

SocialTICTEA, a technology-based social skills programme: impact and generalisation of learning in students with autism

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The generalisation of learning is one of the main elements to take into account when carrying out an educational intervention. This process involves certain difficulties for the population with Autism Spectrum Disorder (ASD). In this sense, the aim of the present study is to evaluate the process of generalisation of skills related to the social domain (affected area in the population with ASD), in the special classroom for ASD, the regular classroom and the family environment, after the implementation of a social skills programme based on technologies. We propose a longitudinal quantitative research study based on case studies which employs a pretest-posttest methodology. The sample is made up of four students diagnosed with ASD. Data collection was carried out using two questionnaires. The results obtained reflect a generalisation of learning associated with basic social relationship skills, joint reference and inter-subjective capacity in all the contexts analysed.

Keywords: generalisation; ASD (Autism Spectrum Disorder); social skills; technology

Introduction

One of the aspects that must be taken into account when carrying out an intervention of any nature and which is a major barrier to its success (Wass & Porayska-Pomsta, 2013) is the generalisation of learning (Hong et al., 2018). That is, the initial learning of the specific skills involved in a given context is transferred to other situations with different people, settings, etc. (Carruthers et al., 2020). It is essential for this generalization to occur in order for an intervention to yield benefits in everyday life, extending beyond the office or classroom environment (Carruthers et al., 2020). In this way, the learning of these skills will not only be demonstrated in artificial environments

or with a limited number of people (Neely et al., 2016).

This phenomenon is particularly relevant in people with ASD, characterised by the presence of repetitive and restricted patterns of behaviour and by showing needs in the area of communication and social interaction (APA, 2013; Levaot et al., 2019). A number of authors (Froehlich et al., 2012; Gastgeb et al., 2012) have pointed out that this part of the population tends to have difficulties in transferring learning to novel contexts, displaying less consistency when it comes to generalisation than neurotypical subjects (Hartley & Allen, 2014). In fact, Rao et al. (2008) noted that this is a constant problem in interventions concerning social interaction, which substantially limits their real value (Carruthers et al., 2020).

Theories related to generalisation claim that this process occurs according to the similarity of stimuli (Byron & Murphy, 2014). Thus, the greater the number of common features between the original and the new context, the easier it is for generalisation to take place (Pearce, 1987).

Furthermore, some authors (Brown & Bebko, 2012) have studied how this phenomenon occurs in the population with ASD taking into account the process indicated above. Differences and difficulties in generalisation may stem from where and how people with ASD focus their attention or what they consider relevant in a given context (Baron-Cohen, 2002; Happé & Frith, 2006; Milton, 2017) and how the information retained in their memory is processed, organised and retrieved (Baez & Ibanez, 2014; Miller et al., 2014). These differences may support the idea that the characteristics that people with ASD find common in two contexts may not be the same for the neurotypical population (Carruthers, 2020). In fact, needs arise in social cognition due to difficulties in contextual integration, hindering access to social meaning (Baez & Ibanez, 2014). This suggests that individuals with ASD may struggle to apply social reasoning skills to solve

tasks, although their performance improves when explicit information is provided (Izuma et al., 2011).

However, although the mental processes involved may be different (Church et al., 2015), much research makes generalisation an explicit goal within intervention (Koegel, 2012). In fact, numerous researchers (Hong, Kawaminami et al., 2018; Hong, Neely et al., 2018; Neely et al., 2018) now base their studies on systematic reviews and meta-analyses on this phenomenon in people with ASD. It is worth highlighting the study conducted by Hong, Neely et al. (2018), which aimed to analyze the existing literature on generalization and maintenance in interventions utilizing tablets. Following this systematic review, out of the 39 articles assessed that met specific quality criteria, only 12 were examined for generalization. Furthermore, only 2 of these articles included data collection prior to the intervention.

In relation to the social domain, a crucial component in the symptomatic description of ASD (Alhuzimi, 2020), authors such as Carruthers et al. (2020) emphasize the scarcity of intervention studies in this area that investigate generalization and maintain methodological rigor. Some studies confirm the generalization of skills in classroom or home settings, as demonstrated by the research conducted by Ho et al. (2019). The objective set by these authors was to assess the effectiveness of an intervention based on modeling with animated videos, analyzing the potential generalization of joint attention and social engagement. The six children with ASD, aged between 7 and 11, who participated in the study, demonstrated generalization of their learning. Specifically, three of them were able to transfer that learning to other environments, while another three generalized it to interactions with different individuals. Limitations included difficulties in measuring the long-term effects of the intervention and the focus of findings solely on joint attention and social engagement, neglecting other aspects of social skills.

