COLLABORATIVE EDUCATIONAL ROBOTICS FOR THE INCLUSION OF CHILDREN WITH DISABILITIES

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Abstract. *This literature review aims to collect systematically peer-reviewed research articles published in scientific journals that focus on the participation of children with disabilities in collaborative educational robotics activities. After systematic research, using three major digital scientific libraries, we full-screened eleven research studies that were implemented in inclusive or special settings and published during the period 2010-2022. These articles were selected as they described in detail the psycho-pedagogical methods that were used by the researchers to foster the participation of children with disabilities in collaborative educational robotics activities. The psycho-pedagogical methods have been categorized and presented critically in relation to the research methods and results. Finally, the discussion section of this review highlights the need of promoting collaborative methods in the context of inclusive educational robotics environments.*
Keywords: *Educational Robotics, inclusion, collaboration, autism, developmental intellectual disabilities, neurodevelopmental disorders*.

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Introduction

Educational Robotics (ER) is a promising field with great educational challenges. ER introduces children from an early age to programming, engaging them in STEM scientific concepts within an authentic and motivating educational context (Yuen et al., 2014). Through ER students improve creativity, logical reasoning, critical thinking (Blanchard et al., 2010; Miller et al., 2008; Yuen et al., 2014), problem-solving, social interaction, collaboration, and teamwork (Benitti, 2012). In the field of ER specific types of robots are being used. These are robots that can easily be programmed by children, themselves, in order to complete specific tasks or solve problems in the context of short scale projects (Pivetti et al., 2020). Students that are being engaged in ER projects work together in four main tasks: on designing, building, coding, and testing the educational robots (Yuen et al., 2014). Therefore, ER activities create a context in which students collaborate, sharing thoughts and synthesising ideas to enrich their solutions. More experienced can help less-experienced ones. Sufficient scaffolding by the teacher or by the more experienced peers support students to use higher-order cognitive processes in the zone of proximal development (Vygotsky, 1978). It is well documented that collaboration is connected with higher levels of achievement and positive attitudes to the learning and knowledge requirements process (Bruffee, 1995). Even programming is more effective when it is collaborative (McDowell et al., 2002).

Students, through collaboration, acquire social skills such as explicit, and implicit communication, monitoring, and coordination, and commitment to the common goals, persistence, and patience (Johnson & Hyde, 2003). Joint attention, request for help, management of conflict interventional introduction and social relations, as reported by ICF-CY, are the prerequisites for the effective collaboration (The International Classification of Functioning, Disability and Health for Children and Youth). Social skills have never been as important as they are in the 21st century, where mediated communication is established, and collaboration networks determine an individual's professional and social success.

The occurrence of possible difficulties in social skills can adversely affect the personal development and the social and/or professional relationships of the individual. Social dysfunctions are often more pronounced in people with mental, cognitive, or developmental disabilities, diagnosed with Neurodevelopmental Disorders (ND) (Autism Spectrum Disorder (ASD), Intellectual Disability (ID), Down Syndrome (DS), Attention Deficit Hyperactive Disorder (ADHD) Learning Disabilities (LD)) and social phobia. These conditions limit the ability to participate adequately and satisfactorily in social and learning environments (Bishop, 2010).

The increasing research interest in how the ER collaborative projects could facilitate the social interactions or motivate and enhance the collaboration of children with ND in special or inclusive educational settings is ascertained (Werry et al., 2001; Wainer et al., 2010; Lindsay, 2011; Tsiomi & Nanou, 2020; Nanou et al., 2022; Yuen et al., 2014). It is not only that ER reveals hidden potentials and skills (Karna-Lin et al., 2006), but also that supports and motivates the manifestation of social behaviours for children with disabilities in a variety of communication contexts. The characteristics and the role that the educational robots (ERs) are here to play, the learning objectives of the educational processes and the quality of the interactions that children with disabilities develop when they participate in the collaborative ER activities are the focus of research internationally (Huskens et al., 2013; Huijnen et al., 2019, Werry et al., 2001; Wainer et al., 2010; Lindsay, 2011; Tsiomi & Nanou, 2020; Nanou et al., 2022; Yuen et al., 2014). The strong research interest regarding the role of educational robots in the enhancement of social skills is developed in addition by the need to utilise ER in inclusive environments as, since 2000, the inclusive education through which the 21st-Century skills are equally cultivated for all students has been promoted internationally (UNESCO, 2016).

