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Telepresence robotic technology support for social connectedness during treatment of children with cancer

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Abstract

Children with cancer experience fragmented school attendance during treatment. Telepresence robots that connect them with school during treatment periods were explored through an intervention involving participant observation followed by semi-structured interviews from 2020–22 with children with cancer, their class teachers, and classmates. We used an abductive approach, inspired by the Agential Realism theory and Situational Analysis. The use of telepresence robots in education enables hospitalized children to actively participate in real-time social activities with their classmates. However, consistent monitoring is necessary

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to ensure the success of this integration process as the classmates can lose interest in providing support to a child with cancer.

KEYWORDS

childhood cancer, education, sociality, telepresence robots

INTRODUCTION

During cancer treatment, children can experience high levels of school absenteeism, with rates reaching up to 40%. This absence threatens their social connectedness and exposes them to the risk of isolation and subsequent psychosocial challenges (Helms et al., 2016; Lum et al., 2019; Sandeberg et al., 2008). They are more than twice as likely to experience socioemotional distress compared with healthy peers (Lum et al., 2019). Staying connected with school during hospitalization can support the child in maintaining a sense of normalcy and connectedness and can alleviate school re-entry difficulties post-treatment (Galan et al., 2021; Pini et al., 2013). Furthermore, social interaction with peers is a key factor influencing the child's academic and social development (Helms et al., 2016). While telepresence robots promise to facilitate social connectedness remotely, knowledge is sparse regarding how they specifically facilitate children with cancer while under treatment to participate in social and academic activities (Fletcher et al., 2023; Page et al., 2020; Weibel et al., 2020).

Teachers are essential mediators in ensuring children's social inclusion and well-being at school, however, it is unclear how they can meet the socioemotional needs of children with cancer during treatment (Galan et al., 2021; Helms et al., 2016). Studies suggest that school reintegration programs and supportive interventions before returning to school benefit children with cancer (Bonneau et al., 2011; Galan et al., 2021; Ingersgaard et al., 2021) but few evidence-based interventions exist that facilitate peer support or school re-entry (Helms et al., 2016). Regular contact with peers during treatment can also reduce the apprehension of returning to school (Ingersgaard et al., 2021; Petersen et al., 2022; Wilkie, 2012). In Denmark, the child with cancer's academic development during treatment is satisfied through homeschooling; however, it cannot replace peer-mediated school experiences that offer bonding and social connectedness and normalcy (Danske-Patienter, 2016; Retsinformation, 2014).

Telepresence robots are increasingly used to support children not present in the classroom to overcome school-related problems by facilitating their virtual presence in the classroom (Fletcher et al., 2023; Newhart et al., 2016; Schouten et al., 2022; Weibel et al., 2020). Telepresence robots are designed to allow the remote user to control the robot's "body" (movements and features) in a specific environment. However, telepresence robots differ in mobility features, allowing the user to opt for varying ways of interacting (Newhart & Eccles, 2020).

Teachers and classmates often personalize the telepresence robot by, for example, naming it after the child and in younger classes, even dressing it up or building it a house (Page et al., 2020; Weibel et al., 2020). One study comparing students using telepresence robots to videoconferencing in school indicates that the telepresence robot users felt more socially present due to the

self-control (manually controlling) offered by that technology (Schouten et al., 2022). However, Schouten et al. (2022) state that students using telepresence robots feel equated because of the robot-mediated communication.

Studies suggest that telepresence robots provide a sense of happiness and social presence for homebound children (Newhart et al., 2018; Newhart & Eccles, 2020), and as such reduce feelings of loneliness and ease school re-entry for them (Johannessen et al., 2022; Soares et al., 2017). However, negative experiences with using telepresence robots have also been reported (Newhart et al., 2016; Powell et al., 2021; Weibel et al., 2020). Findings from Weibel et al. (2020) for example, show how incongruence between the children's and class teachers' expectations and understanding of telepresence robots can lead to disappointment. Further, Newhart et al. (2016) report how bullying can occur via telepresence robots.

Studies show how using new telepresence robot technology meets with scepticism among class teachers (Gallon, 2019; Johannessen et al., 2023; Weibel et al., 2023). Sceptics expect the technology to have additional features (Weibel et al., 2023) and see them as a threat to the ideology of being physically present in school and bounded institutions (Johannessen et al., 2023). However, Weibel et al. (2023) show that teachers are willing to allocate additional resources to encourage telepresence robot usage, as they see them as potentially instrumental in reducing absenteeism in homebound children (Weibel et al., 2023).

