Co-designing a social robot in a special educational needs school: *Listening to the ambitions of autistic children and their teachers*

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Abstract

Social robots have the potential to support autistic school children with their wellbeing. This research reveals how a co-design approach with autistic children and their teachers was undertaken. Focus groups with autistic children and teachers collaboratively identified user requirements for the social robot and robot behaviours within the school ecosystem in order to improve student wellbeing. The results reveal the importance of including autistic children in the co-design process to ensure their voices are heard and also that the role of the robot is appropriate and targeted to the users' needs and requirements. Autistic children and their teachers report multiple potential benefits for social robots supporting emotional wellbeing in the school. Autistic children were supportive of the introduction of a social robot in their school, mostly expressing positive attitudes towards the robot. The research is significant in revealing how a user-centred co-design approach involving autistic children and social robots may support emotional wellbeing.

Keywords: Autistic children, social robot, emotion, well-being, school, co-design

1. Introduction

1.1 Overview

This article reports on the outcomes of working with autistic children and their teachers in their school on the role of a social robot. This was achieved by conducting two focus groups with the children, one with teachers, and a workshop with an autistic adult researcher. In response to a lack of research reporting autistic preferences pertaining to what and where social robots could be used by them, we engaged a co-design and participatory study that placed autistic views central to our enquiry. There is also a lack of successful social robot integration into schools combined with limited efforts and/or ambitions to meaningfully co-design a social robot with pupils. Therefore, our research sought to design a social robot that could support the well-being and emotional regulation of autistic children (as suggested by them). Participation of autistic children and their teachers was fundamental to the success of the co-design process. Our guiding research questions were:

1. What are autistic children's views and perspectives of what a social robot, like Pepper, would do in their school?
2. What perspectives can teachers add to support the integration of a robot, like Pepper, in their school?

1.2 Autism

Autism is a lifelong neurodevelopmental condition that can impact how a person perceives, communicates and interacts with the world. This is characterised by significant and lasting differences (from typical development) in social communications and interaction, restricted and repetitive patterns of behavior, interests or activities and sensory perception and responses (APA, 2013; Centers for Disease Control and Prevention, 2019). Recent data suggest that as many as 1 in 54 children in the United States of America are on the autism spectrum (Russell et al., 2014) while other studies suggest a figure of between 1 in 68 to 1 in 100 in the general population (Özerk, 2016). Moreover, work published in 2021 suggests that current estimates from CDC’s Autism and Developmental Disabilities Monitoring Network, that around 1 in 44 children have been identified as being on the autism spectrum (Maenner et al., 2021). In addition, the well-being and emotional regulation of autistic people has been central in supporting meaningful educational experiences (Conner, et al., 2019). In comparison to their typically-developing peers, some autistic children, and adults can experience greater mental health issues, such as anxiety, depression, anger, and possess lower self-concept and these can often impact education and associated factors (Danka et al., 2016; Jackson et al., 2018). In recognition of tensions in this field, and when describing people with autism in research, we identify with research conducted by Kenny et al. (2016) who located preferences in the autistic/autism community. Here they found that being described as both “people with autism” and “autistic people” was preferable.

Therefore, we use both without placing a preference on either; reflecting the views of autistic groups and stakeholders when using terms and language within this field. In addition, and more recently, work by Bottema-Beutel and colleagues (2021) describes ways in which to avoid ableist language in autism-based research. In this regard they propose participatory models of autism research and suggest one hallmark of these approaches is that "autistic people are included in the research process conducted by nonautistic investigators" (p.25). In this regard, and as nonautistic researchers ourselves, we centred our research to include autistic people and young autistic people in the co-design of a social robot; focusing our work around their needs and feedback.

1.3 Research with autistic groups

The field of technology and autism has evolved from early studies in the 1970s (Newbutt, 2019) involving multimedia technology through to innovative application of virtual reality (Parsons, 2016; Parsons & Cobb, 2011) and robotics (Begum et al., 2016). However very few studies place autistic people (presumably the end users too) at the centre of research (Saleh et al., 2020). In relation to research in social robotics, while there have been efforts to better include autistic people in research including the co-design process (Huijnen et al., 2017; Björling and Rose, 2019) there is still very little focus placed on the voices of autistic people in defining or deciding what they want to use social robots for in their lives or education. The premise of using social robots, even when including autistic people, is focused on therapy, improving social skills or communication (Saleh et al., 2020). This in itself can be problematic when we look towards examples of successful applications of social robots after studies have concluded. With limited uptake of social robots in settings that could benefit autistic people, we argue that studies should involve autistic people from the outset and in the co-creation of what a social robot may do with and for autistic groups. Failing to take a meaningful approach to co-design, we risk continuing to design technology without stakeholders and end users input and properly understanding autistic desires for how a robot may engage autistic people in their lives (Bron and Veuglers, 2014). This specific point is highlighted in work by Pellicano et al. (2013) who report autistic opinion of research. They found dissatisfaction expressed by autistic groups over the levels of engagement in the research process and disagreements about the interpretation of research findings. This runs the risk of ignoring and excluding the lived-experiences of autistic individuals and failing to engage them in co-production of research that has relevance to their lives (Pellicano et al., 2013). This is also true of the ethics in and around this field, for example Cascio et al. (2020) argue that: *“Growth in autism research necessitates corresponding attention to autism research ethics, including ethical and meaningful inclusion of diverse participants”*. This suggests that ethics in this field is moving beyond typical ethical review processes (i.e. Institutional Review Board approval / Ethical Review) and towards more meaningful / active engagement of diverse participants in our work

Therefore, research in this area (broadly speaking) has begun to move away from researching *for* and *about* autistic people, moving towards an approach that *includes* autistic people in the design, development and evaluation of technologies (Fletcher-Watson et al., 2019; Walmsley et al., 2018; UNICEF (United Nations Children's Fund), 2020). This move not only encapsulates the design and development of technologies, but more broadly includes the voices of autistic people in the process of research. However, this is not to underestimate the difficulties such an approach can have and is summarised well by Parsons and colleagues (Parsons et al., 2020, p.227), who suggest:

> *co-construction within the technology and autism field may create special challenges because it is not always clear what the best answers or processes are and, therefore, who has the necessary expertise: technology tools develop and change swiftly, as do the expectations from the contexts of their use.*

1.4 Social robots and autism

Research about robots within special educational needs settings with children has located at least five ‘wicked[1] problem’ challenges that can persist and provide barriers to successful uptake and/or use in schools. For example, Galvez Trigo et al. (2019), when interviewing 13 teachers from across the United Kingdom and Spain, found that the main reasons why special needs schools do not normally use robots in their classrooms were associated with: (1) price or availability; (2) difficulty of use; (3) the limited range of activities offered; (4) limited interactions on offer; and (5) the inability to use different robots with the same software. These findings tend to suggest that robot deployment and uptake in special needs schools has many barriers and could be further compounded by a lack of “involving end users in the design and development of new systems” (Trigo et al., 2019, p.59), in addition to “using a user-centred design approach for all the components, including methods of interaction, learning activities and the most suitable type of robots” (p.59). As such, the lack of user-centred designs and even

[1] Wicked in this context refers to the work of Termeer et al., (2019).

including school children in the types of interaction they might want or enjoy via a robot in their school, means that uptake, deployment and successful integration is difficult to achieve.

1.5 Participatory design methodologies and social robots

Participatory Design (PD) methodologies are built around the idea that end-users, and more broadly, stakeholders, should actively join in decision making processes which shape robot design (physical as well as behavioural) and/or the direction of research (Rogers et al., 2021). Many of the points of PD in robotics have been laid out by Lee et al., 2017 with numerous applications since then, mostly focused on assistive robotics and social robotics (see: Azenkot et al., 2016; Björling & Rose, 2019). For example, Arevalo Arboleda et al., (2021) reflect on their experience with conducting participatory design with people with motor disabilities. In doing so, they identify five points to ensure a successful co-design process: (1) a multi-disciplinary team involving a diversity of stakeholders; (2) consider the interplay between primary users (in our case, the children) and secondary users (in our case, the teachers, school staff, and parents); (3) ensure early exposure to the technology (robots in this case); (4) ensure that a diversity of opinions can be freely expressed by e.g. having distinct focus groups for different subgroups of end users (e.g. children and teachers); (5) recognise that ethical implication go beyond consent. Our own work methodology aligns with these points.

Recent work on participatory design in robotics has focused on the idea of mutual shaping, first introduced by Šabanović (Šabanović, 2010) where the technology and the society influence each other, in a co-development process. This has been for instance applied to assistive robotics, with a positive impact on acceptance (Winkle et al., 2020). The same approach has been further developed and formalised as the LEADOR (Led-by-Experts Automation and Design Of Robots; Winkle et al., 2021) methodology, an ‘end to-end’ co-design methodology where machine learning is employed for the robot to directly learn from the final users.

