On the Role of Trust in Child-Robot Interaction*

Paulina Zguda[1], Anna Kołota[1], Mateusz Jarosz[2], Filip Sondej[2], Takamune Izui[3], Maria Dziok[2], Anna Belowska[2], Wojciech Jędras[2], Gentiane Venture[3], Bartłomiej Śnieżynski[2], Bipin Indurkhya[1,2]

***Abstract*—In child-robot interaction, the element of trust towards the robot is critical. This is particularly important the first time the child meets the robot, as the trust gained during this interaction can play a decisive role in future interactions. We present an in-the-wild study where Polish kindergartners interacted with a Pepper robot. The videos of this study were analyzed for the issues of trust, anthropomorphization, and reaction to malfunction, with the assumption that the last two factors influence the children's trust towards Pepper. Our results reveal children's interest in the robot performing tasks specific for humans, highlight the importance of the conversation scenario and the need for an extended library of answers provided by the robot about its abilities or origin and show how children tend to provoke the robot.**

I. INTRODUCTION

Social robots are proliferating our society at a rapid rate and are being deployed in various domains such as education, healthcare and care for the elderly. To design social robots that interact with people naturally and foster a feeling of trust, in-the-wild studies are a source of valuable insights.

The study presented here was aimed to examine how young children react to a social robot in their first encounter. In the past, such studies have been conducted in Turkey [1] and in Japan [2], and in this research we used a similar in-the-wild methodology to study child-robot interaction with Polish children in the age group 4-6 years: children engaging with a robot in familiar activities were studied under Polish conditions. We should care about the appropriate level of children's understanding of robotic technologies due to safety issues. The level of anthropomorphization incurs some risks, but also creates some opportunities.

- Too high a level of anthropomorphization might result in over-expectations from the robot. This could lead to a lack of critical thinking towards the robot and can contain dangerous connection with possible robot malfunctions (e.g. children have no idea how to react when the robot gets broken).
- Too low a level of anthropomorphization can result in ineffective and non-engaging interactions.

Pretend play and anthropomorphization seem relevant to the ability of children to engage with robots and treat them as life-like agents. However, we, as researchers and interaction designers, should maintain the level of anthropomorphization and trust appropriately.

*This research was supported in part by the National Centre for Research and Development (NCBR) under Grant No. POLTUR2/5/2018.

[1]Jagiellonian University, Kraków, Poland (e-mail:bipin@agh.edu.pl).
[2]AGH University of Science and Technology, Kraków, Poland.
[3]Tokyo University of Agriculture and Technology, Tokyo, Japan.

II. RELATED WORKS

A. Trust

Trust – described by [3] as "the behaviour, statements (verbal or written), or promises of others can be relied upon" – is an important aspect of HRI, especially for child-robot interaction, though it remains controversial. While some researchers [4] found that children are prone to trust humanoid robots as they would trust an adult, other researchers take issues with this [5], emphasizing the impact of other factors like anthropomorphization, the relevance of robot's request to participants and whether it is faulty. In this study, one of our goals was to investigate the influence of trust during the first encounter with robots – we assumed the children will trust the robot and will engage with it naturally.

B. Reaction to the robot's malfunction

One aspect we chose to focus on was the impact of a scheduled malfunction activity. This has been studied in the past [5][6], but we were interested in intercultural differences that may arise in this situation. Do Polish children, most of whom have no prior experience with arobot, react like their peers from other countries? We would like to study children's reactions to a malfunctioning robot and to see how much they treat the robot's "fault" as something natural and appropriate to the machines.

C. Anthropomorphization and de-anthropomorphization

To fully understand the process of building trust in children towards robots, we need to investigate how the feeling of trust is influenced by the children's perception of a robot. Pursuing the anthropomorphization effect can give us an interesting insight. Anthropomorphization is defined as "the tendency to attribute human characteristics to inanimate objects, animals and others with a view to helping us rationalize a situation" [10]. To describe the opposite attitude, we coined the term de-anthropomorphization, which refers to the children's behaviour that shows that they are treating the robot as an object and not as a human-like creature. As mentioned in recent studies, "in the design of socially interactive robots, anthropomorphism plays an important role and is reflected in the robot's form (appearance), behaviour (e.g. motion), and interaction (e.g. modality)" [11][12]. Our study was designed to find out if children in the preschool age anthropomorphize the robot during their first interaction, which would be noticeable by the way they name it or interact with it.