On the other hand, the research conducted by Wichnick-Gillis et al. (2019) centered on initiating social interactions. They implemented an intervention with three ASD children aged between 8 and 10, utilizing social scripts. Subsequently, these supports were removed, and the children were able to generalize this skill to their home environments, where no intervention had been conducted. However, a limitation highlighted was the potential influence of the main researcher, who was present in all sessions, possibly acting as a discriminative stimulus. This could have led the children with ASD to increase the number of social initiations. Furthermore, they emphasize the necessity for further research focusing on the generalization of skills in the social domain. Other investigations, such as those conducted by Mancil et al. (2016), Thiemann-Bourque et al. (2018), or Chang et al. (2016), also yielded positive results related to reciprocity, social play skills, or the initiation of interactions.

Social skills programme (SocialTICTEA)

With the aim of improving and generalising skills associated with the social sphere in people with ASD, an educational program of social skills was designed with technology as the essential instructional tool. This choice was based on the potential offered by this type of resource and the intrinsic characteristics that favour intervention with people with ASD (Lozano et al., 2014). Technological tools are highly structured and predictable (Golan & Baron-Cohen, 2006). They also offer a dynamic and motivating environment with a predominance of visual stimuli (Parsons et al., 2016), which people with ASD have a predilection for (Shane & Albert, 2008).

Moreover, technologies allow for the personalisation of learning (Sanromà et al., 2021), thus making far more individualised teaching possible (Chebli, 2017).

SocialTICTEA was largely based on two of the psychological theories related to the needs presented by people with ASD in the social sphere: the Theory of Mind (Baron-Cohen, 2005) and the Weak Central Coherence Theory (Happé & Frith, 2006). In relation to the first of these theories, work has been carried out on aspects such as the senses and their associated verbs, the different perspectives, the recognition and appropriate use of mental verbs and emotional states. In relation to the second theory, attention has been paid to aspects such as the identification of a whole from certain parts, the relationship between shadow and object or the appropriateness of objects, animals, etc. within a context.

The technological resources included iPads and wearable devices as well as more than 15 mobile applications that were previously evaluated to determine their pedagogical relevance (Cored et al., 2020).

This program is aimed at children between 6 and 12 years old, and in this case, it was carried out with 4 pupils with ASD grouped in pairs. Because of the COVID pandemic, the intervention was finally divided into two parts. With one of the pairs, the youngest, 20 one-hour sessions were implemented. Half of them were conducted during the academic year 2019-2020 and the other half at the beginning of the year 2020-2021. With the other pair, the older pupils, 22 sessions were carried out, also with a duration of one hour each. Eleven of them were held during the academic year 2019-2020 and the remaining ones in the following academic year. In this case, the second part of the intervention took place individually because due to COVID, the school formed bubble groups and these pupils were grouped differently.

The technology-based social skills program was designed by the researchers of this study. Although it is not yet accessible to the general public, it is expected to be published openly in the near future, making it available for use by centers and specialists.

In addition to providing a detailed description of the different sessions, this program includes an in-depth analysis of the 19 applications used. This analysis outlines the content that can be addressed with each digital tool, as well as other technical, aesthetic, functional, and pedagogical aspects.

Taking into account all of the above, here are the research questions

Do technology-based social skills intervention programs have an impact on transfer for students with ASD?

Can children with ASD generalize skills related to the social domain to other contexts and people?

In what contexts can students with ASD demonstrate these learnings?

What types of social skills have become generalized in each context?

From these questions arise the main objective of the study and the specific objectives. The main objective is to analyze whether pupils with ASD who have participated in the technology-based intervention (SocialTICTEA program) have generalized the learning to other contexts and individuals. To achieve this, various measurements were taken at different times during the intervention. Likewise, it also seeks to achieve the following specific objectives:

- Analyze which social skills are generalized in the TEA Preferential Classroom environment during and after the intervention.
- Investigate the generalization of social skills within the context of the regular classroom during and after the intervention.
- Assess the generalization of skills within the family environment during and after the intervention.

Materials and methods

With the aim of improving and generalising skills associated with the social sphere in people with ASD, a social skills programme was designed with technology as the essential instructional tool. This choice was based on the potential offered by this type of resource and the intrinsic characteristics that favour intervention with people with ASD (Lozano et al., 2014). Technological tools are highly structured and predictable (Golan & Baron-Cohen, 2006). They also offer a dynamic and motivating environment with a predominance of visual stimuli (Parsons et al., 2016), which people with ASD have a predilection for (Shane & Albert, 2008).

