Smart and Inclusive Museums for Visitors with Autism: The App Case "A dip in the blue"

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Abstract. This paper aims to investigate how digital technologies can make museums 'smart' and 'inclusive' engaging visitors, especially people with special needs. Adopting a bottom-up approach and a participatory design, this exploratory and qualitative study describes the design and development of a specific App for children with Autism called 'A dip in the Blue' of archaeological museum located in Southern Italy (The Archaeological Museum of Paestum and Velia). Starting from a specific toolkit, a paper visual agenda, planned according to a specific format (forms, figures, colours, and emoticons), which made children and their parents to really enjoy the museum environment overcoming the barriers and limits that usually exist for them, the App provides a digital visual agenda and further services and facilities. Thus, after the first visits at the museum, the paper visual agenda became a virtual visual agenda that supports children with Autism and their family, as well as all the young visitors. The App has been designed and developed following all the specific standards and criteria of the Universal Design and considering the specific needs of the special visitors adopting a bottom-up approach, indeed, autistic children were actively involved in the design and development process with their families and all the operators. The paper provides some effective best practices for museums to become smarter and more inclusive through digital technologies and real users' needs.

Keywords: smart museums, inclusive museums, inclusion, Autism, digital technologies, App, social media.

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1. Introduction

Many museums develop or adopt solutions worldwide to be committed to accessibility and accommodations for the overall general public, such as ramps for wheelchair users or closed captions for the D/HH (deaf and hard-of-hearing) visitors. However, not all disabilities and disorders are visible.

Museum professionals face many challenges in developing solution to allow visitors with specific disabilities and disorders to really enjoy the museum experience [1]. Numerous museums already promoted and adopted special programs for people with specific disabilities or disorders. Studies about the benefits derived from museums for individuals with Autism are still scarce, as well as the additional features required, as services, provided by museums for meeting the specific needs of the individuals with Autism are still undeveloped.

Autism represents a disorder that specifically impacts on the individual's brain before the age of three years, creating much difficulties in communication and social skills, or also influencing the individual's behavior. Autism, which involves more boys than girls, constitutes one of the 5 brain disorders classified under the Autism Spectrum Disorders (ASD)[1]. Individuals with Autism, generally with ASD, have difficulties in non-verbal and verbal communication language and difficulties to socialize. Therefore, museum environments could represent a very strong experience for these visitors becoming stressful and dangerous. Too much noise, flashing lights, etc., stimulate too much making the environment uncomfortable and agonizing for these individuals [1, 2, 3, 4, 5, 6]. Museums increasingly adopt technological solutions to improve their offer to visitors, becoming smart museums, where technologies have been adopted making the visit experience unique and attracting tourists as well as people with special needs [6, 7, 8]. Museums have been eliminating the physical barriers, but thanks digital technologies they can be able to eliminate the sensory barriers, becoming really and much more inclusive.

This exploratory and qualitative study, adopting a research driven research model, through a bottom-up approach and a participatory design, aims to investigate museums in the perspective of being smart and inclusive through the adoption of digital technologies for children with Autism and their families. To achieve this goal, we follow a two-step research process. First, we conduct a review by analyzing and summarizing the most relevant contributions in the research on smart and accessible and inclusive museums, and specifically museums and visitors with Autism. We systematize and underlie the main research orientations of scholars providing a clear scenario about the gaps still existing in the research, especially with regard to the adoption of technological solutions addressed to people with Autism. Second, we design and develop a specific App as a virtual visual agenda investigating several visits at the Archaeological

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[1] The Autism Spectrum Disorders (ASD) includes 5 different brain disorders: Autism, Asperger Syndrome, Childhood Disintegrative Disorder, Persuasive Developmental Delay-Not Otherwise Specified (PDD-NOS), and Rett Syndrome (WebMD). More specifically, due to the variety of symptoms and the complexity in providing a coherent and homogeneous clinical definition, it is more common to correctly use the expression Autism Spectrum Disorders (ASD, Autistic Spectrum Disorders) which includes a whole series of pathologies or syndromes having the aforementioned behavioral characteristics as a common denominator, albeit at varying degrees or levels of intensity. In this study we generally talk about "children/young teenagers with Autism" or "children/young teenagers with ASD", by distinguishing between low, medium or high level of functioning.