The present review aims to seek, through the international literature, remarkable research outcomes on the use of ER technologies as facilitators for social interaction of children with mental, cognitive, or developmental disabilities (ND) in ER collaborative educational settings and record the psycho-pedagogical methods that are being used to foster collaborative behaviours. This review aims at answering the following research questions:

1. Are there any published researches on collaboration of children or adolescences with ND during ER activities? Are those researches implemented in inclusive or special environments?
2. Do they present adaptations to foster participation in ER?
3. Do they present psycho-pedagogical methods to foster collaboration in ER?

Related Work

Most of the researches on the social skills' development of children with disabilities had been conducted by the researchers of Social Assistant Robots (SAR). SAR factions as social mediators to promote social interaction of children with autism or intellectual disabilities (Hedgecock et al., 2014). They support children with autism to initiate social interaction with a parent, a sibling, or a therapist (Fridin & Yaakobi, 2011), they are being used to access children's imitation ability or to teach simple coordinated behaviours (Billard et al., 2007). Social Assistant Robots, in general, support vulnerable groups, ranging in age, impairment, or need, through social interaction (Feil-Seifer & Matarić, 2005). The goal of SAR is to create the best circumstances for human-robot interaction for the purpose of giving vulnerable groups assistance or progress in learning or rehabilitation etc. There are a lot of literature reviews on the use of SAR for therapeutic reasons (Papakostas et al., 2021).

In the field of ER, systematic research reviews have been conducted to collect and analyse how the educational robots are being used in special educational for children with autism (Pennisi et al., 2016) or other kind of disabilities (Miguel Cruz et al., 2017). A more recent

review focused on collecting and analysing research focuses on ER projects for children with neurodevelopmental disorders (Pivetti et al., 2020). A most current review focus on ER researches that present results concerning inclusion of children with disabilities (Syriopoulou-Delli et al., 2021).

In order for ER to be accessible to children with ND, specific collaborative methods have to be designed, implemented, and assessed. It is well documented that collaborative robotics projects motivate students not only to participate in STEM activities and learn scientific concepts, but to develop collaborative behaviours and peer interaction. As established, there is a need to concentrate on research on ER with the aim of social skills development and especially collaboration skills of children with autism as ER activities are mainly collaborative (Yuen et al., 2014). Very few studies focus on robotics as a facilitator for social interaction among students with ND in special or inclusive settings (Nanou et al., 2022; Wainer et al., 2010). There is a lack of a systematic review of research focused on the use of educational robots as facilitators for social interaction and collaboration with participating children with ND.

Research Methodology

This literature review was based on the methodology of Grant & Booth (2009), to answer the research questions with the specific aim to collect the research on ER collaborative projects with the participation of children with ND (ASD, ID, DS, and ADHD, LD) that were published in peer-reviewed scientific journals after 2010 till 2022. The review research has been conducted from January 2022 to April 2022 in multiple digital libraries including Web of Science (webofknowledge.com), Scopus and Google Scholar. The keywords "intellectual and developmental disability", "educational robot(s)", and "collaboration" were applied in the text-search fields (i.e., title, abstract, keywords, full text), using several logical combinations of "AND" and "OR". Figure 1, depicts the selection process, showing each stage of the research procedure.