Population and sample

The sample chosen for the study comprised 4 schoolchildren in an ASD special needs school in the town of Huesca (see Table 1). In order to select this sample, a non-probabilistic sampling procedure was used, specifically, purposive or convenience sampling. Likewise, as inclusion criteria, firstly, the subjects had to have been diagnosed with Autism Spectrum Disorder (ASD) and, secondly, they must have developed language skills (to a greater or lesser extent). It is important to emphasize that the specialists working with the study participants had previously conducted some generalization tasks, but not in a systematic manner and without the use of technology. In other words, it was the first time that a specific program based on technology was implemented with them, with the objective of generalizing certain skills and evaluating their effectiveness.

(Insert Table 1 about here)

Instruments

Two questionnaires were used for data collection. The first of them is the "Escala valorativa de habilidades sociales y emocionales, personas con Trastornos del Espectro Autista" [social and emotional skills assessment scale, persons with Autism Spectrum Disorders] by Alcaraz et al. (2009), based on the "Inventario de Espectro Autista (IDEA)" [Inventory Autism Spectrum] by Rivière (1998) and validated by an expert panel comprised of specialists in ASD and special education. This scale allows social competence to be assessed and, specifically, three dimensions associated with it. First of all, basic social relationship skills appear, linked to attachment, initiative and motivation for relationships with peers and adults, etc. Then, joint reference skills are observed, which are made up of the interest in objects and actions, looks or gestures, motivation to share actions, use of significant joint reference looks or an interest in sharing joint concerns with others. Finally, there are the intersubjective competence skills. This last area refers to patterns of emotional expression, the expression of interest in and attention to other people or the use of mental terms (emotions, thoughts, etc.).

The assessment, in this case, was conducted on a Likert scale from 1 to 5, with 1 being considered as "No, never" and 5 as "Yes, always". In each of these dimensions, in turn, four levels were considered. On level 1, there were needs linked to people with ASD with more severe symptoms, and on level 4 there were needs associated with people with greater functioning. In reference to the social skills as regards social relations, there were 32 items, 30 items were associated with joint attention skills and 24 indicators appeared in relation to intersubjective capability skills.

The "Cuestionario de Habilidades de Interacción Social (CHIS)" [Social Interaction Skills Questionnaire (SISQ)] by Monjas (1993) was also used. Delgado (2017) highlights that the internal consistency of this instrument, assessed using Cronbach's Alpha, in a population aged between 8 and 12 years, is 0.954. According to

González and Pazmiño (2015), this value indicates an acceptable level of internal consistency. This instrument assesses pupils' functioning in different social behaviours on a Likert scale from 1 to 5, with 1 representing "never" and 5 meaning "always". The 60 items that make up the CHIS are divided into 6 subscales as follows (see Table 2).

(Insert Table 2 about here)

Procedure and data collection

The social skills educational program was implemented by the lead researcher and supervised by other team members. It took place weekly, consisting of 1-hour sessions, conducted in the TEA-preferred classroom for a duration of 20 to 22 weeks, as detailed in previous sections. This classroom is specialized, distinct from the reference classroom, and primarily serves students with ASD, addressing specific needs of this population. During the sessions, participating students engaged in various tasks meticulously designed to target aspects of Theory of Mind and Weak Central Coherence. The primary tool utilized throughout these sessions was the tablet. Additionally, to enhance the program's effectiveness, several fundamental intervention principles were applied, including instruction, modeling, reinforcement, feedback, and the utilization of visual supports. Moreover, all sessions followed a consistent basic structure, which facilitated student engagement and performance.

For data collection, both questionnaires were administered at four different points in time. The first took place before starting the intervention (early November 2019), and the second when, for reasons due to the COVID pandemic, the schools were closed and the social skills programme could not be continued (March 2020). They were administered a third time prior to the start of the second part of the intervention (November 2020) and lastly at the end of the intervention (April 2021).

In this case, the social and emotional skills assessment scale, persons with Autism Spectrum Disorders (Alcaraz et al., 2009) was completed by the tutors of each of the pupils and by the two specialists in Hearing and Language and Therapeutic Pedagogy who carry out the intervention with them in the ASD special needs classroom. On the other hand, the SISQ test (Monjas, 1992) was answered by the relatives of the subjects participating in the research. All participants were thoroughly instructed on how to complete the questionnaires, and any doubts that arose were promptly clarified.

The questionnaires were given to the participants beforehand and were explained by the research team to ensure familiarity and comprehension. Participants were informed of the specific times, as previously mentioned, when the questionnaires would be provided. Those tasked with completing the questionnaires observed the social and non-social behaviors of the students in various settings: the reference classroom (supervised by tutors), the TEA-preferred classroom (supervised by specialists), and at home (under the observation of their families), both in interactions with peers and adults. This approach ensured that when participants completed the questionnaires, they reflected the level of development of the skills being studied within that particular time and context.