Museum of Paestum and Velia in Southern Italy, Campania Region. Also, the importance to adopt a collaborative orientation, with a participatory design, and to develop effective managerial and didactic/pedagogical practices for achieving the maximum social inclusion has been evidenced, as well as it has been outlined the need to effectively train and educate all the people involved in the museum visits and the design process for children with Autism, including parents, museum staff and operators.

In summary this study describes the design process drawn from a multidimensional approach (bottom-up approach and participatory design) to conceptualize and design an accessible and inclusive museum-based app.

The reminder of the paper is structured as follows. The Section 2 describes the methodology adopted, that is a two-step research process. In the Section 3, a brief review of the main contributions in the literature has been conducted for clearly explaining the concept of smart and inclusive museums through the digital technologies. Then, the subsequent sub-section 3.1. focuses on the specific link between museums and visitors with Autism with the contribution of technologies. Section 4 provides details about the design and development of the specific App for the museum experience visit. Finally, the section 5 provides concluding comments, limitations and future perspectives of the study.

2. Method

This paper consists of two-step study process. Firstly, we conduct a deep review of the literature for analysing and summarising the most relevant contributions existing on museums considering two main related topics, that is smart museums and inclusive museums. Smart museums consist of a symbiosis between technology and exhibitions, where the adoption of digital technologies aims to improve the delivery to visitors of the large and complex cultural heritage, also creating the conditions for enhancing their interaction allowing creative processes. In this case, several advanced technological applications have been developed and implemented, like Internet of Things (IoT), Augmented Reality (AR), Augmented Virtuality (AV) and so forth. Inclusive museums concern the accessibility and usability of the museums, for all the visitors by overcoming all the physical, cognitive or sensory barriers making visitors with disability, and in general with special needs, able to completely and successfully experience museum visit. We consider only published studies clearly focused on smart museums, inclusive museums, social inclusion, disability and Autism over a 20-year period (1998-2020). The online search adopted and combined the key words "museum", "smart museum", "inclusive museum", "accessible museum", "autism friendly museum", "autism", "managerial solutions for accessible museums", "managerial solutions for inclusive museums", "pedagogical and didactic practices", "teaching solutions". This was performed in two main freely accessible web search engines specifying in academic contributions, that is the ISI Web of Science (WoS) and Google Scholar (GS). Specifically, the online search in both websites was conducted in two main phases: 1. The key words 'smart', 'inclusive' and 'accessible' were combined with the term museum ("smart" OR "inclusive" OR "accessible" AND "museum"). Here, we obtained 15.900 results in GS and 2755 results in WoS; 2. The previous key words were combined with the terms 'autism' and 'autism friendly museum' ("smart" OR "inclusive" OR "accessible" AND "museum" AND "autism" AND/OR "autism friendly museum"). Here, we obtained

3.500 results in GS and 25 results in WoS. 3. We matched the results from both websites and only we considered papers and chapters in English language with at least one key word in the title corresponding to "museum", "smart", "inclusive", "accessible", "autism". Finally, we had about 355 results. In more detail, the papers have been selected using the criteria described below. First, we consider only papers in academic journals and chapters published during the last two decades, 1998-2020. Second, the papers had to be published in English and contain at least one of the selected words and terms directly or indirectly in their titles. Third, the papers had to have dealt with research issues and the most relevant keywords, i.e., "smart museum", "accessible museums", "inclusive museum" and "autism friendly museum", need to be included. All the identified studies were analysed to identify relationships between the issues investigated. The abstract of each paper has been briefly read by the authors and then undertook a complete reading of each paper after outlining its relevance for our research.

Secondly, we investigate the experience of one specific App, the Project 'A dip in the blue', designed and developed within the program Autism friendly realized in one archaeological museum, located in Paestum (Salerno) in the Southern Italy, in Campania Region, the Archaeological Museum of Paestum and Velia. The Archaeological Museum of Paestum and Velia was chosen for two main reasons. First, this museum pays an increasing attention to accessibility issues and especially to the social inclusion, mostly in the last years where it is possible to observe numerous interventions in this direction, e.g. the introduction of ramps for wheelchair visitors, the proposal of specific programs for blind or deaf visitors. Second, this museum records a significant growth of its visitors. Indeed, in the last four years, in Italy, especially in the Southern regions, like Campania, museums record a significant growth of their visitors and profits. In particular, in 2017 the Archaeological Museum of Paestum is among the most visited by tourists in Italy with 441,037 visitors with an increase of about 15.10% compared to 2016 (about 382.172 visitors) [9].