III. IN-THE-WILD PARADIGM AND ACTIVITIES CHOSEN FOR THE INTERACTION

We chose to follow in-the-wild paradigm because it allows us to study child-robot interaction in a natural setting. This poses some challenges. For instance, the researchers must take care of the safety and well-being of the participants and the robot through the whole procedure. That is challenging due to the specific, dynamic behaviour of children - they are eager to touch the robot and run around the room. Sometimes it might also be difficult to arrange suitable space and choose activities that are engaging to the children.

Based on our previous experience [1][2], we chose activities familiar to the children for our child-robot interaction event [7]. We also introduced a variety of activities so that the children do not get bored [22]. To address the safety issues and avoid cases of aggression towards the robot [8], we had teachers and researchers moderate the interaction. Considering all these factors, we chose dancing, drawing, reading and free-form question-answering as the activities to be incorporated in our child-robot interaction event.

IV. METHODOLOGY

A. Participants

We conducted interactive sessions with the humanoid robot Pepper in five groups, with 15-23 children (aged 4-6) in each group. Each interactive session lasted about 25-30 minutes. Participants were recruited via leaflets and information provided by the teachers from a kindergarten in Kraków, Poland. While registering for the event, parents consented that their child will join a scientific experiment, will be recorded, and they agreed to share the data anonymously. Table I presents a summary of the information about all the groups.

TABLE I. CHARACTERISTICS OF THE GROUPS

Group	*Size of the group*	*Gender (F/M)*	*Age of participants*
1	20	8/12	5-6
2	20	10/10	5-6
3	22	11/11	5-6
4	20	8/12	5-6
5	23	11/12	5-6

Each group was roughly balanced between boys and girls. The experiment was conducted in the presence of the kindergarten teachers and a group of researchers. The teachers helped with initiating the introduction, facilitating the dance interaction, helping with the choreography, calming down the children when they got too excited and comforting them if needed. The researchers mostly stayed in the background; except two researchers who assisted during some interaction tasks (in collecting the drawings from children, asking them to step back from the robot and so on). Besides these, the adults did not interfere with the interaction.

Fig.1 presents the room layout where the study was conducted. Each session was recorded with two cameras from the back of the children so that their faces were generally not visible (for reasons of privacy).

B. Robot Pepper

Pepper is a user-friendly, humanoid robot. Its height (120 cm) is comparable to the participants. It has large eyes, and its 20 degrees of freedom to allow free natural movements. Robot movements, including the dance routine, were implemented in the Choreographe program [23].

C. Study design and procedure

The interaction scenario consisted of six phases with the children engaging with the robot in different activities.

The first phase was entering the room and greetings. The children (who saw Pepper for the first time) took their places on the carpet in front of it and briefly greeted it.

The second phase was dancing and singing. With prior consultation with the teachers, the dance for the song *Heads, shoulders, knees and toes* was chosen for this activity.

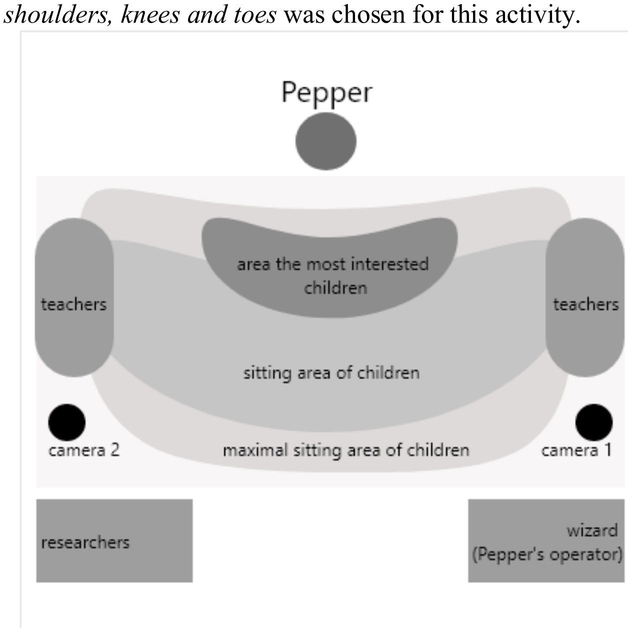

Figure 1. The layout of the experiment room

All the children were familiar with this song and dance.

