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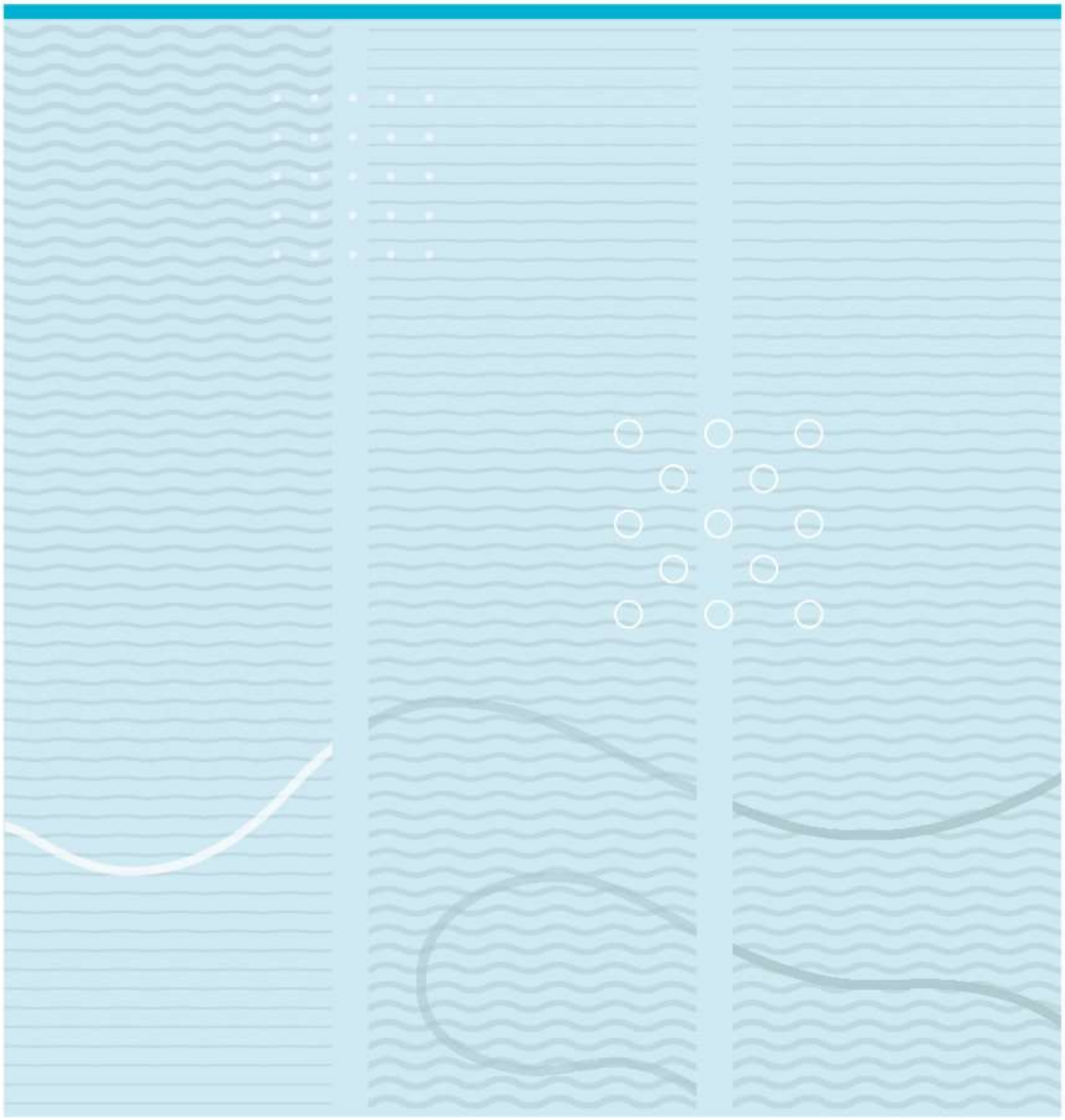
Enhance social communication and interaction skills of ASD children with Social Robot



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This thesis is worth 30 study points

Summary

This thesis study is a part of ROSA (Robot-supported education for children with ASD) project and Norsk Regnesentral is the coordinator for the project and responsible for creating parts of ROSA toolbox. The aim of this thesis is to identify the factors associated with social robot oriented lesson prototype to enhance ASD children social communication and interaction skills. To pursue the aim of this thesis a literature review and a qualitative research was conducted.

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List of Abbreviations

Abbreviation	Definition
ASD	Autism Spectrum Disorder
SAR	Socially Assistive Robotics
ABA	Applied-Behavior Analysis
PRT	Pivotal Response Treatment
PTM	Pivotal training method
HMM	Hidden Markov Model
RET	Robot-enhanced treatment
SHT	Standard human treatment
TD	Typically developed
RCT	Randomized controlled trial
ROSA	Robot-supported education for children with ASD
CARS	Childhood Autism Rating Scale

Contents

Acknowledgement

It was an incredible journey filled with exciting challenges as I pursued my master's degree in Management Information Systems. In my situation, that journey would have been impossible or difficult without the University of South-Eastern Norway (USN), its professors, and staff members. First and foremost, I'd like to express my gratitude to Veralia Gabriela Sanchez, respectfully for her supervision in this master thesis. Then I would like to thank Frydenhaug School for allowing me to get participants and I also would like to thank all participants in this study for enlightening me to capture new insight knowledge of the ASD children social communication and interaction skills.

My heartfelt gratitude to my family for their support and for their tolerance. They understand my concerns, and I can share my closet moments with them.

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Rokeya Akter Rumky

1 Introduction

According to studies, incorporating robots into the learning process has an impact on children and indicates enormous possibilities and opportunities in educational systems. Robots are promising as an assistive tool for enhancing social interaction and empowering learning capability in children with ASD (Autism Spectrum Disorders). Social robots are well-known for their ability to interact with humans, as they provide a common interactive platform for both humans and robots. Social robots are well-known in the field of child education because they improve children's learning abilities by providing personalized lessons and individual progress reports. Children with ASD have poor social communication and interaction skills, and social robots can help bridge the gap and influence their participation through an interactive and personalized learning platform.

Autism spectrum disorder (ASD) is a neuro-developmental disorder and yet its causes are a mystery. A wide range of impairments are associated with autism, mainly including social communication and interaction, cognitive developments, repetitive behaviour. Children with autism shows disinterest in communication with human, not expressive about their feelings of joy or sad and repeat same tasks for several times (Kostrubiec & Kruck, 2020).

Autism spectrum disorder impact children social interaction skills since they are not able to express their feeling to others and cause them to produce frustrated behaviour. ASD child deficiency in tendency of visual coordination obstruct them to focus or make joint attention with others in the context of verbal and nonverbal communication (Ali et al., 2019).

Autism treatment has no permanent cure, and the disorder's progression is unknown. Hence the children with autism need special care in regards to education, health and social services. Symptoms of these disorders start to become visible in child within age of three. Since adverse effect of autism begin very early of human life requires expensive maintain cost throughout their life, An individual with ASD requires higher maintain cost throughout their life and the overall expense of an ASD one’s lifespan cost 2.4 million US dollars in United State and in United Kingdom this cost is £1.5 million. Adults with autism requires expensive residential setup to ensure supportive and efficient accommodation (Abdo & Al Osman, 2019).

Traditional way of treat ASD child is through psychiatric therapy and psychologist determine level of autism on the basis of actions of the child and provide several cognitive therapies as per child ASD level to improve their cognitive skills psychiatric therapy and cognitive therapy is the traditional approach to provide treatment to ASD children in order to help them to improve their cognitive skills and psychologist rely on the action of the child to determine the severity level of

autism (Ali et al., 2019). The severity of autism is categorized into three different levels range from mild to severe. Mild level autism identified as level 1 and severe as level 3. On the autism spectrum, mild level 1 autism is known as high functioning autism and is frequently referred to as Asperger's syndrome. Level 2 is known as autism and demand substantial support while severe level autism is categorized as Level 3 autism, People at level 3 autism suffers severely from social and communication deficiencies(Ali et al., 2021, Giannopulu et al., 2020).

Studies have shown that assistive technologies such as robotic intervention plays an effective role in the development of communication and interactive skills in ASD children. Socially assistive robotics (SAR) coined as social robot designed to meet demands of social interaction and to assists human users. Social robot are beneficial for children sufferings from neurodevelopmental disorders known as autism spectrum disorders due to enhance communication skills through effective intervening (Desideri et al., 2018) . In this thesis, the basic features of social robot is the main focus of investigating child-robot interaction.

The impact of assistive robots are rapidly increasing because of their promising robotic application in the rehabilitation of disabled and elderly people (Hamzah et al., 2014). Social robot studies are popular among scholars due to their interactive features and highlighted as interactional partners of children with ASD. In addition, ASD children are lacking with adaptive behavior influence their ability to learn social skills with social robots effectively because of robots restricted behavior and use of a simplified method of delivering instructions. These features are persuasive and significant in learning social behavior (David et al., 2020). Children with ASD shows interest in robots and engage themselves in robot-oriented learning sessions which improve their motivation toward social interaction (van den Berk-Smeekens et al., 2020). Furthermore, studies reported that physical interaction with robots are more engaging than screen-based technologies (Desideri et al., 2018).

This thesis investigates the factors of social robot and the associate child-robot interaction factors need to consider to design child-oriented lesson prototype.

The social robot assume to act as a learning-aided tool to empower ASD children learning deficiencies in social and communication interaction skills. In this thesis, I try to find an answer or answers to the research question:

RQ: What factors of human robot interaction should be consider for designing lesson prototype?

The purpose of this study was to explore the factors needed to consider to introduce a robot based learning environment within the context of phenomenology.

The structure of the thesis is as follows:

Chapter 1 provides background information on the relevance of this research and its contextual perspective, introduces the research problem, describe the research purpose, and introduces the research question and objective of the research.

Chapter2 provides the background of the literature review of social robot interaction with ASD children to enhance their social and interaction communication skills.

Chapter 3 provides research methodology describing the research approach, research design, research strategy, data collection and analysis, recruitment process, ethical consideration.

Chapter 4 presents the findings of the literature review and qualitative and qualitative analysis result.

Chapter 5 provides discussion on child robot interaction factors need to take into consideration when designing lesson prototype and the level of autism impact the interaction with social robot.

