning and disability are understood as umbrella terms denoting the positive and negative aspects of functioning from a biological, individual and social perspective […]. ICF is a multidimensional model that covers the entire life span and shifts attention away from the conditions of health to the functioning of the person[…]. ICF is not associated with specific health problems or diseases; it describes the associated functioning dimensions in multiple perspectives at body, person and social levels". The interactions between the elements of the ICF model are outlined in Fig. 1, which draws inspiration from [20].

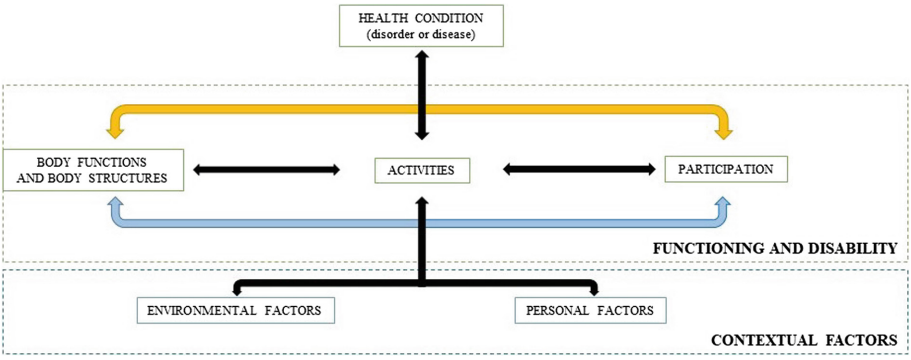


**Fig. 1.** Interaction between the different parts of ICF model

As shown in Fig. 1, the information is organized in two parts: the part of Functioning and Disability, which includes the Body Functions and Body Structures, Activities, and Participation components, and the part of Contextual Factors, which includes the Environmental Factors and Personal Factors components. The Environmental Factors interacting with the person in a specific health condition determine the level and extent of the person's functioning. In other words, the Environmental Factors can represent barriers or facilitators for the functioning of the person. The attitude of a school group towards inclusive play, as well as the communication of rules within a digital game, are external environmental factors with respect to children with disabilities and play a key role in its inclusive processes.

Focusing on children, in 2007 WHO developed the International Classification of Functioning, Disability and Health: Children & Youth Version ICF-CY, thus responding to the need of defining a specific and universally recognized document for children, in the health, education and social sectors [22].

The ICF-CY has paid particular attention to the issue of participation, understood as involving the person in life situations. In the early part of childhood, opportunities for participation are determined by those people in close connection to the children (family members, babysitters, educators). Social interactions develop substantially in the environment closest to children and involve parents, siblings and peers. The nature and complexity of social interactions change in the transition from early childhood to adolescence and together with them environments change as well. These changes are associated in particular with the development of skills and independence.

Environmental factors, defined as "the physical, social and attitudinal environment in which people live and conduct their lives" can be viewed as a series of successive systems that differentiate and expand according to the age and level of development of children. Environmental factors have a significant impact on the developing children and play a key role in its functioning: "intervention and prevention efforts to promote children's health and well-being focus on modification or enhancement of the physical, social or psychological environment" [22].

Within the ICF-CY, information about play can be found in chapters 8 and 9 of the Activities and Participation components. Chapter 8, entitled Major life areas, contains the alphanumeric codes d 880 Engagement in play, d 8800 Solitary play, d 8801 Onlooker play, d 8802 Parallel play and d 8803 Shared cooperative play. In Chap. 9, entitled Community, social and civic life, there are alphanumeric codes d 920 Recreation and leisure and d 9200 Play. Information on technological devices used during game situations can be found in Chap. 1 of the Environmental Factors component. In Chap. 1 entitled Products and technology, there are the alphanumeric codes and 1152 Products and technologies used for play and 140 Products and technology for culture, recreation and sport.

### 2.3 Benefits of Adopting ICT Solutions

"Play" is a key factor in the life of children with disabilities and its benefits may be fostered by the usage of technological solutions.

