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Analysis of apps used by teachers with autism students in early childhood in Spain

Análisis de apps utilizadas por profesores con alumnado autista en la etapa infantil en España

Dr. Juan Manuel Trujillo Torres
Catedrático de Universidad. Universidad de Granada. España.

Dulce Fernández Montoro
Estudiante de Doctorado. Universidad de Granada. España.

Dra. María Dolores Benítez Márquez
Profesora Titular de Universidad. Universidad de Málaga. España.

Carmen Rocío Fernández Fernández
Contratada predoctoral FPU. Universidad de Granada. España.

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ABSTRACT

The importance of the benefits obtained from the use of new technologies in the teaching-learning process is agreed-upon by most of the authors who have published about technologies, education, and autism. Likewise, in Spain, there are very little empirical studies on teachers in the early childhood stage with autistic children (3 to 6 years old). This justifies the present cross-sectional study, which includes the participation of 251 active teachers residing in Andalusia (Spain). The aim of the study is to provide knowledge on a specific technology (apps) used by the professionals in the context described. Among other objectives, in first place, the skills that need to be developed by the autistic students, through the use of 23 Spanish-language apps, are classified, at the same time that the characteristics of the apps are summarized. Additionally, an analysis is performed of the significant differences in the number of different apps used by each teacher with respect to gender, school location (rural-urban), age, years of teaching experience, and years of teaching autistic children. In third place, the linear correlation was performed between the number of different apps used by each teacher and age. Among the most notable conclusions, with respect to skills, the apps that developed the needs to be improved related with communication and socio-emotional aspects were the most valued, while the ones related to behavior were least valued. With respect to the summary of their characteristics, all the apps used in Spain were free, and both Spain and the USA were notable for the creation of the apps selected. Lastly, the number of different apps used by the teachers and age had a scarce negative relation.

RESUMEN

La relevancia de los beneficios de utilizar nuevas tecnologías en el proceso enseñanza-aprendizaje es una idea consensuada por la mayoría de los autores que han publicado sobre tecnologías, educación y autismo. Asimismo, en España, hay pocos estudios empíricos sobre el profesorado en la etapa educativa infantil con niños autistas (3 a 6 años). Esto último justifica la realización de este estudio de corte transversal, donde participan 251 docentes activos residentes en Andalucía (España). Con ello, se pretende aportar conocimiento sobre una específica tecnología (las apps) utilizadas por los profesores en este contexto descrito. Entre otros objetivos, en primer lugar, se clasifican las habilidades necesidades a desarrollar por el alumnado autista con las 23 apps educativas utilizadas en idioma español, al mismo tiempo, que se sintetizan las características de las apps. Adicionalmente, se analiza si hay diferencias significativas del número de apps distintas usadas por cada profesor por género, por ubicación del colegio (rural-urbano), por edad, años de experiencia docente y por años de experiencia docente en autismo. En tercer lugar, se analiza la correlación lineal entre el número de apps distintas utilizadas por cada docente y la edad. Entre las más destacadas conclusiones, respecto a las habilidades, las apps que desarrollan las necesidades a mejorar de comunicación y socio-emocional presentan las evaluaciones más valoradas, mientras que las conductuales son las menos valoradas. En relación a la síntesis de sus características, todas las usadas en España son gratuitas, así como, que España y USA destacan en creación de apps de las seleccionadas. Por último, el número de apps distintas utilizadas por el profesorado y la edad presentan escasa relación negativa.

PALABRAS CLAVES · KEYWORDS

Applications-apps; autism (ASD); Information and Communication Technologies (ICT); early childhood education, teacher.
Aplicación-apps; autismo (TEA); Tecnologías de la Información y la Comunicación (TIC); educación infantil; profesorado.

1. Introduction

Applications (apps) play important roles in current technologies. An app is a type of software that is mainly executed in tablets, mobile phones, and computers. Digital contents through apps have a very attractive design for school children, and in the beginning, their aim was recreational or to support learning (Gabarda Méndez et al., 2021).

Additionally, it has been noted that there is a positive assessment of learning with mobile phones using a participative methodology in the context of Early Childhood and Primary Education in Spain (Gil Quintana, 2019). Nevertheless, in general terms, a warning has been issued about the risks of an excessive exposure to screens, as a study with primary school children (8 years old) associated a lower performance in linguistic communication and mathematical reasoning as the exposure time increased (Ortiz-de-Villate et al., 2023).

Most of the studies point out that the use of technologies improves the teaching-learning process of students with Autism Spectrum Disorder (ASD), according to a systematic review (2010-2020) performed by Durán Cuartero (2021). For example, Omar et al. (2020) performed a qualitative study with 8 teachers in Malaysia to obtain their opinion about the use of tablets by autistic children in class; they concluded that motivation and the use of technology improves learning in the classroom. However, some difficulties were observed in the implementation of technologies in some countries, with respect to the use of mobile phones and tablets in the context of autism (Sabayleh & Alramamneh, 2020).

As for the teachers, the priority is to assess the performance of learning outcomes and to analyze the effects of the use of technologies on people with ASD (Hasan & Nene, 2022) to find solutions to learning (Chinchay et al., 2023). Thus, the selection of applications will be better adapted to the individual needs of autistic students, starting with the proposed education objectives (López-Díaz et al., 2024). With respect to early childhood ASD, the relevance of the teacher's selection of practices to promote the development of social communication is indicated (Hugh et al., 2022).

With respect to the entertainment or learning nature of the apps, some scholars believe that they must be separated, independently, into entertainment apps and learning apps (Griffith et al., 2020). Nevertheless, the results from the studies show that the apps have a mixture of curricular and entertainment elements in the early childhood education stage, although perhaps more centered on entertainment than didactics (López Gómez et al., 2021). As for the apps in early childhood ASD education, these apps must be strengthen using a usability-based approach, to significantly improve the quality of education for all students (Bosse et al., 2024).

Some novelties related with the education apps applied to autism are found in Table 1.