Chapter 6 provides the strength and limitations of this study

Chapter 7 presents the conclusion

2 Background

Kanner in 1943 first identified the term autism and characterized as an inability to link with other people (Scassellati, 2005). Social interaction is one of the phenomena which has direct and indirect impact on individual with ASD includes speech, linguistic, conventions and interpersonal skills (Williams White et al., 2007). Children with ASD face challenges to communicate socially, suffers interpreting visual or auditory cues, and also not able acknowledging the significance of social cue such as gaze (Scassellati et al., 2018).

Integration of social robot in education setting is receiving huge interest, particularly in children education as they found more enthusiastic to interact and engage with robots. Robots influence learners to learn through interactive session this helps learners to improve motivation and engagement with learning materials and facilitates teachers with new learning aided tools (Fuglerud, K. S., & Solheim, I., 2018). Robot are used to enhance ASD children attention in time of diagnosis or therapy and it is used as a learning tool to tech children different subjects to engage children in active learning (Pivetti et al., 2020).

Social robot uses as an interaction partner for children with ASD to make effective communication in social tasks due to the simplified way of presenting information, predictable behaviour, and embodiment of the robot, human-like social cues. Having these features in robot make social communication is easier for ASD children because Child ASD are not able to deal with the complexity of human behaviour. Children with ASD interested to interact with social robot because it follows rules during interaction and these rules help children to predict robot's behaviour.

The uses of social robot in teaching children second language has gained huge interest in comparison to teaching children language with digital device such as computers, laptops or tablets. The interactive robot features such as embodiment, situatedness, human-like appearance that is capable of interacting with human in a semi-natural way and for longer period of time causes to gain children interest. Introducing a robot in group learning has more interaction rather than in an individual session and also the physical appearance of the robot such as the robot is presented to the child as a machine or as a social entity has impact on child interaction with the robot in future (Vogt et al., 2017).

Children with ASD suffers through different level of autism, not every children with autism react the same with robot interaction. Children with ASD likes to get reward from robot more than their human teacher. On the other hand their undesirable behaviour may not be reduced with robot

interaction and only can reduce the frequency of it. The intellectual functioning level of ASD effects child robot interaction. If the robot can directly interact with the child without any external devices such as a remote control and can play the role of social entity such as a teacher, a guide then children with ASD might be benefited with the robot interaction and they might be able to interpret and transform the social cues they are practicing with robot in their day to day life (Kostrubiec & Kruck, 2020).

This is important to maintain the positive impact of using social robots in education, so precautions should be taken to avoid any situations in which humans may suffer a negative impact (Khan & Germak, 2018). Learner oriented lessons emphasize on the term personalizing refers interaction between robot and children which can be achieved to provide a common platform between child and robot and robot will act as a peer to track child learning progress and build long-term relationship(Belpaeme et al., 2018).

3 Research Method

This chapter covers two research methods, one is for the literature review and the other is for the qualitative data. This chapter also include the research approach and design, data collection, the requirement process, data analysis, limitations and issues relate to the validity of the research.

3.1 Literature Review

3.1.1 Design

Literature review of this study is reported by following the general guidelines of the Preferred Items for Systematic Reviews and Meta Analyses (PRISMA) guidelines. The PRISMA flow diagram is used to present the selected articles (Figure 1).

3.1.2 Search Process

The academic Search Premier IEEE Xplore, Science Direct, SAGE, PubMed and Nature databases were searched in year 2012-2022 articles in English. Journal articles and conference proceedings were chosen. The following search terms were used: ASD child, interaction, robot, social, lesson to identify all relevant papers.

3.1.3 Data Selection

The initial search returned articles across five databases [N=133]. I screened the articles based on title and keywords. The inclusion criteria were 1) studies must be focused on the social robot to teach social and communication interaction skills children with ASD 2) Studies must mention child-robot interaction in terms of teaching social skills 3) studies must use social robot during intervention during teaching, therapy and school curriculum 4) studies must mention ASD children regardless the severity level of autism 5) studies must be published and available in full-text in peer-reviewed journals or conference proceedings or study reports from year 2012-2022 and must be available via a common scientific databases 6) studies must be published in English language.

Articles were excluded if: 1) studies are missing fields include: no author, no title, no abstract, no journal information 2) studies which were no book chapters, no poster session, no abstract available, not relevant (no focus on children, Digital media, gestational, no sports or

physical education, robot care, no focus on autism, anxiety treatment, on adult/youth ASD). After the first screen the number of papers was reduced to [N=38]

From the 38 articles, 10 articles were deleted after abstract reading. This resulted in 28 articles read in full text. Then, 16 articles were excluded for the following reasons: a) the studies based on designing computer interaction, designing robot UX/UI, , social robot architecture, toy robot b) studies include innovative technology-based interaction, wearable devices for ASD child, mobile technologies, mobile application based persuasive technology to teach social skills, sensor-based learning devices, computer-based interaction, tablet/iPad based social skills learning c) article ethical challenges faced by ASD school administration and copy number of gene and clinical information. Twelve articles met both inclusion and eligibility criteria and nine more articles from other source met both inclusion and eligibly criteria. (N=21).

Reading twenty one articles helps to identify child-robot interaction factors and areas of social and communication interaction skills enhanced by using social robot in ASD learning. Several articles have pointed out structured learning, predictable robotic features, contingency robot, repetitive, reward giving by robot is used to enhance ASD child communication and interaction skills.

3.1.4 Data Analysis

Data extraction from the literature is followed by study design as the methodology is important to know what kind of study it is and the journals to see the relevancy on the field of robot and child interaction to enhance social interaction and communication skills. Themes are determined from the articles to understand the underlying meaning and their connections with social robot intervention in teaching ASD child social interaction and communication skills.

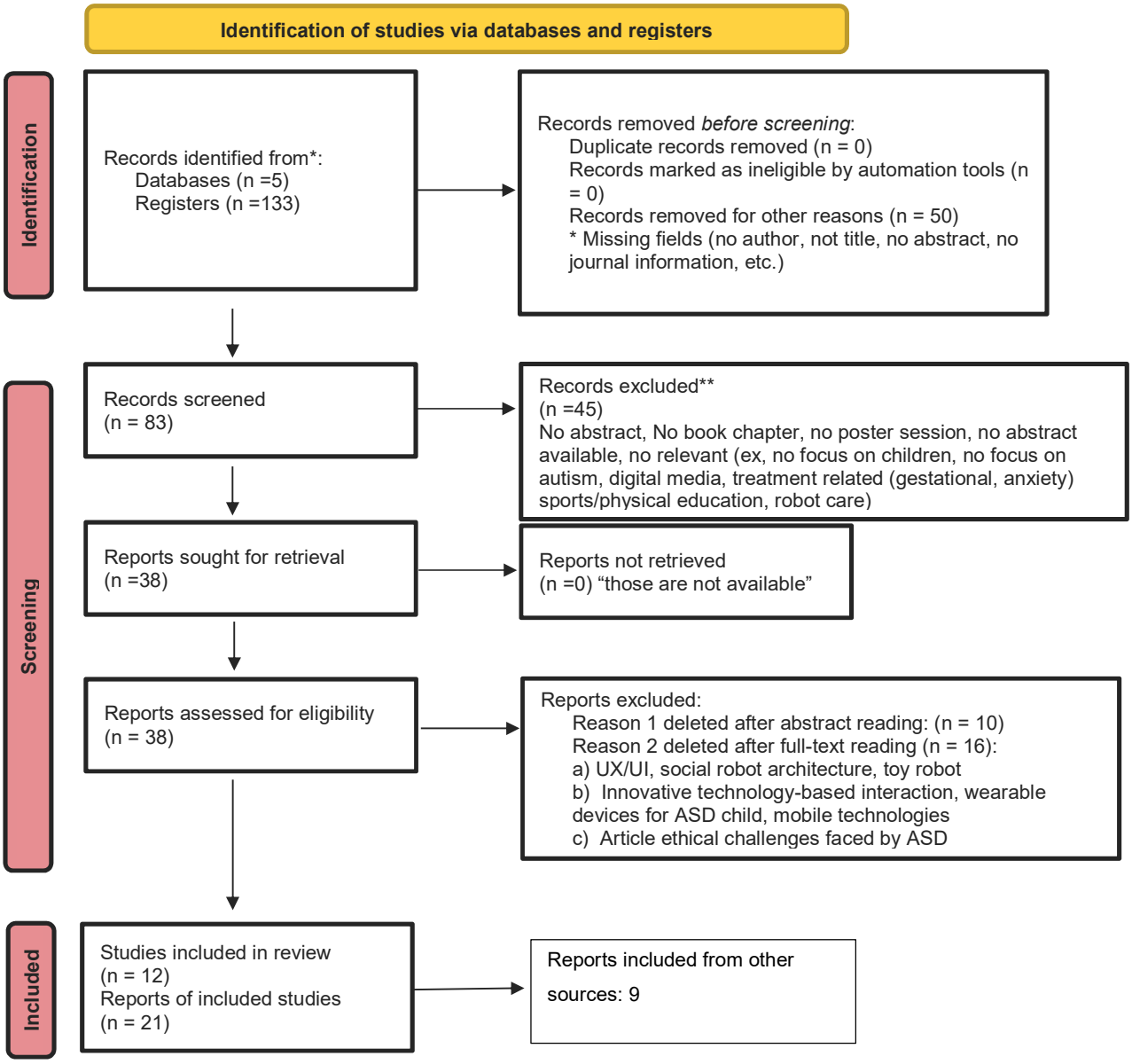
Identification of studies via databases and registers
Identification
Records identified from*:
Databases (n =5)
Registers (n =133)
Records removed *before screening*:
Duplicate records removed (n = 0)
Records marked as ineligible by automation tools (n = 0)
Records removed for other reasons (n = 50)
* Missing fields (no author, not title, no abstract, no journal information, etc.)
Screening
Records screened
(n = 83)
Records excluded**
(n =45)
No abstract, No book chapter, no poster session, no abstract available, no relevant (ex, no focus on children, no focus on autism, digital media, treatment related (gestational, anxiety) sports/physical education, robot care)
Reports sought for retrieval
(n =38)
Reports not retrieved
(n =0) "those are not available"
Reports assessed for eligibility
(n = 38)
Reports excluded:
Reason 1 deleted after abstract reading: (n = 10)
Reason 2 deleted after full-text reading (n = 16):
a) UX/UI, social robot architecture, toy robot
b) Innovative technology-based interaction, wearable devices for ASD child, mobile technologies
c) Article ethical challenges faced by ASD
Included
Studies included in review
(n = 12)
Reports of included studies
(n = 21)
Reports included from other
sources: 9

Fig 1: PRISMA

3.2 Qualitative Research

A Qualitative Phenomenological Study to investigate social robot interaction factors in designing lesson prototype

Qualitative research aim is to study a research problem with the use of a qualitative approach to inquiry, data collection in natural setting with consideration of the sensitivity of people and places of study, and then establishes theme or patterns through data analysis in both inductive and deductive logic. Qualitative research used to understand participants meaning about the phenomena which gives researchers multiple views and themes, qualitative research used to understand the contextual meaning as it provides unique information about the context, qualitative research used because of its flexible nature of planning as in this study the form collecting data changes during the data collection phase (Creswell, J. W., & Poth, C. N. (2016)).