The research study was conducted through a partnership between local public universities in Campania Region in the Southern Italy that is 'Parthenope' and 'Federico II' University, the Archaeological Museum of Paestum in Southern Italy, and a local social enterprise involved in social services for people with disability, especially individuals with Autism, the social enterprise 'Il Tulipano', and the all associations of families with children with Autism.

This App has been designed and developed thanks to the numerous experiences gained previously through the visits at the museum planned and carried out for families with children with Autism using specific programs (didactic and managerial solutions) supported by the toolkit "visual agenda" for the kids. The App represents the translation of the paper visual agenda used during the first visits at the museum, in digital visual agenda with several advanced functions for improving the involvement and interaction of the kids. The App has been designed and developed thanks to the data and information collected during the previous visits at the museum through interviews, questionnaires, personal schedules, focus groups directly with the families with children with Autism, museum staff and operators. The App considers and can be used by children/young teenager with Autism, with low, middle, and high-functioning abilities (low being low verbal skills and high being Asperger syndrome). The design and development of the App were based on the didactic program and all the previous visit experi-

ences following always a bottom-up approach, in fact, all the actors (researchers, museum staff, operators and parents of children/young teenagers with Autism) participated, through planned meetings (specific focus group) for discussing and defining contents and putting together different ideas strictly taking into account the concrete needs of the participants, responded to interviews and questionnaires, and compiled fact sheets for the visitors. According to previous studies on the topic [1, 2, 4, 5, 10, 11, 13, 14, 15] and past practical directed and undirected experiences already documented [10, 11, 12], the App is, therefore, the result of a deep analysis and further development of the original entire program (the visual agenda used during the visit, the steps of the museum visit path, and the instruments used for evaluating the overall initiative) using digital technologies. Hence, the current App project was realized thanks to previous studies and experiences on the topic and also of an opened discussion directly involving all the partners and players. An integrative schema for analysing the museum visit "Autism friendly" was developed, firstly defining the program (visual agenda) used during the visit of one specific area of the archaeological museum for the children with Autism. The original paper visual agenda consists of a little book created for kids with images representing parts to visit in the museum, emoticons for making the kids able to express their feeling and emotion about the visit, colours and forms for supporting kids in their visit in making the museum environment more comfortable and friendlier for them. The App can represent digitally the paper visual agenda.

3. Smart and Inclusive Museums

In the last decades, museums have been changing their way to serve visitors catching the attention of the tourists and to respond to their interests, museums provide innovative solutions, like interactive and personalized museum tours, using also advanced digital technologies, like IoT (which can involve the extension of the Internet to small and low-cost "things" thought to create smart environments to provide new services to the users), AR or AV applications (which could support to appreciate art more deeply and make it more accessible to everyone), and so forth. In this perspective, museums become "smart", where heterogeneous technologies make the museum environment much more interactive, innovative and accessible. Museums develop and implement apps able to facilitate the visitors in their fruition process, making information available, more or less automatically additional, in the form of text, audio or video files, images, that the museum intends to make available for specific part of its environment [6, 8,12, 13, 14, 16, 17, 18]. Smart museums provide additional services and support to their visitors becoming much more attractive and giving real interactive experiences, using digital technologies with multiple applications able to give different and useful services.
In this direction, there are many interesting examples that we can considered as expressions of smart museums experiences. For instance, Alletto and colleagues [8] in their study designed and validated an indoor location-aware architecture for enhancing the museum user's experience. This wearable device uses "combines image recognition and localization capabilities to automatically provide the users with cultural contents related to the observed artworks" [8: 244]. The device uses a system which is based on a mix of elements, such as a Bluetooth low energy (BLE) infrastructure for the localization information, the Cloud to store multimedia contents produced by the users and

to share environment-generated events on their social networks. All the services provided interact with physical devices through a multiprotocol middleware. The effectiveness of the system, designed also for being used with other IoT technologies, was evaluated in the MUST Museum in Southern Italy.