Table 1

Novelties related to apps applied to autism

Author (year) sorted by year of publication	Document type – Type of study (quantitative or qualitative)	Sample or participants – Country – Technology – Skill (need)	Results
Rodríguez Malebrán et al. (2020)	Article – Quantitative and qualitative study and app design	114 elementary school students, 28 teachers and 25 researchers, students between 8 and 11 years old – Chile - Design of the Aphids Attack video game for mobile devices - behavioral	Its objective is to describe in an educational way the ecological interactions between organisms and the environment. It improves student behavior and connects the recreational and curricular (learning) aspects.
Yan et al. (2021)	Article – Quantitative study and app design	15 children of unspecified age – Hong Kong – app based on Auditory-Motor Mapping Training (AMMT) – communication (Mandarin language)	The app's results provide the first empirical evidence that it facilitates speech and word learning in nonverbal and speech-impaired children.
Lee et al. (2022)	Article – Quantitative study	24 children aged 7-12 – Korea – App design for children's social skills (PEERS) – social (stress)	Develop and implement a metaverse-based PEERS app. It improves social interaction skills in stressful situations.
Camilleri et al. (2024)	Article – Quantitative study	Preschool children and, unspecified age – United Kingdom – Stories Online For Autism (SOFA) app – social and communication (language)	SOFA is a digital application for Social Stories. The stories' results support children's language development.
Cordioli et al. (2024)	Article – Quantitative study	18 children with ASD aged 4 to 7 – Italy – ABA App – behavioral	The results show that it improves the effectiveness of therapy sessions, reducing non-therapeutic time, increasing patient concentration, and improving behavior.
Fernández et al. (2024)	Article – Qualitative and Quantitative Design	30 children aged 8-17 – Manila (Philippines) – Convey with FER – mobile app – emotional	The Convey app allows children to express their emotions and help their interlocutor better understand them. The model used in the app is 98% accurate.
López-Bouzas et al. (2024)	Article – Quantitative study and app design	54 subjects aged 3 to 17 – Oviedo (Spain) – AGE app (Augmented Gamified Environment) – socio-emotional	Design of the AGE app. The results show that socioemotional skills improve after the intervention, regardless of gender, age, ASD level, comorbidity, and language type.
Panda et al. (2024)	Article - Quantitative Study – Mobile App	37 children in intervention and 27 in control, aged 2 to 6 years – India – IMPUTE ADT-1 – mobile medical – behavioral	IMPUTE ADT-1 is effective in improving the severity of autism symptoms in children. Parents report that it is beneficial in improving their children's socialization and verbal communication.
Sweidan et al. (2024)	Article – Quantitative study and app design	Arab students of unspecified age, Saudi Arabia – MOLHEM mobile app in Arabic and English – communication skills	Design and implementation of the MOLHEM app. It allows for real-life conversations in Arabic or English with a chatbot represented by a cartoon avatar.

		(language), mathematics, and social skills	Students improved their social skills, as well as their language and math skills.
Wang (2024)	Position paper presented at the conference – Value judgment	Young students of unspecified age - interactive emoji-based application - No country mentioned - socio-emotional	The app helps neurotypical individuals express their emotions and encourages them to understand the emotions of children with ASD, fostering two-way social interaction.
Wall et al. (2025)	Article – Quantitative study on app	15 children and their caregivers, ages 8-16 – iPad app for facial emotion recognition (TYLES) – Central Coast and Hunter regions, New England (Australia) – emotional	It is concluded that by using the application for 12.6 minutes a day, the users achieved a high accuracy (>90%) in recognizing emotions, regardless of the type of expression.
Zurita Díaz & Calleja Reina (2025a)	Article – Quantitative study and development of EC+ technological support	18 children with ASD level 3, aged 6 to 12 – EC+ app (multimodal list) integrated with AAC – Málaga (Spain) – communication, social and behavioral.	The EC+ app is an augmented and alternative communication system. It offers significant benefits during the intervention phase, resulting in significant improvements in all areas of communication, social interaction, and behavior.
Zurita Díaz & Calleja Reina (2025b)	Article – Quantitative and application app and EC+ technological support	40 autistic participants aged 6-12 with level 3 in a Spanish-speaking context – SymboTalk (communication board) and EC+ (multimodal list), combined with assisted augmented reality – Málaga (Spain) – communication and behavior	Significant improvements in receptive and expressive communication were observed. No significant differences were observed between the combined behavioral and communication groups in a Spanish-speaking context.

Source: Created by the authors (2025).

With respect to the evaluation of the apps against each other, several studies can be described:

- Santiago and Marques (2023) analyzed the reviews of education apps found in the Google Play Store. These reviews provided information on the experience of the user, the usability, and the accessibility for users with ASD. The authors presented a text analysis of the reviews extracted from eight education applications available in Portuguese with a focus on autistic children.
- Gallardo et al. (2021a) evaluated a total of 88 applications for children and adolescents with autism based on instrumental skills. Among other conclusions, the authors underlined: (1) lack of specialization of the apps on reading and mathematics; (2) most did not specify the age group to which their content was directed; (3) the application with the best score in all the instrumental skills was Smile and Learn.
- Gallardo-Montes et al. (2021b) evaluated 155 apps for autism applicable to all ages and uses (educational, parental, and professional), downloadable from the Google Play Store. A total of 14 apps obtained a notably higher evaluation score than the rest.

- Gallardo-Montes et al. (2022a) identified the most relevant apps for people with autism, up to adolescents, based on a ranking system previously established by the same authors. Likewise, they concluded that there are significant differences in some items related with the benefits, uses and the frequency of use of apps between Florence and Granada educators according to sex, age (per group), years of experience, workplace, and the type of teacher. Granada educators provided the most benefits, as well as the use and frequency of use as compared to Florence.
- Gallardo-Montes et al. (2022b) reviewed 155 free apps from the Google Play Store to improve the education and therapy needs of children and adolescents with autism. Among the conclusions, the following were underlined: (a) most of the apps were applied to multiple areas; (b) many of the apps were dedicated to the areas of executive functions, language, and entertainment, and not many were centered on emotional aspects and time management; and (c) they provided diverse classifications according to the 7 areas.
- Gallardo-Montes et al. (2023) administered the questionnaire by Rodríguez-Fuentes et al. (2021) to 310 education professionals (28% were teachers) in early childhood (52.9%), primary education (72.9%) and secondary education (28.1%). These participants worked in Granada (Spain), at schools and associations that helped people with ASD. They concluded that there were statistically significant differences on the frequency in the use of apps based on sex, age, type of institution, and type of educator. The special education professionals showed to be more competent than the rest in the use of education technologies applied to people with autism.
- Gallardo et al. (2024**),** in their sixth study, the authors evaluated 52 apps to teach English to people with autism, without specifying any age range, in Spain. The authors concluded that 23.1% were highly recommendable, 75% recommendable, and 1.9% not recommendable.