While our work is grounded in this previous work and strongly influenced by the idea of mutual shaping, we follow a more traditional participatory design process where the design phase (involving the end users) and the implementation phase (involving only the researchers) are clearly distinct. Note that contrary to projects like the EMAR project (Ecological Momentary Assessment Robot; Björling & Rose, 2019) or the work on participatory design of social robots conducted by Darriba Frederiks et al. (2019), we did not explicitly include the embodiment and physical appearance of the robot in the co-design process. While we did not observe spontaneous comments or discussions on the general appearance of the robot during our focus groups, we discuss this limitation of our approach at the end of the article. Use of participatory design to specifically design child-robot interactions is much more limited.

Probably the most significant piece of research to date is the recent work by Alves-Olivera and colleagues (Alves-Oliveira et al., 2021) who conducts a wide-ranging investigation of how children can be involved in the co-design of robots. Based on Alves-Olivera's typology of children's roles in PD, along with Druin's (2002) work, our work focuses on children as informants and (to a lesser extent) partners (they played an active role in shaping the robot's behaviours, but the final design decisions were made by the researchers). While centred on the physical design of robots with neurotypical teenagers, Björling's work (Björling & Rose, 2019) is also notable for its scale (several years of co-design process).

2. Methodology

The research adopted a co-design strategy incorporating a series of events with stakeholders to collaboratively identify user requirements for the robot behaviour and role within the school ecosystem (Sanders & Stappers, 2008; Steen, 2013). The methodological approach was adopted in order to gain insights and understanding from key stakeholders and ensure the intervention was appropriately targeted for effectiveness to address the research aims (Stewart and Shamdasani, 2014). At each focus group, video and audio recordings were undertaken with written notes and materials drawn by the participants collected during the session. Subsequent quantitative and qualitative analysis of the data was conducted; more detailed information on these methods and sampling approach is set out in the following subsections.

The focus groups explored two research topics, to:

1. Elicit potential roles for a social robot Pepper within the school ecosystem for autistic children.

2. Identify appropriate behaviours for a social robot Pepper to assist with wellbeing[2].

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[2] We refer to wellbeing as: mental well-being which can be "described as a combination of hedonic and eudaimonic well-being such that positive psychological functioning (not merely the absence of mental illness) is represented; incorporating not only happiness and eudaimonia but also concepts such as agency and self-esteem" (Stimpson, et al., 2021, p. 289)

The data and findings in this paper are centered on the focus groups; the goal of the focus groups was threefold: (1) to enable identification of the role of Pepper within the school; (2) to understand the potential behavioural characteristics for Pepper; and (3) to identify potential locations within the school for Pepper. This study focuses on the co-design activities; however based on these co-design activities this research led onto full-sale deployment of a social robot at this school (the school was already pre-selected as a site to collaborate with).

2.1 Ethics and Procedures for Engagement Throughout the process, the autistic pupils, teaching staff and parents/caregivers were kept informed of the project (Slattery et al. 2020). This has been achieved through communication by the school in school letters and their website (note: all the research was undertaken during various degrees of Covid lockdown restrictions, which in practice meant much communication was done virtually; nonetheless all primary research was conducted in person). Events involving stakeholders from the school community included, in turn: introducing the social robot Pepper to the school via newsletters and digital communication with pupils; an opportunity for all pupils in the school to meet and interact with the robot; two focus groups with pupils; Pepper spending a day in the staff room to allow time for staff to meet and become familiar with the robot, one focus group with teaching staff; mini-pilot testing of Pepper's interactivity. Additionally, we sought engagement and feedback from an autistic adult researcher (known to the first author of this paper) at three key points in the research journey and hosted webinar with the broader autistic community (attended by autistic people, parents of autistic people and other researchers within the autism field, from across the UK and Europe). This study received full ethical approval before commencing and the researchers worked closely with the Ethics Committee and school to ensure safe working practices and that all activities were undertaken in line with UK Government guidance around Covid-19 (since this work was undertaken during 2021 when some restrictions were still in place). Our work was conducted under strict guidance in consultation with the school and adherence to the UK governments' guidance and the school's own health and safety risk assessments. We sought parental consent and assent from the children before any research commenced. The research was conducted at the school, in situ and the authors were present to collect the data. School teachers confirmed that the pupils who took part (along with their parents) were native speakers (English). All names that accompany direct quotes in this article are aliases and not the pupil's actual names. This is to ensure anonymity. By way of further context, Figure 1 highlights that the work reported in this article was part of a larger project in which we formally evaluated Pepper in the school post co-design and focus groups. This article reports on Stage 2 of the process, highlighted grey. We report on the other stages elsewhere.

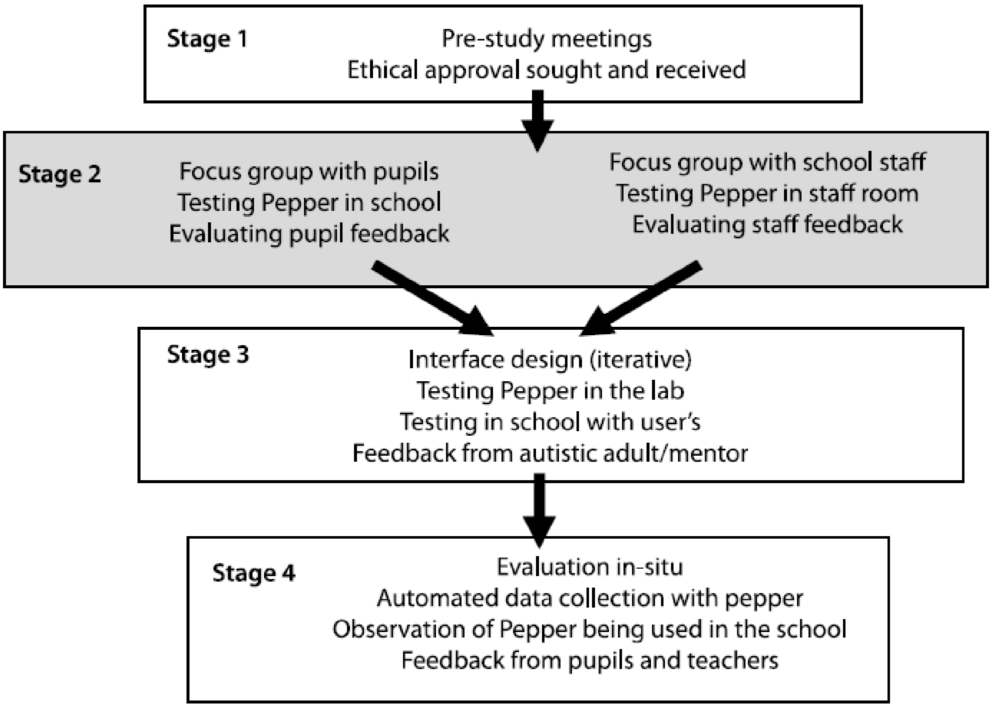

Figure 1. *Outline/overview of the wider project of which this article reports one part.*

2.2 Setting and Participants - Autistic children's focus group All of the 144 children in the school were given the opportunity to meet Pepper, as were their teachers, and to interact with the robot. However, only two class groups were formally studied as part of the research focus groups. The decision to hold two children's focus groups was partly down to the capacity of the school and the researchers to conduct focus groups in the time available within the allotted school day (and the availability of children who gave formal consent). The researchers had planned role-playing as a manner in which to engage and elicit views from the children. However, due to time constraints we were unable to achieve this; but represents a method that could be explored in the future.

The research was conducted at a UK special needs school for autistic pupils aged 4 to 19. The school is non-denominational and has 144 children across the range of ages and with a 70/30 male to female ratio; 97% of children have English as a first language, with some of the children non-verbal.

2.2.1 Procedure – Autistic children's focus group Two focus groups were held with autistic children at their school; the location of the focus group was in a general meeting room within the school. The children were taken out of their classrooms at specified times and brought to the meeting room. The children are familiar with the space in which the focus group took place as the room is part of the school and used for a range of events and functions including one-2-one meetings with their teachers. The research team prepared the room beforehand, arranging a large table to one side of the room, and a clear open space in the other half of the room (see Figure 2). Video and audio recording equipment was set up in the room; and the robot was brought into the room and set up; it was briefly tested to confirm it was ready to use/start the focus groups.

Figure 2. Photo of the room, highlighting size, space and layout. Left image first part of the focus group with Pepper and right image; brainstorming ideas for Pepper in their school.

Table 1. Demographics of the focus groups with children

Focus Group 1 41 mins.	6 males 2 females	$n = 2$, 12 years olds $n = 3$, 13 years olds $n = 3$, 14 years olds	All confirmed autistic (statement of special needs)
Focus Group 2 31 mins.	2 males	$n = 2$, 11 years olds	All confirmed autistic (statement of special needs)

The first focus group had 8 children and the second focus group had 2 children; the first focus group lasted 41 minutes followed by the second at 31 minutes. See Table 1 for details of the pupil demographic in each focus group. Two researchers lead the session as moderators with 2 further researchers assisting with digital recording, note taking and remote control of the robot. Each session also had a number of teachers and teaching assistants present. The first focus group had two-three staff (at various points) and the second focus group had one to two staff (at various times). Figures 3 and 4 highlight the room layout and who was present and where they were located for the duration of the focus groups.