Subsequently, the means of the data obtained from the specialists were obtained using the statistical programme SPSS (version 26) and the results of all the tests at the different time points were compared.

The triangulation of data has been used as a methodological strategy, considering different sources of information, which has allowed us to take a more comprehensive approach to the object of study (Vallejo & De Franco, 2009). In this way, the validity of the research is guaranteed.

Results

The results are presented below, organised according to the specific objectives. Firstly, we will show the results linked to the ASD special needs classroom, then, those associated with the regular classroom and, lastly, the results related to the family context.

Context 1: special needs classroom

Subject 1

With respect to subject 1, improvements can be seen in two of the three areas analysed. On the one hand, there is an increase in basic social relationship skills. In the pretest, a score of 100.5 points was achieved, while in the posttest, scores of 107, 113.5, and 122.5 were obtained out of a total possible score of 160. Specifically, improvements are observed in behaviours such as motivation to engage in spontaneous relationships (score 1.5 to 4.5), flexibility in relationships with peers (score 2 to 3.5), motivation in relationships with peers (score 3.5 to 4.5) and helping others when asked to do so (score 2.5 to 4).

Furthermore, although there was no overall improvement in joint reference skills (In the pretest, a score of 106 was obtained, while in the posttests, scores of 114, 112.5 and 110.75 were achieved out of a total possible score of 150), an increase was observed in attempts to share actions or experiences (score 3.5 to 4) and in joint reference looks to understand situations that they find strange or interesting (score 4 to 4.5). In addition, this increase was also shown in both directed (score 3.5 to 5) and spontaneous (score 2.5 to 4) participation in games.

Finally, an improvement in intersubjective ability skills was observed. In the pretest, the score was 64, while in the posttests, scores of 63.5, 69 and 83 were achieved out of a total possible score of 120. Linked to these areas, there has been an increase in

the identification of situations that create discomfort (score 3 to 4), in the response and recognition of basic emotions (score 3 to 4), expression of feelings (score 3 to 4) and in the limited use of terms such as happy or sad in natural situations without adult intervention (score 3 to 4).

Subject 2

In relation to subject 2, an improvement is observed in all 3 areas assessed. The first of these, associated with basic social relationship skills, shows an increase in behaviours such as non-avoidance of people (score 3 to 4), motivation to engage in spontaneous relationships (score 2 to 3) or greater relationship with peers, albeit unconsciously (score 2 to 3.5). Overall, 61 points were obtained in the pretest, while in the posttests, scores of 65.75, 70.25 and 80 were achieved out of a total of 160 points.

Linked to the increase in joint reference skills, the pretest score was 67, and in successive posttests, scores of 68.75, 73.25 and 85 were achieved out of a total of 150 points. The score increased interest in other people's actions (score 3 to 3.75), increased gaze in highly directed situations (score 1 to 3) and attention to adult facial expressions, gestures and gazes, even if only to a limited extent (score 2.5 to 3.5).

Similarly, the increase in intersubjective capability skills takes the form of an increase in smiling when others smile (score 2.5 to 4) or sharing experiences, emotions and objects (declarative function) with others (score 1 to 3.5), as well as an improvement in the expression of feelings and emotions (score 1.5 to 2.5) and the use of mental terms (happy, sad, etc.) referring to oneself and others (score 1 to 1.75). It is observed that 120 points were obtained in the pretest, while in the posttest, scores of 123.5, 127.5 and 133.5 were achieved out of a total of 160 points.

Subject 3

On the other hand, subject 3 shows improvements in all three areas assessed. Firstly, linked to basic social relationship skills, it is observed that in the pretest 120 points were obtained and in the posttest 123.5, 127.5 and 133.5 out of 160. Specifically, improvements are observed in the easy to communicate with the subject and it is not necessary to face each other and produce direct gestures (score 4 to 5). Similarly, there is an increase in relating to peers with adult mediation (score 3 to 4), in initiating conversations that are not induced and directed by others (score 3 to 4) and in relating to other people in a fluent manner (score 2.5 to 3.5).

Linked to joint reference skills, there is an increase in eye contact (score 3 to 4.5) and in interest in games and activities with children and adults (score 3.5 to 4.5). There is also an increase in the number of gestures and glances to share interests in situations, objects, etc. (score 3.5 to 4.5). Overall, a score of 102.5 was achieved in the pretest, while in the posttest, scores of 106.5, 115.5 and 120.5 were attained out of a possible 150.

Similarly, in relation to the skills that make up the intersubjective capability, an increase in attention and reaction to the emotional expressions of others (score of 3 to 5) and in sharing objects, experiences and emotions with others (score of 3 to 4.5) is noted. On the other hand, the perception of pleasant and positive emotions (score 3.5 to 4.5) and responses to others' expressions of affection increase, showing that they are recognising basic emotions (score 3 to 4). In this case, a score of 68.5 was achieved in the pretest, while in the posttest, scores of 69, 76, and 85.25 were obtained out of a total of 120 points.