With respect to the autism apps included in the questionnaire by Rodríguez Fuentes et al. (2021), and partially on the results from the research by Gallardo et al. (2021a, 20121b, 2022a, 2022b, 2023), the objectives of the present study are:

i. To classify the apps used in the early childhood education of children with ASD according to: (a) the priority skill-need to be improved. From here on, we will refer to the skill-need term only as need, justifying this decision in that we consider that the area of emotions is not a skill; (b) combinations of needs; (c) ranking of 88 apps by judges; and (d) ranking of the teachers surveyed.

ii. To summarize the characteristics of the apps based on: download links and/or information, age groups of the students to which these apps are directed, OS (Android/iOS/Windows/Kindle), if it is free or paid, languages (number of languages), country and original language the app was developed in, year of creation, latest year it was updated, priority need, along with the most complete combination of needs it covers.

iii. Based on the variable that was used as the proxy for the evaluation of the teachers polled, the number of different apps used by each teacher, a correlation coefficient will be obtained between that variable and age.

iv. To analyze if there are significant differences in the number of different apps used by each teacher according to sex, the location of the center, age, the years of experience in education, and the years of experience with autism.

2. Methodology

The research study is non-experimental and quantitative. The data are cross-sectional and were collected from November, 2022, to September, 2023. The sampling was non-probabilistic, using the snowball method, and was performed via the telephone. Part of the validated Demands and potential of ICTs and apps for the care of people with autism questionnaire (DPTIC-AUT-Q) was used, which was designed by Rodríguez Fuentes et al. (2021).

2.1. Population

The sample was composed of 251 teachers (data already screened) who taught students with autism in the Early Childhood stage (3-6 years old) at schools located in the Community of Andalusia (Spain).

2.2. Sample

From the sociodemographic and professional characteristics, the following were notable: 82.3% were women, and 17.7% men. The mean age was 45.6 years old, with a standard deviation of 8.4 years, a minimum of 24, and a maximum of 64 years old. With respect to the years of experience in education, < 1 year of experience (0%), ≤ 5 years (8.3%), from 6 to 10 years (11%), from 11 to 20 years (33.9%), from 21 to 30 years (33.5%), and 31 years (13.4%). As for the years of experience with autism, ≤ 5 years (47.6%), from 6 to 10 years (31.9%), from 11 to 20 years (13.8%), from 21 to 30 years (2.8%), ≥ 31 years (0.8%), and none (3.1%). Therefore, 29.5% had worked with autism for less than 10 years. Most of the education centers were public, with 33.1% being rural, and 66.9% urban.

2.3. Data collection instrument

The part relative to the 23 specific apps that teachers used with early childhood autistic students was used. In addition, other variables related with the education apps described in Table 2 were used; two were quantitative, two dichotomous, and three categorical. The software used was SPSS v.28.

Table 2

Variables used in the study

Variable	Type	Items
Number of different apps used by teachers	Quantitative	1
Age (years)	Quantitative	1
Experience in education (year intervals)	Categorical	1
Experience in education with children with autism (year intervals)	Categorical	1
Age (in year intervals)	Categorical	1
Sex (female, male)	Dichotomous	1
Location of the school (rural, urban)	Dichotomous	1

In addition, the results obtained by Gallardo et al. (2021a) were used for the rankings, and the evaluation of the teachers surveyed was based on the variable created from the

total number of times that an app from the 23 selected was utilized. With respect to the ranking, a series of clarifications are necessary. In first place, we considered the classification by Wing (1988) to catalogue the priority needs to be improved in autism, as: communication (COM; including reading, speaking, writing, mathematics, and language); socio-emotional (SE) or behavioral (BE). In the early childhood education stage, we only considered the COM needs (only reading and oral expression), SE (socioemotional, including play), and BE (including motor skills); the cognitive part is considered implicit in all the apps, the curricular part begins to be applied in primary school, and mathematics are not included. Thus, the attention is centered on the needs of communication, socioemotional interactions, and basic behavioral skills. In second place, the language used in the apps was Spanish. In third place, the ranking of the apps used by the teachers in the area of early childhood education is provided by the creation of a new variable: the number of times that an app was used by the total set of teachers.

2.4. Analysis technique and software

Descriptive statistics were used, as well as a correlation coefficient and inferential analysis to compare the means of independent samples. The software used was SPSS v.28.

3. Analysis and results

3.1. Ranking the apps

The questionnaire includes a question that asks if other apps are used, as a closed-ended question (yes or no), and is not complemented with an open-ended question if affirmative. The analysis of the data from Table 3 provides various results. In first place, of the priority needs, 13 apps were associated with COM (56.5%), 9 with SE (39.1%), and 1 with BE (4.3%). In early childhood education, the teachers prioritize the need of communication, followed by socioemotional aspects. In second place, with respect to the combination of needs, there were 4 apps (17.4%) that did not show combinations, prioritizing COM. Of those that showed combinations, 7 combined COM+SE (30.4%), none combined COM+BE (0%), 2 combined SE+BE (8.7%), and 10 SE+COM+BE (43.5%). COM combined with other needs appears in 73.9% of the apps, while the emotional need combined with others appears in 82.6% (30.4+8.7+43.5=82.6). Therefore, the SE need plays an important role in early childhood education. Thus, the teachers try to select apps that support the three needs, as 10 out of 23 cover all three needs. In third and last place, among the apps that were most utilized by the teachers, two stood out: Smile and Learn, with the priority need of communication and COM+SE+BE combination, a free Spanish app that is also available in English. It is followed by Emotions, feelings, and expressions!, created in the United Kingdom in English. It is free and available in Spanish, with the priority need of SE and the SE+COM combination.