Otherwise, a novel smart museum concept was proposed by Korzun et al. [6] considering intelligent services able to enrich the museum's collection, including knowledge acquired from museum's experts and visitors. This novel concept for smart museums adopts the smart spaces approach for an IoT museum environment proposing a semantic infrastructure. Other scholars try to understand user's onsite physical behaviors outlining that IoT allows to understand visitors' information needs [19]. Also, a specific further architecture was proposed by Mighali *et al*. [20] able to improve the users' cultural experience including connectivity, wearable devices, mobile devices, multimedia data in the cloud and a processing centre. Going beyond these important contributions for implementing the smart museum where the focus is on technological developments, others focus much more on visitors' interaction. For example, Lopez *et al*. [6] have explored "alternative forms of interaction which take advantage of the virtual continuum, able to include real objects in museum's exhibitions making it behave like a smart object" [6: 3]. Overcoming the real environment, the virtual continuum goes from real environments to virtual environments at the other, where thanks to the virtuality users can fully immerse within a digital synthetic world. Also, mixed Reality (MR) in the middle of the virtual continuum can allow real-world and virtual objects to interact and being displayed in a combined way [21]. In this scenario, AR increases information from the reality with digital content, while AV incorporates visualizations of real objects within a virtual environment [21].

Beyond being smart museums, as well as all informal learning institutions (e.g. zoos, art museums, science centres), have been increasingly paying their attention for improving access and inclusion for people with disabilities, overcoming any kind of barriers [3, 22, 23], also using much more digital technologies.

Although museums promoted and implemented numerous actions for making their environment more accessible and inclusive, people with disabilities still report feeling excluded from museums [3, 5, 24, 25]. Full inclusion concerns cognitive and social dimensions, as well as physical, following the overall thoughts in the informal science education field [23]. Focusing the attention on criteria for inclusion, learners are able to "physically interact with and perceive the space, cognitively engage with the materials, and socially interact with one another" [23: 15]. Otherwise, inclusion efforts mostly focus on physical and cognitive inclusion and less on social inclusion [23, 24].

The international community, including institutions, academics, and firms, argues that museums should be "open to the public" [5, 26, 27]. Specifically, museums should be also accessible to all people with disabilities, overcoming any kind of barriers, that is physical, cognitive or sensory obstacles [28, 29, 30]. For trying to be accessible and inclusive museums also tend to adopt much more digital technologies, otherwise, Asensio and Asenjo [31] argued that technology represents a useful tool able to mediate between people and their own heritage messages [33].

Ramirez and Dominguez [34] investigate the case of Appside in Spain, an App developed thanks to the collaboration with GVAM and Orange Foundation. This specific App was designed for hearing and visually impaired visitors, and is consisting in the development of autonomous and details routes for visiting the museum through various

languages, maps and sound and visual recordings. These technologies were co-designed and tested by over 200 disabled people in Spain, Austria and the UK [35].

Other examples of technological solutions developed and implemented for making museums much more accessible and inclusive are tools like are tactile digital replicas and interactive gesture-based audio guides, capable to enrich the tactile experience through digital interaction especially for visually and blind impaired people with audio feedback activated touching objects [36]. Other museum tools concern the use of 3D-printed models, laser cutting and the use of reliefs for sculptures and paintings, like for instance the laser cutting and 3D printing tools were developed in the Australian art galleries by Holloway and colleagues (2019), providing to all visitors, especially disabled people, a better texture of the sculptures. Furthermore, Cavazos *et al.* [37] designed a prototype combining 3D tools, plus other sensory experiences called 2.5D, with printed elements in thermoform, elements such as audio, wind or heat, and verbal elements for supporting above all the blind public. In most of these technological solutions the goal is always to improve and support the blind visitors' autonomy and dependence in living the cultural experience also involving the artists during the p process of the tools [38]. In this direction, we mention also the 'Façade project' consisting of tactile representations by means of 3D printing for blind people [39], or the 'SeeingVR project' representing a virtual reality which combines visual and audio zoom for low vision public [40].

Other interesting experiences come from the USA, like USA, the 'Incluseum project', based in Seattle, Washington, which propones new ways of being a museum through critical discourse, community building and collaborative practice related to inclusion in museums [Incluseum 2015 cit. in 41] creating a community, like a digital environment, between museums and public and technology experts, where the solutions and progress in the field of cultural inclusion are shared, stimulating informal partnerships for promoting inclusive practices. Ad well as in Spain, regarding the virtual museum collections, the DOMUS platform is capable to consolidate a Digital Network of Museum Collections in the entire country, which is currently CER.ES [42]. An interesting study by Vaz, Fernandes, and Veiga [43] provides an evaluation about the use of technologies comparing experiences in museums and exhibitions worldwide, investigating the way for designing and implementing facilities and digital media in order to improve the experience, especially for disabled people. Thus, wearable technologies, like smart watches, are considered as nonintrusive and lightweight solutions that are able to improve the visitor experience generating new and different emotions paying attention to different features during the visit [11].