In total, 1063 references were found. After the removal of 250 duplicates remained 813 articles for the first screening. Three main inclusive criteria were applied:

- The study must be published in peer-reviewed journals in English
- The study must be dedicated to ND
- The study must focus on the use of one or more ERs (programmable by children)

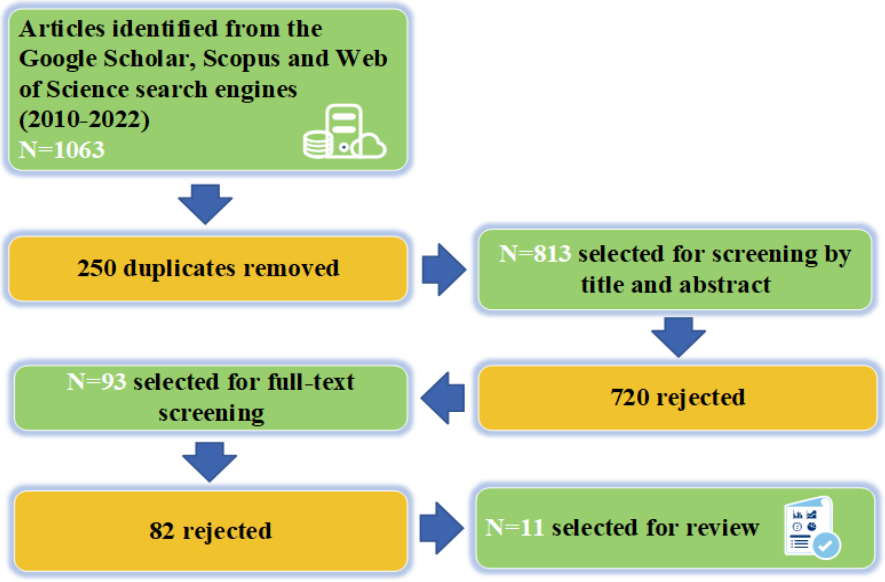

Figure 1 ***The selection process and each stage of the review***

We started by first screening the articles by their titles and abstracts based on the inclusion criteria. After the first screening, 720 articles were rejected and 93 remained for full-text screening. In the full screening, we applied two main inclusion criteria:

- The study must take place in a special or inclusive educational setting
- The study must include an ER collaboration experiment or evaluated model of or a design of an associated product for use by participant/s in teamwork

After a thorough reading, 82 articles were rejected, and 11 research studies remained for the review that met the inclusion criteria.

Results

In further analysis, as presented in Table 1, we reviewed eleven (11) research studies according to the following methodological elements, type of intellectual or developmental disability, setting (special/inclusive), age range, ER kit, the aim of the research, adaptations, duration of the intervention, psycho-pedagogical method of team collaboration, research methods, and results.

The eleven research articles that were selected for analysis constitute empirical research on collaborative ER projects that were conducted with the participation of a group of children or adolescents with all kinds of ND, aged 5-17 years old. Five of the selected research studies (45%) took place in inclusive settings, two in inclusive schools (n=2, per=18%), two in inclusive after school clubs (n=2, per=18%) and one in a summer school club (n=1, per=9%). Six of them (n=6, per=54%) took place in special education settings, two in special schools (n=2, per=18%), two in hospitals (n=2, per=18%), two in after School clubs (n=2, 18%).

Table 1 ***Research Teams in relationship with the participants, the setting, and the aim of the research study***

RESEARCH TEAM	TYPE OF DISABILITY	INCLUSIVE APPROACH	RARTICIPANTS/ GROUPS	AGE RANGE	SETTING	ER Kit	AIM
Nanou et al., 2022	ASD level2/TD	Yes	Four (4) TD and two (2) ASD level 2 /3 children one TD and ASD	10–11 years old	After school club	LEGO NXT 2.0 Mindstorms	Present effects of SaSS Training in the participation of children with Level 2 ASD as “suppliers”, in teamwork with typical peers during the inclusive ER activities

