REVISTA ELECTRÓNICA INTERUNIVERSITARIA DE FORMACIÓN DEL PROFESORADO
CONTINUACIÓN DE LA ANTIGUA REVISTA DE ESCUELAS NORMALES

http://revistas.um.es/reifop

Recepción: 24 de noviembre de 2023
Aceptación: 20 de enero de 2024

Gallardo-Montes, C.P., Rodríguez Fuentes, A. & Caurcel Cara, M.J. (2024). Aplicabilidad y funcionalidad de las aplicaciones específicas para personas con autismo. *Revista Electrónica Interuniversitaria de Formación del Profesorado,* 27(3), 1-17.

DOI: https://doi.org/10.6018/reifop.614821

Aplicabilidad y funcionalidad de las aplicaciones específicas para personas con autismo

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Resumen

La confección de apps con buenos parámetros de aplicabilidad y funcionalidad es una tarea compleja y muy investigada actualmente, sobre todo, si se atienden a los últimos aportes de la Neuroeducación y la tecnología educativa. Aun así, esta labor requerirá de mayor atención cuando las apps se crean y diseñan para personas con autismo, donde la usabilidad y accesibilidad son de vital importancia. La finalidad de este estudio fue conocer la opinión y percepción sobre la funcionalidad y aplicabilidad de apps para personas con autismo por parte de profesionales en dicho trastorno. Siguiendo un enfoque cuantitativo, con diseño descriptivo, se administró el cuestionario DPTIC-AUT-Q a 159 educadores de Granada (España), que trabajaban específicamente con personas con autismo. En general, los participantes presentaron una percepción favorable hacia la funcionalidad y aplicabilidad, pero destacaron mejoras en su accesibilidad y funcionamiento. Se hallaron diferencias estadísticamente significativas según la edad y la zona y etapa de trabajo del participante. Así mismo, se destaca la relevancia de contar con apps accesibles que faciliten a las personas con autismo su empleo y aprovechamiento.

Palabras clave

Accesibilidad; usabilidad; apps; autismo.

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This article forms part of the research project entitled: "Opinión, requerimientos de las TIC y empleo de las mismas por parte de educadores que trabajan con personas con diversidad funcional en la ciudad de Granada" ("Opinion, ICT requirements, and use of ICT by educators that work with people with functional diversity in the city of Granada") [Reference: INV-INC204-2022], funded by the Vice-Rectorate of Equality, Inclusion and Sustainability of the University of Granada, Spain.

Applicability and functionality of apps specifically for people with autism

Abstract

The creation of apps with good parameters of applicability and functionality is a complex and highly researched task nowadays, especially if the latest contributions of Neuroeducation and educational technology are taken into account. However, this task will require more attention when apps are created and designed for people with autism, where usability and accessibility are of vital importance. The purpose of this study was to learn the opinion and perception of professionals who work with people with autism on the functionality and applicability of apps specifically for this disorder. Taking a quantitative approach, with a descriptive design, we administered the DPTIC-AUT-Q questionnaire to 159 educators from Granada (Spain) who worked specifically with people with autism. In general, the participants showed a favorable perception of the functionality and applicability of the apps, but highlighted improvements that could be made in their accessibility and how they functioned. We found statistically significant differences according to the age of the participants and the area and educational stage they worked in. This study also underlines the importance of having accessible apps that make it easy for people with autism to use and take advantage of them.

Key words

Accessibility; usability; apps; autism.

Introduction

Smartphone apps today form an essential part of people's daily lives. They are used in many varied areas, providing assistance in everyday tasks, as well as offering different options for information, education and entertainment. They are present in the healthcare sector, in finance, tourism, sports, engineering, and education, which has led apps to reach millions of users across the world (Sánchez-Rodríguez et al., 2018; Santillán & Martínez-Casas, 2015).