THEORETICAL BACKGROUND

This study is inspired by Karen Barad's Agential Realism theory (Barad, 2007). Barad (2007) emphasizes the entanglement of material and discursive aspects of material-discursive practice. In addition, temporality (time) and spatiality (space) are considered quantities that have transformative effects on how a phenomenon for example, telepresence robots, comes into existence. A myriad of times thus shapes the present and impacts how meaning or matter is created through material-discursive practice (Adrian, 2016; Barad, 2007; Hein & Søndergaard, 2020). As such, Barad denotes that everything (human and non-human) has agency and works together. In this approach, human existence is formed by complex intra-actions between human and non-human (materiality, spatiality, temporality) forces. Barad's theory of Agential Realism is used in this study to explore contextual intra-actions. Barad creates an understanding of phenomena as relational quantities that are only temporarily separated from each other. The concept of interaction assumes that entities exist before the interaction and are seen as separate and delimited. Conversely, intra-actions refer to entities that do not exist before an intra-action but are constructed and sustained through them (Barad, 2007; Plauborg, 2018). Intra-actions do not imply that, for instance, a child was not that child before the intra-action, but rather that the child's position and behaviour come into existence in specific ways under certain circumstances, for example when intra-acting with the telepresence robot (Hein, 2012; Hein & Søndergaard, 2020). This study uses intra-action to explore how children and classmates intra-act via telepresence robots.

Inspired by Agential Realism, materiality had a prominent place in the interview guide and participant observation notes focused on human (children with cancer, classmates, and teachers) and non-human (e.g., telepresence robots, tables, spatiality, and temporality) forces and their relationships (Barad, 2007; Hein, 2012).

In this study, the concept of social connectedness refers to a subjective evaluation of meaningful relationships with others and a sense of belonging to a group (O'Rourke & Sidani, 2017).

AIM

To explore how telepresence robots can support social connectedness in hospitalized children with cancer, their classmates and class teachers and to explore intra-actions through telepresence robots.

METHODS

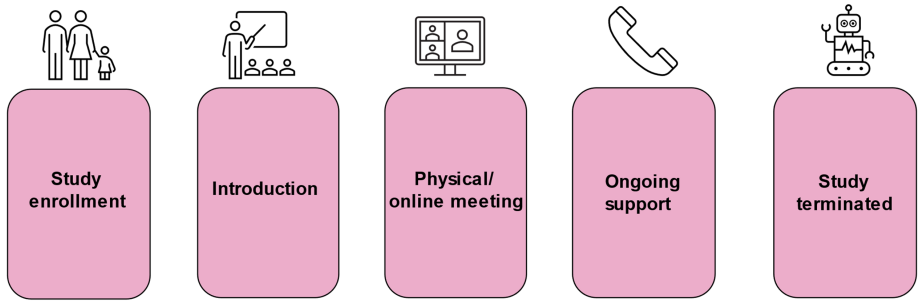
Study design

This qualitative study is part of a multimodal intervention study exploring experiences of children with cancer with telepresence robots during treatment. Data were analysed through an abductive approach based on the Agential Realism theory and a Situational Analysis (Barad, 2007; Hein, 2012; Tavory & Timmermans, 2014).

The telepresence intervention model used in this study is illustrated in Figure 1.

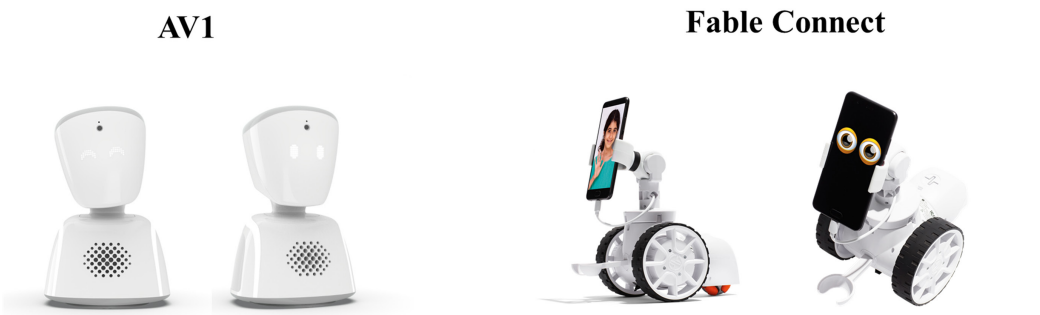
Telepresence robots

The child with cancer connects remotely to an AV1 or Fable Connect system (as illustrated in Figure 2) through an application on a tablet that interfaces with the telepresence robot located in a classroom (see robot functionalities in Figures A1 and A2 in Appendix A). And 14 robots (7 AV1 and 7 Fable Connect) were used in this study. In 2020, children with cancer only tested and reviewed the AV1 robot as the Fable Connect was only in its design phase. From January 2021, seven Fable Connect robots were made available to the study. From that point onward, the