Table 3

Total number of times each app was used by all teachers, priority needs and combination of needs, app rankings by experts and ranking by teachers

N	TITLE	PRIORITY NEED TO IMPROVE			COMBINATION OF NEEDS TO IMPROVE				RANKING BY 12 EXTERNAL EXPERT JUDGES (Gallardo et al. 2021a)			RANKING BY TEACHERS (Total number of times each app was used by all teachers surveyed)
N.	App title (Primary language: Spanish)	1	2	3	1. MIX	2. MIX	3. MIX	4. MIX	SCORE A	SCORE B	SCORE C=A+B	
		COM	SE	BE	COM + SE	COM + BE	SE + BE	COM + SE + BE	*Oral (max =7)	*Reading (max =9)	*score COM (max =16)	
16	Smile and Learn: Educational games for children	1	0	0	0	0	0	1	6	6	**12 (R1.5)**	163 (R1)
15	Proyecto Emociones	0	1	0	0	0	1	0	-	-	-	107 (R2)
07	José Aprende*	1	0	0	0	0	0	1	4	4	8 (R9)	84 (R3)
18	#Soyvisual	1	0	0	1	0	0	0	4	5	9 (R6.5)	71 (R4)
10	Lista visual schedule	0	1	0	1	0	0	0	0	4	4 (R17)	67 (R5)
23	Visual Schedule and social stories	0	0	1	0	0	0	1	3	2	5 (R14.5)	62 (R6)
08	Juego de niños para bebés de 2 a 5 años	0	1	0	0	0	0	1	0	0	0	56 (R7)
09	LEA Lecto escritura	1	0	0	0	0	0	1	3	5	8 (R9)	50 (R8)
16	Proyect@ PECS*	1	0	0	0	0	0	0	5	5	**10 (R4)**	49 (R9)
06	Emociones, sentimientos y expresiones!	0	1	0	1	0	0	0	4	2	6 (R11.5)	40 (R10)
17	Social skills for Autism Mkloog 2	0	1	0	0	0	1	0	2	3	5 (R14.5)	31 (R11)
21	Terapiaz tabletem	0	1	0	0	0	0	1	-	-	-	27 (R12)
20	Symbotalk AAC	1	0	0	1	0	0	0	6	6	**12 (R1.5)**	24 (R13.5)
02	Aboard Comunicación Aumentativa y Alternativa (CAA)	1	0	0	0	0	0	0	5	5	**10 (R4)**	24 (R13.5)
12	MiTA	1	0	0	1	0	0	0	3	3	6 (R11.5)	22 (R15)
05	CPA	1	0	0	0	0	0	0	5	4	9 (R6.5)	21 (R16)

04	Commboards (Therapy AAZ)	1	0	0	1	0	0	0	5	5	**10 (R4)**	6 (R17.5)
22	Vi.co hospital	1	0	0	0	0	0	1	4	4	8 (R9)	6 (R17.5)
11	Michelzhino	0	1	0	0	0	0	1	3	2	5 (R14.5)	11 (R19)
03	Autastico	0	1	0	1	0	0	0	3	2	5 (R14.5)	8 (R21.5)
13	Otsimo Special Education	0	1	0	0	0	0	1	-	-	-	8 (R21.5)
19	Speech Blubs: Language Therapy	1	0	0	0	0	0	0	-	-	-	8 (R21.5)
01	ABA DrOmnibus for Parents	1	0	0	0	0	0	1	-	-	-	6 (R21.5)
24	Otros	-	-	-	-	-	-	-	-	-	-	-

Notes: N: Number. 1: Yes, 0=No; Applied needs priority (classification performed by the authors' analysis): 1. COM, communication (Reading+Oral); 2. SE, socio-emotional (includes games); 3. BE, behavioral (includes psychomotor skills). 25. In cases where more than one app is mentioned, it is not possible to assign a score (–, not available) because the app names are not specified. Source: Ranking made by the authors. *Judges' ranking from Gallardo-Montes et al. (2021a); those apps without a score are those not included in the Gallardo-Montes study. Tied rankings have been broken according to the average corresponding to the positions that would be assigned if they were not tied.

Table 4 shows another series of characteristics, such as the name of the app, the URL used to obtain information on the application and the download choices, the recommended age, the operating system, if it is free or not, the languages in which it is translated, the total number of languages in which it was translated, the country where it was developed, the development language, year of creation, latest update year, the priority need to improve in ASD. In this respect, the following results stand out:

- Age. Some apps, for example, appear as Early Childhood education, and do not show a precise numerical value. Other apps are made for all ages (see age limits in Table 4).
- Operating system. 100% of the applications are available for Android.
- Free or not. All of them have a free version, and at the same time, better paid versions.
- Description of languages/dialects/ (total). All the apps are available in Spanish (working language) and in English. Apart from that, they are translated to other languages.
- The number of languages they have been translated to. The minimum is two languages, Spanish and English (LEA Lectoescritura) and the maximum is 57 (ABA DrOmnibus for Parents).
- Country (native development language). Most of the apps were initially developed in Spanish and English, with a tie between Spain and the USA. These two countries are notable in the application of apps in the area of autism in Spain, with five apps each, and with these 10 applications accounting for 43% of the applications used.

- Year of creation. The first app created was the PEC project (1985), with the second being CPA (2003). Another app that is commonly used is Smile and Learn (2015) and Proyecto Emociones (2012). The last one created was LEA Lectoescritura in 2020.
- Last year updated. Some are very obsolete according to the latest online information, such as Proyecto Emociones (2016), or Austastico (2017), while MiTA, Juegos de niños para bebes de 2 a 5 años and LEA Lectoescritura were updated in 2025.
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Table 4

Other features of educational apps

APP TITLE Download link/information	**Age (01)**	**OS (02)**	**Free (03)**	**LANGUAGE DESCRIPTION (Total languages/dialects)) (04)**	**Year of creation, Country (native language), year, last update**	**PRIORITY NEED** *MAXIMUM COMBINATION OF NEEDS*
1. ABA DrOmnibus for Parents – ABA DrOmnibus para padres https://apkpure.com/es/aba-dromnibus-for-parents/com.dromnibus.dromnibus2.home	3-6	A/I	Yes	Chinese, Vietnamese, Zulu, Uzbek, Arabic, Ukrainian, Turkish, Wikang Tagalog, Telugu, Tamil, Swahili, Swedish, Serbian, Slovenian, Sinhala, Russian, Portuguese, Polish, Punjabi, Dutch, Nepali, Northern Sami, Burmese, Marathi, Bengali, Malayalam, Macedonian, Latvian, Lithuanian, Lao, Italian, Korean, Kannada, Kazakh, Japanese, Icelandic, Indonesian, Armenian, Croatian, Hindi, Gujarati, Galician, French, Finnish, Persian, Basque, Estonian, Spanish, English, German, Danish, Catalan, Czech, Bengali, Byelorussian, Cebuano, Amharic (57).	USA, English 2017-2018	**COM** *COM+SE+BE*
2. Aboard CAA (Tablero ACC) https://apkpure.com/aboard-caa-aac/assistive.aboard/download	All ages	A	Yes	Chinese, Zulu, Vietnamese, Uzbek, Ukrainian, Arabic, Turkish, Talago (Austrolesian), Telugu, Tamil, Swahili, Swedish, Serbian, Slovenian Lake, Sinhala, Russian, Portuguese, Polish, Dutch,	Brazil (Brazilian Portuguese) 2017-2024	**COM**