Qualitative research was suitable for this study because this study requires to explore the detailed comprehension of teaching ASD children and uses of robot in the classroom during learning social communication and interaction skills through direct conversation with experienced participants on their own settings and to listen their stories. Also, this study used qualitative approach because the nature of quantitative and statistical analysis do not fit for this thesis (Creswell, J. W., & Poth, C. N. (2016)).

To address the research question, the approach taken in this study is qualitative phenomenological study as a vehicle to explore the flow, the dynamic and the complexity of views.

3.2.1 Research Design

Phenomenology study, facilitates researcher to describe a common meaning of several individuals about their lived experiences of a concept in order to bring the very nature of the phenomena. Moreover this human experience about such phenomena is a source of rich data which helps to develop a concrete descriptions of the participant's experience. The process of bracketing is to take researchers own experience out of the study in order to focus on the participants experiences and not to engage researcher past knowledge with participants experiences. This is not only a process of describing phenomena also an interpretive process and researcher's present interpretation of the lived experience (John W. Creswell & Cheryl N. Poth, (2016)).

The topic and the research question in this study can fit the characteristics of the qualitative study, including researcher as an instrument, inductive logic, participants meaning, emergent design, reflexivity and holistic account (John W. Creswell & Cheryl N. Poth, (2016)).

As we see within the literature, children with ASD face difficulties to communicate and interact with human while social robot due to its restrictive and predictable behaviour can motivate child to interact with robot. The creator of humanoid robot NAO Aldebaran Robotics a worldwide robotic company noticed autism child's are significantly attractive to technology which influence them to introduce new features of NAO in child therapy and education to make connection between robot and human social world (Hamzah et al., 2014). By considering only one or a few aspects to make them investigable and measurable with variables and coming up with numerical data may not reveal the significance of social robot intervention in child education and desire outcomes. To understand the importance of social robot interaction with ASD child, we need to listen to involved personnel such as special educator and have their view and perspectives. We need to know what learning methods are using in classroom, what types of child-oriented lesson are using in developing their social and interaction skills and what technology can offer to facilitate the teachers and the child's to make the learning interactive and to grab their attention.

3.2.2 Recruitment Process/Participants

Frydenhaug School in Norway, Drammen Kommune, was used to recruit sample. There were two reasons involved to consider Frydenhaug School for data collection first this school is for students with disabilities and extensive adaptation needs and they are working together in the ROSA project. The recruitment process was challenging as it was difficult to find participants. Only one recruitment techniques were used, in this approach the participants are selected according to predetermined inclusion criteria. The inclusion criteria is: having the experience of teaching ASD children, being able to speak English or Bengali and being connected to the ROSA project.

ROSA (Robot-supported education for children with ASD) is expected to create and develop a robot-based tool-box to support teachers in order to customize learning content to cater the specific need of each child with ASD. This robot-based project will also focus to sustain child motivation to learn with the progress of the lessons through personalized lesson plan and expressive movement of the robot. The sociocultural approach of the project includes experts in social robotics, education, and ASD. The project is conducted by Norsk Regnesentral (nr.no).

3.2.3 Data collection

The primary source of data collected in this study is an open-ended one to one interviews. However, focus group interview was planned before but due to lack of time only one to one

interview conducted. Before the interview information letter was sent by email to the school authority and during the interview participant acknowledgement has been collected on the printed information letter. Information letter is given in Appendix B.

Open-ended Interview

An interview has many aspects from the qualitative research point of view such as it facilitates researchers to involve in a conversation with social interaction, helps to build knowledge (John W. Creswell & Cheryl N. Poth, (2016)).

The standardized open-ended interview was most suitable for this study and conducted by following extremely structured wording of the questions. Both participants were asked the same set of questions and the wording of the questions encourage participants to response in an open-ended manner. This approach of questioning allowed participants to share in-depth information about their lived experience on the phenomena. Additionally, due to an open-ended interview questions participants were able to include their own view points and experiences (Turner, 2014).

First an interview guide was developed to ensure all related aspects are covered during the interviews (Appendix A). The interview guide contains an introduction about the research, the rights of the participants, privacy rights, the right to withdraw the consent, the security of the information, and permission to start recording. The first section of the interview guide contains a set of questions about participant's background, and rest sections are related to emotion, social and communication skills of ASD child, importance of social robot interaction and how can information technology help. The interview guide has an ending section, informing the participant about the stopping the record, re-informing about the participant's rights, and questions if the participants has any consideration.

Next an information letter containing information about the project, criteria, the rights of the participants, including privacy and consent withdrawal rights. Responsible persons and parties and contact information followed by a consent form was prepared (Appendix B).

All participants signed the consent form during the interviews session. The interviews were contacted via email using the education account of the University of South-Eastern Norway. On 2nd March, 2022 an email has been sent to seek for permission for interviews and then permission of one to one interview has been granted on 18th March, 2022 via email from Frydenhaug School. On 22nd March 2022 the interviews took place at Frydenhaug school where both participants working as teacher. Both interviews were recorded with the permission of the participants, and later they were transcribed and anonymized for data analysis and future research. Both interviews were conducted in English, the expected time for each interview was first approximately 60 minutes, but

the average time of each recorded interview is about 39.04 minutes the off record parts, including the introduction and ending, are about 03-05 minutes.

The researcher's rule was not to engage in the dialogue and push his or her opinion. The interviewees could talk, and the researcher wanted to bring participants real time experience of teaching ASD children from the answers and ensure that the topics in the interview guide are covered. The researcher involvement in the interview is about ten percent.

Participants	Gender	Profession	Work Place	Interviews
Participant 1	Female	Teacher	Frydenhaug school	26: 08
Participant 2	Male	Teacher	Frydenhaug school	52:17

Table 1: Open-ended Interviews – participants and Interview duration

3.2.4 Data Analysis

Interview data then transcribe into text using MS word software for further analysis. The text has been organized into a table of 2 columns and 21 rows in order to compare their experiences and viewpoints. Data analysis for this report follows the guideline of (Graneheim & Lundman, 2004) in order to extract categories from the transcription. Interview text are organized into 12 categories: **ASD child social communication**; **Group activities; Structured learning** ; **Impact of social skills on ASD child personal life**; **Imitation, eye gaze and understanding feelings of others**; **Level of autism**; **Digital devices for communication**; **Social Robot interaction with ASD child**; **Rewards with robot**; **Interactive learning and role selection**, **Imitation, joint attention (social skills) with social robot**; **Impact of social robot interaction on ASD children family and peer**; **Robot as an assistive tool.**

3.2.5 Ethical considerations

To comply with data protection legislation regarding the processing of personal data, including data the collection, storing, and share in this research project for Master Thesis Management Information Systems, the Norwegian Centre for Research Data (NSD) was notified. NSD assessed the project with reference number 703356.

4 Results

4.1 Literature review

A wide range of social robots have been developed along with human-like appearance such as Kasper, FACE, Robota, Aibo, Charlie, NAO etc. Social robots make simple emotional response which is an important factors for effective communication and maybe useful to reduce the motivational and sensory barriers to some extent faced by the children with ASD (Hamzah et al., 2014, Kostrubiec & Kruck, 2020)

A systematic review conducted by Raptopoulou et al., 2021 stated that using of anthropomorphic robots are very popular among education researchers, due to the presence of non-distractive, approachable features as well as perused child interest. This is related to the inherited responds nature of human beings towards technologies, they are more attract to human appearance technology rather that machine appearance technology. A wider range of spectrum disorders in ASD cause the same to show different outcome on the same stimuli. There is lack of standard methodology for assessment the level of autism. As a result, researcher's name them high/low, intermediate state, IQ scores and plethora of weighted test. To reduce the impact of the control group in human robot intervention researchers used A-B-A-B scheme as comparison measurement where A act for baseline B for intervention and A-B-A-C scheme where B for human intervention, C for robot intervention and A acts as former. To measure child preference of the robot interaction conducted by very few or large number of session and evaluation of the degree of acceptability rely on survey and often lack of information regarding benefits of using robot interaction over human interaction as well as habitually and sustainability of acceptance of robot. Raptopoulou et al., 2021 suggested experimental protocol with a series of sessions, in first few sessions' extraction of information on child acceptance of the robot, and then the rest of the sessions were used to make more comprehensive conclusion along with follow-ups in order to measure the reliability of the result.

Human acceptability and trustworthiness on robot connected to the emotional capabilities of the robot shows while interact with human stated in Jeon, 2021. Reading others emotions and expressing one's own emotions is critical for human-human interaction which facilitates natural communication and social interaction". Human prefer to make verbal emotional communication with robot if the robot demonstrates human-like, voice styles, gender, accent and prosody.

Robots demonstration of human-like voice styles, gender, accent and prosody associated with people preference in terms of verbal emotional communication. Robot anthropomorphism appearance and voice styles significantly influence human to communicate with robot as well as emotionally expressive robots impact verbal communication. On the other hand, absence of naturalness in robot appearance effect user perception. People perception on robot's human like appearance reported as frightening, uncomfortable due to human-like appearance and the emotional responses. Despite this fact, humans show more enthusiasm and acceptance on the dynamic nature of emotional expression and movement of humanoid robot. Also ASD child shows preference on robot over human. This issue provides ground to investigate more about this thesis study on the factors of child-robot interaction.

Children with ASD suffered through expressing their own emotions and interpret other's emotions. Emotional robot oriented learning is encouraging for ASD children's since robot can play reinforcer role to maintain learning and sharing experience with others. Robotic intervention designed to elicit ASD child's social interaction skills, motor and vocal skills along with multiple sensory experience and in physiology-based affective-inference robot used to identify child's affective state(Jeon, 2021).