Participating in play and entertainment activities becomes an essential condition for achieving full social integration and complete individual development for children with disabilities [9].

In this framework, ICT can first contribute to facilitate children's relationships either within intimate contexts (family, schoolmates, group of friends) or external contexts (public parks, entertainment venues, community initiatives). ICT can also reduce distances between the needs of the game (environmental characteristics, relationships with other participants, etc.) and the abilities of the children with disabilities, through supports for the functional areas involved at certain moments of the game as well as through appropriate adaptations to the single activities present in the game [15].

In order to know, identify and monitor the frequencies, intensities and types of these supports and adaptations, the use of ICF-CY, an international language shared by different professionals, can help in understanding the functioning of children with disabilities, placing their skills and performances in the spotlight [23].

Based on these considerations, the adoption of ICT is widely recognized to have a high potential of providing opportunities of social inclusion [24]. Specifically addressing to children with disabilities, technological tools can be used for different purposes, ranging from education (school e-inclusion) [25] and rehabilitation [26] to playful and entertainment activities [27]. Table 1 lists some of the main skills that can be improved through play and entertainment and the corresponding benefit the technology can provide.

**Table 1.** Skill-Technology benefit matrix.

| Skill | Technology benefit |
|---|---|
| Motor | Improve movement skill including coordination (physical rehabilitation) |
| Cognitive | Improve cognitive skills (cognitive rehabilitation) |
| Sensory | Improve sensory skills |
| Communicative | Support inclusive practice |
| Learning | Assist and enable learning |
| Social | Improve social interactions and enhancing acceptance |
| Leisure | Support for playing and engagement in play and recreation |

Focusing on playing activities and social inclusion and on the role of digital technologies in this context, the improvement of children skills may rely on three main functionalities of the technology solutions. These are:

1. *Communication Function.* Speech-generating devices capable of producing voice output from a written text, as well as Augmentative and Alternative Communication (AAC) software, allow children to communicate with other participants during various stages of play. Communication can also be facilitated by simple switches connected to devices with pre-recorded voice messages. In the presence of children with sensory disabilities, other forms of communication such as different textures,

Braille text, tactile/auditory/visual feedback, symbols of sign language, etc. can be incorporated into toys [15].

2. *Computer or Tablet Accessibility Function*. Devices such as keyboards (standard or modified), mice (standard or modified), ocular/vocal tracking systems and head pointers can facilitate direct selection when using a computer or a tablet. Similarly, specific switches (mechanical, electromagnetic, electrical control, proximity, phonation, etc.) can support the choice of the desired element among those that run on the screen, in cases where direct selection is impossible [15].
3. *Assistive Sensory Function.* Devices for displaying an enlarged image of a subject captured by a video camera can increase the visual capacity of visually impaired children (*seeing capability*). Tactile computer displays, screen readers, devices that concentrate, amplify and modulate sound, can increase the hearing ability of children with hearing problems (*hearing capability*). Sound indicators as well as voice to text software represent an alternative to sensory pathways for deaf children during game situations. Moreover, operating and controlling devices, such as buttons or switches, allow children to manage an electronic toy (*manipulation capability*) [15].

## 3 ICT Solutions for Social Inclusion

Different digital technologies are proposed to improve lives of children with disabilities in terms of autonomy, goal achievements, entertainment and social inclusion. Focusing on ICT for social inclusion, [24] explores which types of ICT applications and/or digital services have been suggested to facilitate the social integration of people with different types of disabilities. The authors highlight that while all of the revised works consider beneficial the adoption of technologies to increase the active participation of these people in society, the analysis of any potential infrastructural, socio-technical, cultural, or legal obstacles is missing.

### 3.1 The Design of a Digital Game

Digital games have gained a considerable role in children's daily experiences and this brings an emerging need for adults to take on a role of control and support. The choice of any new game should be guided, taking into account the element of fun, interests, motivations and preferences of children. In order to make a game to become a pleasant and meaningful moment, it is necessary to analyze the communicative, motor and visual abilities of children, as well as the possibility of accessing and activating the game with ease [15].