				Paniabi, Norwegian, Burmese, Nepali, Malayalam, Macedonian, Lithuanian, Lao, Korean, Kannada, Kazakh, Japanese, Italian, Irish, Armenian, Hindi, Croatian, French, Gujarati, Finnish, Persian, Estonian, Basque, English, Spanish, German, Danish, Catalan, Czech, Bengali, Amharic, Cebuano (51).		
3. Autastico https://apkpure.com/es/autastico/com.bigheadbrogames.autastico	0-8	A	Yes	English, Spanish, Portuguese, Indonesian, Russian, Vietnamese, Thai, Arabic, Turkish, Italian, French, German, Korean, Japanese, Dutch, Polish, Hindi, Simplified Chinese, Traditional Chinese (19).	Brazil, English, 2016-2017	**SE** *COM+SE*
4. CommBoards terapia aut AAC https://tracxn.com/d/companies/shmoontzapps/__3fnspSj02TDAyohQ2efaWr6hSl2tIe6gOuT_2B9L_Rs#competitors-and-alternates https://apkpure.com/es/commboards-lite-aac-assistant/com.shmoontz.commboards.lite	All ages	A	Yes	German, Chinese, Spanish, French, Hebrew, English, Russian (7).	Israel, English 2018-2025	**COM** *COM+SE*
5. CPA, Comunicador Personal Adaptable https://apps.apple.com/us/app/cpa-3-0/id1347832830	4+	A/I / W	Yes	Spanish, Russian, Portuguese, Polish, English, French, German and Italian (8).	Spain, Spanish and English, 2003-2021	**COM**
6. Emociones, sentimientos y expresiones! - Emotions, feelings and expressions!, https://allbestapps.es/android/emociones-sentimientos-y-expresiones https://emotions-feelings-and-expressions.softonic.com/android	Early childhood education	A/K	Yes	Portuguese, English, Korean, Arabic, Thai, German, Vietnamese, Japanese, Russian, Polish, Swedish, Dutch, Turkish, Simplified Chinese, French, Spanish, Italian (17).	United Kingdom, English,2016-2021	**SE** *COM+SE*

7. José Aprende https://apps.apple.com/es/app/jos%C3%A9-aprende/id815105400 https://fundacionorange.es/aplicaciones/cuentos-visuales-jose-aprende/ https://play.google.com/store/apps/details?id=com.orange.joseaprende&hl=es_419	4+	A/I	Yes	Spanish, English, Italian, Hindi (Indonesian), French, Dutch, Arabic, Turkish, Swedish, Chinese, Polish, Thai, Japanese, German, Korean, Russian, Vietnamese, Portuguese (18).	Spanish (developed in the USA by Fundación ORANGE, S.A.). English, Spanish2014-2024	**COM** *COM+SE+BE*
8. Juegos de niños para bebés 2 a 5 https://apps.apple.com/es/app/juegos-para-bebes-de-2-4-a%C3%B1os/id1037749621	2-5	A / I	Yes	Spanish, German, Bulgarian, Catalan, Czech, Simplified Chinese, Traditional Chinese, Korean, Croatian, Danish, Slovenian, Estonian, Finnish, French, Greek, Hebrew, Hindi, Hungarian, Indonesian, English, Italian, Japanese, Latvian, Lithuanian, Malay, Dutch, Norwegian, Polish, Portuguese, Romanian, Russian, Serbian, Swedish, Tagalog, Thai, Turkish, Ukrainian, Vietnamese, Arabic (39).	United Arab Emirates, English, Spanish,2018-2025	**SE** *COM+SE+BE*
9. LEA Lectoescritura para autismo https://www.uv.mx/iice/lectoescritura-para-autismo/	All ages up to 12 years old	A	Yes	Spanish and English (2).	Mexico, Spanish,2020-2025	**COM** *COM+SE+BE*
10. Lista Visual (Visual Schedule) https://apkpure.com/es/visual-schedule/com.intoronto.myschedule#google_vignette https://www.linkedin.com/company/bean-wizard-solutions-inc-/?originalSubdomain=ca	Early childhood education	A	Yes	English, Portuguese, Spanish, Russian, Indonesian, Danish, French, Italian, Turkish, Malaysian, Arabic, Traditional Chinese, Simplified Chinese, Japanese, Polish, German, Vietnamese, Korean, Thai, Urdu, Persian, Bengali (23).	British Columbia, Canada, English2015-2018	**SE** *COM+SE*
11. Michelzinho - Emoções e Autism https://apkpure.net/es/emotions-and-autism-michelzi/com.fenix.emotionmichel/download/2.4 https://propp.ufu.br/conteudo/michelzinho-emocoes-e-autismo	Early childhood education	A	Yes	(Brazilian origin) Brazilian Portuguese, Spanish (Spanish), English (4).	Brazil, Brazilian Portuguese, 2018-2021	**SE** *COM+SE+BE*