RESEARCH TEAM	TYPE OF DISABILITY	INCLUSIVE APPROACH	RARTICIPANTS/ GROUPS	AGE RANGE	SETTING	ER Kit	AIM
Chaidi et al., 2021	All kinds	Yes	Twelve (12) children formed in two groups of six.	9-12 years old	Primary general school	LEGO Boost kit	The project aims to introduce "coding and robotics" to primary school students with fewer opportunities.
Di Lieto et al., 2020	All kinds	Yes	187 children with typical developme nt and 42 children with SN (in total 13 classes from nine schools) in groups of 5 or 6 children	Mean age 6 years old	General school	Bee-Bot and Pro-Bot	To verify the efficacy of the ER-Lab on Executive Functions in children with Special Needs for the first time by using an RCT within their school environment
Fachantidis et al., 2020	ASD and intellectual disabilities	Yes	Twenty-two (22) students (14 boys and 8 girls) who were in the same class. 21 were typically developing children and one presented with ASD / small groups	9-10 years old	General inclusive school	LEGO based robot	Whether intervention using ER in general classroom, will improve the level of educational adjustment of a child with ASD, help develop communication and social skills and lead to a reduction in undesirable behaviors
Bargagna et al., 2019	Down syndrome (DS)	No	Eight (8) children / 3 children per group	5-12 years old	ER laborator y (ER-Lab)	Bee-Bot	To evaluate ER training feasibility, adapting methodology and previously

RESEARCH TEAM	TYPE OF DISABILITY	INCLUSIVE APPROACH	RARTICIPANTS/ GROUPS	AGE RANGE	SETTING	ER Kit	AIM
							experimented activities to promote executive functions in DS children
Lindsay et al., 2019	All kinds	No	Ten (10) children working in pairs	6-9 years old	Special / pediatric hospital	LEGO WeDo 2.0	How a group-based robotics program for children with disabilities impacted their STEM activation
			Ten (10) children working in group of 2 or 3	10-14 years old		LEGO Mindstorms	
Albo-Canals et al., 2018	Severe ASD with cognitive impairments	No	Twelve (12) participants / 2 children per group	6-14 years old	Special school	KIBO programmable toy robot	The feasibility of using the KIBO Robot as an engaging platform to positively impact social and emotional development in children with ASD
Lindsay & Lam, 2018	ASD, physical disability (cerebral palsy, Duchenne muscular dystrophy, etc.), brain injury	No	Twenty-one (21) children / 2 children per group / 2 children per group	6-8 years old	Special /pediatric hospital	LEGO Mindstorms and WeDo	To explore types of play, solitary, parallel, and cooperative play
Lindsay & Hounsell, 2016	Various	No	Ten (10) children working in pairs or groups of three	6–8 years old	Special /pediatric hospital	LEGO WeDo 2.0	To understand the development and implementation of an adapted robotics program to enhance the participation of

RESEARCH TEAM	TYPE OF DISABILITY	INCLUSIVE APPROACH	RARTICIPANTS/ GROUPS	AGE RANGE	SETTING	ER Kit	AIM
	Various	No	Ten (10) children working in groups of 3 or 4	9–14 years old		LEGO Mindstorms	youth with disabilities while fostering an interest in STEM
Yuen et al., 2014	High functioning ASD (Level1)	Yes	Ten (10) typical and two (2) ASD in groups with 2 or 3	12-14 years old	STEM education center after school	LEGO NXT 2.0 Mindstorms	To evaluate the extent to which students with ASD interact with their peers more during structured versus unstructured settings.
Wainer et al., 2010	High functioning ASD (Level1)	No	Eight (8) children / 2 or 3 children in a group	8–14 years old	After school club	LEGO Mindstorms NXT	To promote social interaction of middle school children with ASD, foster collaboration and investigate how ER could mediate social interaction if collaborative behaviour could be generalized

Independently of the number of participants, in most of the research, (9/11, per=81%) they were divided into groups of 2 or 3 children. An exception was the two of the selected research studies that were conducted in school settings where the participants were divided into groups of 6 children. The groups in inclusive settings were in an analogy 1:2 (1 child with Disabilities/2 Typical Development), or 1:1 (1 Dis/1 TD). Only two of the selected researchers addressed preschool children, (n=1, per=18%) while the other ten addressed primary school children (6-14 years old). Concerning the kind of robot, two research teams used Bee-Bot (n=2, per=18%), three used LEGO WeDo (n=3, per=27%), one the KIBO (n=1, per=9%), and the other five the LEGO Mindstorms (n=5, per=45%). Concerning the aim of the studies seven (63%) were focused on social skills and especially, collaboration (n=2, 18%), participation (n=2, per=18%), interaction (n=1, per=9%), emotional 1 (n=1, 9%), and communication (n=1, per=9%). The next four researchers (36%) addressed the investigation of the teamwork and collaboration in cognitive domains such as executive functions (n=2, per=18%), STEM (n=1, per=9%), and coding (n=1, per=9%).