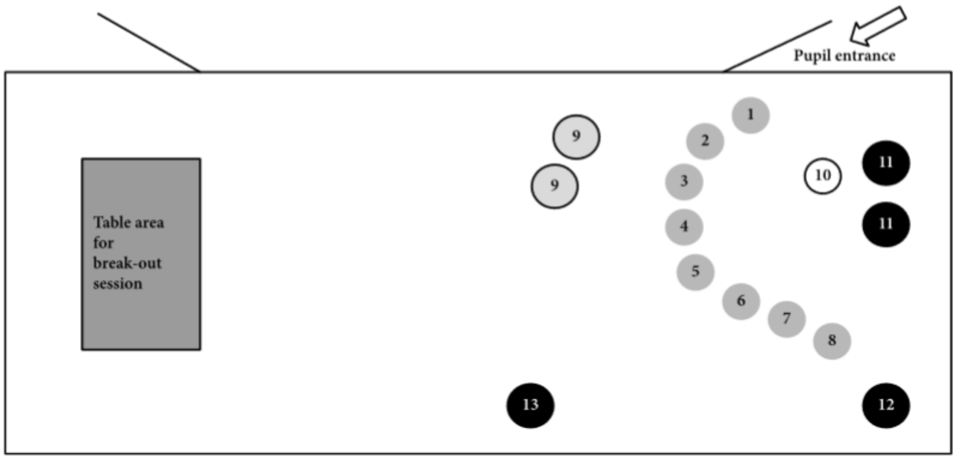

Figure 3. Room layout for the first focus group with children. Key: 1=pupil 1 (Jess), 2=pupil 2 (Matt), 3=pupil 3 (Pasha), 4=pupil 4 (Mark), 5=pupil 5 (Jennifer), 6=pupil 6 (Stuart), 7=pupil 7 (Tony), 8=pupil 8 (Mateo), 9=teaching assistants, 10=Pepper the robot, 11=facilitators leading the session (2 of the researchers/authors), 12=observer/photographer (1 of the researchers/authors), 13=Pepper remote control and videographer (1 of the researchers/authors)

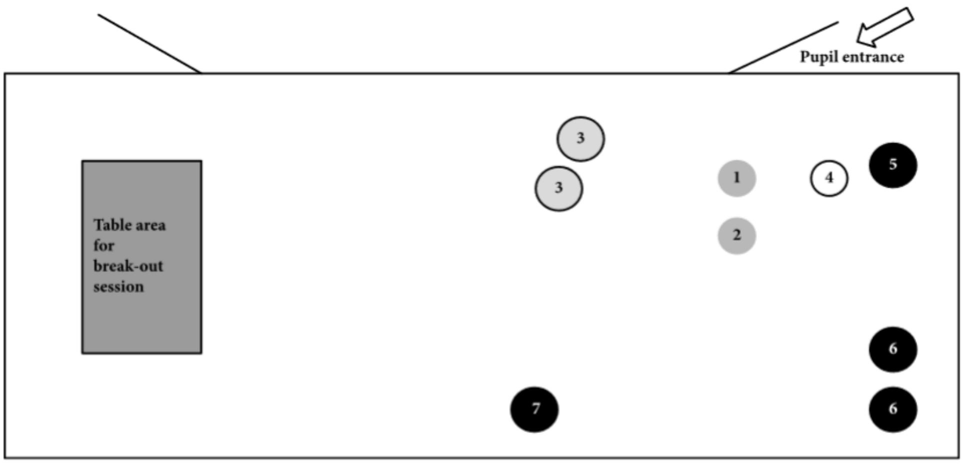

Figure 4. Room layout for the second focus group with children. Key: 1=pupil 1 (Albert), 2=pupil 2 (Jude), 3=teaching assistants, 4=Pepper the robot, 5=facilitator leading the session (1 of the researchers/authors), 6=observer/photographer (2 of the

researchers/authors), 7=Pepper remote control and videographer (1 of the researchers/authors)

At each focus group, the session began with the children introduced to the robot and with Pepper displaying some of its possibilities, such as singing, dancing and story-telling. The moderators then asked a series of questions related to the potential deployment of Pepper in the school. Questions included: "*How would you like to interact with Pepper? What might Pepper do in the school? What behaviours would you like Pepper to have? Where in the school might Pepper be placed?*". The children were then invited to approach Pepper and touch and/or play with the robot. For the final third of the focus group, the children were invited to a large table with paper, pens and some pictures of the robot and children (with speech bubbles) and prompted with the questions/prompts: *"If you could just imagine these little people are you and there's the robot you've just been speaking to – we have these speech bubbles we'd like you to imagine: "what might you say to Pepper? What might the robot say to you? What would you like to do with Pepper? What would you like Pepper to do when you are feeling happy or sad?"*. The moderators (and also the teaching assistants) prompted children if they appeared to be stuck with aspects of the task. The teaching assistants were helpful in assisting different children to communicate appropriately to the capabilities of each child (i.e. some more verbal, some doing drawings, some writing text).

***2.2.2 Data Collection* - Autistic children's focus group** The audio from the autistic children's focus groups was transcribed verbatim after the event by two of the researchers, with a time code assigned to each statement. Notes were also made of the children's behaviour and physical interaction with the robot (with a time code for each interaction). In total 465 statements were transcribed and coded. The drawings and text of the children written in the second half of the focus group were photographed and collected digitally.

***2.2.3 Data Analysis* - Autistic children's focus group** The transcripts of the autistic children's focus group were undertaken by two of the researchers adopting a content analysis approach (Potter & Levine-Donnerstein, 1999). Four different coding strategies were undertaken on the transcripts in order to elicit data on the themes set out below. The four identified coding themes are listed below in table 2 and justified briefly here.

Code 1: Existing literature points to the importance of development of social skills for autistic children (Matson et al., 2007). The robot as a social agent might play a potentially important, and hitherto unknown, role in facilitating and participation in social skills for autistic children. Accordingly, a number of categories for teaching and practising social skills with autistic children have been established with criteria to enable classification of interactions (Varughese, 2011) the categories are listed below. Code 2: Existing literature highlights the significant role the perception of the robot might play for the children (Belpaeme et al., 2013; Tung, 2016). Importantly, if the robot was to work towards the improvement of children's wellbeing, then it is important that children looked positively towards

Table 2 Coding Structure for the children's focus groups

Code no.	Code name	Description of code
Code 1	Social interactions	Based on the pupils and what they said during the focus group.
Code 2	Attitudes towards Pepper	Each of the utterances by the pupils was categorised into whether their comment was *positive*, *neutral* or *negative* towards Pepper.
Code 3	Content of comments to Pepper (directed to, about or not related)	The content of comments made in relation to Pepper were made, according to three categories, whether the comment was: directed *to* Pepper (about anything); a comment *about* Pepper to a human; or nothing related to Pepper.
Code 4	Location of Pepper	The location of Pepper within the school as proposed or mentioned by pupils during the focus groups.

the robot. Code 3: This code attempted to understand how autistic children spoke in relation to the social robot. This analysis provides evidence as to whether the children would not speak to Pepper at all or if the children had no interest in Pepper whatsoever; it also explored whether the children spoke directly to Pepper, perhaps suggesting the children believe Pepper had some form of social agency. Code 4: The fourth coding was undertaken to reveal the locations within the school where children would like the robot.

For code 1, the coding categories were derived from predefined codes identified from previous work (see Newbutt, 2013). Varughese (2011) and Hadwin et al. (1997) defines categories for teaching and practising social skills with autistic people, and highlights the criteria as a model to highlight quality and scope of interactions. They also take into account children's responses to adults in conversation The 'understanding Pepper better' category came from the specifics of this research and emerged as a category during the research process.

1. Perspective-taking: considers others' likes/dislikes; understands effect on others; acknowledges comments of others.

2. Maintaining social interaction: turn-taking; organised conversation; navigating misunderstandings.

3. Initiating social interaction: greets others; asks for help; responds to comments.

4. Perseverative/echolalic: if responses were echolalic or repetitive.

5. Inappropriate comments: out of context or inappropriate to the situation.

6. Understanding Pepper better: comments that enquire about Pepper, ask for more information.

7. None of the above.

In order to provide reproducibility and accuracy for the coding, a reliability test was undertaken, accordingly, two reviewers carried out analysis independently to the other each before a comparison of similitude was carried out to assess interrater reliability (Hsieh & Shannon, 2005). A trial of the robustness of the two reviewers was made partway through, before completing the review. The final agreement (using Cohen's Kappa) for focus group 1 was 0.734 and weighted Kappa of 0.688 (indicating substantial agreement) while the Kappa for focus group 2 was 0.886 and weighted Kappa of 0.968 (indicating almost perfect agreement). Having conducted focus groups with the pupils we next arranged a focus group with teachers. This was purposefully arranged after the children's focus group as we intended to build on the initial feedback from the pupils. This was to position their views first and foremost in this study, but to be sure the feedback received from both pupils and teachers could be appropriately aligned; that is using the pupils' feedback to inform what the robot would do and where, coupled with teachers views of how a robot could be used in a pedagogical and well-being sense. Therefore, we take both sets of data and use them to construct a meaningful robot interface for the pupils.