The third phase was reading, where Pepper read a Polish children's poem to the children.

The fourth phase was drawing. Children were asked to draw something that was in the room. We wanted to see how many children would choose to draw the robot rather than some other object in the room. After finishing their drawing, the children were asked to show the drawings to the robot. They received positive voice feedback from it.

The fifth phase was "robot malfunction" activity. Pepper was programmed to produce strange noises and assume a contorted pose to look like a broken machine. After holding this pose for about one minute, Pepper straightened up and said that everything is fine.

In the sixth and the last phase, children could ask questions to Pepper on any topic. The answers were typed in real-time by one of the researchers (*Wizard* in Fig. 1), using the Wizard-of-Oz paradigm, and were voiced by Pepper.

All interactions with Pepper were conducted in the Polish language, except the dance song, which was in English. Here, we will focus on the analysis of data from the malfunction and the Q&A phases.

D. Procedure of the malfunction phase

After the drawing phase, while the children took their places on the carpet in front of the robot, the malfunction activity was conducted. Pepper, which was standing idle during the drawing activity, suddenly started to produce strange sounds and twisted its body and arms in an unnatural contortion (Fig. 2). This pose lasted for about a minute, after which the robot straightened up, said that everything was ok, and carried on as if nothing had happened.

The purpose of this malfunction phase was to see how Polish children react to an unexpected situation. Also, children's reaction to this behaviour might prompt them to think that a robot is not a real, living thing, thereby influencing their questions in the Q&A phase.

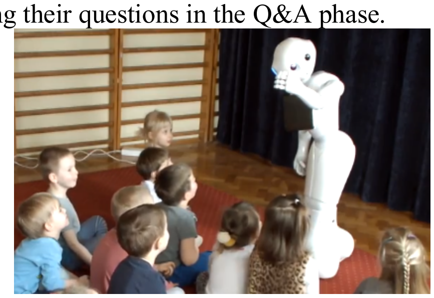

Figure 2. Malfunction: Pepper assumes a contorted, unnatural position

E. The procedure of the Q&A activity

The Q&A phase was conducted using the Wizard of Oz approach, supported by text-to-speech conversion. The children believed they talked with Pepper, but in reality, Pepper was operated by a researcher sitting behind them. (In contrast, the behaviours of Pepper in other phases were pre-programmed, which might have influenced the children's perception of Pepper.) The answers to the questions were typed by one of the researchers and were voiced by Pepper. All the conversations were in Polish.

Pepper encouraged the children to ask questions. When many questions were asked simultaneously, the teachers or one of the researchers moderated the discussion.

F. Measurement and data collection

Three types of data were collected during the sessions: videos (shot from two cameras capturing the event from different angles), drawings, and post-event interviews with the parents. Parents were not present during the workshop with Pepper, however, they received feedback from the children at home regarding their impressions after the meeting.

V. Analysis

There are several known methods of analyzing HRI [20][21]. In our study, data analysis was performed by Dedoose software based on the video transcriptions covering the Q&A phase. The transcripts were coded in an open coding approach by two researchers and a comparison of coding trees was carried out. The main categories of behaviours that emerged during the analysis were: *provocation* (attempts at grabbing attention), *anthropomorphization* (behaviours where children treat the robot as a human creature), *the distance between the robot and the children* and *children's reactions to the malfunction activity*.

A. Provocation as a sign of trust

An analysis of provocation (behaviours demanding an answer or action) lets us understand children's concept of robots set of behaviours. In the videos, provoking was a sign of direct, voluntary perceptions and assumptions about the robot. It shows what the robot should do or say at that time due to the children's mental model of its behaviour.

Observations of children reveal that they come closer to the robot when they do not get a response immediately, especially the first row; children in the rear stand up to see the robot, they lean towards the robot.

Provocation also signals the level of trust in the child-robot relationship. For example, children challenged Pepper about its physical abilities (like performing very specific fist movement or asking it to dance breakdance and teasing it about it: "For sure you cannot do it!"). Moreover, they asked if the robot knows what cinema is; if it said yes, they dug deeper by asking it to describe it. The level of trust can be affected by the relevance of the robot's answers (irrelevant answers lead to laughter), the pace of answering questions and the number of questions answered (some are skipped).