Child interest and motivation is significantly important for the acceptance of robotic intervention. A study combined motivational components of PRT and robot in order to measure the likability of children and parents robotic intervention therapy. However, the outcomes shed light on the fact that children with high ASD severity showed lower positive affect ratings after robot-based session as they liked the human-based session more. ASD children are familiar with PRT therapy characteristics which emphasized careful selection of robotic motivational features which best served child interest. Child motivation is influenced by several robotic features associated with speech, movement and game scenarios. Contingent robot increase child interaction and motivation as child found the robot responsive to their behaviour and conduct meaningful interaction. There is lower parent's rating recorded due to lack of direct robot reinforcement and the scenarios of the game either very easy or too complicated for ASD child. Furthermore, if the robot is less autonomous and the game scenario is predictable, a child with ASD will refuse to accept it. The challenging nature of robot-assisted scenarios can be reduced by using flexible robot behavior to support a collection game library with various complexity levels to meet the needs of ASD children and allow therapists to adjust as needed during therapy sessions (van den Berk-Smeekens et al., 2020).

So, Wong, et al., 2019 compared robot and human-based gestural training in Chinese speaking ASD children. There is no significant difference resulted from the learning outcome even though one interesting finding includes eye contact with teachers noticed higher in the children received robot-based training. ASD severity may have impact on the effectiveness of the intervention whereas they attributed feedback after each pretest and posttest facilitated children to recall the correct and incorrect answer. Children from the intervention group improved better than wait-list compare group which attributed to the feedback. It is also mentioned that both human and robot based teaching are useful for training gestural recognition and production skills, even though ASD children are more enthusiastic to learn from their robot partners. Children make less stereotype behaviour when they interact with robot instead of human which is aligned with social motivation theory of autism, ASD individual lack of engagement skills with human. The second outcome registered in line with the empathizing-systemizing theory said that children suffers from ASD learn through highly structured lessons and produce positive learning outcomes. Either human or robot based intervention children with ASD requires a well-structured learning environment to learn and developed skills. This is also related with the features of social robot, systematic and predictable, repetitive in terms information sharing with children and maintain consistency throughout learning sessions.

Robot-based intervention to teach ASD child gesture along with narrative skills, A pilot study conducted by So, Cheng, et al., 2019 reported remarkable improvement in the intervention group compare to wait-list control group with regards to narrative length, syntactic complexity, narrative structure, cognitive inferences and overall gestures. The robot-based play drama helped children to understand the characters goals and their action in the drama and later on children were able to interpret the events of the drama by making cognitive inferences in their narrations as well as identified the patterns and sequences even though they produce low affective inferences. Later on children from intervention group took part in the role play in order to have practical experiences about the characteristics and their cognitive meaning with the patterns and sequence of life. The highly structured drama provided children with a sequential and predictable framework in order for them to maintain long-term comprehension in their own narratives. Gestures made by social robot in the drama influenced children with ASD to adapt those gestures and motivated them to incorporate those gesture in the appropriate context, in accordance during ASD child role plays robot gestures were made spontaneously by them, and enhance their understanding ability. Though it is limited only children made deictic gestures, not iconic or marker gestures demonstrated by

social robot in the drama. Socially assistive robots have higher acceptance rate in ASD individual rather than human reported in many articles as well as accordance with social motivation theory of autism stated ASD individual deficiency in engagement with human. Children engagement also noticed in the robot-based drama as robot played the roles in systematic, organized and predictable manner which meet the learning requirements of ASD child and this is in line with the Intense World Theory which stated children with ASD produced positive learning outcome in highly structured leaning environment (So, Wong, et al., 2019).

The study conducted by Giannopulu et al.,2020 on interpersonal synchronization of ASD child in both France and Japan with robot vs human partner provided outstanding results. Higher autonomic reactions reported while children in both France and Japan participated with robot and autonomic reactions are recorded similar in children from different countries. Interpersonal synchronization reported different while French and Japanese children interacted with the same human perceiver. Even though the interpersonal synchronization and autonomic reaction was similar in ASD children despite their countries. Children from both French and Japan reported analogous and better emotional feelings after they interacted with robot than before interaction. There is significant indifference in empathetic reactions observed between neurotypical and ASD child from both countries which is not due to the cultural differences rather to the heterogeneous nature of autism spectrum, and autonomic activities of ASD children are based on the intensity of "predictability and unpredictability or the level of intentionality of the perceiver"(Giannopulu et al., 2020). Additionally, ASD child and neurotypical child perform similar autonomic reactions with robot perceiver. Empathetic reactions in terms of verbal and nonverbal are higher and ASD children better synchronized with robot than human partner, which directly contribute to the improvement of ASD children's emotional feelings. Interpersonal synchronization and emotional empathy are linked with autonomic reaction which directly or indirectly connected to cortical (prefrontal, temporal, and cingulate) areas and connected with empathy in neurotypical children which is similar with ASD children when they interacted with robot rather than human. ASD child interaction with robot increase "mobilizations" resulted children engagement and spontaneous interaction with robot partner. This is aligned with the "human inclination to enact in synchrony with machines or humans without being aware of it" (Giannopulu et al., 2020).

ASD child capability of synchronous interaction with non-human partner at an autonomic level is associated with lower load of social and emotional, child in French and Japan interact with robot partner due to low-level intentionality. As per adaptive resonance theory human brains

capable of learning automatically from the changing environment, Giannopulu et al.,2020 reported children in both countries France and Japan showed spontaneous interaction synchronization with the minimalistic robot interacting by nodding only as well as they synchronized with robot at better heart rate and heart rate variability which is referred to child's preferences, due to their inclination that they are more attracted to objects with minimalistic features encourage them to align with their own or others mental states. This result intrigue the fact that ASD child might have desire to engage in social communication with human using robot perceiver as robot is the miniature version of human being and making human-like responses by nodding head. ASD child in both France and Japan maintained the nonverbal communication with robot as similar way neurotypical child do with humans (Giannopulu et al., 2020).

To enhance social and communication skills interactive scenarios are significant since ASD child deficit in social and interaction communication skills. Robotic intervention helped children to overcome this problem to a remarkable extend. Hamzah et al., 2014 conducted a study by designing robotic interactive scenarios based on pre-school curriculum to enhance child understating and communication skills with simple words. Applied behaviour Analysis approach used to meet the learning demand of ASD child. Neurotypical children learn from their surroundings without intervention, however regards to ASD child, they required systematic approach and intervention to develop social, commination skills. ABA is comprised with reinforced behaviour and broken down learning technique of target behaviour into structured and achievable steps, which is helpful for ASD children to learn and get reward each time they approach the correct action. Robots nonverbal communication (i.e. waving hand, eyes blinking) such cues motivate ASD children to engage in interactive communication with robot. Instruction with visual assistance of robot helps children to imitate robot movements. Teachers accepted the interaction method of the learning approach, and robot-based learning scenarios were designed to contribute as a learning tool in the classroom (Hamzah et al., 2014).

A collaborative study conducted by Kostrubiec & Kruck, 2020, proposed several roles of robot 1) reward deliver: ASD children like to receive reward from their robot partner compare to praises from human. Because of its appealing features, the presence of a robot improves the effectiveness of the reward delivered, but did not serves as a motivator. 2) Undesirable Behaviour Reducer: Stereotypic behaviour can be reduced through robotic intervention only for mild and no intellectual deficit child. 3) Social Moderator:

The level of ASD severity has greater impact on children interaction with robot partner. Low level ASD children prosocial behavior is higher with robotic intervention than those who have severe ASD symptoms. According to Social Motivation Theory of Autism, ASD children are more drawn to robots than to human teachers, which can lead to a lack of interpersonal social skills in the child. The authors proposed that prosocial behavior can be initiated by a robot in which children interact directly with the robot and the robot is controlled without the use of a remote control. In this context, a robot could be assigned roles such as teacher, prompter, and assistance, among others. Child-robot interaction would encourage children to interpret social cues produced while interacting with the robot, and this learning could be beneficial for children in their interpersonal interactions in general. 4) Sensory Aversion and Inter-individual Heterogeneity Issue: On the one hand attractive features (lighting signals, noisy functioning) of robot draws child attraction, other hand they might cause turn away the child from the robot.

As per the warning of the Intense World Theory of Autism, there may be ASD child with hypersensitive to these stimuli for instance, auditory-sensitive child turned away from robot. Individual inter-heterogeneity of ASD child is the reason of their reaction towards robot. This matter sheds light on the selection of individual intervention method instead of general selection of robotic intervention. In traditional clinical intervention settings, selection of intervention methods done with care as to meet each individual ASD child needs for instance, sensory and cognitive particularities used to determine the type of toy or of educational goal required by the child and to maintain their attraction, anxiety, instructions, rewards and pauses. Kostrubiec & Kruck suggested that adding more sensory options and educational goals in robots help to personalized education. 5) Collaboration Issues: To meet the standards of excellence it is required for stakeholders to work together which is challenging in the field of robotic assistance for ASD child 6) Implementation Fidelity Issue: If the robot's design makes it easier to structure the intervention in accordance with educational guidelines, the robot may participate in the action and application of the structure learning method. 7) Acceptance of the Robot-Assisted Intervention: there is fear among researchers to consider the sensitivity of the ASD child that robot as an assistive tool give cause the human educator of being more relax and satisfied (Kostrubiec & Kruck, 2020).

ASD child communication and social interaction skills would significantly impact with pre diagnosing and proper intervention, though this is demanding in terms of clinical setting which open doors for social robot intervention to treat autistic child. From the above discussion it is certain that the severity level of autism is critical in order to determine the intervention methods and to meet

individual ASD needs. Robotic intervention is not only limited to teaching and training children communication and social interaction skills.

Moreover, robots are using to identify the level of autism , Ali et al., 2021 research focus on multi-robot therapy to predict the level of autism using Hidden Markov Model (HMM). Multi-robot interaction without requiring a therapist used to address core impairments: joint-attention, imitation and HMM model used to predict the level of autism in child on the basis of former observable state. The accuracy achieved 76% of the prediction model then tested with Childhood Autism Rating Scale (CARS) by the physiologist. Authors stated their model as an evident that integration of robot with Hidden Markov Model resulted beneficial to categorize the severity level of ASD children (Ali et al., 2021).

Srinivasan et al. compared the effects of rhythm and robotic interventions on repetitive and affective states of ASD child represented systematic review of 26 studies emphasized that ABA-based intervention on school settings has positive effect on reducing challenging behaviour of ASD children. Additionally, different intervention approaches such as Early Start Denver Model, Pivotal Response Treatment, Pivotal Response Treatment, and parent- /peer-mediated therapies help children enhance social behaviour with positive impact by reducing maladaptive behaviour. To date therapies sustain for 30-40 hours per week and outcomes are not as satisfied as desired for ASD child. Hence, improvise robot based intervention to pursue children inherent interest on robotics. Uses of robot in child intervention make the procedure simple, helps to mediate the learning environment, and initiate interaction with social partner, enhance children social communication, motor skills. Predictable characteristics of robot-child interaction helps children with ASD to learn in highly motivating and manageable manner while adult-child interaction is characterized as complex, conventional and variable learning environment. (Srinivasan et al., 2015).