2.3 Procedure – Teacher's focus group

Two researchers lead the session as moderators with one further researcher assisting with digital recording, note taking and remote control of the robot. One of the moderators welcomed the staff and gave an overview of the research project to the staff. Each of the staff had previously met the researchers and Pepper at either the earlier focus groups sessions or informal demonstration / welcome meeting and were therefore already broadly familiar with the research project, the researchers and the capabilities of the social robot. Written ethical consent was then sought from the participants who were given the relevant documentation for their own records and to sign and return a copy to the researchers. The moderators asked similar questions as at the childrens' focus group "*How would you like the children and Pepper to interact? What might Pepper do in the school for the pupils? Where in the school might Pepper be placed?*". This was initially undertaken in small groups around the tables with teachers writing on the large sheets of paper (33×23 inches) and discussing in small groups of 2 or 3. At the conclusion of this phase of the focus group, a broader discussion with all of the staff ensued on these same questions. The final phase of the focus group focused on the feedback gathered during the autistic children's focus group, particularly the initial prototype interaction screen developed for the robot behaviour.

2.3.1 *Setting and participants – Teacher's focus group*

A focus group was held with teachers and teaching assistants at the same school in their music / library space. This event was held one week after the children's focus groups and was held in the afternoon shortly after the teaching had ended for the day and the children had departed the school. The researchers prepared the room before the event began with 4 small tables pre-prepared with large sheets of paper and pens. Video and audio recording equipment was set up in the room; and the robot was brought into the room and set up ready to go. Eight members of staff attended and were invited to sit at the prepared tables. Table 3 shows the demographics of the attendees and their experience of working with autistic children, while Figure 5 highlights room layout.

Table 3. Demographics of the focus groups with teachers.

Gender	Type of role in the school	Years' experience working with autistic children	Newly Qualified Teacher (NQT) (within 2 years)	Other notes/details
Female	Leader	6–10	N	
Female	Teacher	2	N	Mainstream initially, transferred to Special Educational Needs (SEN) teacher
Female	Teacher	5	N	Previously a Teacher Assistant (TA) at school
Female	Teacher Assistant (qualified teacher)	1	N	Promoted to teacher this year
Male	Teacher	5	N	Previously a TA at school
Female	Teacher	11–15	N	
Female	Teacher	1	Y	Previous TA at school
Female	Teacher	2	Y	Previous TA at school

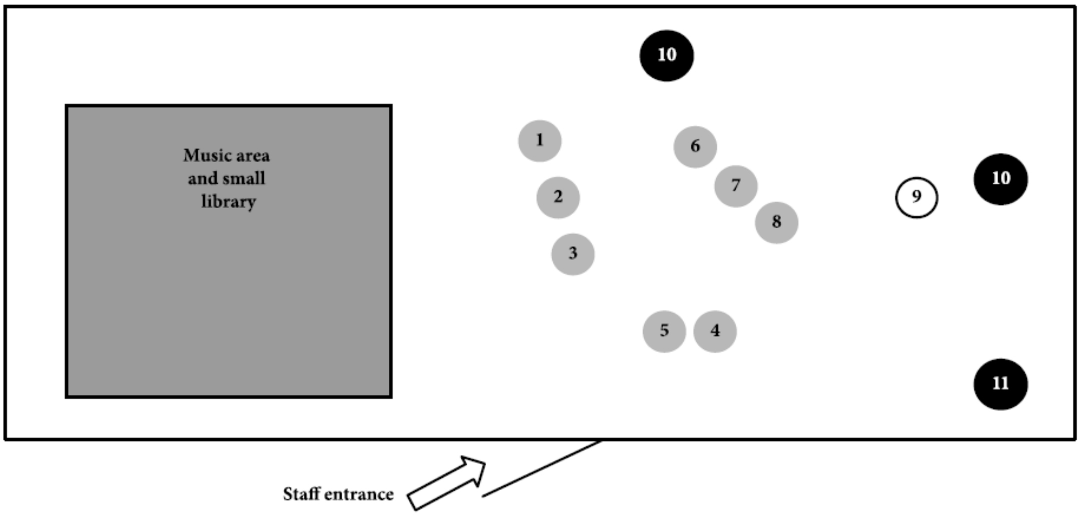

Figure 5: Room layout for the focus group with teachers/staff. Key: 1=teacher 1 (Aoife), 2=teacher 2 (Mike), 3=teacher 3 (Rebecca), 4=teacher 4 (Sophie), 5=teacher 5 (Molly), 6=teacher 6 (Katerina), 7=teacher 7 (Nora), 8=teacher 8 (Louise), 9=Pepper the robot, 10=facilitators leading the session (2 of the researchers/authors), 11=Pepper remote control and videographer (1 of the researchers/authors)

2.3.2 *Data collection – Teacher's focus group*

The audio from the teachers' focus group was transcribed verbatim after the event by one of the researchers, with a time code assigned to each statement. The teacher's drawings and written text created during the discussion phase of the focus group were photographed and collected digitally.

2.3.3 *Data analysis – Teacher's focus group*

The transcript of the teachers focus group was not formally analysed using a coding scheme. This was mainly due to constraints and limitations of time. Instead, an understanding of the content was used to help improve and implement the children's feedback onto the robot platform. The aim of this was to give increased confidence of the utility and appropriateness of the robot behaviour within the school setting and to achieve the aspirations as established in the earlier focus groups.

3. Findings

The findings from the children's focus groups are presented first and then the results from the teacher's focus group.

3.1 Focus group (children)

3.1.1 *Part 1: Transcriptions; quantitative data and themes*

The aim of the focus groups was to elicit autistic children's views and perspectives of what a social robot like Pepper might do in their school. The focus groups provided data that addressed this research aim; these findings set out, in turn, the different themes that emerged from those focus groups.

3.1.1.1 *Code 1: Children's social skills*

The analysis was undertaken according to seven different themes as presented in Section 2.1.3. The most common (*n*=104, 54%) was 'initiating social interaction' and included behaviours such as greeting others, asking help or responding to comments. Almost all the pupils greeted Pepper when they first encountered the robot, verbally and often with waves and hand gestures (see Figure 6).

Figure 6. Example of child to pepper interaction

Pupils also responded to the comments made by the two moderators, answering their questions and prompts. For example, when the moderator asked: "how does it [being with Pepper] make you feel?" Tony responded by saying 'quite happy yeah'. Similarly, when the moderator asked "What do you think of a robot like this?" Tony continued by saying "I think it's… brilliant". Throughout both focus groups, there was a high level of social interaction initiated in relation to prompts, discussion and questions about the robot. The second most common theme (*n*=55, 29%) was 'maintaining social interaction' whereby pupils take turns in organised conversation and navigate misunderstandings. The relatively high frequency for this behaviour was encouraging as this requires quite complex interaction between the pupils (and in this case also including the behaviour of the robot) which can be difficult for some autistic children. An example of this type of interaction included:

Moderator: “Have you all seen this type of technology before on TV or something?”

Multiple children answer: “Yes” or “Yeah”

Mateo: “Yeah you can definitely find it on TV”

Jess: “I’ve only seen it on the TV”

In another exchange between four different children and Pepper, the following

conversational exchange is maintained:

Mark: “It’s looking right at me”

Jennifer responds to Mark: ‘It’s staring right at you’

Jennifer: “They’re looking right at Stuart”

Mark: Bends down to stare into Pepper face “Hello”

Mark: “Staring contest” – stares at Pepper

Tony: Giggles

On numerous occasions, the children could maintain complex exchanges in a conversation that included other children, the moderators and Pepper. The rest of the exchange behaviours were all much less common than these first two. However, the category ‘perspective taking’ (which includes activities

such as considering others likes, understanding the effects on others or acknowledging comments on others) can be considered relatively difficult interactions for some autistic children who display empathetic behaviours less frequently. It was not anticipated there would bemuch of this category before the coding took place, nonetheless it was encouraging that this was the third most common category (*n*=16, 8%). Pupils expressed comments that suggest Pepper had human emotions or physiological attributes, for example, when themoderator suggests, in response to Peppers behaviour/expression:

“It looks a little bit sad now”

Mark: Exclaims “Oh dear… poor Pepper”

Tony states “Maybe it’s a teensy bit confusing for her?”

Mark concurs: “She is very confused”

The children also made empathic comments about Pepper being tired, for example:

Mateo: “It’s definitely tired”

Mark agrees: “Yes tired”

Stuart: “He is really tired”

When amoderator makes a comment about Pepper (in a joking fashion): “Robots are pretty terrible they always go wrong”, Tony defends the robot by interjecting:

“Don’t say that in front of her”.

Although not specifically empathetic, the issue of Pepper’s gender was raised directly, Jennifer asks: “How do we know which gender it is?”. One child states to the moderator:

Mark: “She doesn’t like you”

The moderator responds: “Do you think it is a he or a she?”