Subject 4

Finally, subject 4 also showed an improvement in all three areas analysed. In relation to basic social relationship skills en el pretest se ha obtenido una puntuación

global de 119 y en los posttest 119, 121.75 y 131 de los 160 posibles. An increase was observed in the motivation to engage in spontaneous relationships (score 3.5 to 5) and in the initiation of interactions with adults (score 3 to 4.5) has been found. On the other hand, an improvement is observed in the rigidity of peer relationships (score 2.5 to 4).

Furthermore, linked to joint reference skills, in the pretest, an overall score of 119 was achieved, while in the posttest, scores of 119, 121.75 and 131 were obtained out of a possible 160. There is an increase in the sharing of emotions with others (score 3 to 4.5), as well as greater attention to the facial expressions, gestures and looks of adults (score 3.5 to 4.5). Similarly, there is an increased interest in joint actions with others (score 3 to 4.5) and in the use of joint reference gazes, i.e. gazes in which the subject seeks and can share experiences with others (score 2 to 4).

With regard to intersubjective skills, the points obtained in the pretest were 68.5, while in the posttest, scores of 69.75, 76.5 and 93.5 were achieved out of a total of 120 points. An improvement has been observed in sharing experiences, objects and emotions with other people (score of 3 to 4.5) and in the response to expressions of affection from others and identification of basic emotions (score of 2.5 to 4). Finally, an increase has been shown in behaviours related to understanding other people's states of belief, by linking certain emotional manifestations to them.

Context 2: Regular classroom

Subject 1

In this context, linked to subject 1, improvements are displayed in all areas. As regards basic social relationship skills, a score of 108 was obtained on the pretest, and in the posttest, scores of 121, 130 and 144 were achieved out of a total of 160. There is an increase in motivation to engage in spontaneous relationships (score 3 to 5), especially

with peers and with adult mediation (score 2 to 5). Similarly, there is a greater spontaneous physical approach to other pupils (score 3 to 5).

With regard to joint reference skills, a greater number of non-avoidance behaviours appear in response to attempts to approach, gestures or looks of others in interactive situations (score 3 to 5). Likewise, increases are shown in the imitation of gestures (score 3 to 5) and in attention, albeit limited, to the adult's facial expressions, gestures and gazes (score 3 to 5). In the overall scores, 113 points were obtained in the pretest, while in the posttests, scores of 126, 126 and 143 were achieved out of a possible 150.

Linked to intersubjective skills, in the pretest, a score of 79 was obtained, and in the post-test, scores of 89, 87, and 96 were achieved, respectively, out of a total of 120. Specifically, improvements are observed in the identification of conflictive situations that cause discomfort in the subject and their verbalisation (score 3 to 5), as well as in the expression of emotions and feelings (score 3 to 5), with the limited and infrequent use of terms such as "happy" or "sad" without adult intervention (score 3 to 5).

Subject 2

In subject 2, improvements appear in two of the areas analysed. On the one hand, an increase in basic social relationship skills is perceived. The overall points obtained in the pretest were 50, while in the posttest, scores of 55, 55.5 and 64 were achieved out of a total of 160 points. Specifically, an increase is observed in responding to others' attempts at interaction and in seeking out both adults and peers (score 2 to 3), as well as in greeting and saying goodbye when addressed by others (score 1 to 3).

On the other hand, there is no increase in joint referencing skills. The score on the pretest was 52, and on the posttest, scores of 52, 49 and 55.5 were obtained out of 150.

However, there is an increase in some behaviours such as sharing actions with the subject (score 1 to 2) or sharing glances in highly directed interactive situations (score 1 to 3).

Likewise, improvements are perceived in intersubjective skills. In the pretest, the points obtained were 29.5, while in the posttest, scores of 30.5, 30, and 36.5 were achieved out of 120 possible points. Some behaviours that have increased in frequency include showing interest in other people's emotional expressions (score from 1 to 2), responding to the expressions of affection of others and recognising basic emotions (score from 2 to 3) and the subject's own emotional expression (score from 1 to 2).

Subject 3

With respect to subject 3, progress is observed in two of the areas assessed. Firstly, there are improvements in basic social relationship skills. The overall points obtained in the pretest were 104, while in the posttest, scores of 107, 110, and 117.5 were achieved out of a total of 160 points. Specifically, there is an increase in non-avoidance behaviours towards people (score 4 to 5), in peer relationships (score 2 to 4) and in approaching peers in organised situations (score 4 to 5).