Children asked Pepper repetitive questions when it did not respond or responded in a way they did not accept (the answer was not relevant, was delayed, or was not specific enough). They demanded to repeat the answer, using pretentious voice ("Do you have a female friend? Or at least a male friend?!") and expressive body language (like spreading and shaking hands while repeating insufficient, unsatisfying answer of the robot).

Other actions at grabbing the robot's attention were:

- Waving hands in front of the robot. This may have been related to the robot's empty gaze directed above children during the whole Q&A session.
- Repeating or reformulating a question to get the robot to answer. This suggests that children think the robot does not understand the phrase.

B. Anthropomorphization

Table II shows categories of questions asked by children that describe their anthropomorphic or de-anthropomorphic character.

Some children raised their hands to get Pepper's attention. This may be a sign of treating it as if it were a teacher, or that it could understand human behaviours regarding group interactions and hierarchy. Children accepted life-like explanations for robot's actions such as "I'm tired". Even though Pepper explained that its battery charge was low, children still asked it human-like questions. In some cases, they even tried to be helpful, asking where is the charger (so they could help to plug it in).

The reaction of shushing other children indicates that, in children's view, the same social rules as for human group interactions apply to the child-robot interaction. Children in the age group 4-7 are aware of certain social behavioural norms and include robot while performing them [14]. In Poland, if someone in a group is talking, the rest should remain silent to hear the person who is talking and show respect. It can be seen in the videos that once a child became aware that the robot was speaking (e.g. "I can handle it [weak battery]"), he or she shushed others and repeated the robot's answer to others while pointing at the robot (which shows the emotional development in childhood) [14].

Not only shushing but also helping the robot indicates that children treated it as a group-member – the whole group tried to help the robot when it said that its battery is weak. They also tried to explain its behaviour in human terms, e.g. by assuming that the robot has an immune system ("why do you have a tablet attached to you? so that you don't get ill?"). However, it can be argued that these assumptions arise from the fact that children do not fully understand the robot's mechanisms.

Children also sympathized with Pepper using soft expressions like "sooo little", when the robot said that it is 2 years old; "poor robot", when it said it has no wife. They assumed Pepper has parents and asked about them, which is another sign of searching for human-like attributes in the robot ("do you have parents?" "if he was born, probably yes").

Another anthropomorphizing behaviour towards the robot was the begging/praying gesture after asking for a favour ("please, display something"). It indicates that children think the robot sees them and understand their social gestures. They also raised hands to get the robot's attention and tried to touch it during the malfunction phase to see its reaction.

Treating the robot in a human-like way includes the expressions they used to address it: they used "sir", "you", "he" (for indirect approach).

It is important to mention that the teachers tended to anthropomorphize the robot as well, e.g. by telling the children to wait for its answer as it needs some time to think. This might be a factor affecting the children's attitude.

- *De-anthropomorphization*

Despite showing signs of humanizing the robot, the children also asked questions indicating that they saw the robot as a mechanistic creature. Some children did not ask about parental relationships of the robot but asked specifically about its creators (in Polish the distinction is apparent – "who created you?", "he wasn't born, he was created!"). They also made assumptions about the robot's life ("robots never have birthdays"), and asked questions that transcend human abilities or behaviours ("can you change into something?").

TABLE II. CHILDREN'S QUESTIONS TO THE ROBOT AND THEIR ANTHROPO/DE-ANTRHROPOMORPHIC CHARACTER

Group of children	**Anthropomorphization/de-anthropomorphization**									
	1		***2***		***3***		***4***		***5***	
	A	D	A	D	A	D	A	D	A	D
ORIGIN *Being born vs being made/created*			1	2	3	3	4	5		
BODY *Having human/robotic body feature*	2	1	6	1			4	**10**	3	3
AGENCY *Having self-agency/being controlled from outside*								3		
EXPERIENCES *Having human-like experiences/ non-human-like experiences*	8		3		7		1		1	1
ACTIONS *Having human-like actions/non-human-like actions*	6		**16**		4		4	5	8	3
RELATIONSHIPS *Having human relationship/lack of it*			7						1	

VI. OTHER SIGNIFICANT FACTORS

A. Distance between the robot and the children

We analyzed the distance between the children and the robot at the beginning and at the end of the Q&A phase, as well as at equally spaced time intervals ($\frac{1}{5}$, $\frac{2}{5}$, etc.) during this phase. The beginning of the Q&A phase was considered to be the moment Pepper asked: "do you have any questions?" or, in the case of one of the videos, the moment children said: "Robot? Robot?". The end of the interaction was taken to be when Pepper said goodbye.