Mark: “It could be any”

Moderator: “I agree with you”

Mark: “You just cannot tell coz it’s a robot… but it has the body of a lady”

Throughout the focus groups, different children refer to the robot in a variety of pronouns, using “she”, “he”, “it” or “the robot”. In this instance, there was no correlation between the gender of the child and the ascribed gender of the robot.

The next category concerned ‘understanding Pepper’ and related to quite specific, often technical questions about how the robot worked, for example Stuart asked: “Why are their [eyes] blue?” and “What’s that noise?”, while Tony asked: “Is Pepper connected to the internet”. There were not many of these comments (*n*=10, 5%), as the moderators had already described and demonstrated much of the behaviours, capabilities and characteristics of the robot to the children. There were no (*n*=0, 0%) behaviours evident from the ‘perseverative category’ whereby children might express repetitive or echolaic comments. There were very few ‘inappropriate’ comments (*n*=4, 2%), where children made comments out of context or irrelevant to the general topic of discussion. This could be indicative of the robot (or the discussion of the robot) keeping the children’s attention sufficiently and thereby the children kept focus. Throughout both focus groups, the children’s body language and gaze in relation to the robot further provides evidence that the children found the robot engaging. The ‘not applicable’ category (*n*=3, 2%) related to comments that neither reviewer could categorise elsewhere, for example Tony began to say, “I’d say that…I’d say definitely…” but did not finish their sentence.

3.1.1.2 *Code 2: Attitudes towards pepper*

This coding analysed the autistic children’s positive, negative or neutral perceptions of the robot. The children made a number of comments with respect to Pepper (*n*=128, 61%) and the majority of those were positive. Figure 7 highlights the percentage of neutral, positive and negative coded comments related to Pepper.

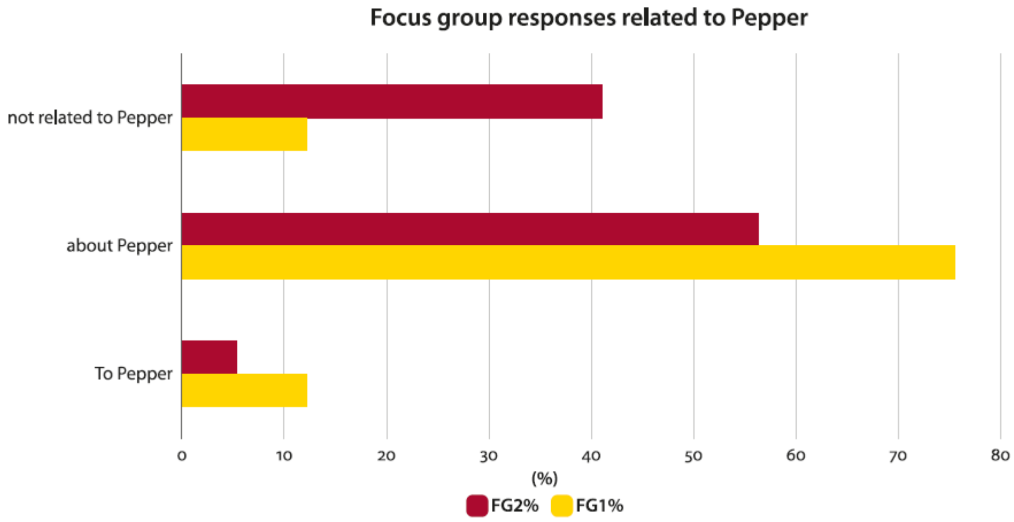

Figure 7. Data relating to the percentage of comments coded as neutral, positive or negative in relation to Pepper.

Examples of positive interactions included:

Pasha: “Pepper’s perfect”

Mateo: “I’d say I am like excited with it”

Mark: “I kind of like him”

Tony: “Robots are cool and very, very helpful for learning”

Tony mimics robots arms and says: “Those are cool arms”

Stuart: “I think it’s… brilliant”

Some of the children’s comments (*n*=71, 34%) were neutral and mostly inquisitive or curious comments to find out more about Pepper, for example:

Tony “Are they cameras?” (he points to Pepper’s eyes)

Stuart: “Why are they blue?” (in response to Pepper’s eyes turning blue)

Mark: “Why has it an ipad on its chest?” (describing the tablet attached to Pepper’s chest panel)

Matt: “It’s got like a camera” (pointing to Peppers eyes)

A small percentage of comments were negative towards Pepper (*n*=12, 6%) with children expressions statements such as:

Mark: “It was so weird”

Mark: “He’s boring” (referring to Pepper)

Mateo: “I’d definitely say it’s a bit strange… really quite strange”

Pasha: “It’s like ‘it’ can see into your soul… probably”

It is also worth noting that a very small number of children in the school (*n*=2, 1%) held such negative attitudes towards robots that they would not come to meet the robot and did not participate in the focus groups. One of those children held unfavourable attitudes towards all technologies for fear of the technology not working and the other child did not like the idea of social robots but did not specify more precisely the nature of their concern.

The feedback from the children’s focus groups evidenced a broad consensus of positive attitudes towards the social robot by the autistic children. This was helpful in that it gave the research team confidence that this specific social robot would be appropriate for the research project. The school and research team were mindful to ensure that the robot’s presence in the school would not negatively impact on the wellbeing of any children. The school in collaboration with the research team devised appropriate plans and strategies to ensure the presence of the robots would not further impact those pupils (for example by ensuring the children could access all of the relevant spaces in the school without having to pass this robot). Despite the very small number of children with an extreme dislike of robots and digital technologies, it is very important that their views are valued and respected in the future deployment of social robots.

3.1.1.3 *Code 3: Speaking to Pepper*

This set of coding was aimed at understanding how the children were speaking to Pepper. The narrative was coded according to whether the comment was: directed *to* Pepper (about anything); a comment *about* Pepper to a human; or *not* related to Pepper.

Across both focus groups, a minority (*n*=22, 10%) of comments were directly made to Pepper. The children also waved directly at Pepper and greeted it with “Hello” or “Hi Pepper” and also to say “Thank you Pepper” at the end of the session. Children also spoke directly to Pepper either as an attempt to interact or prompt Pepper to carry out a behaviour or in response to Pepper’s behaviour, e.g. Tony: “Stop robot!”. For example, when Pepper went to ‘sleep’ (i.e. was rebooting) Mark said: “Wake up mister”. He went on to say: “Pepper… let’s dance”, after Pepper had finished dancing in an attempt to get Pepper to dance again. Tony asked Pepper to: “Move your hand!” and Stuart asks: “Let’s take a selfie, Pepper!”. In one instance, one child speaks to Pepper about another child in the room. Mark points and tells Pepper: “That’s Jess over there”. Tony then asks Pepper “Are you friends with Siri?”.

Most comments (*n*=152, 72%) were *about* Pepper, sometimes showing empathy towards Pepper as an emotional agent. For example, Mark says: “Oh dear … poor Pepper” and Mateo states: “It’s definitely tired”; Pasha adds: “It could help with people’s feelings” and Stuart says: “He is really tired”. Mark says: “She is very confused” and Tony says: “Don’t say that in front of her”. Other comments were descriptive of the robot. Mark says: “It has the body of a lady”; Mateo: “It’s got like a red dot", Pasha: "I find it funny how she can make animal noises"; Tony: "It kinda feels like something in Wall-E… or Evie" and Stuart: "It's like having a person in a costume here". Whilst some were questions to better understand the robot or how it works, for example, Tony asks: "Is Pepper connected to the internet" and Mark also asks, "Why has it an ipad on its chest?". Finally, Jennifer asks "How do we know which gender it is?". A recurrent theme was the issue of Pepper staring at the pupils; many pupils made comments on this subject. Pasha states: "It's funny how she is looking at me" and Mark say's: "And it's looking right at you" (to another child). Jennifer states: "It's staring right at you" andMateo: "Pepper is looking at me". For some of the children the gaze of Pepper might be somewhat problematic as they did not appear to enjoy the prolonged gaze; however, many other children seemed to enjoy the attention and deliberately stood in front of where Pepper was looking in order to be gazed upon. Mateo suggested that: "It could be like a teaching assistant". Tony agreed and went on to explain that: "The only reason I am saying this about a robot being a good teaching assistant is because they are good with people". Towards the end of the focus groups when the children were asked to move over to the table for the mindmap exercise, Mark asked: "Maybe Pepper could come over with us?" to propose that the robot could join in with this activity. In response to one of the moderators asking whether it could cheer them up, Tony stated: "Yes, especially if the robot knows any good jokes". Lastly, some comments (n=37, i.e. 18%) were not about Pepper, often the conversation drifted off topic or children made comments seemingly out of context, for example, Mark says: "All we need now is an electric car".

3.1.1.4 *Code 4: Locations for Pepper in school*

The final coding was to ascertain where in the school the children might foresee a role for Pepper. Many previous studies have deployed social robots in the classroom to assist in specific teaching activities; the researchers were keen for this project to not repeat this and instead to explore the use of the robot in spaces elsewhere as part of the broader school 'ecosystem'. However, if the children had stated a keen interest in the deployment in the classroom, the research direction would have responded accordingly to meet the aspirations of the children. The most popular places were the corridors, playground and cafeteria; with pupils also proposing the deployment in the reception area, assembly hall, quiet room, group room and classroom (see Figure 8).