1. Study enrollment: Eligible hospitalized children with cancer and their parents received oral and written information about the study, in acceptance, the included children received a telepresence robot, a study specific tablet, and technical advice.
2. Introduction: At the child's school, teachers, classmates and their parents received oral and written information about the use of telepresence robots. Further, setting up the telepresence robot and educating the teachers on the telepresence robot functionalities and providing technical advice in the school/class.
3. Physical/online meeting: A physical or an online meeting establishing the mutual expectations of the telepresence robot intervention was conducted between the child with cancer, their parents, and teachers.
4. Ongoing support: Technical advice and support during the intervention period was provided.
5. Study terminated: Study participation was terminated when the child did not use the telepresence robot regularly or attended school on a regular basis (had returned to school).

FIGURE 1 The telepresence intervention model used in this study. [Colour figure can be viewed at wileyonlinelibrary.com]



The AV1 (No-isolation, 0560 Oslo, Norway) can rotate, display emotions with its eyes, raise a hand, and have two-way audio communication. AV1 has one-way video communication so the child can see the classroom but not the other way around.

The Fable Connect (Shape Robotic, 3520 Farum, Denmark) can move around through remote command, shows emotion with its eyes (Fable eyes), raises a hand and has two-way audio and video communication so that the child and class can see and hear each other. The child can switch off the camera and only use the Fable eyes as nonverbal communication..

FIGURE 2 The telepresence robots AV1 and Fable Connect. [Colour figure can be viewed at wileyonlinelibrary.com]

AV1 and Fable Connect were randomly assigned to the children. The same random assignment process occurred whenever a child returned a robot.

Setting and participant recruitment

This study and intervention were conducted from January 2020 to September 2022 by the University Hospital of Copenhagen (Rigshospitalet). The telepresence robots were placed in several Danish elementary-, middle-, or high schools. All hospitalized children were offered instruction at the hospital school. The children's school attendance was fragmented due to treatments, medical examinations and countering side effects. Between treatment cycles, the children were discharged and could attend their regular school or be homeschooled.

Based on convenience sampling, the study inclusion criteria were: (1) school-aged children (5–18 years of age); (2) a diagnosis of cancer or a cancer-related disease; and (3) more than one day of school absence per week during treatment. The criteria for exclusion were: (1) limited Danish language skills; or (2) cognitive disorder. Convenience sampling conducted at the University Hospital of Copenhagen (Rigshospitalet) was used to recruit children with cancer and the Study nurses approached potential participants directly. In total, 38 children fulfilled the eligibility criteria, of whom 31 accepted participation. Seven children declined participation since they were already attending classes via video services like Teams or Google Meet or were unwilling to participate in classes via a telepresence robot. Whenever a child returned a telepresence robot, a new child fulfilling the inclusion criteria was included in the study. The children with cancer had a telepresence robot for 2–18 months, depending on their treatment trajectory. Hours of school attendance via the telepresence robot varied among the children, depending on their illness/treatment, willingness to participate, COVID-19 restrictions or arrangements made between the school and the children/families.

Based on convenience sampling, class teachers ($n = 30$) and classmates ($n = 118$) were recruited via the participating children's schools. Prior to establishing the telepresence robot

process in each participating child's classroom, permission was sought to conduct interviews with the class teacher and classmates (Table 1).

Data collection

To ensure a nuanced understanding, the varying perspectives and faceted descriptions of the children's genders, ages, and diagnoses were included in the study. In addition, the different types of telepresence robots used and a multi-faced data collection (interviews, focus group interviews, participant observation) were also included. With respect to the sample, one limitation of the study is that only one child with central nervous system tumours was included; an important subset of children with cancer who tend to face the most education-related problems (Koch et al., 2004).

Semi-structured interviews with children with cancer and their class teachers were conducted to provide insight into thoughts, feelings and experiences with using telepresence robots, in a psychosocial intervention (Tanggaard, 2015). Focus group interviews with classmates were used to capture values and experience variations (Halkier, 2015). Open-ended questions (as illustrated in Table 2) provided the children with cancer, their classmates, and class teachers the opportunity to elaborate on how telepresence robots impacted school connectedness of children with cancer (Table 3).