The mean time of the collaborative ER projects duration was 14 h, SD 5,9. In more detail, in three articles (36%) the authors implemented ER projects for 16,5-18 h, in four (36%) for 10-12 h, in one for 27 h, in another one for 8h, and only one for 39,5h (7,5 hours of training were held in class while 32 hours took place online). The longest ER projects took place in inclusive schools with the use of the LEGO Mindstorms kit and the shortest in disabled pre-schoolers (DS) with the Bee-Bot.

In the exception of three of the selected research articles, where the staff was not specified, an expert in ER was included in the support team of the children in the inclusive or special setting, in parallel with the teachers or the therapists, in order for the ER activities to be performed. Volunteers and therapists or teachers supported the ER education of the children with disabilities at schools inside the hospital or in the afterschool activities.

Concerning the methods of collaboration among the members of the group of participants in ER activities, two of the selected studies (18%) emphasize the need to be introduced specific rules necessary for group collaboration, and in two studies (18%) there are not any methods that were introduced as their aim was to observe how the interaction and collaboration will be developed spontaneously between the members of the group while playing or programming of ER tools, while in the remaining three (27%) of the selected research studies more general indirect methods are described.

Indirect methods of collaboration that are being presented in three studies (27%) are presented below:

- small groups division or one to one collaboration (3/3)
- gradually integration from one-to-one interaction with the adult mediation to bigger groups (1/3)
- group thinking (1/3)
- adult mediation for relational reinforcement (3/3)
- Direct Methods of collaboration are described as being implemented in the five of the selected articles (45%) assigning of specific roles from the beginning of the teamwork. Planner - for reading the instructions, Searcher- for finding peace, Builder - for constructing the ER model. In another study, the roles had different names were changed to engineer supplier and builder, but their work was the same (3/5):
- collaboration script (1/5)
- SAS Strategy for successful collaboration between specific roles (the supplier and the builder) (1/5)
- prompts to enhance turn-taking (2/5)
- prompts to assigning roles (1/5)
- staying on task (2/5)
- changing roles (1/5)
- Six of the selected studies (54%) describe how the activities and the ER equipment were adapted in order to be accessible to children with ND and enhance their successful inclusion.

These adaptations concern:

- structuring of the lessons (5/5)
- systematic cycles of start-pause-end of activities considering low attention spans (3/5)
- reduction of possible sources of distraction (1/5)
- an easier narrative context (1/5)
- adapted Bee-Bot card keys (special larger sensors, switched on/off sensors of 65 mm diameter (Jelly Bean), were inserted in the place of the original ones) (2/5)
- time was progressively increased (1/5)
- frequent breaks were proposed (1/5)
- token economy strategies (2/5)

- relational reinforcements (1/5)
- Jelly Bean sensors could be temporarily put off-line, thus limiting the choices of planning and making the activities simpler (1/5)
- specific goals for each lesson with an emphasis on cooperation (2/5)
- bigger monitors (2/5)
- tablets (2/5)
- adequate space around the tables (1/5)
- blended learning accessible for children with disabilities (1/5)

Concerning the methodology and the results of the research studies 10/11 (90%) based their results on qualitative methods direct observations with two observers, and use of interrater validity tools, or videotaped sessions to assess collaboration, and interviews with parents and staff and six research studies additionally used pre-post ER intervention assessments methods. Only in one research study, did there was not a specification of the research methodology. Most of the articles (10/11, 90%) presents improvements in social skills, in collaboration teamwork, in social inclusion, in social interactions improvement, in communication and cooperation skills. It is documented that the sense of teamwork during the ER activities created a context of sharing the material, improved the cooperative play and collaborative learning, and fostered interactions/collaborations with other children. Concerning the research methodology, 10/11 (90%) describe in detail the efficient description of the use of the statistical method of interrater agreement when the observation method was used for data selection and the triangulation methods of reliability. Only in one of the selected articles, there is a detailed description of the educational processes and the aims of the educational intervention, but the results are described without a detailed description of the methodology. In all the research studies, the limitation of the existence of the control group was mentioned. The outcomes of our review work related to the methodology and the results of each research team are presented in Table 2.