An increase in joint reference skills is also observed. The final pretest score was 80, and in the post-test, scores of 88, 96 and 105.5 were achieved out of a possible 150. There is an increase in meaningful glances with adults to understand situations that interest or surprise the subject (score 2 to 4) and interest in the games and activities of other children and adults (score 3 to 5). Similarly, the subject engages less frequently in behaviours aimed at avoiding approach attempts, gestures and glances of others in interactive situations (score 2 to 3.5).

Also, although intersubjective skills have not improved significantly in general terms (76 points were obtained in the pretest, while in the posttest, scores of 74, 76.5 and

79.5 were achieved out of a possible 120), some specific behaviours such as sharing experiences, objects and emotions with others (score 3 to 4) or paying attention to others' expressions of emotion and being able to imitate them (score 3 to 4.5) have improved.

Subject 4

Finally, in subject 4, an improvement has been perceived in all three areas analysed (see Figure 8).

Linked to basic social relationship skills, the initial score was 107, and in the posttests, scores of 110, 117.5, and 127 were obtained out of a total of 160. An increase was observed in the relationship with peers with adult mediation (score 2 to 4) and in physically approaching other peers in organised situations. Also, behaviours related to doing favours for other people if asked to do so in a directive manner (score 2 to 4) appear more frequently.

On the other hand, with regard to joint reference skills, the points obtained in the pretest were 100, while in the posttest, scores of 106, 124 and 123 were achieved out of a possible 150. An increase is shown in behaviours such as limited attention to adult facial expressions, gestures and gazes (score from 2 to 4), directed participation in games (from 3 to 5) and looking with interest at what another person is looking at (from 2 to 4).

Similarly, associated with intersubjective skills, the area of least improvement, there is an increase in the ability to share experiences, objects and emotions with others (score 3 to 4), in responding to others' expressions of affection and recognition of basic emotions (score 3 to 4), as well as in the limited use of terms such as "happy" or "sad" without adult intervention (score 2 to 4). At a global level, the initial score obtained was 85 points, while in the post-tests, scores of 86, 82 and 89 were achieved out of a possible 120.

Context 3: Family context

Subject 1

In relation to subject 1, out of the six scales analysed, five have shown an improvement (see Figure 1).

(Insert Figure 1 about here)

The first of these, linked to basic social skills, has undergone one of the biggest changes. Behaviours such as responding appropriately when children address the subject, greeting others appropriately or responding when greeted have increased and improved their score from 3 to 4.

Making friends was the other scale that increased the most. In particular, there was an increase in appropriate responses when invited to play by another child (score from 3 to 4), as well as in cooperation with others in activities and play (score from 3 to 4). An increase in play initiation behaviours and other activities has also been observed (score 3 to 4).

Similarly, conversational skills have increased but to a lesser extent. Some of the behaviours that have increased in frequency are participating in a conversation according to established norms and ending a conversation appropriately, both with a score that has changed from 3 to 4.

On the other hand, linked to the increase in skills related to emotions, feelings and opinions, improvements appear in the expression of both positive and negative emotions and feelings, as well as in appropriate responses to the unpleasant and negative emotions and feelings of others. In all of them, the score changed from 2 to 3.

The scale associated with interpersonal problem-solving skills is the only one that has not shown any significant improvements. Even so, an increase in the identification of the causes of some problems is observed (score from 2 to 3).

In the last of the scales, linked to relationship skills with adults, improvements are also evident. An increase is observed in responses to requests or demands from adults or in the subject's response when addressed in a polite and courteous manner, both with a change in the score from 3 to 4.

Subject 2

With respect to subject 2, significant improvements appear in four of the six scales assessed (see Figure 2).

(Insert Figure 2 about here)

In relation to basic social skills, an overall improvement has been observed. Specifically, there has been an increase in greeting behaviours and in responding when addressed by other children in a friendly way. Both have increased from a score of 2 to 3.

An improvement is also perceived in the ability to make friends. Behaviours such as asking others for help (score 3 to 4) or initiating games and other activities with children (score 1 to 1.5) appear more frequently.

Conversely, no significant improvements in conversational skills have been observed and only an increase in the number of appropriate responses by the subject when another child wants to enter into the conversation being held with other people (score 1 to 2) has been evidenced.

The most significant improvement has taken place regarding skills related to feelings, emotions and opinions. Behaviours such as appropriate expression of pleasant (score 2 to 4) and negative (score 2 to 3) emotions and feelings have increased in frequency of use.

Another of the scales that has not shown any improvement is that associated with interpersonal problem-solving skills. None of the ten behaviours that make up this type of skill showed an increase.

Finally, an increase in relationship skills with adults has been observed, specifically, in behaviours such as responding appropriately to adult requests and demands (score from 2 to 4).