3.1. Technological Solutions for Inclusive Museums: Focus on Visitors with Autism

Social inclusion, which is essential for all museum's inclusion efforts, is very important especially regarding a subset of the disability community, that is individuals with ASD and their families [3]. ASD presents different expressions from person to person, but this kind of disability usually concerns challenges with social communication and interaction, along with the presence of narrow and repetitive behaviours, interests, or activities [44]. Thus, individuals with Autism spectrum can present different characteristics ranging from having no or minimal verbal language to having well-developed language skills, or from having cognitive disability to above average IQ, and from needing only some support to function in daily life to needing substantial support. Museums

need to deeply consider the inclusion issue for visitors with ASD. People with ASD, more than other people with disabilities, experience several barriers in museums settings [1, 4, 32]. Indeed, museum environments generally can be distressful for people with Autism, because of many factors beyond the noise, for instance, flashing lights from a screen, children with loud voices, machines dinosaurs with too big roars, and heavy crowds [1]. These factors can make the museum visit for individuals with ASD a source of anxiety and sometimes panic, they can experience negative feelings related to the museum visit because the environment is not comfortable, without adequate accommodations and appropriate sound and light solutions, as well as quiet and inclusive setting. In this case, something that seems fun becomes for individuals with ASD very dangerous and sad. In the last decades, museums are paying a significant attention to the needs of people with Autism, trying to become more comfortable for them also thanks to the participation and partnerships with external institutions and specialized organizations [1] and also through the design and development of useful and effective technological solutions [10, 11]. Otherwise, numerous studies show that the integration into the community, as well as through the museum visit experience, is very beneficial for children with disabilities, especially for children with ASD, as shown significant results from analysis of parent's perceptions of their children's participation in museum visits [45, 46, 47], but these studies are still scarce.

Although there are numerous studies in the literature about the accessibility and inclusion of museums environments, most research focuses on visitor motivations and identity related to visitors at large, compared to studies about people with disabilities (including families with children with ASD), which are still less numerous and so researchers are beginning to explore this area more [3], as well as the research on the adoption of technologies for making the museums much more accessible and inclusive for people with ASD is still scarce.

Otherwise, many museums worldwide, especially in the United States, have been implementing special programs and other educational experiences for better meeting the needs and preferences of individuals with ASD, and specifically with Autism [31]. In many cases, the museum efforts promote "sensory-friendly" solutions for providing a welcoming environment which is better in line with individuals with ASD because it is not over-stimulating, indeed, the sound or light features are limited in exhibits, programs, or performances. Other museums plan special events for individuals with ASD, such as the Opening Our Doors offered thanks a partnership between the Museum of Fine Arts, Museum of Science, and Boston Children's Museum in Boston [48], or another special event consists of webinars and workshops hosted by some museums, for instance the American Alliance of Museums [1]. These special efforts play a crucial role because can contribute to the social participation of people with ASD, who usually are less frequently involved in social activities and experience limited activities in the community [49, 50].

In this scenario briefly described, most programs developed and implemented by the museums worldwide described and investigated by scholars adopt some specific technologies.

Indeed, several scholars have evaluated the technology-based programs in the area of Autism [51, 52], but the usability of such digital platform is still underrepresented [10, 53, 54, 55]. It is no easy to design and develop interfaces for autistic groups because of their impact on children's behaviors and attitudes with high risk that the technology

program is not able to fit autistic users' needs [56, 57]. In order to overcome these limits, it is necessary: to adopt much more inclusive design approaches and best practices in designing these technologies [53, 54, 55, 56]; and also, to really understand autistic people's needs involving them in the design process 58, 59].

In this direction, the active involvement in technology development have advantages for both autistic users and designers and represents the most effective solution [10, 60]. Participatory design (PD) implies the active involvement of end-users in the design process requiring continuously their ideas and opinions also reflecting and using the prototypes [60, 8, 61]. This process generates ideas interactively refining the design through the user's feedback, needs and desires [62]. This approach allows to identify possible limitations, enhance functionality and test the validity of the interface, giving a very useful support for the successful design of new technologies.