We observed that the children came closer, roughly 1-2 meters, to the robot as the interaction proceeded (Fig. 3). However, some caveats must be added here: sometimes children were being gathered and were asked to sit down or were moved away from the robot by teachers/researchers who were afraid that the children might damage the robot.

The general tendency of children to lean towards the robot shows an increasing trust and interest, which suggests that robotic companions, at least in Polish kindergartens, could become a part of children's daily activity schedule. Others have also investigated a robot's potential as a teacher or as an instructor, e.g. teaching children through play [13].

B. Malfunction

An interesting insight comes from three of the five groups. In the first group, the children did not pay attention to the strange behaviour of the robot but repeated the sounds it was producing (i-o, i-o – repeating sounds at the beginning of the activity). In contrast, children in the fourth group kept asking questions during the malfunction activity. After the robot said, “It is all fine,” they asked: “What happened to you?”.

An initial conclusion we may draw is that the malfunction activity did not affect the children in our study significantly. They either did not pay attention to it or did not realize or did not care about the state of the robot. Moreover, it did not scare them. Only one group asked directly about the cause and the state of the robot after this activity.

Because of the tentative nature of these observations, the malfunction activity needs to be studied further with more carefully designed interaction scenarios.

Figure 3. Children gradually getting closer to the robot

C. *Points of interest on Pepper’s body*

An analysis of the Q&A transcripts reveals a special interest in children aroused by the robot’s appearance. Children asked about its human-like features (e.g. nose, hair, height), as well as about non-human features (e.g. wheels, engine, tablet). Fig. 4 shows all the points of interests on Pepper’s body mentioned by the children in the Q&A sessions. Studies show that children apply body awareness while interacting with a robot, which results in identifying the robot’s body features with human body features [9]. This issue of embodiment needs further investigation.

D. *Further analysis*

Other observations based on the collected data, behavioural analysis and group comparison reveal the following aspects of child-robot interaction behaviours:

Questions containing signs of anthropomorphization and questions about the robot’s functionality co-occur. This suggests that children combine functions and abilities to form the concept of a robotic being. They asked deeper questions about relationships and the exact mechanisms behind the functioning of the robot. Generally, children asked a lot about robot’s general knowledge, e.g. if it knows what cinema is. Children tended to provoke the robot by telling it what to do, saying “you look like you can’t move”. The question about walking ability appeared in every group.

Apart from all this, children made assumptions about the robot and tested them by asking questions, as shown below (it is important to note here that children referred to robot as “he” due of the Polish grammar): “This is metal”, “He is made from plastic”; “He has to be charged”; “He has wheels”; “He has to think”; “You do have parents, right?”, “Engineers are your parents”.

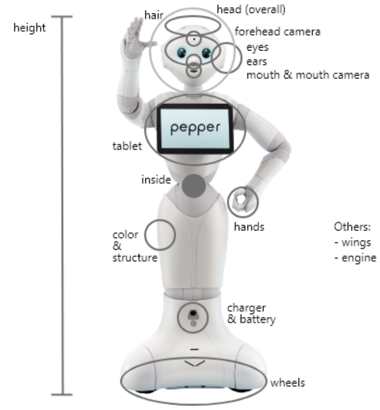

Figure 4. Children’s points of interest on Pepper’s body

VII. CONCLUSIONS AND FUTURE RESEARCH

Our goal is to study how 4-6-year old children anthropomorphize a humanoid robot and develop trust towards it. Recent studies show that certain layers of anthropomorphism are desirable for robots [15]. Our study suggests that one important factor in the children’s perception of robots as human-like agents is the robot actions: an ability to perform tasks specific for humans. On the other hand, the biggest influence on the robot’s de-anthropomorphization is its embodiment. This suggests that developing trust in children towards a robot must focus on a friendly, accessible design. Previous studies suggest the culture influences robot’s lifelikeness [15] which could also be further investigated in our study in the Polish environment.