A systematic review on educational robot stated robot oriented education are beneficial for technical education (the activity of building robots) and no-technical education(teaching science and language) though their roles are yet not clear among scholars. Additionally, several types of robots in terms of their dimensions to be developed such as Lego Mindstorms, NAO robot suitable for enhancing cognitive and social skills, whereas KIBO facilitates child to engage with cognitive, emotional and social objectives all together. Teachers and parents voices are emphasized to report children experiences with robot cause children with ASD are unable to express their own robotic experience by themselves (Pivetti et al., 2020)

#	Authors and year	Title	Type of paper/study	Journal	Themes
1	(Jeon, 2021)	Turning HART into HEART: Human Emotional AI/Robot Teaming	Theoretical: A guidance to design a better Human AI/Robot teaming	Proceedings of the Human Factors and Ergonomics Society Annual Meeting	Human AI/Robot teaming, affecting computing, Emotions and affect
2	(van den Berk-Smeekens et al., 2020)	Adherence and acceptability of a robot-assisted Pivotal Response Treatment protocol for children with autism spectrum disorder	Robot-assisted therapy protocol based on motivational components of Pivotal Response Treatment	Scientific reports	Motivation for social interaction and self-initiation, game scenarios with 7 level of complexity, 14 parent-child session, 4 parent session, 2 child's teacher session, component of PRT, motivational component robotics, social interaction, self-initiation, contingent robot, robot-child interaction, robot acceptability and likability robot-assisted therapy protocol, motivation, PRT, ASD child and parent acceptability ratings,
3	(So, Wong, et al., 2019)	Who is a better teacher for children with autism? Comparison of learning outcomes between robot-based and human-based interventions in gestural production and recognition	A Comparative study of robot-based and human based interventions to teach ASD child gestural communication	Research in Developmental Disabilities	Structured learning environment, human-based teaching, robot-based teaching, gestural training, eye contact, social motivation theory of autism, empathizing-systemizing theory
4	(So, Cheng, et al., 2019)	Robot-based play-drama intervention may improve the narrative abilities of Chinese-speaking	Experimental Pilot study: robot-based drama-play intervention	Research in Developmental Disabilities	Affective inferences, play drama intervention protocol, structured approach, role play, narration, imitate, gesture, motivation, eye contact

		preschoolers with autism spectrum disorder			
5		Ordered interpersonal synchronisation in ASD children via robots	Experimental analysis of interpersonal synchronization between ASD child and robot versus human form two different countries (France and Janpan)	Scientific reports	Interpersonal synchronization, Emotional empathy, autonomic reactions(heart rate, heart rate variability),spontaneous interpersonal synchronization Conscious vs Unconscious
6	(Hamzah et al., 2014)	Development of Interaction Scenarios Based on Pre-school Curriculum in Robotic Intervention for Children with Autism	Fundamental study to understand social effects of language learning scenarios through ASD child robot interaction	Procedia Computer Science	ABA, interaction scenario, per-school curriculum, English language, communicate and understand simple words
7	(Kostrubiec & Kruck, 2020)	Collaborative Research Project: Developing and Testing a Robot-Assisted Intervention for Children With Autism	Collaborative research to test the effectiveness of the robot-assisted intervention	Frontiers in Robotics and AI	Pivotal training method(PTM), applied analysis of behaviour, sensory reward, prosocial behaviour, social skills(requesting and turn taking), Intense World Theory of Autism
8	(Ali et al., 2021)	An Experimental Trial: Multi-Robot Therapy for Categorization of Autism Level Using	Experimental study combing of existing Multi-robot-mediated Intervention Systems (MRIS) with	Journal of Educational Computing Research	Joint attention(visual, speech and motion), imitation(Move Forward", "Move Backward", "Raise Hands", "Hands Down), HMM, level of autism (minimal and mild autism) prediction, multi-robot interaction,

		Hidden Markov Model	Hidden Markov Model (HMM) in order to classify autism severity level		
9	(Arshad et al., 2020)	Robots as Assistive Technology Tools to Enhance Cognitive Abilities and Foster Valuable Learning Experiences among Young Children With Autism Spectrum Disorder	Quantitative and Qualitative analysis	IEEE Access	Play-based learning activities, cognitive skills, non-formal therapy and learning, motor manipulation, supporting autism, action and reinforcement cycle, mathematics(place value learning), motivation, focus, immersed, assistive tool
10	(Vogt et al., 2017)	Child-Robot Interactions for Second Language Tutoring to preschool children	Theoretical provide design features of social robot to tech ASD child second language	Frontiers in Human Neuroscience	Situatedness, embodiment, Temporal Contingency, Semantic Contingency(children focus of attention, joint attention), gesture, feedback, tack learning progress, adaptively of emotional state,
11	(Srinivasan et al., 2015)	A comparison of the effects of rhythm and robotic interventions on repetitive behaviors and affective states of children with Autism Spectrum Disorder (ASD)	Systematic comparison of rhythm and robotic therapies using a randomized controlled trial (RTC) design	Research in Autism Spectrum Disorders	ABA-based intervention, repetitive behaviour, highly structured activities
12	(David et al., 2020)	Effects of a Robot-Enhanced Intervention for Children With ASD on Teaching Turn-Taking Skills	Single-case experiments represents a valuable and common methodology for clinical research	Journal of Educational Computing Research	Rhythm, robotic, Eye contact, High perform child in SHT have less benefit from RET, turn-taking,

13	(Efthymiou et al., 2022)	ChildBot: Multi-robot perception and interaction with children	Experimental	Robotics and Autonomous Systems	Perception module: audio-visual active speaker localization, 6-DoF object tracking, visual activity recognition(gesture and action recognition), distant speech recognition, modular approach of child robot interaction
14	(Desideri et al., 2018)	Using a Humanoid Robot as a Complement to Interventions for Children with Autism Spectrum Disorder: a Pilot Study	A Pilot study using ABA single-case design	Advances in Neurodevelopmental Disorders	active engagement, passive engagement, active non-engagement, ABA, facilitator, mediator, child preference
15	(Alves-Oliveira et al., 2016)	The Role that an Educational Robot Plays	Empathetic robot tutor designed and developed to teach children sustainability	Robot and Human Interactive Communication (RO-MAN)	Robot role assigned by children(TD), perception, Facilitator, motivation, empathetic, personalized learning approach, empathetic role, non-empathetic role, other roles(friends, classmates, stranger, neighbor), pedagogical strategy, NAO robot
16	(Halbach et al., 2021)	Robot-Enhanced Language Learning for Children in Norwegian Day-Care Centers	A case study to investigate the existing digital language learning using app and its enhancement by using NAO robot	Multimodal Technologies and Interaction	Robot role, language learning, NAO robot, gamification,
17	(Shamsuddin et al., 2012)	Initial Response in HRI- a Case Study on Evaluation of Child with	Case study	Procedia Engineering	Initial response, behaviour, eye contact, NAO robot, joint attention, Human robot interaction

		Autism Spectrum Disorders Interacting with a Humanoid Robot NAO			
18	(Raptopoulou et al., 2021)	Human–robot interaction for social skill development in children with ASD: A literature review	Systematic Literature Review by using bibliographic research for article surveyed due to investigate human robot interaction used to enhance ASD child social skills	Healthcare Technology Letters	Language disorder, anthropomorphic robot
19	(Pivetti et al., 2020)	Educational Robotics for children with neurodevelopmental disorders: A systematic review	A systematic review	Heliyon	Education robot, teachers and parents voice, engagement, social interaction
20	(Boucenna et al., 2016)	Robots Learn to Recognize Individuals from Imitative Encounters with People and Avatars	An experimental study	Scientific reports	Person recognition, mutual imitation, autonomous robot, cognitive development
21	(Albo-Canals et al., 2013)	Comparing two LEGO Robotics-based interventions for social skills training with children with ASD	An analysis of two comparable studies of LEGO robotic-based activities	Robot and Human Interactive Communication (RO-MAN)	Social skills, child preferences and motivation, child familiar, robots roles on turn taking, mediators, shared attention

Table 2: Summary of Literature Review

Abbreviation	Definition
ASD	Autism Spectrum Disorder
ROSA	Robot-supported education for children with ASD
ABA	Applied-Behavior Analysis
PRT	Pivotal Response Treatment
PTM	Pivotal training method
HMM	Hidden Markov Model
RET	Robot-enhanced treatment
SHT	Standard human treatment
TD	Typically developed
RCT	Randomized controlled trial
CARS	Childhood Autism Rating Scale

Table 3: Abbreviation

4.2 Qualitative analysis results

ASD child social communication

As per Participant1 social communication for ASD child depends on children interest and their motivation. To add all little things in communication would be influential to taking starting and also help them to learn and follow social rules. According to participant 2 put children in small groups so that they can interact with each other and they can experience the sense of community, moreover social communication is ASD children ability to understand cues from people during verbal and nonverbal communication in order to have normal life as possible.

An individual learning program may help child to meet their required level but also miss out the opportunity to interact with each other. Social communication in terms of waiting for their turn, waiting for others turn is a problem with these children due to their diagnosis or autism diagnosis. Moreover, children are having different life at home than in school, in home they might get higher priority and they usually don't need to wait for their turn and in school the priority level differ during teaching different subjects.

Participant 2 said

> *I know I have three children myself and it's difficult with those and those are all normal functioning children*

And this is more challenging with ASD children to teach to wait, take turn and to see others as an individual to think to work with them in group. In an structured situation for example child may asked to produce a piece of writing with four or five sentences in English or Norwegian and if there are two or three children then they may be work together in group to help each other to fill out the sentences. Teacher can also involve them in group activity as writing sentence on smart board and leave space blank for missing verb to get children to choose which verb to make the sentence or other details a combination is of working together in group and to learn to help each other. And because of this their social skills get better through interaction and knowing the experience of working in group.

Group Activities

Robot can be used to engage a child in group activities and it is important for a child to notice an individual or an object and to get to know each other to interact with. Robot can play a part of being with the child as companion in the education setting. Having a robot in the classroom may allow a child to get to know the robot and to work together as a group to perform a task. Robot can be used to grab child attention back by calling the child name or by pointing out the child.