12. Terapia del Lenguaje y Cognitiva con MITA https://play.google.com/store/apps/details?id=com.imagiration.mita&hl=es_419	0-5	A/I	Yes	German, Chinese, Korean, Spanish, French, English, Italian, Portuguese, Brazilian Portuguese, Russian, Arabic, Farsi (12).	USA, English, 2015-2025	**COM** *COM+SE*
13. Otsimo https://apkpure.com/es/otsimo-special-education/com.otsimo.app	+4	A/I	Yes	German, Greek, English, Spanish, Turkish, Finnish, French, Hindi (8).	Türkiye, English, 2016-2024	**SE** *COM+SE+ BE*
14. Proyecto PECS (Picture Exchange Communication Systems) https://pecs-spain.com/el-sistema-de-comunicacion-por-el-intercambio-de-imagenes-pecs/ https://autismosnoautismo.blogspot.com/2015/01/que-es-el-pecs-o-picture-exchange.html	It started for EC and is now for all ages.	A	Yes	Spanish, English, Portuguese, Brazilian Portuguese, French, German, Greek, Italian, Japanese, Korean, Mandarin Chinese, Polish, Portuguese, Romanian, and Russian (15).	USA, English, 1985-2024	**COM**
15. Proyecto Emociones (SP) https://autismodiario.com/2013/07/08/proyecto-emociones-una-aplicacion-que-ayuda-al-desarrollo-de-la-empatia-en-los-ninos-con-autismo/ https://creena.educacion.navarra.es/web/recursose/2019/03/18/el-proyect-emociones/	3-5	A	Yes	Spanish, English, Portuguese (3).	Chile, Spanish, 2012-2016	**SE** *SE+ BE*
16. Smile and Learn Juegos_educativos_niños https://apkpure.com/es/smile-and-learn/net.smileandlearn.library https://drive.google.com/drive/folders/1UbgEMFDyOK7dyuVdAXCm4wiBr346Kfyx https://www.smileandlearn.com/	3-12	A/I / W	Yes	Spanish, French, English, Italian, Portuguese and Catalan (6).	Spain, Spanish, 2015-2024	**COM** *COM+SE+ BE*
17. Social skills for Autism Mkloog 2 https://www.autismconnect.com/resources/apps/app/16 https://kloog2-return-to-zugopolis.soft112.com/	3+	A	Yes	English, Czech, Dutch, French, German, Italian, Japanese, Korean, Polish, Portuguese, Russian, Simplified Chinese, Spanish, Swedish, Traditional Chinese, Turkish (16).	Ireland, English, 2016-2024	**SE** *SE+ BE*

18. #Soyvisual (SP) https://fundacionorange.es/aplicaciones/soyvisual/ https://www.soyvisual.org/	4+	A / I	Yes	Spanish (original Spanish app). French, Chinese, Russian, Czech, Greek, Norwegian, Malay, Slovenian, African, Ukrainian, Croatian, Lithuanian, Hebrew, English, German, Japanese, Dutch, Danish, Hindi, Swedish, Hungarian, Vietnamese, Bulgarian, Tagalog (Philippines), Farsi (Iran), Serbian, Zulu (South Africa), Swahili (Tanzania or Kenya), Portuguese, Italian, Arabic, Polish, Finnish, Korean, Turkish, Thai, Romanian, Belarusian, Slovak, Slovenian, Amharic (Ethiopia), Estonian, Latvian (44).	Spanish (developed in the USA by Fundación ORANGE, S.A.) 2016-2022	**COM** *COM+SE*
19. Speech Blubs Language Therapy https://apps.apple.com/us/app/speech-blubs-language-therapy/id1239522573 https://www.linkedin.com/company/blub-blub/about/	1-8	A/I	Yes	Russian, Arabic, Dutch, French, Italian, Thai, Polish, Simplified Chinese, Indonesian, Korean, Swedish, German, Turkish, Vietnamese, Japanese, Portuguese, Spanish, British English, American English, Brazilian Portuguese (20).	USA, English, 2017-2024	**COM**
20. SymboTalk AACTalker https://apkpure.com/es/symbotalk-aac-talker/com.elelad.comboard https://play.google.com/store/apps/details?id=com.elelad.comboard&hl=es https://play.google.com/store/apps/developer?id=Elad+Elram	4+	A/I	Yes	Bangla (Bangladesh), Bangla (India), Cantonese (Hong Kong), Czech, Danish, English - Australia, English - India, English - UK, English - US, Finnish, French, German, Hindi, Hungarian, Indonesian, Italian, Japanese, Khmer (Cambodia), Dutch, Korean, Mandarin, Mandarin - Taiwan, Nepali, Norwegian, Polish, Portuguese, Portuguese - Brazil, Russian, Sinhala (Sri Lanka), Spanish - Spain, Spanish - US, Swedish, Thai, Turkish, Ukrainian, Vietnamese (37).	USA, English 2016-2024	**COM** *COM+SE*
21. TerapiaZ Tabletem https://apkpure.com/es/happy-	Early childhood	A	Yes	English, Spanish, Arabic, Simplified Chinese, Japanese, Portuguese, Russian,	Poland, Polish, 2014-2024	**SE**

therapy/com.dromnibus.dromnibus	education			Traditional Chinese, Polish, French, Hindi, Italian, Indonesian, Dutch, German, Turkish, Vietnamese, Korean, Malay, Thai, Urdu, Bengali, Persian (23).		*COM+SE+ BE*
22. Vi.co hospital Lite https://apkpure.net/es/vi-co-hospital-lite/com.vico.hospital.lite https://apps.apple.com/cr/app/vi-co-hospital-lite/id1006234987 https://play.google.com/store/apps/details?id=com.vico.hospital.lite&hl=es_419	All ages	A/I	Yes	Spanish, German, French, English and Italian (5).	Italy, Italian, 2015-2023	**COM** *COM+SE+ BE*
23. Visual schedules and social stories https://www.meshtechsolutions.com/portfolio/visual-schedules-and-social-stories/	6-12	A/I	Yes	Indonesian (Indonesia), Dutch, Turkish, Italian, English, Vietnamese, Thai, Russian, Chinese, French, German, Portuguese, Korean, Arabic, Japanese, Polish, Spanish (17).	Pakistan, English, 2016-2018	**BE** *COM+SE+ BE*

Notes: SP = App produced in Spain. Cost: Free = 1, Not free (paid) = 0. Some of them are translated into other languages. (b) OS = Operating System: Android (A), iOS (I), Windows (W), K = Kindle (K). Regarding the operating system, it is not certain whether some apps are currently available on iOS given the speed of updates. *No language information was found.

3.2. Number of different apps used by the teachers

The mean number of apps used by each teacher increases to 4.06 apps with a standard deviation of 2.05 apps. The linear correlation between the number of different apps used and age was significant ($p<0.001$) and weak ($r=-0.199^{**}$) (Table 5 and Figure 1).