Further, according to our results, functional design of the robot, which stimulates trust in children and encourages them to cooperate with it, includes not only an appropriate body design but also a carefully thought out conversation scenario. The robot should have a large library of answers for handling questions about its family and origin, as well as for more general questions. It is recommended to introduce the robot by showing off some of its actions, especially moving (walking using his wheels), counting, and using its other physical features like the tablet. An acknowledgement (feedback) that the robot heard a question would also be very helpful in smoothening the communication, as children tend to repeat the same question many times if they do not see any reaction. This may be due to similar findings of the expressiveness of robots [16]. Recent research shows that trust in robots qualitatively mirrors human trust in other humans and consists of at least two important facets: capability and intention [17] – children asking Pepper about its experiences seem to focus on its intention, whereas bodily features help them to imagine its capabilities. As children younger than four years have difficulty in inhibiting the normally reasonable expectation that what an adult says is true, it may also be useful in the future to study groups of four-year-olds separately to examine their understanding of robot’s intentions [18]. In our study groups, older children could take a more critical approach to the robot and lead the group in provoking behaviours.

An interesting insight arises from an analysis of the types of questions children asked the robot. An earlier study suggests children ask mostly affective qualities (e.g. reporting the robot liked them) rather than cognitive or behavioural ones [17]. Polish children seem to not mind about this aspect, as they tend to provoke the robot.

Based on our previous experience, we emphasize again the need to plan child-robot interaction around activities that are familiar to children, which is also confirmed by other studies [19]. Children are eager to interact with the robot even if they see it for the first time: interestingly, they engage in not only imitative (dancing, singing) activities but also take a proactive attitude (Q&A part). This shows that children want to influence the course of the interaction, and often work together to get the desired effect (like repeating a question that was previously asked by another child). We aim to find if other activities can have the same impact on children (like facilitation of interaction) and if we can generalize these observations for all children.

Children in all the groups wanted to continue interaction at the end of the session. Most children were willing to interact with the robot: they came up to it enthusiastically from the beginning, and they wanted to touch it and explore it physically. In our targeted age group, it seems that children are willing to interact independently, but teacher supervision is helpful, especially in a group setting for regulating and explaining the role of the robot.

We are conducting further studies to gain an understanding of children's mental model of a robot and their behaviour and attitude towards it. We plan to investigate more of children's inner thoughts about robots by using children-adjusted surveys. We also plan to program the robot to be more interactive and study interaction in smaller groups; even individual studies. We will design scenarios that allow children to interact with the robot more freely. These studies can also help in designing a toolkit for CRI analysis in the wild.

REFERENCES

[1] A. Guneysu, I. Karatas, O. Asık, B. Indurkhya. "Attitudes of children towards dancing robot Nao: a kindergarten observation," *International Conference on Social Robotics* (ICSR 2013): *Workshop on Taking Care of Each Other: Synchronisation and Reciprocity for Social Companion Robots*, Bristol, UK, October 2013.

[2] G. Venture, B. Indurkhya,T. Izui. "Dance with me! Child-robot interaction in the wild," Proceedings of the *Ninth International Conference on Social Robotics*, Tsukuba (Japan), Nov. 22–24, 2017, pp. 375–382.

[3] R. E. Yagoda, D. J. Gillan. "You want me to trust a ROBOT? The development of a human–robot interaction trust scale," *International Journal of Social Robotics*, 2012, *4*(3), pp. 235-248.

[4] C. L. Bethel, M. R. Stevenson, B. Scassellati. "Secret-sharing: Interactions between a child, robot, and adult. In Systems, man, and cybernetics," *IEEE International Conference, SMC*, 2011, pp. 2489–2494.

[5] M. Salem, G. Lakatos, F. Amirabdollahian, K. Dautenhahn. "Would you trust a (faulty) robot?: Effects of error, task type and personality on human-robot cooperation and trust." in *Proceedings of the Tenth Annual ACM/IEEE International Conference on Human-Robot Interaction, ACM,* 2015, pp. 141–148.

[6] D. Y. Geiskkovitch, R. Thiessen, J. E. Young, M. R. Glenwright.. "What? That's Not a Chair! How Robot Informational Errors Affect Children's Trust Towards Robots," in *14th ACM/IEEE International Conference on Human-Robot Interaction (HRI), IEEE*, 2019, pp. 48-56.