The most popular locations are notably the most accessible and public spaces within the school. For technical reasons, the playground was discounted as the robot cannot operate outdoors; and for pragmatic reasons, the cafeteria was discounted due to issues related to temporary Covid-19 restrictions in this space. Classroom locations were also limited as the researchers and school felt there would be greater chance for all pupils to engage with Pepper outside of the classrooms (it would be fairer to all pupils to have equal access to Pepper). The decision to place the robot in the corridor follows the original aspiration of the research team, backed up by the proposals of the children and the democratic logic as expressed by Jude to use: “A space where everyone in the school could see the robot”.

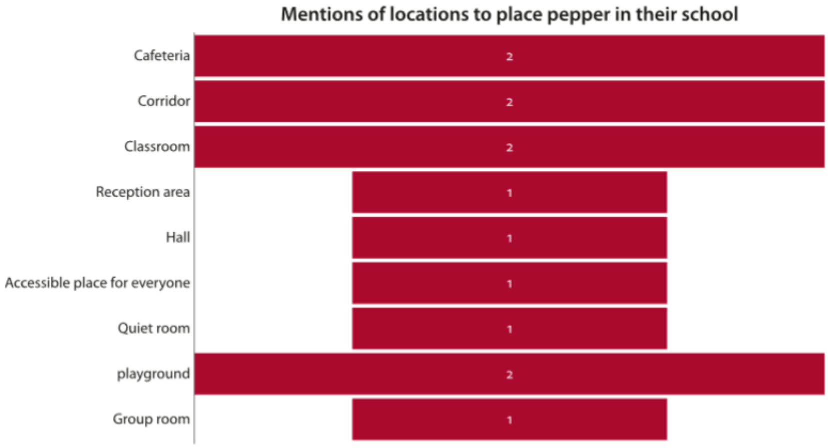

Figure 8. Possible locations for Pepper, based on comments from the children.

3.1.1.5 Emotional wellbeing of children

Discussions in the focus group also centred on how children regulated or controlled their emotional wellbeing. The aim was to establish whether the robot might be able to support the children when they seek these regulatory behaviours. When children became overwhelmed or had negative emotions, they stated the types of activities, behaviours or tools that they exploited to support themselves and their emotional wellbeing. In response to the moderator asking what the children do when they are cross, the children responded: Albert: “To calm I go onto an exercise ball… And bounce on it…” and “I watch a tiger documentary by David Attenborough”. Other activities mentioned by the children during the focus group also included spending time with a teaching assistant, having personal space – typically in a quiet room (aka group room), calming music, quiet reading, playing with the pet animals in the garden and looking at the ambient lights in the quiet rooms.

3.2 Part 2: Mind maps and speech bubbles

The children wrote ideas and comments into the speech bubbles provided during the focus group. These were used to help the children imagine what they might say to Pepper. These included comments such as “What dances can you do [Pepper]?”, “Can you dress up […] can you play hide and seek?”, “Do you like playing games?”, “Can you read me a book?”. As a result of this part of the focus group, we were better informed, overall, of how the children felt about Pepper and the way’s they imagined sharing their school with a robot. After the session ended, three of the researchers organised the children’s comments into themes and created a mindmap/diagram of the event as highlighted in Figure 9. The diagram organised the ideas expressed by the children into the following different themes: calm, touch, place (school specific/building) and stories. Post-focus group the researchers put all the comments into themes/categories that included: school specific (place), learning, games, feelings, sounds/music, physical, movement and random. The aim of this thematic organisation was to assist the researchers with the next phase of the project, namely to programme the robot with behaviours and enable interactions as desired by the pupils. The category 'calm' was associated with: music, ambient sounds, dance; touch was associated with cuddles, hands and head; and place listed the hall, group room, medical room, corridors with linked question marks over playground and classroom. As a direct result of our analysis and time spent reflecting on the data, we created a formal structure of how, at that point (after the children's focus groups only), the robot might operate/function. This is articulated in Figure 10 and highlights the flow and logic behind the researchers' initial ways Pepper could be programmed to express the children's preferences.