Participant 1 mentioned

I have to actually spent time with them so they start want to interact with me. In break time we played with children we played with train and I felt that devices we have to sort of try them to get them into were interested in trains so we could drive the train together but then you might lose the other ones you have pull them again and you have to be quite flexible with all of them

Participant 2 pointed out

We have groups in class they begin their day with a small assembly around a smart board with activities sing a welcome song then we have pictures of all children in the group on slides, we move the pictures on smart board to show which one will be next. We ask them to go to the board to move their own picture or to move others children. We use the same setting for teaching children preposition and it's easy to fit in a kind of learning situation where we start with one children sitting with and then the next person sitting next to them.

Structured learning

Participants 1 mentioned

There are lots of different situations in life where may be you have to walk step by step through situations even more in social situations.

A study based on highly structured robot based drama showed that children with ASD learn to understand the sequences and pattern of the social moment played by social robot then they identify the gestures made by the characters and later on they were able to incorporate those gestures in appropriate context (So, Cheng, et al., 2019).

Impact of social skills on ASD child personal life

Participant1 mentioned

It's quite important to teach actually social moments because otherwise it might be quite overwhelming for the child and attend tantrums which would be quite hard for the family and outings.

It is very important to work with all the arena of the child and family can take part in it by taking them in place or the routine work such the events regular in family to go shop or the park to have the sensory experience of it.

Participant 1 also pointed out

We had a child who freaked out every time when go to the dentist. We taught the child going to the dentist for a year first it was just to take the child in the dentist room and we have followed little step and one step at a time with symbols like what it is needed to do in

dentist treatment. First it was just going into the room and go out then sit on the chair and accept the light on the face. The process is long but it's very important because they have to get some health checkup throughout their life and then the family was very happy that the child could have teeth checked.

Participant 2 mentioned

Hmm of course I hope so if we can improve the communication and interaction with us and with the other students in the school then I am hoping those skills are but change anything. Some basic skills with regards to communication, general politeness or social skills we teach in school crosses over on how they interact at home.

There are some children with ASD can never wait for their turn, they cannot hold themselves if they have something to share or something to say. By teaching social communication a child can improve their level of patience, learn to wait and this can significantly impact their social and family life.

Participant 2 pointed out on teaching children patience

There is a child in my class who could never wait for turn also could never hold if something had to say and simply run to the person or shout at that person. Now the child has learn patience and parents said their child has improved which has changed their life lot and now they can go to restaurant together, and go to beach as family know that the child is safer which was not possible due to the child difficulties.

Imitation is another social communication and interaction skills which have greater impact on ASD children social life. By learning imitation ASD children improve self-esteem, they learn the importance of social activities, and they learn the importance of social activities and moreover it helps them to build relationship with others and make them feel as a part of the society.

On this point participant 2 mentioned

We have other child who like to imitate others as the child likes to see what others are doing and enjoying, so every Saturday this child go to the supermarket with family to get Saturday sweet(Norwegian tradition) or a bottle of coke or lemon aid. Though the child doesn't like to sweet of coke but every Saturday the child buys a small paper bag sweet and a bottle of coke and by doing this the child feel proud of being same as other children around him.

Imitation, eye gaze, communication and understanding feelings of others

Participant 1 expressed that teaching imitation with robot can be beneficial because children can learn many things by imitating others.

Participant 2 pointed out

we use imitation in the classroom a lot specially with speech, independent living skills by showing them what to do and how to do for example we show them how to organize their eating style from holding knife and fork to put the stuffs in the sink. So the children who are having difficulties to understand can directly copy us and learn by imitating others. We use Imitation to teach children language and social skills.

Participant 1 also shared that communication and feelings of others is very important because children with ASD will be in social environment. Imitation can be helpful in teaching language and a robot can be a great help as it can talk in group and tell them the meaning of the words and through imitation robot can point out body parts and pointing out different other objects. This can enhance children learning process and it might be motivating for the children learning with robot. In terms of teaching children to understand feeling of others by telling social stories and try to explain things beforehand and try to give them an overview of a situation and symbols would be helpful for children to understand more about feeling of others.

According to Participant 2 feeling of others can be challenging for children with autism as they don't see other students as individual, they only responsive to the adults in the class. They don't see other children in the class as people to interact with because of their communication difficulties. It varies from children to children as there are few children who actively try to have an eye contact with the person speak into and there are other students who are seemingly unaware of the person presence.

Level of autism

Participant 1 emphasized the importance of consideration of ASD children. Eye gaze in an important skills to learn to conduct social communication and this would be good for something but the children with autism might have other reasons for this problem so it is significant to understand the child problem. Also it is sensory experience for them and said that

Participant 1 mentioned

So the sensory experience cannot be too overwhelming and there are other medical reasons so many things that contribute that the child doesn't cope in social situation.

Instead it is needed to find out the core reason without expecting them to take part in. A child might not look straight at thing may be the child required to see things from an angle, this might not be because of autism.

Participant 1 mentioned

But it's actually brain disorder or might be others things like that so I think it important.

Participant 2 shared that the children with severe autism have difficulties and restricted to make concise choice of making an eye contact, to have an initiate a conversation or an interaction with the others. During learning imitation children with severe autism caught up in a pattern of behaviour and these patterns become detrimental for their progress. Fox example, if a child with severe autism start repeating the same phrase over and over again without understanding its meaning and without comprehending its uses in the right context, then a child would progress from their stage and also got stuck in the patterns of behaviour.

Participant 2 mentioned

> *Children with autism face challenges in self stimulation for instance holding an objects to their hand and we try patterns of behaviour so that the child can move away from their current stage. The challenges are setting the right balance of pattern behaviour as children with severe autism are unable to distinguish. Robot interaction with ASD children depend on the severity of the autism, there are some students who I hope and I imagine I am going to thrive in that setting they haven't interested they haven't excitement about new things or having a new way to learn or new activity.*

Children with severe ASD might take months to show any progress or show any signs of understanding what is happening around them. There are some children with autism can communicate actively, speak verbally, and use communication devices to write sentences to answers questions working with robot could produce instant results. Having a robot in class could be something very motivating for these children from the first day. On the other hand this could be very frustrating working with them for months and at the end child with severe autism have not shown any progress. It's even more complicated when working with an autistic spectrum in tremendous order.

Participant 2 mentioned

> *there is a whole branch of other variables of not only it's hard to neglect the effects of we don't know which variables are there if the children don't have the ability to communicate with everyone already and express where they have difficulty we don't necessarily see the response from a child for example there might be something the child finds unsettling or disturbing about the robot but they can't express that to us because they don't have the language skills or they are unconsciously aware themselves.*

It is possible to remove those things from the study group but the children with ASD is not an easy group to work with. The expert who are working with the ASD child for decades and some of them are working with some of the specific children for several years still they don't know

everything because the children with ASD cannot communicate all of the information with an adult or they don't understand all the information themselves.

Digital devices for communication

Several digital devices such as iPad, PC, different apps on iPad, interactive smart board to access resources on internet and Google search engine to look for information, YouTube videos, sign language apps, mobile phone to record students speaking in order to play back the audio to discuss with other teachers about children progress for all subjects and also for teaching ASD children to communicate with their peers and with adults. In addition children are using switches in cooking class to turn on and turn off equipment and some of them who have difficulty in verbal speech use simple prerecorded messages as Yes or No and they also use to convey others. To teach children speech digital devices are used to model the learning materials and some children liked technology based teaching which yield better results though there are others who prefer to work on paper.

Social Robot interaction with ASD child

Several children with ASD like technology.

Participant 1 pointed out

> *I suppose robot could give that kind of flashy light and positive reinforcement whatever it's called make like sounds or clap light flashes to train social skills.*

Robot may give extra support and it can be carried to the other person diagnosis the child and can be expand from this point. Robot can also be helpful to teach child imitation, by pointing out things for example body parts during word learning this could be motivating for the child. There are children who have special way to talk and there are other children may have sign language but use their own signs.

Participant 1 also mentioned

> *I think the robot needs to be prompt to get if it is like session of language input from the child the program needs to be very good in recognizing the child's works.*

Robots emotional capabilities to interact with human enhance human acceptability and trustworthiness on robots (Jeon, 2021).The robot needs to be very fine tuned with the child signals that comes from its body or there have to have an adult who needs to be very quick to help the child in terms of pronounce the word correctly or if the robot is not responding. The robot can get better if it can make less delay during communication with children. Also, the robot needs to have the response the child finds interesting like sounds, lights.

Participant 2 pointed out disagreement as

If the child has to say something and adult in the room the staff member has to then translate what the child has said to the robot and then the robot has to control by the adult in the room. This goanna make there are too many stages too complicated the children have enough difficulty having an interaction one and one with the person

Having a robot would be affective and measurably bigger if the robot can understand what the child saying and response directly, we have children with verbal speech difficulty and there are some students who use digital communication system to synthesize voice. Hopefully the robot can understand the digital communication system some children are using with synthesize voice and the robot can answer them. In a social interaction environment if we expect a robot is going to be involved, if an adult in the room has to control the robot responses and has to translate the what the child said to the robot to get an answer or to respond to the child

Participant 2 also mentioned

otherwise there is no difference between the child interacting with the robot and the child speaking to me, if they want to see the robot as a partner in communication then there has to be the fewest possible boundaries in a way between the child and the robot I think.

As per participant 2 there are several benefit to have a robot in classroom as the robot never gets tried, repeating signs and activity and always would be repeating in same activity same way the continuity or the best ability in the activity that the activity children aspect would be learning so using a robot in this way would be helpful to remove some of the variables which are yet unknown through reintroducing into learning. Hopefully, the robot might make learning easier for children. Also robot would be useful to give instructions for example to sit on a chair, it's your turn to speak now and activity based on multiple choice. For example robot ask the children option 1, option 2, option 3 which follows a pattern and this would be very flexible for the child to understand how the robot ask question and the child have a pattern what the robot is going to be asked

Participant 2 mentioned

Instead of expecting that the robot can speak can understand the whole Norwegian language they can just understand what the children say one, two or three words that kind of things for example.

Rewards with robot

Participant 2 mentioned

we found that when children come to work then they are not interested working for an edible rewards one girl who only wants high-fives or praise as reward and something the robot should definitely able to do.

Children with ASD respond positively with reward given by robots rather than the praises given by human educator (Kostrubiec & Kruck, 2020).

Interactive learning and role selection, imitation, joint attention (social skills) with social robot

Participant 1 said

Yeah, I think so, because the robot can be quite predictable

Robot facilitates children to practice any lesson or activity in a predictable environment and robot can be with students who requires more waiting time in comparison with other communication partner. It is suggested that trying out the robot with the children with ASD it may be useful to try it out with the stuffs beforehand who can imitate the child behavior quite well if in case there is any technical problem.