Subject 3

As for subject 3, significant improvements appear in three of the six scales analysed (see Figure 3).

(Insert Figure 3 about here)

In the first of these, i.e. basic social skills, substantial increases are observed. An increase can be perceived in appropriate greeting (score 2 to 3.5) and in smiling at others in specific situations (score 3 to 4).

With regard to the ability to make friends, there are no relevant improvements, although there is an increase in the frequency of asking for help from other people when the subject needs it (score from 3 to 4).

The largest increases, however, appear in conversational skills. Associated with this scale are more frequent initiation of conversations with other children (score 2 to 3),

actively maintaining a conversation (score 3 to 4) and intervening appropriately in a conversation (score 2 to 3.5).

Similarly, an increase is observed in skills related to feelings, emotions and opinions, such as appropriate expression of both pleasant and negative emotions and feelings. Both behaviours change their frequency rating from 3 to 4.

In relation to interpersonal problem-solving skills, no relevant changes have been perceived at a general level, except in one of the items linked to the generation of possible solutions to a problem with another child (score from 1 to 2).

The same is true for scale number six. There are no significant improvements in adult relationship skills overall, but there are improvements in some of the component skills, such as making requests or complaints to adults (score 2 to 3).

Subject 4

Finally, as far as subject 4 is concerned, relevant improvements appear in four of the six scales analysed (see Figures 4).

(Insert Figure 4 about here)

Firstly, an increase in basic social skills is observed. Specifically, there is an increase in the frequency of greeting other people appropriately (score 2 to 3), responding when addressed by other children (score 2 to 4) and smiling at others (score 2 to 3).

In the same way, there is an increase in the ability to make friends – in fact it is the scale with the biggest increase. Linked to this is an increase of two points in the behaviours of asking others for help when necessary and in sharing one's own things with others. Moreover, the subject responds appropriately when another child wants to join in playing or doing an activity on a more frequent basis (score 2 to 3).

Furthermore, improvements in conversational skills are also perceived, specifically, there is an increase in behaviours of initiating, maintaining and ending conversations in an appropriate manner with other children. All of them change their score from 2 to 3.

Likewise, skills related to feelings, emotions and opinions show a relevant improvement. Behaviours such as the appropriate expression of positive emotions or unpleasant feelings towards others, as well as the appropriate response to negative emotions of others increase in frequency by 2 to 3 points.

Conversely, no major changes are perceived in the scale related to interpersonal problem-solving skills, although the subject's ability to generate solutions to a problem with another child improves (score from 2 to 3).

Finally, no significant improvements are observed in the skills of relating to adults. However, there is an increase in behaviours related to responding to adult requests and demands (score 2 to 3).

Discussion

Individuals with ASD often have difficulty generalising a change in their behaviour (Phillips and Vollmer, 2012), especially when this process is not specifically programmed (Foxx, 2008). Indeed, generalisation is a critical component of teaching social interaction skills (Wichnick-Gillis et al., 2018).

One of the aspects in which people with ASD have needs in this area concerns social skills (Leekam, 2016; Thye et al., 2018). Therefore, they should be an essential component to work on in intervention programmes for people with ASD (Bellini et al., 2007).

Yet, it cannot be forgotten that the use of various tools, such as technology, can enhance this type of intervention (Cored et al., 2021; Hong et al., 2018). So much is this the case that many professionals use this type of resource, especially tablets, to respond to the needs inherent to ASD (Clark et al., 2015) with results that indicate a generalisation of skills (Hong et al., 2017; Stephenson & Himbrick, 2015).

Consequently, this research has sought to analyse the impact of a technology-based program on the generalization of learning to other contexts such as the ordinary classroom or the family environment as well as to other individuals. In this way, it has been possible to demonstrate an overall positive impact on this process after the implementation of a technology-based social skills programme implemented in 4 children diagnosed with ASD.

If we delve deeper into the results, firstly, we have obtained a generalisation of basic skills in social relations along the lines of studies by authors such as Solomon et al. (2014) or Jung et al. (2008), where the 3 participants generalized these skills with their peers in different environments. However, in other research such as that of Levy and Dunsmuir (2020), the generalization was not consistent since it only occurred in 3 of the 6 students with ASD who participated. Furthermore, the measurement was only carried out in the home and not in other contexts.