The adult as a facilitator should try the game first, with the aim of assessing whether or not it will be suitable for the children and possibly making adaptations to the environment or to some characteristics of the game itself. Within the gaming practice, the adult should however limit her/himself to provide support only if necessary, respecting the children's preferences and leaving them the possibility to explore the different application methods of the game.

As reported in Sect. 1, we consider *digital game* any interactive and electronically mediated game, either online or live. In order to highlight how digital games can be an opportunity for social inclusion for people with disabilities, the main features that should be considered in the definition and design of digital games are analyzed in the following. Moreover, to better detail the main requirements, they are grouped based on the different and specific disability contexts.

*Visual Impairments.* In the presence of mild or medium visual disabilities, games should have a simple background with relevant visual information. The contrast between background and foreground should be high both in terms of color and in terms of brightness. Controls and actions should also provide auditory feedback. From one screen to another, the various game controls should maintain the same position. In the presence of important or total visual disabilities, it is necessary to rely only on tactile and auditory feedback [15].

*Motor Impairments.* In the presence of motor disability, games should take into consideration which gestures are necessary in order to interact within the different game phases - for example, whether movements with a finger, such as touching, holding, scrolling, dragging, etc., or with two fingers like rotating, moving, etc. are required. Extensions that allow the game to tolerate involuntary touches, the possibility of returning to the previous action in case of error, the size of buttons and the distances between them should also be assessed. In case of need, it should be possible to use alternative inputs such as voice controls, eye tracking and single switches [15].

*Hearing Impairments.* In the presence of hearing impairments, games should accommodate the possibility of associating visual feedback with audio rewards and directions provided during the game phases, with the aim of generating pleasure in the children. In case of mild or moderate hearing difficulties, it becomes important to assess the presence of background sounds that could somehow disturb the children [15].

*Autism Spectrum Disorders.* In the presence of autism spectrum disorders, it is important to evaluate the possibility of adjusting the game sound and using headphones to support concentration on individual game actions. It is important that there is consistency in the position of the various game controls during the succession of screens as well as in the effect produced by a certain action during different phases of the game. Being able to personalize content with images and symbolic representations allows the children amplifies the children's involvement and enjoyment, just as it is useful to be able to return with ease to a familiar screen after a random and rapid exploration of the game [15].

*Intellectual Disabilities.* In the presence of intellectual disabilities, it is important to be able to access the game and interact throughout the different phases of the game in a way that is intuitive and easy to remember. The on-screen scenarios, the possibility of recovering from errors, as well as the overall flow of the game, must be linear and simple. The various levels of difficulty generally expected within a game must be determined by the children and not automatically by completing the previous level [15].

To design an effective digital game for children with disabilities, besides following the previous recommendations, it is worth highlighting the importance of participatory approaches in the definition of the system interactivity, including the user interface with the involved technologies.

The field of Human-Computer Interaction as a whole relies on a participatory design to satisfy the needs of the end user and improve their quality of experience. Focusing on children with disabilities, the adoption of the participatory design (PD) concept raises specific challenges and poses more fundamental questions about the limits of PD. In [28], the principles of deep engagement, interdisciplinary, individuality, and practicality are discussed, while [29] reviews the design methods and techniques that have been used to involve children with special educational needs and/or disabilities in the technology design process.

### 3.2 Robotics and Interactive Devices/Platforms

In the framework of digital games, both robotics and interactive devices/platforms play a key role in the context of advanced solutions for engaging children with disabilities. In the following, for each category, some examples of existing systems, mainly focused on increasing participation and communication capabilities, are reported.

***Robotics.*** Robotic technological solutions are widely diffused and represent a key element to support play activities with children with severe disabilities.

Assistive robotics (AR), socially interactive robotics (SIR) and socially assistive robotics (SAR) are some examples. Differently from SIR, which aims at developing close and effective interactions for the sake of interaction itself, SAR combines the concepts of AR and SIR, providing assistance to users through social interactions in order to achieve a measurable progress in some activities (e.g. rehabilitation, learning, etc.) [27].