Participant 1 said

When you with the child try to check it out really well before because the technical problem could be overwhelming for the child

Robot can be helpful to teach children imitation by pointing out things like the robot put its hand on the head then the child put them and it is possible to expand from.

Participant 1 mentioned

That put your hands on head or command you could say where is the head you could build up I suppose the reinforcement, it would be like motivating for the child more in the beginning with the robot.

Robot can be also be beneficial to learn children in movement based activities, songs and stories with different learning steps.

Participant 2 mentioned robot can be used to

Humor, dancing, walking high five ", high fives are big one in my class".

Joint attention is another social communication way where robot can play a role

Participant 1 said about join attention

Joint attention I do think that the child would have more joint attention may be with the robot at points

Besides joint attention robot can be a motivational tool for children with ASD as they are very interested toward technology. Robot can assist them to practice the same lesson as many times as they need by tracking their progress and can provide them guidance to proceed which can be helpful for children to maintain their attention level on a task.

Participant 2 mentioned that it is important to decide which children would be in the group and their motivation, interest, attention

I worked with for example where autistic children who go into these groups have a measurable improvement in attention span and behaviour not just when they are in those groups when they are in other sessions, so I would hope if the robot works not just in the group the robot is there but then children is going to other lessons with other groups without the robot the same benefits would be transferred throughout the students in school.

The other side of introducing a robot in child education is that not all children are equally interested in robots, the robot is lack of emotion and this is one benefit for ASD children as they have difficulty in understanding people emotions.

Participant 2 said

so robot with a non-expressive face could be a benefit but it could also be those small differences mean that the child does not mean at all and focus is elsewhere may be they need that person even though they have difficulty they need someone with an actual face someone who can move, someone who can imitate them I don't know.

Impact of social robot interaction on ASD children family and peer

The impact of social robot in school can be extended to the other area of child life as Participant 1 mentioned that

I can imagine it would help because it would give like a systematic approach may be of trying things with robot then expand from there that it give the child predictability and may be you could use the same robot interaction at school and then at home.

It is difficult for the ASD child to generalize things and robot could be linking part if the sessions are carried out it different settings.

Moreover, robot interaction with children can improve their social interaction and leaning in school which they can carry later on their life and use those skills to have most normal life. The skills they will learn not only with the technology but they will improve being in the robot project thrive in all aspect of their life.

Participant 2 mentioned

I don't knot know I don't but if the as I said before where would be working with children on things like patience and concertation and taking turns if we can do that if the robot has the benefit with the children I am assuming that also helps to interaction with their family not just in school hoping.

Robot as an assistive tool

Participant 1 said

I think you have to use the robot as supplement you can't just use robot and just use technology. I think it has to be real sensory experience with that or real object if you want teach language or social skills.

The robot can be used as a part of introducing a subject, it can be an extra motivation and may be use it in group activities.

Participant 2 said

It just an another tool we still going to teach the children on the other way we are helping may be a but having a robot might be an extra boost in some sessions so that the students are be exciting something different in the class.

One child can first practice with robot then two child can work with same task together with the robot then children in groups can have social interaction with each other.

Robot can play a part in giving instructions

Participant 1 said

Instructions from the robot I think some children may take better because it always come at the same way. There is no personal variation as human staff have different personalities.

Participant 2 mentioned that robot can be a new teaching tool

It can be good try with something new like a robot, children can repeat the same activities and practice the same lessons over and over aging so it can be used to train them up. Hopefully it will cause to take a lead forward "so that I someone know who is very excited a typical year boy in my class who his parent told him about the robot project and he ask about the robot now a lot and I think he could be one of the best candidate.

5 Discussion

This chapter brings the research question, findings, participants experience and viewpoints, and background literature together by discussing whether the findings can answer the research question and what patterns can be identified within the findings. Next, this chapter revisits the theme identified from literature and the categories of qualitative data, employing them as a lens to see whether they apply to the case or need to be extended, reformulated, or these are not applicable at all.

5.1 Back to research question

Back to the research question, what factors of human robot interaction should be considered for designing lesson prototype?

The findings of this phenomena first indicate that it is important to consider the children with ASD and the challenges they face during their social communication and interaction. Children with ASD have difficulties to understand other emotions and lack of motivation in social interaction with their human communication partner. ASD children suffer through anxiety and face complexities to deal with human behaviour. In any social situation, ASD children are not able to see others as an individual and to involve them or get involve in social communication and interactions. These difficulties in social communication and interaction skills impact ASD children education and their social life as well.

To deal with the deficiencies present in ASD children's social communications and interaction skills researchers proposed to introduce a social robot in ASD children education. Social robots are very popular among researchers to study and incorporate a social robot to teach children social communication and interaction skills. Social skills are very important to learn for ASD children because they would be different social settings throughout their lifetime. Moreover, children with ASD have difficulty to interpret information by their own and then use those information in the correct social context. Therefore, social robots can be used to enhance their interaction skills with robotic features but it needs to consider several factors of child robot interaction to make lesson prototype. The very first and most important factor to be consider before presenting a robot in child education is that their level of autism as a high priority.

Researchers have categorized autism in three different levels from mild to severe. Individual with severe level of autism face higher degree of deficiencies in their social communication. And the

children with low level autism may actively interact with robot based lessons and feel motivated and interested in learning session conducted by social robot but the children who suffers through higher level of autism, they might not show any interest in robot-based learning. In addition, children with severe autism are not able to understand about their surroundings, they are not able to convey their feelings to others and don't feel any emotion for an individual. Presenting a robot to the child with high level of autism may be overwhelming and might be time consuming to have any effective results. Prosocial behaviour of low ASD child is significantly higher than the children suffered with high level of autism. It is mentioned in the result chapter, ASD has a broader spectrum of disorders that cause the same stimuli to produce different results.

The efficacy of assistive technologies in terms of social robots is enormous, and their implications in teaching children social communication and interaction have piqued the interest of social robot researchers. Since children with ASD have deficiency in learning adaptive behaviour, social robot can play an important role to help children to develop their social skills through offering restricted robotic behaviour and simplified way to present information to the children. During interaction with robot partner, children with ASD learn to interpret the social cues which help children to develop their interpersonal interaction skills.

There are a number of robot features associated with child motivation such as speech, movement, responsive towards child behaviour and able to conduct a meaningful interaction. The result of literature review shows that child motivation and interaction is higher with contingent robot and this is aligned with the qualitative data as participants pointed out the robot requires to be prompt to the child and need to able to acknowledge child works and the robot can provide notification to the child with lights or sounds. These features should be taking into consideration when designing lesson prototype. On the other hand, if an adult needs to control the robot or convey a messages every time they interact with the robot then it would be complicated for ASD children to maintain multiple stages of communication since children with ASD have difficulty in one to one interaction.

Children with ASD need a safe and systematic approach to learn social communication and interaction skills. They need a robot partner which can enhance their learning motivation and help them to hold their interest on the learning content and track their learning progress for future reference. ASD children are interested in robots due to its predictable behaviour. It is easier for an ASD child to interpret robot systematic and constant movements because robots are quite predictable and it can perform the same task as many times as the child require to and also maintain

the same approach to repeat the task. It needs to be considered when designing lesson prototype for children with ASD to have the features in their robot partner would be easier for them to learn.

ASD children show higher enthusiasm while they interact with their robot partner and they produce lower stereotype behaviour with robot interaction. According to empathizing-systemizing theory ASD children can easily learn through systematic learning platform and robot can produce better outcome as robot in nature is predictable, systematic, and repetitive and consistence in terms of communication and interaction. Robot can be helpful to tell social stories, play drama based on social situations and robots are able to produce similar gesture or emotions every time it plays the role of the drama and able to tell stories with exact tone or repeat the same stories several times. This systematic and structured way of producing different social activities should be talked into consideration when designing lesson for children with ASD to influence children to learn and to understand the patterns of sequences which would be easier for ASD children to remember and recall later in the appropriate situation or in social situations.

Imitation is another dimension of social communication and interaction skills and this plays a significant role in child life. Teaching children independent learning skills, language skills, and speech, social skills can be easily teach through imitation and robot can be used to point out different things form surround. Hence a robot should include this when designing lesson prototype to teach children imitation.

In addition robot can be beneficial as robot can show children many times how to do some tasks in certain way without getting tired in comparison to humans and it is also possible to avoid multiple human emotional cues. The consistency of repeating tasks for multiple time can be achieved better with robot intervention and a robot for ASD children should include this when designing lesson prototype.

ASD Children can practice narrative skills, interpersonal synchronization skills with a robot and they can actively engage to produce spontaneous interaction with robot partner as it causes them lower social and emotional load. In comparison to neurotypical children, they can learn from their environment, whereas ASD children require more care and effort to develop their social skills. They require reinforcement and needs to break down the whole task into smaller and attainable steps and a reward is highly appreciated when it comes from robot partner after accomplishment of each step of the task and ASD children prefer to have rewards in the form of waving hand, eyes blink, HI fives instead of any editable items. It is mentioned in the result chapter from qualitative data as children with ASD are more interested to have HI fives or praise as a reward rather than anything

else and robot can be used in this context. Hence, it needs to be considered when designing lesson for children with ASD.

Robots can be used as a social companion which can offer adequate time, patience, motivation to the child during learning and developing any social skills. Robot can be with the child during practice a lesson longer than any human partner, it is quite flexible in this regards as it never gets tried. A child might need more response time during group activities and robot can play the role of their social companion and can allow enough time to the child to response. A robot for ASD children needs to be considered when designing lesson prototype as it is important for ASD children to learn to engage in group activities, moreover the child can learn to develop their turn taking skills as children with ASD have difficulty to wait for their turn and allow time to others. Robot can be used to teach children joint attention which is an important skill to learn in terms of maintain social communication.

In the era of technology multiple digital devices are used to help develop ASD children social and communication skills. However, social robot plays the most important role because it's human like appearance, voice, verbal and nonverbal gesture influence children to engage physically in communication rather than individual interaction with screen based technologies. Moreover, participants pointed out several digital devices to conduct learning session such as iPad, PC, interactive smart board, different apps for playing videos, and additionally they used their own mobile phones to record children speaking in order to track children progress and to store those recordings for future references.

Robot can also be used as a supplement as another teaching tool, it might give an extra boost in some learning sessions and it needs to be considered when designing lesson for children with ASD so that the robot in education setting may facilitate educators to keep record of child works, to store a child's day to day progress and can be used to obtain an instant feedback.