Over the past ten years, the technologies for autistic children have been significantly increasing adopting mostly a child-centered approach to design products and novel work platforms involving autistic children in the design process [63]. Thus, PD has been considered as "a well evidence-based practice to involve the end-users and other stakeholders within the context of the design process and to identify how novel platforms can work in real situations" [62]. In this case, autistic children operate assuming several roles, that is co-designer, tester, user and informant [64]. In the autism field, this specific approach has been mostly adopted developing useful interactive technology platforms with the children's input also for the museums.

Indeed, other studies provide an assessment of 'MicroCulture', a digital and tangible installation created directly involving children with ASD and bridging history learning across museums and schools in the perspective of game based learning [65, 66]. Also, Giaconi and colleagues [67], adopting the principles of universal design, explored the potential of digital technologies, specifically virtual and augmented reality, for supporting inclusive practices in museums and co-planned and implemented actions with people with ASD to increase their participation during the visit experience. In particular, unpredictable and chaotic contexts in the museum were redesigned, developing a technological prototype for creating an accessible virtual museum tour with important benefits, that is the improvement of empowerment of people with disabilities and the cultural rights of the whole community [67].

Furthermore, other scholars help people with ASD to enjoy their museum experience thanks to digital technologies, especially specific digital solutions developed directly involved the special visitors, like Wearable Immersive Virtual Reality (WIVR) and Wearable Immersive Social Stories (WISS) adopting a digital storytelling approach [68], or a museum-based application tailored to autistic children's needs [69].

"Most of the projects were designed by incorporating user-centered techniques and collaborating with indirect stakeholders, such as parents, autistic children, teachers, and assistive technology practitioners throughout the process" [10: 5]. For instance, the co-designed tablet applications developed by [70], helped autistic children to improve their social skills, as well as in the ECHOES project [71], the focus was on the process of the co-design sessions instead of the outcomes.

Also, a narrative story and sensory exploration through different techniques contributed to effective participation [71]. In the IDEAS framework, based on TEACCH (a structured teaching intervention approach), the designers supported significantly an effec-

tive and creative involvement of participants with ASD [72, 73]. Furthermore, Malinverni *et al*. [74] investigated the way PD activities can help the validation of initial designs, collecting new ideas by autistic children and assessing aspects able to motivate children.

4. The App Case

The study described in this paper was built adopting a bottom-up approach and a participatory design as already outlined considering previous studies on the phenomenon and experiences carried out with focus on the relevance to create the conditions in the museum environment to be comfortable and welcoming to parents and their children with Autism, responding to their special needs.

Firstly, several visits at the museum were carried out with parents and their children/young teenagers with Autism supported and guided by trained operators and social therapists with an identified support tool, that is a "paper visual book". This tool was developed by the researchers, operators and all staff involved in the study, taking into account the special needs of visitors with Autism, that is their specific ways to communicate and socially interact with others, so images, forms, colours and emoticons were introduced into the "paper visual agenda" which each child had during the visit and helped him/her to follow the narration of operas of the archaeological museum.

The visits regarded the "Tomba del Tuffatore" ("The diver's tomb") located at the Archaeological Museum of Paestum and Velia. As already said, for supporting parents and their children with Autism to experience museum visit a didactic program was built and realized thanks a continuous and active discussion between all the partners involved (researchers, museum staff, operators, therapists, families).

The proposal provides for the presentation of a story calibrated on the real one of the "Tomba del Tuffatore" which will be narrated by an operator (the content of the story was previously shared with all the partners). The children/young teenagers with Autism were able to follow the narration, also using an activity notebook (a paper visual agenda) that was provided to them at the beginning of the guided tour and which could take home as a tangible element of the museum visit. The narration in the notebook was supported by images, colours, forms and emoticons that the participants could freely choose based on their interests and accompanied by the sounds. There was a key concept to guide and support the participants in their museum visit, that is the water, with connected other relevant objects used during the narration, for example, the jar, the wine, and so forth, these elements for supporting the narration during the visit were reported in the visual notebook with the images of the operas (See Figure 1).

Figure 1. Page Examples of the Paper Visual Book.

On each page of the paper visual notebook the five plates in the room of the "Tomba del Tuffatore" were shown: for each plate there will be an explanation of the meaning for the image and some individual elements will be highlighted and examined in the image. The narration will be set up based on those specific elements. The language used is simple, immediate, non-allegorical and direct in order not to carry too many verbal stimuli that could lead the participants to excessive load.