Starting from the assumption that play-like activities and play for play's sake are very important for children with special needs, some robots developed for rehabilitation and education are presented below (Fig. 2), highlighting their potentialities in supporting play activities.

IROMEC (Interactive RObotic Social MEdiator as Companions) is a mobile robotic platform developed with the aim to help children in discovering different play styles. It acts as a social mediator and it is addressed to children with autism spectrum disorder, children with severe motor impairments and children with cognitive disabilities [27]. It is equipped with sensors, camera, touchscreen, screen (face), wheels, moving lights and wireless interfaces and can be used in several scenarios such as collaborative turn taking activities, follow me, get in contact (tactile, fear and communicative mode [30]).

ZORA is a 58 cm high humanoid robot with seven senses for natural interaction: moving, feeling, hearing and speaking, seeing, connecting and thinking [31]. In order to interact with users or dance, pre-programmed scenarios can be used; moreover, ZORA behavior can be created by pre-programming sensors (e.g. to react on the user's touch). Its appearance and the capability of creating different interactions and communication situations, makes ZORA suitable both for achieving therapy and educational goals and for playful sessions. The qualitative and quantitative study reported

in [27] identifies three main domains where ZORA represents a promising solution: movement, communication and cognitive skills. However, ZORA also contributes towards eliciting motivation, concentration, taking initiative and improving the attention span of the children.

ZORA is a commercially available robot as NAO [32], which is the same robot including simplified software developed for ZORA and focused on application in the rehabilitation and care sector.

In the context of "robot assisted playing" for severe physically disabled children, robots should assist in manipulation of standard toys and thus allow autonomous playing. PlayROB [33] is a remote controlled robot system helping the user to handle LEGO bricks. To demonstrate the potentialities of the robot and its learning effects, a long-term multicenter study is carried out [34]. Results show that children's concentration and fun increase while playing also over a longer period of time and no significant reduction of interest is seen. Using the robot is recognized as "learning with great fun" and PlayROB is attractive also for children who were normally able to play with bricks.

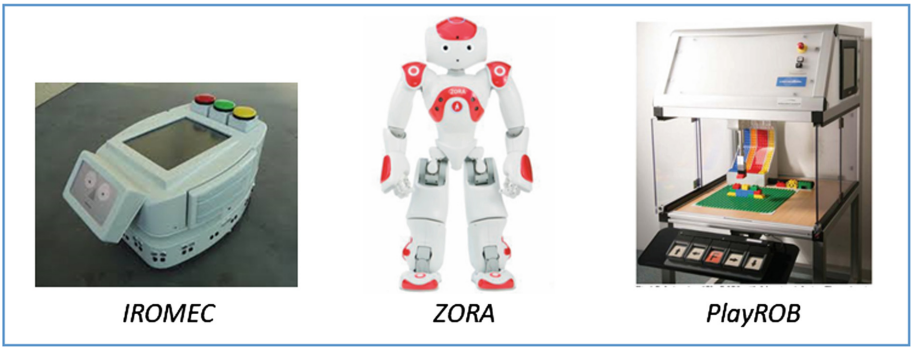


**Fig. 2.** IROMEC, ZORA and PlayROB robots.

***Interactive Devices and Platforms.*** Besides assisting children in setting goals, interactive platforms including video games, enhance and stimulate interactivity through fun activities, helping the development of social skills even in children with severe cognitive disabilities and developmental problems (e.g. autism). Providing skills in psychomotor coordination and in simulations of real-life events, training aids in classrooms and therapeutic settings are some of the main potential of video games.

Some studies are carried out to investigate the potentialities of the Nintendo Wii both as solution to support disabled children in education and as a platform for improving motor skills. [35] describes the achieved results on the evaluation of Wii and commercially available games: (i) to assist in the development of key skills; (ii) to provide students with an adequate simulation of real-life events; and (iii) to help in the areas of health and therapy. Thanks to new engagement mechanisms, such us the Wii Remote Controller, a wireless controller including sensors which can detect motion and

rotation in three dimensions, physical interaction may engage different groups in individual and collaborative activities ranging from simulating real life events to sports. Results show that with any game even students who had more difficulties are able to play at least one game on the Wii console and improve over time. Wii provides a platform, which is engaging, motivating and interesting to the learners, and therefore suitable for therapeutic setting and social interactions (e.g. those students who were watching encouraged those who were playing).