A total of 139 semi-structured interviews were conducted from January 2020 to September 2022.

All included children with cancer were interviewed at least once. For each of the 29 children with cancer included in the study, one class teacher and 2–6 classmates participated in the

TABLE 1 Participant descriptions.

	Children ($n = 31$)	**Classmates ($n = 118$)**	**Teachers ($n = 30$)**
Sex			
Female	11 (35%)	55 (47%)	20 (67%)
Male	20 (65%)	63 (53%)	10 (33%%)
Age			
Age at interview (median, range)	11 [7–17]		
Grade			
Elementary school (5–10 years)	9 (29%)	36 (31%)	9 (30%)
Middle school (11–13 years)	8 (26%)	46 (38%)	8 (27%)
High school (14–18 years)	14 (45%)	36 (31%)	13 (43%)
Diagnosis			
Haematological diseases	24 (78%)		
Extracranial solid tumours	6 (19%)		
Central nervous system tumours	1 (3%)		
Telepresence robots			
AV1 users	17 (55%)		
Fable Connect users	14 (45%)		

TABLE 2 Examples of open-ended questions in the interview guide.

Research question	Child	Classmates	Teachers
How can telepresence robots support the social relationships of children with cancer and classmates across different contexts?	How do you think your classmates perceived you when you participated through the telepresence robot? How does it feel to experience class life through a robot?	What is it like having XX in the classroom on a telepresence robot? Do you think robots can help children with long-term illness? What can telepresence robots help with?	How do you think the child felt when he / she participated through his / her robot? Do you think robots can be a social support for children with cancer? If so, can you give an example?
Which intra-action processes can be identified when children with cancer participate in school through telepresence robots?	Can you describe your regular school day? What did you do with your classmates through the robot?	Can you describe a normal school day in which XX participated via the robot?	Can you describe a normal school day in which XX participated via the robot? What did he/she do?

TABLE 3 Overview of data collection.

Participants	Data collection tool	Number of participants	Re-interview	Time	Number of interviews
Children with cancer	Semi-structured interviews	31 children	21 child interviews	7–31 min	52
Classmates	Focus-group interview	118 classmates	13 focus group interviews	8–32 min	43
Teachers	Semi-structured interviews	30 teachers	14 teacher interviews	9–45 min	44

interviews. One class teacher interview and one focus group interview with classmates did not occur due to a practical issue or to COVID-19 restrictions. All interviews were audio-recorded and lasted 7–45 min (mean = 15 min). Interviews with the children with cancer were cut short if there were any signs of fatigue or if the child lacked concentration. Teachers and classmates were interviewed in line with their availability. When interviewing was only possible during a break or a lesson, then the session was brief. As such, repeated interviews became necessary to achieve a more in-depth understanding from respondents.

The children with cancer were interviewed at home ($n = 1$), in the hospital ($n = 29$) or through audio recorded telephone interviews due to COVID-19 restrictions ($n = 1$). Interviews were conducted with class teachers and classmates in 28 Danish schools. Five class teacher interviews were audio-recorded via telephone due to COVID-19 restrictions or for the convenience of the participant. All focus group interviews with classmates were held at school and were gender balanced. Interviews with the children with cancer were performed by first author MW or by a study nurse. Focus group interviews with classmates and interviews with class teachers were performed and moderated by first author MW and co-author SS or a member of the research group. All interviews were conducted in Danish and later translated into English by a native medical writer.

Participant observations were used to note social interactions between the child with cancer and their class teachers or classmates, whenever the child attended school remotely through the telepresence robot. Observations made it possible to capture verbal and nonverbal communication, artefacts, architecture, and symbols (Szulevicz, 2015). During these sessions, attention was paid to the following: how classmates intra-acted with the child through the robot; how the child with cancer intra-acted through the robot; what opportunities the child had to position him/herself in the class via the robot; and how the classroom layout affected the child's sense of inclusion (Barad, 2007). A total of 19 h of participant observation was undertaken by first author MW in nine classrooms, from September 2021–June 2022. Field notes were taken during each session and structured afterwards. The field notes were divided into descriptions and analytical reflections.