This increase in apps has inevitably also reached people with functional diversity, since their use offers promising results. There have been many recent studies on the implementation of technological resources in classrooms and therapies for people with functional diversity, across many disciplines; and they show the potential that information and communications technology (ICT) has, and the benefits derived from its use. Some examples of these studies have come from the field of physical disability (Ilyas et al., 2020; Rabhi et al., 2018; Sinha & Dasgupta, 2021; Zainuddin, et al., 2021), intellectual disability (Fernández-Batanero et al., 2021; Mitchell et al., 2021), cerebral palsy (Bertucco & Sanger, 2018; Curioso, 2021; Karlsson et al., 2018; Petroni et al., 2018), Down syndrome (Chalarca, 2018; Cubukcu et al., 2020; Nacher et al., 2018; Porter, 2018), and neurodevelopmental disorders (Mowling et al., 2018; Spitale et al., 2019).

In terms of attending to people with autism specifically, there are hundreds of apps focused on the areas in which they present the most difficulties. Many studies have demonstrated the encouraging results that come with their use, such as those addressing executive function (Flynn et al., 2019; Li et al., 2018; Wagle et al., 2021; Wright et al., 2020; Yerys et al., 2019), the basic instrumental skills (Aguilar-Velázquez et al., 2020; Sweidan et al., 2019;

Teixeira & Cunha, 2019), or Theory of Mind (Fage et al., 2018; Jiménez et al., 2017; Weisblatt et al., 2019).

Indeed, in the field of autism, great effort is being made. Current studies show that both the specialists who work with people with this disorder, and app developers, are collaborating together to develop apps that are accessible and with designs that adapt to the specific characteristics of users. Autism is a disorder that causes difficulties and deficits in the areas of social communication and interaction (APA, 2014; 2022); therefore, a functional, usable and accessible app for these people should be able to count on wide-ranging work agreed upon between future users, their families, and professionals from the field (developers and autism professionals). In this sense, the contributions of Neuroeducation applied to educational technology can be decisive (González-Cano et al., 2020; Meza et al., 2020. The different ways in which ICT and, specifically apps, provide information directly influence the cognitive styles of the student (Barroso-Osuna et al., 2020). Thus, the design of apps adapted to the user's characteristics requires knowledge and understanding of how people learn, especially if they have some kind of disorder or special educational needs.

As Gil (2013, p. 9) states, "an app is accessible when any user, regardless of their functional diversity, can satisfactorily use it on their mobile device with their usual access system." In this regard, people with autism have a wide array of potential needs, depending on the degree to which they are affected, and thus an app is accessible if it covers all the needs that may be sought (Aguado & Estrada, 2017). Similarly, it is important to pay attention to usability. According to the International Organization for Standardization (ISO 25000, 2018), usability refers to the capacity of the software product to be understood, learned, used and to be attractive for the user, when used under certain conditions (ISO/IEC 25010). Usability does not only depend on the product, but also on how it is directed at the final user, which is why the design should make an effort to show the content clearly and without details that can cause confusion.

Previous studies have revealed these requirements. Boyd et al. (2022) designed a virtual reality app with the participation of everyone interested and involved in its use (adults and children with autism, their families, and doctors). Boyle and Arnedillo (2022) stated that the inclusion of children with autism in the technological design guarantees a final product that reflects their educational needs and requirements. This study, which children with autism, teachers and developers participate in, makes clear the effort that is needed to maintain the active participation of the person with autism, since this is sometimes made difficult due to the nature of the actual disorder. Johnson et al. (2022) wrote that an app functions better when it is attractive for the end user. This entails taking into account the specific contextual needs of children with autism and incorporating a design that is focused on them. Mazon et al. (2022) worked alongside families, children, teachers and healthcare professionals to develop the app ToGather, based on the idea that it should not focus only on the individual but also on their social environment. Nuske et al. (2022) revealed that, despite not involving people with autism in the development of their app, they worked together with behavior support specialists for the purpose of incorporating designs focused on the user and their behaviors. O'Rourke et al. (2022) designed an app to improve communication with the collaboration of people with autism. They concluded that having their contribution promoted creativity and flexibility in making projects based on the user. Varriale et al. (2023) have designed the app A Dip in the Blue, with the aim of making museums inclusive and accessible. To do so, they followed the standards and specific criteria of Universal Design with the active participation of children and families. Furthermore, other authors, such as Costa et al. (2022) and Taynar and Marques (2022),

have worked and reflected thoroughly on the design of accessible apps, looking into the problems of accessibility that users, families, and professionals detect.