In this context, it is worth mentioning the Xbox Adaptive Controller [36], which is a customizable controller designed primarily to meet the needs of gamers with limited mobility. It consists of large programmable buttons and connects to external switches, buttons, mounts and joysticks to make gaming more accessible. The high customization feature of the controller allows the creation of multiple controller profiles (e.g. button remapping) and an easy switch among them. Its design, functionality and packaging are the results of inputs coming from strong partnerships with The Able Gamers Foundation, The Cerebral Palsy Foundation, Special Effect, War Fighter Engaged and many community members.

Other interactive platforms consisting in touch-sensitive screen, voice recognition systems, screen magnification programs and specific assistive software programs have been developed to support children with disabilities especially for educational purposes (e.g. TAPit platform [37]).

### 3.3 The Role of Artificial Intelligence

Artificial Intelligence (AI) is a branch of computer science that deals with the definition and development of algorithms and systems able to make a machine imitating intelligent human behavior. It allows computers to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages.

This technology is becoming part of our daily lives (e.g. Siri, Alexa, Cortana and other similar services). In particular, many companies have been investing in inclusive designs of their products, making them simpler for everyone to use, including disabled people (accessibility and inclusive design).

AI is behind robotic and interactive platforms and devices. An interesting application of the AI in the context of games for children affected by autism is presented in [38]. The authors proposed a method called Dynamic AI Difficulty of the game. It consists of a fuzzy logic that allows the game to identify the adequate game-difficulty to be dynamically proposed to the player according to his/her level of skills. This is performed by recording some relevant parameters shown by the player during playtime and by processing them to measure the player location within the autism spectrum. Social skills in autistic people are improved by the dynamic evaluation procedure which enables the tuning of the game challenges based on the player's communication level.

In the framework of serious game (SG), [39] proposes a SG, Antonyms, for enhancing inhibition mechanisms in children with Attention Deficit/Hyperactivity Disorder (ADHD) by promoting learning and autonomous management of impulsive behaviors and inhibiting irrelevant thoughts. Antonyms focuses on a cognitive mechanism (inhibition), prompts self-regulation, and stimulates metacognition and provides

multi-modal, detailed, and immediate feedbacks (visual and auditory messages); moreover, it is capable of monitoring the player's behavior during the game by saving different types of errors (e.g. errors in waiting, wrong answers, etc.) and playing time.

## 4 The ICT Challenges in the Context of Social Inclusion

### 4.1 ICT Limits and Main Challenges

In general, people with disabilities encounter barriers due to: (i) inadequate funding, legislation and strategies; ii) the lack of services provided; (iii) negative attitudes and discrimination; (iv) the lack of accessibility, awareness and understanding of disability situations; and (v) the lack of participation in decisions that directly affect their lives. Many of the barriers are avoidable and the disadvantage associated with disability can be overcome [3].

ICT is deeply impacting on multiple aspects of the society and may convey a great potential in facilitating the social inclusion of everyone. However, even if many possibilities can be fostered by ICT, there are some key challenges that remain to be addressed if we expect people with disabilities to fully benefit from the use of ICT.

An important challenge refers to the cost of the assistive technologies, in particular their assessment, training in the use and related support services. When considering people with disabilities living in developing countries, the aforementioned issue becomes a tough barrier into the ecosystem of the technologies. Typically, one of the primary channels supporting the assistive technologies is the education system, which is often underfunded in most of the countries. This may lead to the absence of programs promoting the use of assistive technologies.

In the lifelong education area, the main challenge can be identified in the lack of policies to foster widespread availability of accessible ICT, the lack of an effective implementation of the aforementioned policies, and the lack in the awareness by people with disabilities of what ICT could do for facilitating their social inclusion. At the moment, only 36 percent of countries have a definition of accessibility which includes ICT or electronic media in their lows of regulations compliant with the definition of accessibility in UNCRPD (Article 9) [40].