Table 2 ***Research teams in relationship with the research methodology and the results***

RESEARCH TEAM	PRE- AND POST-ASSESSMENT	QUALITATIVE METHODS OF ASSESSMENT DURING THE ER ACTIVITIES	RESULTS
Nanou et al., 2022	Autonomous participation in the ER activities	Observation of the application of SASS / 2 observers in each child protocol / Cohens kappa	The barriers of the participation of the children with autism in teamwork with their typical peers in ER reduced.
Chaidi et al., 2021	Not Specified (NS)	Not Specified (NS)	Socialized and felt accepted, thus boosting their self-esteem
Di Lieto et al., 2020	Standardized neuropsychological tests and qualitative measures of robotic-programming skills	Teachers' qualitative observations	Social inclusion efficient learning motivation and interest in activities and in social interactions
Fachantidis et al., 2020	Sociometric test	Frequency of behaviour videotaped + 2 observers / interrater agreement. interview with the mothers	Improvement in communication and cooperation skills, in focus and completion of the tasks, accepted by 2 classmates

RESEARCH TEAM	PRE- AND POST-ASSESSMENT	QUALITATIVE METHODS OF ASSESSMENT DURING THE ER ACTIVITIES	RESULTS
Bargagna et al., 2019	Pre and post assessments, standardized tests	Not Specified (NS)	Sense of teamwork among peers and supported imitation learning a qualitative enhancement of passive visuospatial memory span (NS changes)
Lindsay et al., 2019	Questionnaire on STEAM activation/participation	Parent'svinterviews	Improvement in STEAM activation
Albo-Canals et al., 2018	No	Observational checklists/video recordings of all the sessions / PTD Engagement Checklist	Create a context of sharing the material, as we wanted to validate the usefulness of KIBO by itself
Lindsay & Lam, 2018	No	Direct observations / four researchers / play skills / disruptive behaviours interviews with parents and staff	10/21 children manifested cooperative play by the last two weeks of the programme, the majority (62–71%) of the children shared.
Lindsay & Hounsell, 2016	Pre-post surveys	Observation protocols, interviews with parents and staff	Enjoy and learn terminology, and have experience with programming and building robot
Yuen et al., 2014	No	Observation of social interaction / Visual analysis / Interobserver agreement	Collaborative learning environments increased the duration of social interaction for two middle school students with ASD
Wainer et al., 2010	No	Observation of social interaction / Interobserver agreement / structured interviews	Improved their interactions / collaborations with other children

Discussion

This review provides answers to the research questions that were set at the beginning of this work. Concerning the 1st research question, we retrieved few peer-reviewed articles published in scientific journals since 2010 with a focus on collaborative methods in ER activities for children with ND. The lack of research studies in this specific domain was recognised by the first studies in the field (Wainer et al., 2010; Yuen et al., 2014). It must be underscored that 12 years later (2022), little progress had been made in the specific research domain. Although it is strongly documented that ER projects are collaborative in nature (Yuen et al., 2014) and ER has already been introduced into the classroom, from kindergarten through high school (Nanou et al., 2022) we have few scientific results about how groups of people with disabilities in special or inclusive ER settings work together, and how collaboration and collaborative working might be supported. The lack of research results in the field deprives the scientific community of evidence-based empirical data that are necessary for the enhancement

of equal participation of children with disabilities in ER putting them at risk of not achieving their goals and not being able to engage in ER school or afterschool activities.