In spite of the studies that show the effort made to design accessible apps that have been adapted to people with autism, their use is not as widespread as one would wish. The recent literature reveals that professionals give favorable evaluations of apps for attending to people with autism in the classroom or in psychopedagogical therapy (Gallardo-Montes et al., 2022), yet they are still not used very frequently. This may be due to a low level of training (Gallardo-Montes et al., 2023; Lledó et al., 2020; Sabayleh & Alramamneh, 2020; Saladino et al., 2020), the lack of digital resources in institutions (Sabayleh & Alramamneh, 2020), or their lack of quality (Gallardo-Montes et al., 2021a).

Having reviewed the previous research on this subject, we set out the following objectives:

1. To discover the opinion and perception of autism professionals from Granada about the functionality and applicability of apps that are specialized for this disorder.
2. To determine which operating system is preferred (iOS/Android/both), the type of apps downloaded (free/paid/both) and the frequency with which they are used.
3. Explore professional use according to sex, gender, area of work, age, years of experience, stage of work, and type of educator.

Taking all of the above into account, we put forward the following hypotheses, with the aim of accepting or rejecting them:

- H1. The educators from Granada have a favorable perception of the functionality of apps that are specialized for people with autism.
- H2. The opinion of the educators shows that the apps' applicability is capable of improvement.
- H3. The educators use free apps for Android devices frequently.
- H4. The variables of sex, gender, and type of educator are not determinants in their opinion on the functionality and applicability of the specialist apps.
- H5. The educators from urban areas have a more favorable opinion regarding the functionality and applicability of the specialist apps than those from rural areas.
- H6. The more experienced and older educators give a less favorable opinion on the functionality and applicability of the specialist apps.
- H7. The educators from the Primary Education stage have a better opinion of the functionality and applicability of the specialist apps.

Method

The study took a quantitative approach with a non-experimental (Johnson, 2001; Tsin-Yee & Tan-Lei, 2018), descriptive, comparative and cross-sectional design (Cantrell, 2011; Siedlecki, 2020).

Participants

The questionnaire was initially administered to 442 educators from Granada (Spain) working in the sphere of caring for diversity. Following the sample analysis, only 159 participants stated that they worked with people with autism and also used apps in the schools, specific associations or care centers where they were employed. Hence the final

sample of the study comprised 159 professionals who specialized in autism in the city of Granada. Non-probability convenience sampling was employed (Baxter et al., 2015; Edgar et al., 2017; Galloway, 2005; Van de Vijver, 2001; Wilson et al., 2014). In total, 134 women (84.3 %) and 25 men (15.7 %) participated, who identified as female and male, respectively. The high number of women participants is significant, but this high level of representation does not entail bias, because research in the field of Social and Legal Sciences is predominantly female (Gallardo-Montes et al., 2022, 2023; Gialamas et al, 2013). The ages of the participants ranged from 20 to 64 years old (M = 37.59; SD = 10.48), with less than ten years of professional experience (84.9 %). They were mainly Therapeutic Pedagogues (34.6 %), general teachers (20.1 %), Speech and Hearing teachers (10.1 %), and speech therapists (10.7 %), among others (see Table 1). Most of them worked in the stages of primary (80.5 %), early-childhood (57.2 %), and secondary education (25.8 %), but a high percentage stated that they worked in both early-childhood and primary education at the same time (44.7 %). These educators worked mainly in state schools (62.3 %) in urban areas (73 %) with internet (98.7 %).

Table 1.