Table 5

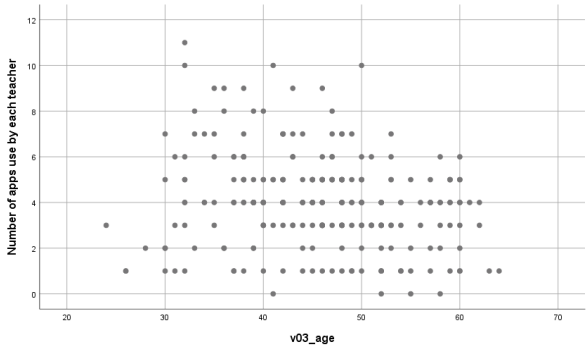
Correlation between the different apps used and age

		Age
Number of apps used by each teacher	Pearson's correlation	-.199**
	Sig. (two-tailed)	.001
	N	254

**. The correlation is significant at the 0.01 level (two-tailed).

Figure 1

Scatter plot



Scatter plot (r = - 0.119**).

Before the analysis of equality of means between groups that could be considered for each variable, the Kolmogorov-Smirnov (K-S) test was performed (Table 6), concluding that the number of different apps used by each teacher did not meet the assumption of normality (p<0.001).

Table 6

Kolmogorov-Smirnov test for a single sample

		Number of apps use by each teacher
N		254
Normal parameters[a,b]	Mean	4.06
	Standard deviation	2.051
Maximum extreme differences	Absolute	.138
	Positive	.138
	Negative	-.118
Test statistic		.138
Asymptotic sign. (two-tailed)		.000[c]
a. The distribution of the test is normal.		
b. Calculated from the data		
c. Lilliefors significance correction.		

This result led to the selection of non-parametric tests. More specifically, the Mann-Whitney test for two independent samples was applied. The results are shown in Table 7, and led us to conclude that for both sex and location of the school, no significant differences were found.

Table 7

Results of the two-sample Mann-Whitney U tests

Number of apps use by each teacher		
	Grouping variable	
	Sex	Location of the school
Z	-.832	-.466
p-value	.406	.641

For the remaining variables, the Kruskal-Wallis H test was used, with the results shown on Table 8. It was concluded that there are significant differences in the case of age and years of experience in education with autism, for the number of different apps (Table 8).

Table 8

Results of the Kruskal-Wallis H tests for independent samples

Number of different apps use by each teacher			
	Grouping variable		
	Age (in intervals)	Years of experience in education	Years of experience in education with children with ASD
Kruskal-Wallis H-test	14.420	7.600	14.544
p-value	.002	.107	.013

4. Discussion

4.1. Ranking

With respect to the work by Gallardo et al. (2021a), the gap in the completion of the age groups for the apps analyzed has been covered. Smile and Learn was the best evaluated by the participating teachers according to our results. The differences between that former study and the present one are: (a) stage of education: primary and secondary school as compared to early childhood education; (b) priority needs: communication (oral and reading), socioemotional and behavioral including reading and mathematics as compared to communication (oral and reading), socioemotional and behavioral; (c) 88 apps as compared to 23 apps; (d) the evaluators: 12 judges such as technicians, professionals who were not the teachers, speech therapists, therapists, some of which do not work with the students, as compared with 100% of teachers who work with young autistic students; (3) the judges did not provide scores for neither the socioemotional aspects nor behavioral ones as compared to an emotional character app; and lastly, (f) the evaluation based on the characteristics of the content, the design and the educational ones, as compared to the

variable of the total number used by the entire set of teachers, with this being a proxy for how good the teachers considered an app. The lack of agreement between the educational ranking established by the teachers and the judges could be logically reasoned because they were different evaluators and different measurements of evaluation. Despite these differences, the evaluation of the teachers could be weighted in a relevant manner given that the time that a teacher spends with a student is greater as compared to what is found with other professionals (doctors, speech therapist, occupational therapist, psychologists…etc.), and due to this, the teachers have more complete knowledge about the student. Thus, the priority need at this early childhood stage according to the judges is communication. In this sense, we believe that it is necessary for students to be found in a stable emotional state, as it is the only way in which the communication and behavioral needs can be addressed. This could explain that the number apps with a socioemotional priority obtained a high score, right behind the communication apps, according to the teachers surveyed.

In their review of apps dedicated to autism for all ages and uses (educational, parental, and professional), Gallardo et al., (2021b) raised as a limitation, the scarcity of studies related to the evaluation of apps exclusive to autistic individuals. In addition, the authors underlined that the area of emotions was the least emphasized in the 155 apps analyzed by 12 judges. They concluded that the symptomology of autism was closely related with social relations, which were at the same time related with emotions. The former review of the apps covered adolescence as compared to the age of 6 in the present case. In the present study, the evaluators were teachers who worked with autistic children in the early childhood education stage. At early ages, it is difficult to define the threshold between social relations and emotions, and emotions could even play a greater role than social relations, so that in our case, both areas were combined in the early childhood stage. In this sense, the aforementioned gap is covered, as in the exclusive education topic in early childhood, no evaluations of different apps were found in the subject of education, exclusively for the early childhood stage, since early childhood has been studied combined with primary education. An important clarification that must the underlined is that all the experiences took place in Spanish, although all the apps are available in English.

As for the third study, Gallardo-Montes et al. (2022a), the subscales of uses and benefits were not considered, and neither was the variable frequency of use of the apps. With respect to the fourth work by Gallardo-Montes et al. (2022b), no comparisons could be established, as the apps were not evaluated separately. That work, on the one hand, evaluated Communication+Language+Emotions as a whole, and on the other hand, behavioral (BE) instrumental skills.

Lastly, in Gallardo et al. (2023) the following discrepancies were observed: (1) 29% were teachers, as compared to 100% currently active teachers, with most them working in public centers; (2) the early childhood, primary, and secondary education stages as compared to early childhood education; (3) it analyzed the frequency of use of the apps as compared to the total number of different apps used by each teacher. Thus, a discussion was not appropriate.

Given the classification results obtained, a literature search was performed with respect to the combined skills-needs. For example, the core collection of the Web of Science from 2021 to 2025, provided more than 2000 documents for the COM+BE combination, while the BE+SE and COM+SE combinations only provided 36 documents. Likewise, considering Table 1, on the review of the literature of apps applied to early childhood education and

primary education students with ASD, it was observed that the term “emotions” appeared starting in 2024 in all the cases. This supports the finding that there is a lack of studies, and also underlines the current relevance that the emotional aspect has been acquiring in this stage of autism.

4.2. Number of different apps utilized

This variable was not used in the works cited that were the main source of this study. Given that the 23 apps are specific to the questionnaire by Rodríguez Fuentes et al. (2021) and it is a specific case of early childhood education that had not been studied previously, a discussion was not conducted on this respect.