After the several visits experienced (6 visits were carried out) at the museum through the specific program with the toolkit of the paper visual agenda, the team thought to adopt technological solutions in order to much more involve the autistic children and make their visit experience really useful in terms of social participation and funny time.

The digital path 'A dip in the Blue' ("Un Tuffo nel Blu" – "Tulipano Art" project)(conceived by the cooperative company 'Il Tulipano' in collaboration with two universities, Parthenope and Federico II in Naples, realized with the co-financing of the Campania Region POR Campania Fesr 2014-2020) has as its specific and primary objective the proposal of a method of digital use, scientifically validated, for people with autism at the Archaeological Museum of Paestum and Velia and at the network of Campania Museums called 'Tulipano Art Friendly' promoted and coordinated by 'the Tulipano' organization.

The path 'Un tuffo nel Blu', downloadable at the 'Tulipano Art Platform' through the specific App 'A Dip in the Blue', is the transposition of the methodology and instrumentation conceived and created in the homonymous project, active at the Archaeological Museum of Paestum and Velia since 2018 and aimed at people with Autism to enjoy a visit at the museum. The project aimed at creating new models in visiting museum through the support of digital technologies.

Regarding the details of the structure of the specific App, starting from the previous experiences in visiting the museum using the paper visual agenda, the tour is developed with the aid of a digital application, downloadable easily on the smartphone or tablet by autistic children (supported by the Android and macOS system), which acts as a digital visual agenda and where the previously identified elements are recalled for each individual work selected and validated by the scientific research group, useful for being understood by the users of the tour, who were previously involved in designing and developing the same App.

Specifically, regarding the opera to visit 'La Tomba del Tuffatore', this proposal provides for the presentation of a social story inspired by the story of the discovery of this famous artistic opera by an 'archaeologist' represented by an educator, through the technique of storytelling.

Visitors, especially autistic children and their families, can follow the narration in person in the 'museum environment' with a digital application via tablet and/or remotely with connection to a special digital platform called 'Tulipano Art' conceived and created by the partner 'Il Tulipano' for inclusive itineraries in hybrid mode.

The narration is supported by images and sounds and is inspired by specific elements of each plate (highlighted with drawings/photos that represent them in order to capture the attention and motivation of visitors with autism).

The digital visual notebook created with the App reproduces and depicts the five slabs presented in the room dedicated to the opera, for each of them there is an explanation of the meaning of that image and some single elements that are found on the image are highlighted.

The App allows visitors to identify the individual elements to highlight and simplifies and guides young visitors, especially autistic children, through images, colors and sounds appropriately selected and combined.

The educational visit available through the App represents an inclusive proposal that can be used by all: it allows the participation in the museum hall of people with autism together with their family members and/or classmates with whom they can interact and live a positive learning experience and socialization.

At the end of the narration through the storytelling of each work shown on the digital visual agenda (App), visitors are presented with the five basic emotions (represented by emoticons), and they are asked to identify one that represents their state of mind in relation to all the route taken (See Figure 2).

Figure 2. Examples of the Digital Visual Book.

The emotions and elements selected by visitors during the visit and reported on the visual agenda (App) are the memory of the visit also for a possible subsequent work at home and/or at school, allowing visitors to continue to review the images and experience the emotions and sensations perceived during the tour.

Visitors as users of this App are invited to write down a questionnaire (information sheet) for analyzing the specific needs before starting the visit supported by the App and at the end of the visit. The questionnaires aim to collect data and information about autistic children knowing their specific needs, as well as the motivation to participate of the families, satisfaction, previous experience at the museum, and so forth.

4.1. The App: Specific Aim and Characteristics

This App project can contribute to develop much more the research about the technological solutions adopted by museums for making themselves much more inclusive, comparing the results between the use of paper visual diary and digital visual diary. Otherwise, this App can enhance the educational offer of inclusive museum services to implement the territorial offer of proposals and activities for visitors with special needs with positive effects on the school and cultural tourism chain system.