Other sociodemographic data of the participants' occupation

Variables		**Educators *N* (%)**
Type of educator	Therapeutic pedagogue	55 (34.6)
	General teacher	32 (20.1)
	Speech therapist	17 (10.7)
	Speech and Hearing Teacher	16 (10.1)
	Special Education assistant	11 (6.9)
	Specialist teacher	11 (6.9)
	Therapeutic Pedagogy and Integration class teacher	9 (5.7)
	Special Needs class teacher	6 (3.8)
	Psychologist	5 (3.1)
	Therapeutic companion	5 (3.1)
	Occupational therapist	4 (2.5)
	Pedagogue	2 (1.3)
	Psychopedagogue	2 (1.3)

Instrument

The self-report measure used for data collection, called "Demandas y potencialidades de las ICT y las apps para la atención a de personas con autismo (DPTIC-AUT-Q)" ["Demands and potentials of ICT and apps for assisting people with autism"], was validated by Rodríguez et al. (2021). It has a section on sociodemographic data and four subscales connected to ICT: Subscale 1: Opinion, training and uses of ICT by professionals for teaching people with functional diversity; Subscale 2: Training and uses of ICT by professionals for teaching people with autism; Subscale 3: Uses and benefits of apps in assisting people with autism;

Subscale 4: Uses and possibilities of specialized apps for people with autism. In order to meet the aims of this study, we have only used the fourth subscale, "Uses and possibilities of specialized apps for people with autism", which comprised questions with Likert-scale responses (1 = Completely disagree; 5 = Completely agree). The instrument was designed to be used in its entirety, or by subscales or dimensions. For this study, we used the first and second dimensions of the subscale, Dimension 1: Functionality (items 85–92), Dimension 2: Applicability (items 93-105). Furthermore, the teachers were asked how often they used apps (1 = Little, 4 = A lot), their preferred operating system (iOS/Android/both) and the types of apps downloaded (free/paid/both).

The questionnaire has adequate psychometric properties. It obtained excellent Intraclass Correlation Coefficients in Subscale 2 = 0.995; significant Kendall's *W* inter-rater concordance ($p < .001$) = 0.127 clarity; 0.123 coherence; 0.109 relevance; and 0.160 objectivity; and an exceptional internal consistency: $\alpha_{Subscale\_4} = 0.947$. The results of the CFA for Subscale 4 were equally favorable and acceptable (Hair et al., 2018; Muthén & Muthén, 2007): the chi-square value was statistically significant ($\chi^2 = 4158.964$, $p = .0000$). All other values indicated an adequate instrument fit: the chi-square value was statistically significant ($p < 0.05$), RMSEA (0.011), SRMR (0.080), CFI (0.910) and TLI (0.900), demonstrating the goodness of the model. Cronbach's coefficients were high ($\alpha_{\_Dimension\_1} = 0.91$; $\alpha_{\_Dimension\_2} = 0.94$), as was the Composite Reliability ($CR_{\_Dimension\_1} = 0.88$; $CR_{\_Dimension\_1} = 0.92$).

Procedure

This study received a favorable report from the Human Research Ethics Committee [2002/CEIH/2021] of the University of Granada (Spain). It was administered to teachers and educators of schools and associations in the city of Granada. The link to access the questionnaire, designed on the *LimeSurvey* platform, was provided in face-to-face sessions and via email. At all times, participants were informed of the voluntary nature of the questionnaire, its anonymity and data exclusivity, as well as the aims of the study.

Data analysis

The data were analyzed with the SPSS v.26.0 statistics packet for Windows. We calculated descriptive statistics (mean, mode and standard deviation) and frequencies. Non-parametric inferential analysis, since the data did not show a normal distribution (Kolmogorov-Smirnov <0.05) and intrafactorial correlations analysis were carried out. For the analysis of correlations, we calculated Spearman's correlation coefficient (Hernández y Fernández, 1998; Mondagrón, 2014) and to examine the comparisons between "age" and "stage of work" we carried out the Kruskal-Wallis test and the consequent Games-Howell post hoc test, as well as the effect size using Hedges' *g* (Ventura-León, 2019).