5. Conclusions, limitations and future research lines

5.1. Conclusions

With respect to the classification of the apps used in Spain in the Spanish language in the early childhood education stage with autistic children, various conclusions can be made, which will be detailed below. In first place, the teachers prioritized the need for communication (56.5%) closely followed by the socioemotional need (39.1%), and lastly, by the behavioral need (4.3%). In second place, the needs-skills were combined, as observed in the literature reviewed, although only the most current works were included. Of the apps that showed combinations of the needs to be improved, 7 dealt with COM+SE (30.4%), none about COM+BE (0%), 2 about SE+BE (8.7%), and 10 related with SE+COM+BE (43.5%). Thus, COM combined with other needs appeared in a total of 73.9% of the apps, while the emotional need combined with others appeared in 82.6% (30.4+8.7+43.5=82.6%). Thus, the SE need plays an important role in the education of young children according to the teachers surveyed. In third place, the app Smile and Learn, with the priority need of COM and the COM+SE+BE combination, and Emociones, sentimientos y expresiones!, with the priority need of SE and SE+COM combination, were the most used by the teachers.

The second objective posed was to summarize the main characteristics of the apps available. With respect to the characteristics of the apps, the age with which it was used was identified, as well as the education stages in which they were used, which ranged from early childhood to all ages. The operating system that stood out was Android, which may differ from other studies such as those that came from the USA, where iOS may be more relevant. The free versions of all the apps were used, as they were used in public centers, where the resources are limited with respect to the funds for special education innovation. The apps were used in Spanish, although they are also available in English and other languages, with the minimum number being 2 (LEA Lectoescritura) and the maximum 57 (ABA DrOmnibus for Parents). Most of the apps were initially developed in Spanish and English, with Spain and the USA being tied. These two countries stand out for their application of apps in the area of autism in Spain, with five apps each, and with these 10 applications accounting for 43% of the applications used. Of the currently used apps, the first was the Proyecto PEC (1985) and the second being CPA (2003), created in the USA and Spain, respectively. Another commonly used app was Smile and Learn (2015), from Spain, and Proyecto Emociones (2012), created in the United Kingdom. The latest development was LEA

Lectoescritura (2020), from Mexico. As for the last year of an update, the oldest ones were Proyecto Emociones (2016) or Austastico (2017). Regarding the updates, MiTA, Juegos de niños para bebés 2 a 5 años, and LEA Lectoescritura, were all updated ion 2025.

With respect to the number of different apps for autism used by each teacher in the early childhood education stage, many conclusions were obtained. The mean number of apps was 4 apps/teacher. With respect to the third objective, a negative and weak relationship was found between this variable and age, so that the older teachers used less apps.

Lastly, the conclusions with respect to the last objective set will be described. Significant differences were found with respect to the number of apps and the grouping the ages into intervals. This result is in line with the resulting negative linear relationship between age, considered quantitative, and the number of apps. Likewise, differences were found according to years of teaching autistic children. And lastly, there were no differences according to sex, location of the school (urban-rural), and the years of experience in education.

5.2. Limitations

With respect to the questionnaire, the limitation detected in the survey was considering the question which asked if you use other apps, as a close-ended (yes/no) question, and not as an open-ended one, which would allow the teachers to provide an affirmative answer that could be used to obtain the names of other apps used.

Education in Spain is inclusive. The composition of ASD students per class is structured with a maximum of 5-6 children in an early childhood education classroom in an ordinary school, and there is no limit of autistic students to be taught in ordinary classrooms. Obtaining large samples, of both teachers and students, requires a great coordinating effort and willingness from the schools, the teachers, and the receptiveness of parents when authorizing the study of their children. This implies a great limitation of the study, as it is very difficult to access the study population, especially in the case of young early childhood education students, who is considered more vulnerable.

With respect to the review of the literature, it must be underlined that the four most-spoken languages were English, Chinese, Spanish, and Hindi. In this study, the literature reviewed was written in English and Spanish and limited to the Web of Science and Scopus databases, which also implies another limitation.

5.3 Future studies

It is recommended that this study be replicated in other autonomous communities in Spain and other countries but adding more available apps in the current market. It must be noted that economic problems have been posed in the implementation of applications according to some scholars, so that the use of free applications favor their comparison and evaluation among the teachers. As for a recommendation when replicating this study, the new studies should be complemented with qualitative studies through interviews. The objective would be to discover the reasons behind the selection of these apps by the teachers for their application in the classroom, as well as the reasons for working with so many apps.

As for the review of the literature, it must be broadened to other databases and other languages, paying special attention to those coming from China and India due to the broad use of their languages.

We recommend classifying the skills-needs to be improved with the use of apps not only at the level of individual needs, but also combined needs. With respect to the socioemotional aspect, our personal opinion, based on teaching experience, is that a recreational-curricular environment will motivate students more, and will also improve their well-being, along with their emotional aspects. In this sense, games favor the learning of all the needs that appear in the maximum combination (communication, behavior, and socioemotional). Thus, games gain a relevant role within the early childhood education classroom and must not be separated from the curricular part at this stage. In fact, in many countries, the main premise at school during the early years of education, is games, after which, starting at a certain age, the lessons become centered on learning. Given that the Spanish education system prioritizes the curricular aspects, we believe that games are indispensable in the early childhood education classrooms in Spain.

Reviewing publications in languages other than English or Spanish, on apps or technology in the early education stage with autistic children, would be another research line to develop, given the scarce number of publications found.

Lastly, it would be interesting to analyze the influence of the characteristics of each country (weather, geography, gastronomy, clothing, religion, culture, and customs, among others), in the design of apps for mobile phones, tablets, and computers, for young autistic children.

Contribución de los autores
Conceptualization, Autor1 and Autor2; data curation, Autor3; formal analysis, Autor3; obtención de financiación, Autor1, investigation, Autor1, Autor2, Autor3 and Autor4; methodology, Autor4; project administration, Autor1 and Autor2; resources, Autor2; software, Autor3; supervision, Autor1; validation, Autor2; visualization, Autor1 writing of the original draft, Autor1, Autor2, Autor3 and Autor4; review and editing of the draft Autor1, Autor3 and Autor4.

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Conflict of interest
The authors declare that there is no conflict of interest.

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