Specifically, this App project aims to create:

- a tool for living the Museums and specifically the Archaeological Museum of Paestum and Velia for people with autism and their families (both have been involved with museum staff, operators, therapists in the planning phase of the activities and in the fruition phase through the compilation of the questionnaire

booking and especially all of them, especially autistic children and their families were involved in the design process of the App) and the museum operators who will be trained in sharing the project and acquiring communication and management methods shared with the designers;
- a data monitoring and measurement tool aimed at the different groups involved, that is autistic children whose response data and perceptions are monitored and evaluated to analyse their visit by measuring the duration, frequency, latency times during the activities in order to improve the proposal based on their specific needs emerged; parents and families of autistic children, the perception of the model developed and applied, also in terms of impact on participation or social inclusion; the museum staff and all the actors involved for assessing the level of satisfaction and participation in the proposal.

In addition, regarding the live management and operation for the App, some useful details are provided below:
- Dashboard management or control panel, through which to program, manage and control all aspects and functions of the virtual live.
- Live virtual tour scheduling date and time of live sessions, managing access and invitation methods for participants;
- Invitation and reminder via email to participants in live session events, that the platform will send automatically;
- One-click Live to start the virtual tour with a simple click;
- Conduction management of a media library dedicated to the museum in which to store and manage documents, textual and multimedia contents (audio and video) that can be shared with the participants in the live during the virtual tour;
- Moderation management service that can be used to moderate comments, questions and polls during the virtual tour;
- Virtual waiting room;
- Live recordings in MP4 of all live virtual tours;
- Report & Analytics of live shows with reference to actual participation of autistic children, students and families, duration of each live and access statistics.

Furthermore, this App project aims to contribute to make museums a very inclusive environment also for people with Autism, making possible to enjoy it using technological solutions.

Regarding the technical and functional features and graphic customization related to the App especially with concern of visiting museums remotely, here below there are some details:
- Social integration: to broadcast the live streams of the virtual tour also directly on YouTube and Facebook;
- One-click Social Sharing: users can share the virtual tour directly and easily on their social profiles;
- Live Media Sharing: museum operators interact with participants during the virtual tour by sharing documents, multimedia materials (audio and video), presentations, pdfs on the screen, thus making the remote live tour increasingly interactive;

- Screen Sharing: visitors can share with their desktop, an open document or a web page to all connected participants, stimulating engagement and improving learning during the virtual tour;
- Interactive whiteboard: visitors can take notes or comment live presentations and documents, using an interactive whiteboard-style drawing tool, to create graphics, drawings or insert notes;
- Question Time: organizers can make question and answer sessions, with moderation functionality of the conductor and textual or live answers;
- Live Surveys: visitors can take part in real-time surveys during virtual tours, stimulating active participation and involvement;
- Text and voice chat: participants can communicate through a public chat and in real time, with both text and voice messages;
- Request to speak: participants can speak during the tour session using a virtual "show of hands" tool, to speak live or share their screen (from desktop) or text or multimedia content.

This App briefly described has been already tested by few autistic children during a remote visit of the museum and by students from schools.

5. Concluding Remarks

This research provides a deep analysis of one interesting application of technologies in creating a virtual visual agenda for museums by children/young teenagers with Autism and their parents. The overall program used for the museum visit was built adopting a bottom-up approach and a participatory design directly involving all the partners and players of the research team, that is parents, operators and museum staff, especially autistic children for really know and meet their special needs.

Thanks to the self-reported questionnaires, focus group, interviews and direct observations in this first step of the App project, we can outline that there is totally satisfaction and good participation of parents, operators, staff, and especially the children/young teenagers with Autism. Although there are still some criticisms to manage for improving the App, also because limited to one specific area of the museum, the participants express positive opinion and consider their experience in being involved and actively participating to this project really comfortable, welcome and inclusive, having the opportunity to use an effective technological support for visiting the museum considering their specific needs.

In the future, we would like to incorporate the voices of the young individuals with Autism by collecting data from children, as well as their parents and teachers, as already some previous studies did [1, 4]. In this exploratory study we already collect some direct opinions by children thanks to the support of their parents and caregivers because it is very important and represents a unique and significant contribution to the field by investigating the families' motivations and needs when visiting museums [1, 4], especially for designing and developing technological solutions as useful support tools for making museums much more inclusive. Otherwise, as already outlined, some interesting studies outline the effectiveness and the positive impact in terms of social inclusion about the use of web-based resources and technologies in supporting individuals with ASD and specifically Autism in their museum visits [75, 76, 77].

In addition, in the next step of the entire project, the App will be completely and broadly used for visiting the Archeological Museum of Paestum and Velia, as well as in the future development of the research we should consider the idea to further develop the App with specific sections addressed to much more stimulate and involve the special visitors.

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