Results

The frequency of use of the apps fell between the options "sometimes" (40.3 %) and "quite a lot" (50.3 %), leaving low percentages for the options "little" (3.1 %) and "a lot" (6.3 %). The participant educators mainly downloaded free apps (75.5 %) for devices with Android operating systems (58.5 %).

According to mode and mean values, the perception of the functionality and applicability of the apps specifically for people with autism came between the options "neither agree nor disagree" and "agree" (Table 2). Dimension 1, "Functionality", obtained slightly lower scores compared to Dimension 2, "Applicability" ($M_{Functionality} = 3.52$; $SD_{Functionality} = 0.69$ *vs* $M_{Applicability} = 3.69$; $SD_{Applicability} = 0.65$).

Regarding Dimension 1, "Functionality", most of the educators stated that the specialized apps for people with autism respected their learning pace, allowed the uploading of images or personalized pictograms, indicated the age they were aimed at, and were available in several languages. However, there was less agreement over whether they allowed universal accessibility (changes of font size, color, or graphic elements...), functioned correctly, carried out tracking of the work done, or facilitated assessment and follow-up by the user.

According to Dimension 2, "Applicability", the participants were more in agreement in that the apps were indeed available for smartphone and tablet, that they included tasks that met the needs of people with autism, that they had a design that was adapted to their characteristics, offered different codes of communication (visual/written), were intuitive and easy to handle, and had suitable content that was offered up in a clear way. However, there was less agreement that the apps were easy to find on *Google Play* or the *App Store*, that they were numerous, presented a variety of themes (emotions, communication, time management...), specified the content included, and offered a controllable a situation and environment.

Table 2.

Perception of the educators on the functionality and applicability of apps specifically for people with autism

	ITEM	*M*	*SD*	M_o	%				
					1	2	3	4	5
Dimension 1: Functionality	85. They enable universal accessibility	3.49	0.86	3	0.6	10.7	39.0	38.4	11.3
	86. They function correctly	3.50	0.80	3	0	6.9	48.4	32.7	11.9
	87. They respect the pace of learning	3.69	0.83	4	0	6.9	34.6	41.5	17.0
	88. They enable the user to add personalized images or pictograms	3.55	0.91	3	1.3	9.4	37.1	37.1	15.1
	89. They specify the age they are designed for	3.57	0.99	4	2.5	10.1	34.0	34.6	18.9
	90. They are available in several languages	3.55	0.99	4	3.8	9.4	30.8	39.6	16.4
	91. They track the user's progress	3.38	0.95	3	3.1	12.6	39.0	34.0	11.3
	92. They facilitate assessment and user progress tracking	3.48	0.99	4	4.4	10.1	31.4	40.9	13.2
Dimension 2: Applicability	93. They can be found easily on Google Play or the App Store	3.51	0.99	3	1.9	12.6	36.5	30.8	18.2
	94. They are available on smartphones	3.72	0.96	4	0.6	10.1	29.6	36.5	23.3
	95. They are available on tablets	3.96	0.85	4	0	4.4	24.5	41.5	29.6
	96. There are many of them	3.40	0.99	3	1.3	17.0	38.4	27.7	15.7
	97. They are varied in terms of subject area	3.63	0.92	4	0.6	10.1	33.3	37.7	18.2
	98. They include tasks that respond to their needs	3.70	0.86	4	0	7.5	30.8	45.9	15.7

99. Their design is adapted to their characteristics	3.72	0.80	4	0	5.0	34.6	44.0	16.4
100. They offer different codes of communication	3.89	0.83	4	0	5.0	25.2	45.9	23.9
101. They are intuitive and easy to use	3.72	0.83	4	0.6	5.7	31.4	45.9	16.4
102. They present their content in a clear and intuitive way	3.77	0.80	4	0	5.0	30.8	46.5	17.6
103. They specify what content they include	3.58	0.90	3	1.3	8.2	38.4	35.8	16.4
104. They include suitable content	3.79	0.76	4	0	3.1	32.1	47.2	17.6
105. They offer a controllable environment and situation	3.59	0.92	4	1.3	9.4	34.6	38.4	16.4

Note. *M* = Mean; *SD* = Standard Deviation; M_o = Mode; *1* = Completely disagree; *2* = Disagree; *3* = Neither agree nor disagree; *4* = Agree; *5* = Completely agree.