In addition, a robot for ASD children should include this to track child's day to day activities, records their previous lessons in order to help them to recall the tactics they have used to achieve the task if the child stuck at any points. As a motivation robot can remind them of their previous achievement to boost their motivation towards learning. Robots can include to monitor and record a child's behaviour during specific task or during a specific time or specific day of the week, to track a child's activities, the child might show more interest in some lessons or they express more enthusiasm to learn new lesson in new way, the robot can record child's behaviour and give feedback to the teacher to prepare lesson. The robot would be beneficial for educators to manage

their time efficiently with the child and the robot can assist to make lesson plan to meet child interest day to day activities, teachers may set lesson plan to consider the motivation level of the child each day. Also, robots can be used as an extra support to provide more interactive lessons for those days' children are less motivated to work and getting instructions from robot would influence the child to participate.

6 Strength and Limitations

This study has concentrated on the human robot interaction factors to facilitate children with ASD to enhance their social communication and interaction skills.

6.1 Strength

This study has adopted the qualitative approach to learn more about factors involve in ASD child interaction with social robot. This facilitates to analyses the relevant published articles to highlight the existing themes on child robot interaction.

The strength of this study is the flexibility of qualitative research, as this thesis was planned to conduct a focus group interview later it is ended with a one to one interview. Author was able collaborate with the participant to collect qualitative data through in-depth interviews where participant shared their experiences and viewpoints about teaching children with ASD. It is required to mention that having a face-to-face interview allowed the author to understand that each participant has their unique voice.

Another strength of this study is that there is not much research on designing lesson prototype for children with autism. Thus, this study can give future researchers new light on this subject. Although this study was conducted in Norway, the findings of this thesis are applicable to any other country since ASD occurs worldwide regardless of the culture.

6.2 Limitations

The limited number of participants and time was the main constrain of this study. It was not possible to conduct focus group interview as expected at the beginning of this thesis. Due to the short time, finding more participants was not viable and thus only two individual interviews were conducted. Although the recruited school was very willing to help in this project, they reported to have a very busy schedule and asked for more flexibility in the type of interviews. Hence the change from focus group to individual interviews. In addition, language was another limitation. The interviews were conducted in English and the school ensured to provide only participants with good English level.

7 Conclusion

This study has concentrated on child robot interaction factors designing lesson prototype for introducing social robot in ASD children education. ASD children suffer through deficiencies in social communication and interaction skills and the level of their autism significantly impact their interaction with robot partner. It is evident from the above discussion that social robot helps an ASD child to enhance their social communication and interaction skills. However, it is more important to consider their autism level before expecting any positive effect from robotic intervention. Children with low level autism can find the robot as an interested tool to practice different lessons and robot's predictable and systematic approach to interact with child encourage the motivation to participate in several group activities with robot.

There are several dimensions of ASD children social communication and interaction skills mentioned in this thesis for instance: eye gaze, group activities, imitation, joint attention, narration skills, interpersonal synchronization skills, language skills, understanding feelings of others, turn taking, waiting for turn, patience. And these skills have great impact on ASD children social and family life. ASD children can practice all these skills with their robot partner and the robot can offer them to have allocated amount of time by repeating the task several times with consistency. Robot can motivate a child with rewards and children with ASD are very interested to get reward from a robot.

This qualitative study first walked through background literature regarding level of ASD in children, social robot features, children and robot interaction factors, ASD children social communication and interaction dimensions. Next, features of social robot and its interaction factors associated with ASD children as the theme based grounds for data collection and analysis followed by presenting the ROSA (Robot-supported education for children with ASD) project. Then the research method with research approach, data collection, data analysis, limitations, issues related to validity was presented. Next, considering the research question, the factors of child robot interaction when designing lesson prototype reported. The findings indicate that in the case ASD children interaction with robot in terms of teaching children social communication and interaction skills is a strategic move with many benefits, including systematic approach to present a lesson, predictable steps make easier for ASD children to cope with robot partner, repetitive, lower emotional load, motivation, patience, and the importance to take into consideration when designing lesson robot based lesson prototype. To design robot based lesson prototype for ASD children is not without challenges, as presented followed by its benefits. Those challenges are the

unknown variables for children with higher ASD to interact with robot and level trust issue, the robot needs to be responsive automatically to the child and it should interact with directly without being controlled with an external devices or any individual. Otherwise, ASD child might lose their motivation to interact with. It was also presented the factors influential for ASD children with low level autism and their interested towards robot to take into consideration when designing lesson prototype.

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9 Appendix A Interview Guide

Introduction:

Information about research project

Information about the rights of the participants, including the privacy rights

Information about the way data is being stored

Information about the recording

Start recording

1. Background

i. How long have you been working with ASD children?
ii. What is your teaching subject?
iii. What level do you teach?
iv. Do you have experience of using information technologies during teaching lessons/classroom, and if so what are those technologies?

2. Emotion, Social and Communication Skills

i. What is social communication of ASD child means to you?
ii. What do you think about an ASD child's deficiencies such as imitation, eye gaze, communication, and understanding the feelings of others?
    1. Can you give some aspects of those?
iii. How do you influence a child in terms of group activities to interact with their peer? Can you give some examples?
iv. Does social communication have any impact on the child life, relationship with family and peers?
v. Are there any other aspects of the ASD child's social skills that you would like to highlight?

3. Importance of Human robot interaction

i. What do you think could be achieved by introducing social robot in child education?
ii. Do you think a social robot could help to achieve some goals, for instance, establishing an interactive learning session, including role selection?
iii. Do you expect any impact of social robot on child interaction, relationship with family and peers?
iv. For instance, how might social robot impact the interaction, learning and imitation states of the child?
    1. Can you give some examples?
v. Is there anything more to add?

4. How can information technology help?

i. Do you think robot can be an assistive tool for teaching children with ASD? How?

ii. What do you think is needed from a robot to create child-oriented digital lesson? What type of instructions would be useful for a child from a robot based learning besides human teacher instructions?
iii. What kind of activities do you think the child might like from a robot or expect from a robot?
iv. Do you think robot can reduce the gaps regarding social communication deficiencies such as imitation, joint attention?
v. What could a robot help you the most with during teaching?
vi. Suppose you have the infrastructure, systems, and human resources to construct digital lesson. How do you imagine the outcome of the intellectual progress of the child would be in the future?
vii. Is there anything else you would like to add about how a robot can help?

5. Ending

i. Anything else to add?
ii. Turning off the recording
iii. Again giving information about the participants rights
iv. Asking if sh/e has any consideration

10 Appendix B

Are you interested in taking part in the research project "Enhance social communication and interaction skills of children with ASD"?

This is an inquiry about participation in a research project where the main purpose is to investigate robot-supported language development for children with Autism Spectrum Disorder (ASD). In this letter we will give you information about the purpose of the project and what your participation will involve.

Purpose of the project

A master project in the Department of Business, Marketing and Law at the University of South-Eastern Norway, intends to investigate robot-supported language development for children with Autism Spectrum Disorder (ASD). The project is linked to the Robot Supported Education for children with ASD (ROSA) project. Robots are promising as an assistive tool for enhancing social interaction and empowering learning capability in children with ASD. Social robots are well-known in the field of child education because they improve children's learning abilities by providing personalized lessons and individual progress reports. Children with ASD may have poor social communication and interaction skills, and social robots can help bridge the gap and influence their participation through an interactive and personalized learning platform.

Who is responsible for the research project?

University of South-Eastern Norway is the institution responsible for the project.

Why are you being asked to participate?

We are interested in researching what factors of human robot interaction should be considered for designing a lesson prototype. You are asked to participate if you work with children with ASD, work in a primary or secondary school, and speaks Norwegian, English or Bengali.

11 What does participation involve for you?

Participation in the study means to participate in a focus group (also called group interview) with a researcher. The interview will take approximately one to two hours and it will be conducted in English or Bengali. During the interview, we will ask you about your experience on working with children with ASD and about what factors you take into account for teaching children with ASD. The interview will be audio recorded. There is no need for personal information in this research and we will use your response for analyzing the results. Your information will be registered electronically in a data register that only the project group members have access to.

Participation is voluntary

Participation in the project is voluntary. If you chose to participate, you can withdraw your consent at

any time without giving a reason. All information about you will then be made anonymous. There will be no negative consequences for you if you chose not to participate or later decide to withdraw.

Your personal privacy – how we will store and use your personal data
We will only use your personal data for the purpose(s) specified in this information letter. We will process your personal data confidentially and in accordance with data protection legislation (the General Data Protection Regulation and Personal Data Act).

All personal information will be treated confidentially. Your name and contact information will be replaced with a code stored in a separate name list separate from other data. Only anonymous information will be published from the project. It shall not be possible for the participants to be recognized in any publications or other media that come out of the project unless specifically agreed.

What will happen to your personal data at the end of the research project?

The project is scheduled to end 31.08.2022. Then all links between personally identifiable information and your answers will be shredded.

Your rights

So long as you can be identified in the collected data, you have the right to:

- access the personal data that is being processed about you
- request that your personal data is deleted
- request that incorrect personal data about you is corrected/rectified
- receive a copy of your personal data (data portability), and
- send a complaint to the Data Protection Officer or The Norwegian Data Protection Authority regarding the processing of your personal data

What gives us the right to process your personal data?

We will process your personal data based on your consent.

Based on an agreement with University of South-Eastern Norway, Data Protection Services has assessed that the processing of personal data in this project is in accordance with data protection legislation.

Where can I find out more?

If you have questions about the project, or want to exercise your rights, contact:

- University of South-Eastern Norway via Veralia Sánchez by email Veralia.g.sanchez@usn.no or telephone +47 35 57 53 6.
- Our Data Protection Officer, Paal Are Solberg by email (Paal.A.Solberg@usn.no), or by telephone +47 35 57 50 53
- Data Protection Services, by email: (personverntjenester@sikt.no) or by telephone: +47 53 21 15 00.

Yours sincerely,

Project Leader (Veralia Gabriela Sánchez)

Student (Rokeya Akter Rumky)

Consent form

I have received and understood information about the project Enhance social communication and interaction skills of children with ASD and have been given the opportunity to ask questions. I give consent:

- ☐ to participate in focus group (also called group interview)
- ☐ that audio recording are made
- ☐ that anonymized data can be used in reports, master thesis and articles from the project.

I give consent for my personal data to be processed until the end date of the project, approx.31.08.2022

(Signed by participant, date)