[7] F. Tanaka, J. R. Movellan, B. Fortenberry, K. Aisaka. "Daily HRI evaluation at a classroom environment: reports from dance interaction experiments", *Proceedings of the 1st ACM SIGCHI/SIGART conference on Human-robot interaction, ACM*, 2006, pp. 3-9.

[8] A. Coninx, P. Baxter, E. Oleari, S. Bellini, B. Bierman, O. B. Henkemans *et al.* "Towards long-term social child-robot interaction: using multi-activity switching to engage young users." *Journal of Human-Robot Interaction*, 2016, 5(1), pp. 32-67.

[9] S. Costa, H. Lehmann, B. Robins, K. Dautenhahn, F. Soares. "'Where is your nose?': developing body awareness skills among children with autism using a humanoid robot," in ACHI 2013, the *Sixth International Conference on Advances in Computer-Human Interactions*, 2013, pp. 117–122.

[10] B.R. Duffy. "Anthropomorphism and Robotics", presented at the *Symposium on Animating Expressive Characters of Social Interactions*, Imperial College, London, 2002.

[11] T. Fong, I. Nourbakhsh, K. Dautenhahn, "A survey of socially interactive robots" in*Robotics and Autonomous Systems*, 2003, pp. 42, 143–166.

[12] J. Fink, J. 2012. "Anthropomorphism and human likeness in the design of robots and human-robot interaction," *International Conference on Social Robotics*, 2012, pp.199–208.

[13] E. Short, K Swift-Spong, J. Greczek, A. Ramachandran, A.Litoiu, E. C. Grigore, S. Levonisova, "How to train your DragonBot: Socially assistive robots for teaching children about nutrition through play," *The 23rd IEEE International Symposium on Robot and Human Interactive Communication,* Edinburgh, 2014, pp. 924-929.

[14] "Emotions | Emotional Development in Childhood," *Encyclopedia on Early Childhood Development.* [Online]. Available: http://www.child-encyclopedia.com/emotions/according-experts/emotional-development-childhood. [Accessed: 03-May-2019].

[15] H. Tan, D. Wang, S. Sabanovic. "Projecting Life Onto Robots: The Effects of Cultural Factors and Design Type on Multi- Level Evaluations of Robot Anthropomorphism," In *27th IEEE International Symposium on Robot and Human Interactive Communication* (RO-MAN), 2018, pp. 129-136.

[16] B. Mok, S. Yang, D. Sirkin, W. Ju. "Collaboration with Robotic Drawers,"*Proceedings of the Tenth Annual ACM/IEEE International Conference on Human-Robot Interaction Extended Abstracts - HRI'15*, 2015.

[17] T. Beran, A. Ramirez-Serrano, R. Kuzyk, M. Fior, S. Nugent. "Understanding how children understand robots: Perceived animism in child–robot interaction," *International Journal of Human-Computer Studies,* 2011, 69(7-8), pp. 539-550.

[18] V. Jaswal. "Believing what you're told: Young children's trust in unexpected testimony about the physical world," *Cognitive Psychology*, 2010, 61(3), pp. 248-272.

[19] R. Ros, and Y. Demiris. "Creative dance: An approach for social interaction between robots and children,"*International Workshop on Human Behaviour Understanding, Springer*, 2003, pp .40-51, 2003.

[20] K. Dautenhahn, I. Werry. "A quantitative technique for analysing robot-human interactions," In *IEEE/RSJ international conference on intelligent robots and systems*, vol. 2, pp. 1132-1138, September 2002.

[21] P. H. Jr. Kahn, B. Friedman, N. Freier, R. Severson."Coding manual for children's interactions with AIBO, the robotic dog–The preschool study," *University of Washington CSE Technical Report 03-04-03*, 2003.

[22] M. P. Michalowski, R. Simmons, H. Kozima, "Rhythmic attention in child-robot dance play," in RO-MAN the 18th IEEE International Symposium on Robot and Human Interactive Communication, 2009, pp. 816-821.

[23] A. K. Pandey, R. Gelin. "Pepper: The first machine of its kind. A mass-produced sociable humanoid robot," IEEE Robotics & Automation Magazine, November 2018, pp. 40-48.