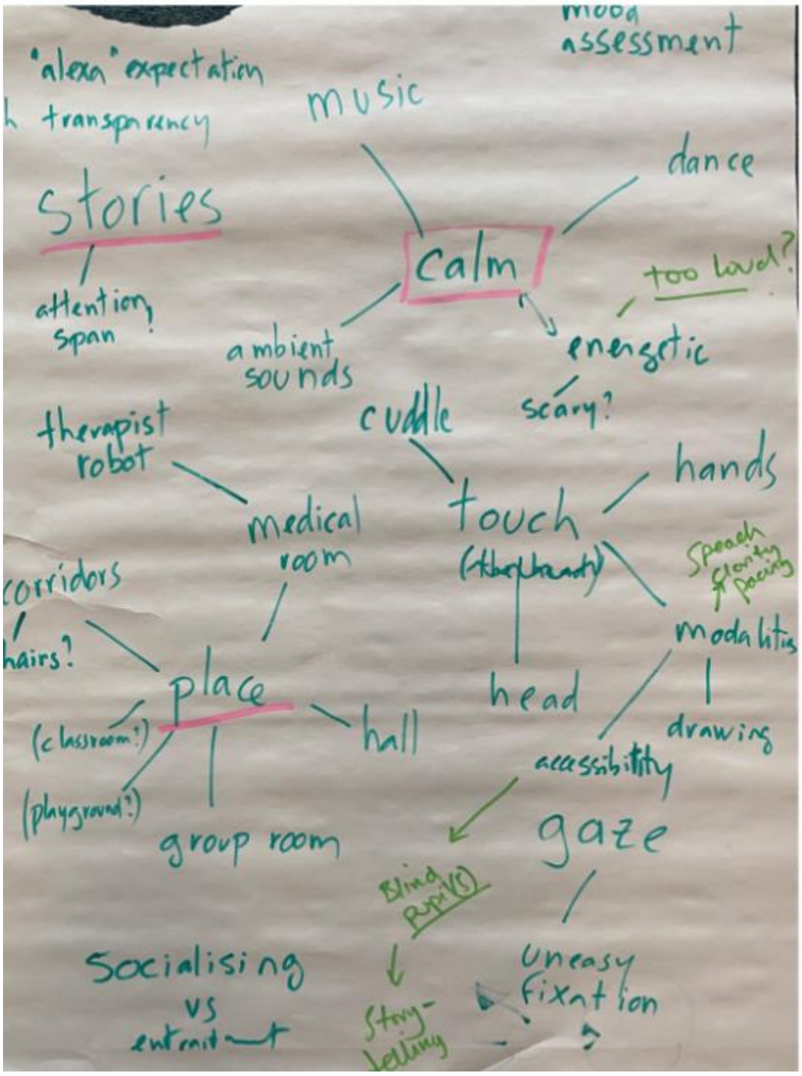

Figure 9. Researchers' initial theming of focus group data

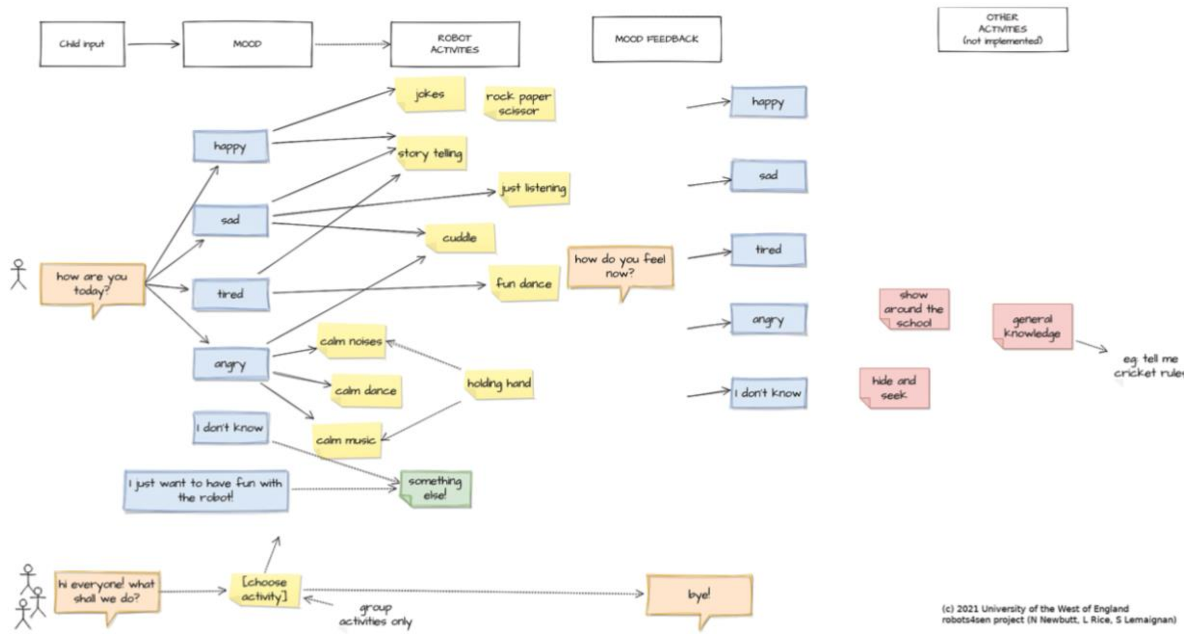

Figure 10. Researchers' initial map of child-robot interactions and functions

3.3 Focus group (teachers)

3.3.1 Part 1: Transcriptions of quantitative data

The child's focus group captured how the emotional wellbeing of pupils was an important issue with respect to the functioning of the robot. On this basis, an initial introductory screen was developed based on emotions (and emoticons) including: 'happy, sad, angry, afraid, don't know'. The teachers thought that this would not work well with their autistic pupils who they felt might struggle to elucidate their feelings (or at least struggle to assign them into these categories) and would instead opt for the 'don't know' button. The teachers all agreed this would be problematic with one teacher clarifying their view: "They [pupils] find it very hard to express how they are feeling – some of them, so they might look at it and just think 'well – I don't know … I don't know what angry is or I don't know". The teachers instead proposed the use of 'zones of regulation': "We use the 'zones of regulation' like the different colours for the different feelings, – so like if you had something like that, they might use that, maybe….". The same teacher goes on to explain the merits of zones of regulation "It's just basically about emotions but it's linked to different colours' so happy is linked to green and feeling calm, and blue is tired.…". The teachers went on to explain that this system is already widely used within the school with children identifying their emotional state each morning and later on each day: "In my class they use it a lot. So they will be able to say like 'I have gone into the red zone" and you will be like 'how are you gonna go back"'?… and they can talk about it and they have different strategies". The zones of regulation system is straightforward to use, with teachers asking pupils to identify the colour zone (and hence emotional state) they are in. Once this is ascertained, for each child there are specific and bespoke programmes of activities for each zone. One teacher explains: “Well so for a child in my class, pushing a chair trolley helps to regulate him; but for someone else it might be like playing football…”. Figure 11 illustrates the system used in the school to support the emotional regulation of each pupil (each pupil has one).

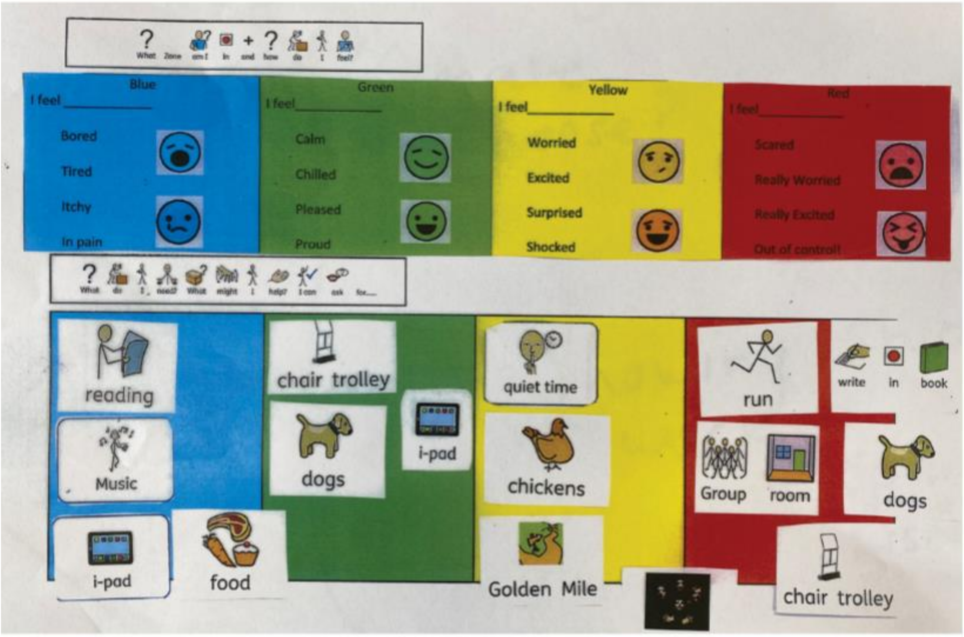

Figure 11. Emotional regulation sheets used to support pupils in the school

One teacher suggested we use emoticons and colour system for the robot’s introductory screen: “We use characters as well – I was just wondering whether you could have those on the screen”. The researchers considered this the most appropriate strategy was to adopt the zones of regulation system as the introductory screen for Pepper and that after interacting with the robot the children would return to the same screen to identify whether they were in the same zone or whether it had changed. It also meant that any data could also be cross-checked against the records the school kept (from the logging of zones of regulation entries) for the emotional well-being of their pupils. Figure 12 highlights the final screen presented to the pupils as they approach Pepper.

The teachers had advised the researchers that each pupil has a personalised set of activities (called ‘behaviour plans’) related to the zones of regulation. During the focus group the teachers realised that the use of the robot by pupils should also be added into the list of potential activities, as the following conversation exchange relays:

Teacher 1: “We will have to add it into our behaviour plan”

Teacher 2: “We actually would”

Teacher 1: “Put it on there”

Teacher 3: “Go and spend some time with Pepper”

Indeed, earlier that same day when the robot was brought into the school staff room to allow the staff time to meet and become familiar with Pepper, one of the staff had already brought a child to see Pepper as part of an informal ‘reward’ for that child. This suggested that time spent with Pepper could be brought into the everyday activities of the school programme easily and as a welcome additional tool for staff.

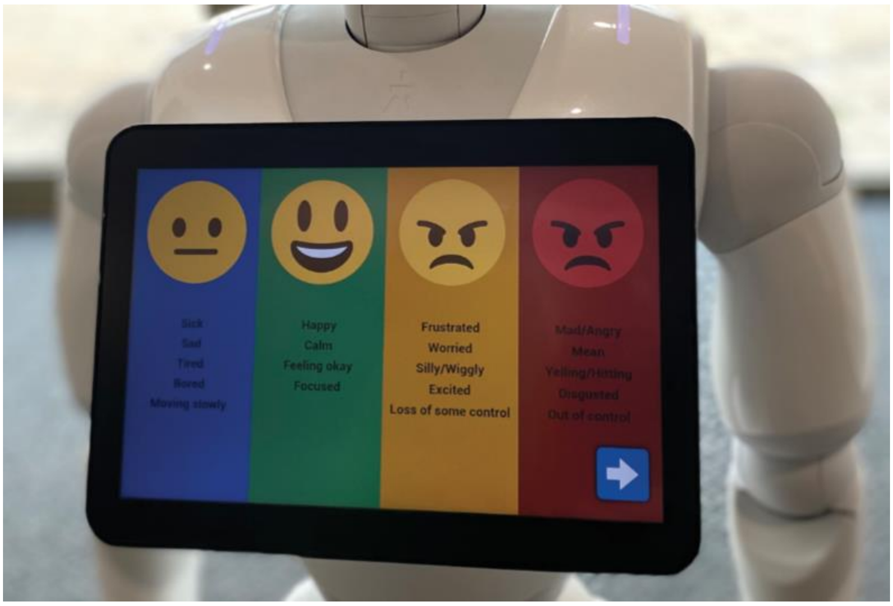

Figure 12. Final interface used on Pepper

Based on previous studies, one of the concerns for the deployment of a robot in a social setting for an extended period is that after the initial excitement by users, the users soon lose interest and stop using the device. When the moderators asked if this was likely in this project, the teachers did not think so. One teacher stated: “I don’t think the novelty value will wear off because like with our dogs – we have got some dogs and chickens… you know the kids love them.. and if a dog was gonna wear off it would, or a chicken..”. The comparison of Pepper akin to a pet or animal is interesting not least in that it suggests that a robot, like the school pets, will be very popular for some, but not all, pupils. The pets provide high levels of benefit for some pupils within the school, whilst some pupils have no interest whatsoever with the animals. The aspiration for the research is that, over time, the social robot provides continued benefit for a sub-population of pupils within the school: “I think it’s like anything – it’s not gonna suit every child”, another teacher suggested.

Lastly, the teachers also advised the researchers of their concerns over the safety of the robot. Initially, the researchers misunderstood and thought the concern was that the robot would injure or harm the children. However, the teachers concern was the other way around and that the robot might be at risk of harm from the pupils, as this exchange highlights:

Teacher: “I would worry for its (Pepper’s] safety sometimes”

Moderator: “Might they come and push it?… do you see any health and safety issues”

Teacher: “Yes – mainly for the robot!” [all teacher’s laugh at this statement]. More specifically, the teacher went on to explain their concerns: “Picking it up and throwing is more what I was thinking of ”. The teachers explained that many of the children could become physically violent when in a rage and that they sometimes damage property or objects within the school. In these instances, the teacher’s concern was that the robot might be picked up and thrown or knocked over. In this particular research project, a human researcher will be present with the robot at all times with the robot, which would minimise the risk of this occurrence. However, it is an important factor for consideration for future deployment of social robots in contexts such as these.