The remaining part of this Section addresses the challenges and points at the solutions to enhance social inclusion through the use of digital games [41]. The latter suffer from a negative consideration among target users, intermediaries and policy makers. There is the perception that digital games lead people to be unsocial, less human, less empathic, and sometimes they are looked at harming to children. Cultural aspects can also reveal barriers in both public and private sectors, in particular with middle management who opposes in including games in programmes and organizational practices. Informing the general public, decision makers and politicians of the potential benefits of digital games can help to overcome these stereotypes.

A considerable part of the value of digital games is realized through organizations that address social inclusion, developing game-based approaches and incorporating them into professional practice where appropriate. Challenges to achieving this can be found at the level of individuals, organizations, and more generally in policy. Digital

games can adapt particularly well to the informal and non-formal learning approaches. With respect to the formal context generally used in school environment, the informal and non-formal ones are commonly preferred within initiatives related to social inclusion and fostered by third-sector intermediary associations. The lack of resources invested towards innovative interventions for people with disabilities causes barriers to an effective involvement of developers, intermediary organizations and users in order to define stable practices. These challenges can be addressed by promoting digital games as a mean of inclusion and empowerment between intermediary organizations. Digital games are often criticized for having low levels of quality and sustainability of game-based inclusion projects. Many research projects produce little lasting impact and implementation projects do not last past the initial funded stages. In order to overcome these issues and building sustainability by ensuring the achievement of the results, clear requirements should be defined and satisfied. The interest and requirements of intermediary organizations and target user groups are fundamental to a successful development of digital game-based approaches. Moreover, multi-stakeholder alignment and the role of innovation intermediaries can facilitate interactions and social learning processes. It is also important to define assessable targets, either qualitative or quantitative. Programmes and projects need to take place within longer term strategies, considering how they will sustain the initiative and approach the market and the user community after the development and testing phases. Projects need well organized and financed studies on marketing researches and dissemination plan adapted to the needs and requirements of intermediaries and target groups.

### 4.2 Innovative Approaches and Future Applications

The massive overall number of children with disabilities along with the characteristics of their countries highlighted in [42], must be taken into account in defining proposals for future applications and innovative approaches. These proposals orientate towards two directions and originate from two international documents.

In accepting the definitions present in Article 2 of the *Convention on the Rights of Persons with Disabilities* (UN, 2006) [10], the concepts of *Reasonable accommodation* and *Universal design* represent respectively the starting point and the arrival point of a cultural and evolutionary path. *Reasonable accommodation* refers to changes that are perceived as necessary and not particularly burdensome, but at the same time are useful for guaranteeing rights and freedoms to people with disabilities. Meanwhile, *Universal design* can be defined as "the design of products, environments, programs and services to be usable by people, to the greatest possible extent, without the need for adaptation or specialized design. […] ".

In reference to play and entertainment activities, the conception, planning and realization of an animated children's cartoon in an inclusive perspective (for example CuerdaS [43], Ian [44], The Present [45], etc.) can be considered as an example of *Universal design*. Through the characters presented and the stories told, an animation can bring participants closer to the themes of selflessness, prosocial behaviors, respect and appreciation of diversity. Taking inspiration from the *Charter to change the lives of people with disabilities* [46], an animated cartoon can include interactive moments in which the participant finds himself making decisions to guide the continuation of the

story, developing capacity for self-determination. Or, taking inspiration from the *Special Olympics Young Athletes* program [47], a cartoon can contain scenes where children with and without disabilities experiment with motor games on various levels of ability, and develop cooperative learning skills, being aware of their fundamental and indispensable role in the success of the game (positive interdependence).