Likewise, this process has also occurred in the initiation, maintenance and termination of communicative interactions, where individuals with ASD have needs (Carpenter, 2013; Paul et al., 2009). This finding supports research that yields evidence of the generalisation of skills linked to the initiation of an interaction (Green et al., 2010; Katz & Girolametto, 2015; Ledford & Wehby, 2015; Wichnick-Gillis et al., 2019) or the maintenance and termination of an interaction. Specifically, researchers Kassardijan et al. (2013) discovered that the four participants with ASD, aged between 4 and 13 years,

who were involved in their study, were able to generalize these skills in natural environments through explicit teaching and the utilization of role-playing. However, it's worth noting that in this instance, the generalization was not analyzed in relation to other individuals, whether they were peers or adults.

Furthermore, a generalisation of joint reference skills has been observed, as in other studies (Ho et al., 2019; Kasari et al., 2014; Kasari et al., 2015). In particular, an improvement in the onset of joint attention has been reported, endorsing research such as that conducted by Kryzak and Jones (2015) or Todt et al. (2021). Gomes et al. (2020), in their study involving four participants with ASD aged between 4 and 6 years old, conducted an intervention utilizing auditory scripts to foster the initiation of joint attention. Both parents and instructors of the participants reported that students with ASD generalized the initiation of joint attention in both home and school settings.

In the same way, an improvement has been noted in joint reference gazes, in the desire to share and in the imitation of gestures, coinciding with the findings of other authors (Gilley & Ringdahl, 2014; Ingersoll & Gergans, 2007; Wong, 2013). Linked to this area, an increase in generalised interest and participation in social games and activities has also been perceived, supporting the results obtained in numerous studies (Au et al., 2016; Chang et al., 2016; Hundert et al., 2014; Jung & Sainato, 2015; Petursdottir & Gudmundsdottir, 2021).

Related to the skills associated with emotions and feelings, this research has also obtained positive results with respect to generalisation. On the one hand, improvements have been observed in the identification of emotional states according to facial expressions or social situations, supporting studies such as those by Akmanoglu, (2015), Baron-Cohen et al. (2009) or Conallen and Reed (2016). In the initial study among those

referenced, four participants with autism, aged between 4 and 6 years, were involved. Employing video modeling methodology, emotions were demonstrated and identified. The subjects successfully replicated this emotion identification within environments and situations simulated by the researchers. However, the investigation did not extend to ascertain whether this skill had been transferred to other natural contexts such as the classroom or home.

Furthermore, increased generalisation has been reported in responses to the emotions of others, understanding of emotions and in acts of sharing feelings, results that are consistent with numerous studies (Koegel et al., 2016; Petrovska & Trajkovski, 2019; Thiemann-Bourque et al., 2018; Sivaraman, 2017). In Petrovska and Trajkovski's study, they intervened with 16 students diagnosed with ASD, aged between 7 and 15 years, utilizing a tablet-based approach. The aim was to enhance their comprehension of emotions and facilitate generalization through the implementation of three types of activities. The researchers noted that the subjects demonstrated improved understanding of emotions depicted in faces and in unfamiliar scenarios. However, it's important to note that only one measurement was conducted. Additionally, the researchers highlighted that since the intervention lasted only 8 weeks, there's a possibility that this newfound ability could diminish over time.

As can be seen, programmes are increasingly more focused on the generalisation of learning and skills (Green & Garg, 2018). Although, as noted by Hong, Neely et al. (2018), there are few studies that specifically concentrate on the utilization of wearable technology and maintain methodological rigor (Carruthers et al., 2020). The objectives of interventions should go beyond purely academic aims and address all areas of the lives of people with ASD, responding to the needs that arise in different environments (Cuesta et al., 2016). This should be even more so considering that the topic addressed in this

research, social skills, constitutes a series of behaviours that are expected to occur in multiple situations (Wichnick-Gillis et al., 2018).

Regular schools and centres must offer appropriate educational programmes to respond to and meet the needs that characterise pupils with ASD (Levy & Dunsmuir, 2020). To this end, it is essential to be able to make use of tools such as technology, which allows individualised intervention to be delivered for children with ASD, especially in inclusive classrooms (Hess et al., 2008; Lázaro et al., 2015).

Furthermore, research, such as the one described here, is essential for studying and confirming that technological resources not only serve as facilitators in interventions but also enable the generalization of essential skills for social development.

Finally, in relation to the limitations of the study, it must be pointed out that the sample that participated was small (4 subjects) and that no control group was used. Furthermore, the pandemic that has been present around the world since 2019 has affected the intervention. Consequently, the social skills programme had to be carried out in a fragmented manner in two phases. It is also understood that the time the pupils spent in confinement may have affected in some way the generalisation of the learning and skills acquired.

As far as future prospects are concerned, it would be very interesting to collect information from the subjects at different points in time (longitudinal study) to see whether the generalisation observed in the research is maintained over time. It could also be potentially beneficial to broaden the sample to include students with autism from different centers and cities, as well as varying levels of severity

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The authors report there are no competing interests to declare.

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