3.3.2 Part 2: Mind maps

As part of the teacher’s focus group, they captured their thoughts via mindmaps. These revealed, and confirmed, what they said in the focus groups. However, they also expanded on several ideas. For example, one group of teachers thought Pepper could be good for sports and used in the hall. This same group commented that Pepper could be useful for reading to pupils and even an exam reader, good for showing students work (speaking and listening) and regulating emotions and feelings (like a quiet room). Another group suggested Pepper might be good as a toilet monitor, to support a distressed pupil 1 on 1, might provide a “wow” factor in classes, playing games outside, to read the class a book and to support teachers. The final group articulated that Pepper might support pupils who struggle to communicate with adults, provide positive praise, support spelling, movement breaks, identify and support emotions (regulate), use as a reward (reward time) and modelling work.

This session and data therein, helped to provide a complete picture (along with the children’s data) as to how an interface might look along with the function. Taken together the feedback from the teachers helped to inform the final design, look and presentation of the robot’s interface (the screen attached to Pepper; see Figure 11). Behind this interface lay the functionality as suggested by the children. We therefore suggest that the data collected from the children and their teachers provided a complete and full dataset to enable design and application in meaningful ways.

4. Discussion

The aim of this research was to identify the potential role(s) of a social robot in a school ecosystem for autistic children. There is a paucity of research that includes autistic pupils in the design, co-design and evaluation in-situ of social robots. This research contributes to this gap in knowledge by identifying appropriate behaviours and potential roles for the social robot Pepper. The findings indicate that it is feasible, necessary and desirable to include autistic pupils' voices in the co-design of a technology of this kind. Although there can be challenges of working in a school setting (complexities of timings, busyness, incidents happening, staff being required at short notice) and with children (ensuring appropriate ethical frameworks are appropriately applied) there is real benefit of working with the end users in order to better understand their needs and requirements. Co-design should improve uptake of the technology and increase the relevance for the stake-holders.

In response to Galvez Trigo et al.'s (2019) barriers to uptake of robots in special needs schools, this research might also add 'relevance of the robot to the user' as an additional barrier. The use of a co-design methodology enables the end-users to identify the behaviours and activities of the social robot that are relevant to them. Without including the autistic children's voices in the research process, the role of the robot might not have been designed to be appropriately or effectively deployed within the school setting. Future deployment of social robots risks being of little value to users unless robot behaviours and activities are designed to be relevant to stakeholders.

Following the pupil's suggestion, the robot was to be located in the corridor space of the school. School corridors are rarely used for pedagogic activities; it is almost unheard of for teaching staff to be deployed in a corridor for this purpose. Some of the children spent considerable time in the corridor engaging with the robots, talking, dancing, wrestling and playing with the robot. For some students, opportunities for non-verbal tactile play was important; for example, some liked to stroke the robot's head as a calming activity, whereas other children preferred to get the robot to stroke their own head. The embodied nature of the robot enabled this physicality of interaction with the technology. As the explicit intention of the researchers is not to replace humans with robots; the presence of a robot in the corridor space provided an opportunity to understand potentially new or additional roles for a social robot in the school ecosystem. The locating of a social robot in an architectural space within the school. not frequently occupied by teaching staff, raises interesting issues for future research into the innovative or unique roles that social robots might play within wider school ecosystems. It also hints at wide-ranging implications for designers of schools for autistic people about the need to also consider social robots as potential stakeholders and/or end-users.

The data tends to suggest that the pupils and teachers reported benefits and potential of social robots in their school and how these could provide an appropriate mechanism for supporting the emotional wellbeing in the ecosystem of their school. It is worth noting that it is likely that social robots will only be of real value for a subset of the entire school population, and this pattern began to emerge when the robot was installed in the three-week study (these results are published elsewhere). There is evidence that the robot helped with children's regulation of behaviour. For example, staff at the school reported fewer behavioural incidents in the part of the school where the robot was located and the incidence levels increased after the robot was removed from the school.

Notwithstanding, there is potential for real benefit for those pupils who wish to engage with the robot. For some children there is also a unique potential to engage with a 'social' presence without the often-troublesome issues of dealing with human-to-human interactions. Pepper could potentially represent a 'friend' in the guise of the robot for pupils who struggle to make friends with their classroom peers. This holds benefits for several domains including social dimensions (Brady et al., 2020), while potentially enabling autistic children to have a friend who can work around their strengths and interact on an individual basis and terms they are comfortable with. The robot (or a robot like Pepper) could support social stories and interactive story-telling, which are both techniques used in the school we worked. In fact, two teachers wanted to utilise Pepper to help with Speech and Language Therapy they undertake at the school. The research also evidenced that there is value in the robot contributing to the wider ecosystem of the school rather than limited to classrooms. The majority of autistic children in the school were positive towards the integration of Pepper within their school, with a small minority showing little or no interest and a couple of pupils strongly opposed to this technology. The research also found that the inclusion of Pepper could be achieved whilst still enabling social interaction, conversation and exchange between and amongst the pupils. The robot creates new affordances and opportunities for social interactions and conversation for students outside of the classroom. For example, the assistant head teacher stated: *"Children who wouldn't normally socially interact with others are now choosing to interact with their peers."* This is helpful evidence to support the introduction of Pepper into a complex school setting where multiple pupils might use the robot simultaneously. There are a number of limitations to this study that should be acknowledged. The study contained a small sample of participants in one school based in the UK; the results might vary in different contexts which limits generalisability. Similarly, the school uses specific educational and pedagogic practices which again vary in other contexts and caution is required when attempting to apply elsewhere. There was a gender imbalance across the children's focus groups with 2 female pupils and 8 male pupils (reflecting the school's female to male ratio of 1:4 overall). This reflects the wider picture of gender imbalance in the autism population with approximately four times more males identified as autistic than female (Looms, Hull and Mandy, 2017). It would have been preferable to get more female voices represented in the research.

The study prioritised users who would be directly interacting with the robot and therefore a group that was not fully represented in the design process was autistic adults. Autistic adults have the benefit of having had the opportunity to reflect on their own childhood experiences and how new technology could have supported them while at school. We worked closely with one autistic adult, and arranged two online events arranged specifically for the wider autistic adult community as an opportunity to voice their opinions on the project. Where possible their feedback was incorporated into the robot's design, but this process was not as formalised as the focus groups with the pupils and staff. The robot itself has limitations on what it is able to do, which is typically less than pupils and users expect or desire. Furthermore, there were limits to what the programmers were able to achieve within the time constraints and available resources. This in turn limited what we could demonstrate to the pupils and teachers. Each child is unique and the school has individual teaching, behavioural and emotional plans in plan for each child; however whilst there is potential for robot technologies to recognize pupils and provide unique and bespoke activities for each child, there were insufficient resources to achieve this for the research project. Future research in this area could exploit the potential for bespoke robot behaviour appropriate for each child. For similar reasons, it was not possible to design the hardware of the robot. Being able to design a robot to the exact preferences of the users has a number of benefits. It minimises the possibility of negative responses, for example comments describing Pepper's eyes as creepy. The ability to design or augment a robot to have the physical capabilities to perform the behaviours desired by the users, for example allowing the robot the dexterity to perform sign language for deaf and hard of hearing students. And finally, having greater control of the robot's form would foster a greater sense of ownership for the users. However, the time and cost to create a robot with this degree of specificity would be far beyond the scope of this project. That said, the response to the Pepper robot was generally positive and the majority of functionalities proposed by pupils and staff could be accommodated.

4.1 Implications

This study is the first to fully involve autistic children and their teachers, in helping to capture autistic views of how a social robot (in this case Pepper) may be used in a school. As such, we suggest that the data presented here reveals key implications for future work in the area. This includes:

1. Greater focus placed on listening to autistic children to better enable designers and programmers to tailor social robots for them.

2. Including teachers (professionals) proved vital to ensure the pupils' views aligned with the in-school systems and pedagogical/behavioral plans in place.

3. Utilising a social robot in schools for autistic children should be focused on well-being and emotional regulation.

4. Ensuring that what young people tell us about social robots is carefully considered, built-in from the outset, and influences the design work completely.

5. Thinking beyond "how a robot can support autistic people", and involving autistic people more meaningfully in the design should become standard practice moving ahead; and in this so should the location-base of social robots in schools. Moving beyond the classroom, where robots are often used

to "fix deficits" (i.e. eye gaze, social skills), and considering social robots part of the broader school eco-system (in our case the corridors), will help to provide greater insight to the way these tools can be more effectively, and sustainably, deployed.

4.2 Conclusion

We have sought the voices of autistic children and their teachers to inform the design of a social robot installed in their school for a three-week study. The input of pupils and staff was elicited at all stages of developing the robot's interface and behaviour. As a result, we were able to build an interface (see Figure 11) that was informed and designed to fit their needs. By doing so, we found that a social robot in the school should be focused around supporting their well-being and emotional regulation. This was connected to the teachers' use of emotional regulation sheets in classes. As a result of our findings and co-designing a social robot with autistic pupils, we revealed key insights to what and where a social robot can be useful in their school.

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