In accepting the invitation expressed by the United Nations through the *Transforming our world: the 2030 Agenda for sustainable development* [48] with its 17 sustainable development goals (SDGs), Goals 3, 4, 5, 8, 10, 11 and 16 become elements of reference and global development. Just like implementing the agenda and reaching its SDGs requires a strong involvement of all the components of the society, the realization of ICT in a manner that is functional to the promotion of inclusive processes through play and entertainment activities similarly calls for the involvement of public and private organizations, philanthropic and political institutions, universities and research centers, information and culture professionals. Within this participatory planning, children with disabilities must have a central position together with their families, friends, interests and motivations. An example of participatory planning linked to play and entertainment activities can be the conception, design and implementation of an mobile application in an inclusive perspective (for example Jooay [49], Yoocan [50], Patient Innovation [51], etc.) through which children with disabilities and their families can identify opportunities for free time, adapted to age and skill levels. In addition to facilitate the participation of children with disabilities in community contexts, such mobile applications represent an enrichment for society, triggering connections between scholastic and extra-scholastic realities. Thanks to the contribution of individuals as well as organizations, these types of mobile applications can become functional transitions of information and learning, fun and useful also for children without disabilities, their families and their friends.

## 5 Concluding Remarks

The aim of this paper is to describe the role of ICT in the processes of social inclusion of children with disabilities through play and recreational activities. Children remain children, regardless of their disability or discomfort. The desire for play is always the same, even in the presence of diseases or difficult living conditions.

As widely described by international documents and as evidenced by the activities promoted globally by the International Play Association and the World Leisure Organization, play is an inalienable right of the children. Play for children becomes a fundamental element for the construction of their personality and well-being. Play can foster the children's self-confidence and their sense of self-efficacy, knowledge of the world, conflict resolution together with the creation of meaningful relationships. During childhood, play is that bridge that connects fantasy to reality and favors the development of resilience in times of difficulties. The game also has the advantage of being a transcultural language and achieving full social inclusion and the participation of all children, especially those with disabilities, is a gradual process that cuts across all countries. First, it is important that family members, professionals and politicians who have the power to change laws and culture recognize the children's right for play.

In the last ten years, the international debate, through the creation of the bio-psycho-social model (as the ICF-CY), has underlined the importance of the context and of everything to prevent or facilitate the participation of all (in this case of children) to social and community life. As reported in [52]: "In fact, in order to make an environment "inclusive", it is required that every activity presented within it is accessible also to children with disabilities".

Functional limitations such as the presence of motor, cognitive or sensorial deficits and environmental barriers, such as the lack of adequate contexts and accessible game materials and not least the presence of cultural prejudices, even on the use of technologies, contribute to the generation of situations of "playful deprivation" and "non-participation". Several studies have shown that the adoption of ICT can greatly enhance children's communication and interactions with other children, with objects and with spaces, in a completely different and unexpected way. Many times the children themselves have shown creative solutions involving the use of technological tools [53]. Although, new technologies can also reduce barriers due to movement in space, shorten the time and become the extension of certain persons' functions, in the last years, the focus of studies on disability and technology has shown that including these tools in living environments is not enough.

In fact, the approach to the adoption of technologies has evolved over time: the focus has shifted from the mere "assistive function" or compensatory function to the "inclusive function", supporting sharing and relationship in the contexts where the technologies are used. Within play and entertainment activities, in addition to facilitating educational and rehabilitative learning, ICT become functional to support children in the need for play for the sake of play [14].

The achievement of this "inclusive function" relies on a dialogue and on an interdisciplinary involvement among the different entities included in the processes of social inclusion: educators, motor science experts, psychologists, engineers, teachers, speech therapists, technicians of rehabilitation, health figures, animators and not least the family and the children themselves. Recent studies have shown that it is important to focus on the objectives before designing.

To this end, the involved adults should know or be trained on the use of new technologies to be able to mediate in a truly inclusive perspective. It is essential to identify the most suitable technology for the selected purpose and to experiment the effects on all the involved variables. Every action shall be individualized and personalized, based on the context and its protagonists.

It is important to understand together with the experts, what to adapt or modify to ensure maximum accessibility, but above all to know the point of view of the children, and to experiment with them the most attractive or amusing tools. Finally, it is worth checking how technologies are really contributing to the creation of an inclusive environment and to the improvement of the quality of children's relationships and lives.

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