It is encouraging that almost half of the research studies that met the criteria had been conducted in inclusive settings. Particular attention should be paid to the last four research studies from 2020 to 2022 (Chaidi et al., 2021; Di Lieto et al., 2020; Fachantidis et al., 2020; Nanou et al., 2022) that were selected by our research review on collaborative ER projects are in inclusive settings and the most three in public schools. One was conducted in an afterschool inclusive setting. As the learning environment, all over the world, comes more inclusive it is hopeful that research on inclusive practices concerning ER collaborative activities has started to attract the interest of the researchers in the field (Chaidi et al., 2021; Fachantidis et al., 2020; Nanou et al., 2022; Tsiomi & Nanou, 2020).

LEGO Mindstorms, LEGO WeDo, Bee-Bot and in one study KIBO educational robotics kits were used in collaborative ER activities. These kits are potentially suitable for children with disabilities and especially for autism. One of the greatest advantages of LEGO Mindstorms and WeDo for the participation of children with ASD, is that the model structure for the assembling step by step is represented in the detailed manual that is being included in the kit. These detailed visually structured manuals describe all the facilitated play options, step by step (Lauwaert, 2008). Through the detailed manuals, the structured activities are visually organized and presented in a planned, sequential, and logical way. This kind of manual is effective in facilitating the constructing play of children with ASD (Hampshire & Hourcade, 2014). Bee-Bot is a referee significand device promoting interest and interaction with adults and peers. Children can easily control the Bee-Bot using the buttons at its back (Bargagna et al., 2019).

Concerning the 2nd research question for the adaptations of the equipment or the place, it was found only six of the selected studies (54%) described in detail the adaptations of the ER activities to be accessible to children with disabilities and enhance their successful inclusion. These adaptations include a) structuring of the lessons through b) use of token economy strategies c) through the assignment of specific goals for each lesson with an emphasis on cooperation, d) bigger monitors, c) tablets, d) systematic cycles of start-pause-end of activities considering low attention spans e) adapted Bee-Bot f) card keys, are being described adaptations by more than one researches. As for structuring referred by five of the six research studies (Albo-Canals et al., 2018; Lindsay, 2011; Lindsay et al., 2019; Lindsay & Hounsell, 2017; Nanou et al., 2022).

Concerning the 3rd research question on the specific methods that are being used to foster collaboration only five of the 11 researchers describe specific methods in order for the collaboration to be developed. three of the five research studies (Fachantidis et al., 2020; Lindsay & Lam, 2018; Nanou et al., 2022) use the method of specific role assigning but only one supported scaffolding of the process of collaboration using a specific strategy (Nanou et al., 2020). According to (Yuen et al., 2014) children with developmental disabilities without proper scaffolding little interaction can develop with peers and gain little from the collaboration. Although scaffolding, derived from the Zone of Proximal Development, (Vygotsky, 1992) has been recognized as the most effective approach and it is known that there is a need for instructional support for both team learning outcomes and individual learning outcomes to be of high quality (Kollar et al., 2006) research studies had a little focus on how collaboration could effectively be supported. Further designs of collaborative robotics projects that include students with ASD would integrate more scaffolds to encourage more intergroup communication and interaction, increase student-initiated participation, and improve collaboration.

Conclusion

This work collected peer-reviewed research articles published in scientific journals that focus on the participation of children with Neurodevelopmental Disorders in collaborative and inclusive educational robotics activities. After a systematic review, using three major digital scientific libraries, we selected eleven research articles published in scientific journals for full review. These articles satisfy most of our criteria and use qualitative methods of research with sufficient description of the research procedure, tools, and methods of data collection. In this review, the proposed methodologies in literature are categorised and presented critically. The research concerning the adaptations and the psycho-pedagogical methods that foster collaboration of children with ND in ER activities is limited till now. We highlight the need of promoting collaborative methods in the context of inclusive ER environments as the results are promising for the development of collaborative skills of children with mental, cognitive, or developmental disabilities, especially in inclusive context. Additionally, to the psycho-pedagogical collaborative methods, the design of educational robots with emphasis on inclusive characteristics could foster the inclusion of children with disabilities in ER and support their accessibility to 21rts century's' curriculum.

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