The analysis of correlations (Table 3) showed that there was a strong positive (r = .721), and significant (p < .000) relation between Dimensions 1 and 2. There was also a positive, medium and significant (p < .001) relation between both Dimensions 1 and Dimension 2 and frequency of use (r = .231; r = .296, respectively). We could discern a weak negative (r = -.172) but significant (p < .000) relation between professional experience with people with autism and Dimension 2.

Table 3.

Spearman's correlation between age, experience, and the applicability and functionality, and frequency of use of apps

	Age	**Experience**	**D2**	**D1**	**Frequency**
Age	1				
Years experience	.454**	1			
Dimension 2. Applicability	-.151	-.172*	1		
Dimension 1. Functionality	-.064	-.118	.721**	1	
Frequency of use of the apps	.015	.000	.296**	.231**	1

Note. ** The correlation is significant at level 0.01 (two-tailed); * The correlation is significant at level 0.05 (two-tailed).

The inferential analyses did not produce differences by sex, gender, area of work, years of experience, or type of educator, but they did for other variables.

We found statistically significant differences between the educators' age and "Functionality" and "Applicability". According to the Games-Howell post-hoc test, the participants aged between 31 and 40 years old (M = 3.28; SD = 0.58) showed a lower perception on Dimension 1, "Functionality," (K = 12.54; p = .006) compared to those aged between 20 and 30 (M = 3.70; DT = 0.77) and 41 and 50 (M = 3.66; DT = 0.63), with a small effect size, according to the Hedges' g values (ε^2 = .008). Regarding Dimension 2, "Applicability," (K = 10.09; p = .018), the younger educators (20 to 30 years old) showed

greater perception compared to their older peers (51 to 64 years old) ($M_{20-30\ years}$ = 3.87; $SD_{20-30\ years}$ = 0.72 *vs* $M_{51-64\ years}$ = 3.38; $SD_{51-64\ years}$ = 0.60), with a small effect size (ε^2 = .006).

If we look at the educational stage that they worked in, we can also see statistically significant differences. Those participants who worked in primary education showed a greater perception toward Dimension 1 "Functionality" (K = 12.47; p = .014), compared to those who worked in both early-childhood and primary education at the same time ($M_{primary}$= 3.69; $SD_{primary}$ = 0.59 *vs* $M_{earlychildhood\text{-}primary}$= 3.35; $SD_{earlychildhood\text{-}primary}$ = 0.71), according to the Games-Howell post hoc test, with a small effect size (ε^2 = .008).

Discussion and conclusions

The quality of apps designed specifically for people with autism, despite not having been studied and researched in the past (Gallardo-Montes et al., 2021a), has increased in recent years, as the literature shows (Costa et al., 2022; Taynar & Marques, 2022). This is so much so that a comprehensive effort has been made to design apps with the collaboration of people with autism, their families, and professionals in the field (Boyd et al., 2022; Boyle & Arnedillo, 2022; Mazon et al., 2022; O'Rourke et al., 2022; Varriale et al., 2023), for the creation of software that is fully accessible to them (Costa et al., 2022; Taynar & Marques, 2022).

As we have seen, the educators participating in this study have a good opinion of the functionality of the apps, highlighting that they respected the different paces of learning, that they allowed personalized images or pictograms to be uploaded, that they indicated what age they were aimed at, and that they were available in several languages. In this regard, such essential aspects as the personalization of the environment and the inclusion of personal images is noteworthy, as they make it possible to individualize the teaching and to provide education that is fully adapted to the characteristics of the person with autism. They also enable the extrapolation of virtual situations to daily settings, for they make it possible for the person to participate and interact actively, as García-Rodríguez and Gómez-Díaz (2015) have mentioned.

It is also worth noting that the educators stated that the apps specifically for people with autism indicated the age they were aimed at, since this was one of the shortcomings highlighted in the evaluation of 155 apps for autism carried out by Gallardo-Montes et al. (2021a).

Looking at the aspects with less agreement between the participants, the most noticeable were that the apps did not allow full universal accessibility, could improve how they worked, and would achieve higher scores if they gave the option of tracking the work done or provided assessment of the user's performance. The finding on accessibility stands out: despite the efforts made to design apps that are accessible (Costa et al., 2022; Taynar & Marques, 2022; Varriale et al., 2023), the educators stated the opposite. People with autism can present a wide range of heterogeneous skills and needs, depending on the nature of the disorder and the degree to which they are affected (Trubia, 2016), which means that for an app to be accessible it must cover all the requirements a user might have (Aguado & Estrada, 2017). Despite these improvable details regarding the apps' functionality, the educators had a favorable perception of this dimension, and so we can accept Hypothesis 1.

Regarding the applicability of the apps, the participants revealed greater agreement that the specialized autism apps were available for smartphone and tablet, included tasks that met the needs of people with autism, had a design that was adapted to their characteristics, offered different codes of communication (visual/written), were intuitive

and easy to manage, and had suitable content offered in a clear way. These findings are in line with what is desirable for an app focused on people with autism, in terms of their pedagogical options and content (Boyle & Arnedillo, 2022; Gallardo-Montes et al., 2021b, Johnson et al., 2022), since an app should reflect the needs and requirements of the end user.

Despite these positive aspects, there was less agreement over whether apps for users with autism could be easily found on *Google Play* or the *App Store*, were numerous, offered a variety of themes (emotions, communication, time management, etc.), specified the content they included, and offered a controllable situation and environment. These findings concur with those of Gallardo-Montes et al. (2021a, 2022), since despite the existence of hundreds of apps supposedly made for this community, often, when carrying out simple searches in the app catalogues through the keyword "autism", the results returned are huge and do not always offer the desired content. Moreover, most of them did not indicate what content they worked on and, if they did, they generally focused on the development of executive functions, basic instrumental skills, and communication, leaving a low proportion devoted to other themes, such as Theory of Mind or time management (Gallardo-Montes et al., 2021a). These results indicated that the applicability of the apps was capable of improvement, thus validating Hypothesis 2.

According to the participants' opinion about the type of apps used, Hypothesis 2 is accepted, since they frequently used free apps for Android devices. These results can be explained by the fact that the regional government of Andalusia (Spain) has handed out tablets to students with autism, via the state schools of Andalusia (Spanish autonomous community made up of provinces, Granada being one of them). These tablets, given to every student who belonged to the autism spectrum disorder (ASD) classrooms, had the Android operating system. Aside from using free Android apps, the educators state that they used apps "sometimes" (40.3%) and "quite a lot" (50.3%), thus it can be assumed that they use is frequent, with a low percentage for the options "little" and "a lot".

Correlations could be discerned between both dimensions, since the parameters "Functionality" and "Applicability" were closely related, given that they currently represent the ideal of an app that is usable and accessible for people with autism. There were also correlations between these dimensions and the frequency of use by the educators, which leads us to conclude that greater use and frequency of apps would entail greater knowledge about them and a more favorable perception of their content, design, form and pedagogical aspects. These results are not comparable with previous studies, because the current literature has not examined these aspects with professionals and specialists in autism.

The inferential analyses did not produce differences by sex, gender, type of educator, or area of work. This means that Hypothesis 4, which states that the variables of sex, gender, and type of educator are not decisive factors in the more or less favorable opinion of the specialist apps, is accepted. However, Hypothesis 5, which stated that the educators from urban areas would have a more favorable opinion of the functionality and applicability of the specialized apps than educators from rural areas, is rejected. Additionally, we found differences according to the educators' age and the perceived "Functionality" and "Applicability" of the apps. The participants aged between 31 and 40 years old showed a lower perception on Dimension 1, "Functionality", compared to the 20-30 and 41-50 age groups. These results could indicate that experienced professionals with a few years under their belts have detected that there is room for improvement in the functionality of the apps for autism, compared to their younger, less experienced counterparts and the oldest educators, who due to their age may be unaware of the specific characteristics of the apps.

However, given the fact that this research is novel, there are no previous studies to compare with in terms of participant age. The differences evidenced mean only the partial acceptance of Hypothesis 6, because the older educators did indeed give a less favorable perception of the functionality and applicability of the apps, but there were no differences according to the years of experience with people with autism.

Regarding Dimension 2, "Applicability", it was the youngest educators (20 to 30 years old) who had a lower opinion regarding this dimension, compared to the oldest age group (51 to 64 years old). Perhaps the older specialists in autism, due to their age, lack in-depth knowledge of the applicability of apps, because apps have not been a part of their professional practice throughout most of their careers as educators. As previously mentioned, there are no previous studies with which to compare these findings.

In terms of the educational stage worked with, we also found differences. Those educators who worked in the primary education stage indicated a higher opinion of Dimension 1, "Functionality", compared to those who worked in both early-childhood and primary education. It may be that working specifically with children with autism aged between 6 and 12 years old makes is possible to examine and understand the potentials of the apps in a more specific way, as the functionality and dedication that can be found when working in this stage is greater. Similarly, most of the apps for people with this disorder are restricted to this age group (Gallardo-Montes et al., 2021a). Again we must stress that it is difficult to relate these results to previous studies due to the novelty of the study. In any case, these findings mean that we can accept Hypothesis 7.

By way of conclusion, it should be stated that there is a need for accessible apps that make it easy for people with autism to use and take advantage of them. There is a wide range of apps specifically for this disorder, and having knowledge of the perception of the specialists who work with them is essential for understanding what might lead them to use these apps or not, precisely due to reasons connected to usability, accessibility, functionality, and applicability. In the end it is all for the purpose of enhancing the teaching-learning process with and for these people. The contributions of Neuroscience in this field allow knowing how information is processed and understanding the cognitive, sensory and emotional capacities of the user. This implies that designers can create apps adapted to the capacities and needs of the person with autism, considering their attention, memory, cognitive load and perception.

As ASD is a special need, the learning process is unique, which is why it is important to be meticulous in this aspect and reflect on the requirements and needs of people with autism to provide the quality of life they deserve and to design individualized digital resources. The pedagogical aim of this study is to discern parameters for the optimization of the design and functionality of apps for people with autism, at the same time as giving guidelines for selecting and using them in the best possible way.

In terms of future research, it would be worthwhile to continue this line to overcome the shortcomings of the present study, particularly by exploring the opinion of educators from other cities and countries to understand how the phenomenon of accessibility is perceived in other contexts and to be able to establish comparative studies between them. Similarly, this research would be enhanced through using the qualitative method, by means of in-depth interviews that would make it possible to reflect on the professional practice based on apps. This methodology would also provide the chance to examine the problems of accessibility that users themselves, the different professionals involved, and the families have all found in apps.

Looking at the limitations of the study, the sample size needs to be mentioned. The DPTIC-AUT-Q questionnaire was administered to 442 professionals from Granada who worked in the area of functional diversity, of whom 310 specialized in autism and only 159 stated that they used apps for working with people with this disorder. This could condition the ability to generalize the results, and, as mentioned above, it would be appropriate to increase the sample with participants from different contexts. In addition to the sampling limitation, there is the limitation of any survey or self-report research (Karpen, 2018; Mabe & West, 1982), even with validated instruments.

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