Data analysis

Nina Hein's combination of Adel Clarkes' Situational Analysis with perspectives from poststructuralist and new materialistic thinking (Clarke, 2005; Hein, 2018) inspired the study. This analytical approach gives insight into complex dynamics where the subject is not exclusively the centre of the analysis. In this approach, non-human agentialities example, telepresence robots, are performative and have agency (Hein, 2018; Hein & Søndergaard, 2020). This approach was relevant in exploring how telepresence robots support social connectedness in hospitalized children with cancer.

In Situational Analysis, a situation e.g., is affected by multiple forces that intra-act and give meaning to how things played out. This analytical approach describes a situation under focus and how meaning is constructed and re-constructed (Clarke, 2005; Hein & Søndergaard, 2020). Clarke (2005) Situational Analysis comprises varied types of analytical maps: messy maps; situational maps; social worlds/arenas maps; and positional maps. Clarke uses these maps to strengthen the structure and classification of the data. Inspired by Hein's (2012), approach and Clarke's Situational Analysis with perspectives from poststructuralist and new materialistic thinking the present study only used Clarke's first level of maps, for example the Messy map that prevents analysis from closing prematurely. The Messy map notes all elements from the empirical data that are seen as filtered forces that intra-act and create meaning in response to the research questions (Hein, 2012). The collective intra-actions depicted in this map can deepen understanding the effects and consequences of intra-actions in specific situations (Hein & Søndergaard, 2020).

The study analysis was initiated by coding the recorded and transcribed interviews and field notes in Nvivo22. First author MW then read the transcribed texts using several cycles of coding, after which the first author MW and co-authors HBL and SS coded and discussed the transcripts and agreed on code definitions and later assigned meaning units to ensure the reliability of the coding frame. Our research question shaped the coding process. Next, the study research questions were centrally positioned in the Messy map (see Figure 3), and the provisional themes from the coded data encircled each question. This allowed connections to form between numerous forces (elements) from the empirical data (individual interviews, the focus group interviews and participant observation notes) that address the research questions (Hein, 2018). The Situational Analysis helped to focus the analysis on the relationships between different forces (human and other) and how they achieve agency through each other (Hein, 2018). Next, using an abductive approach, we placed the phenomenon (social connectedness through telepresence robots) in a new theoretical context to achieve a deeper understanding of it (Tavory & Timmermans, 2014).

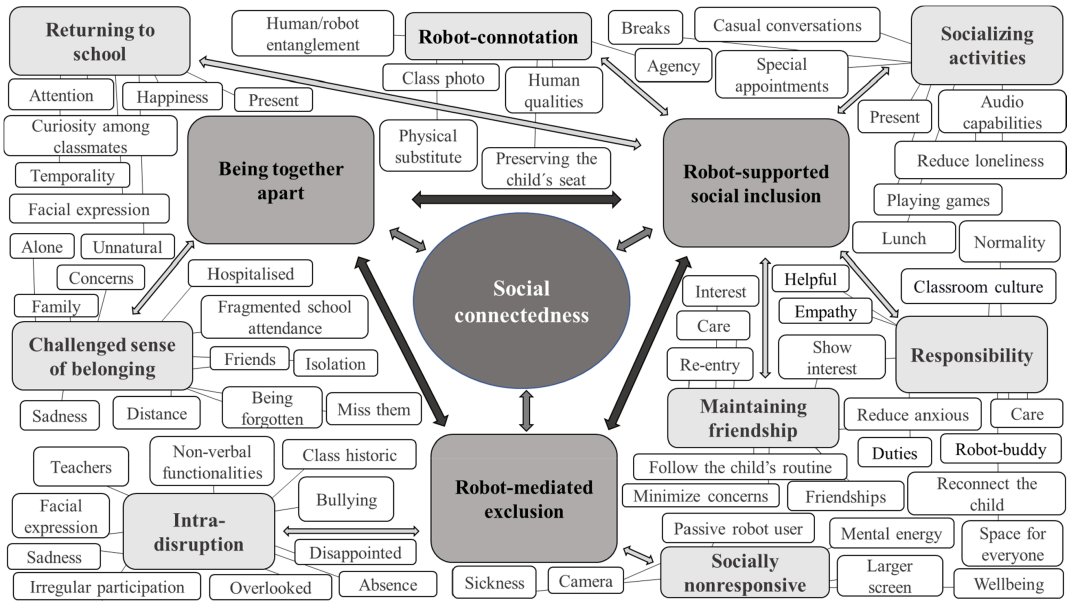


FIGURE 3 Messy-Map.

Themes and subthemes were developed and characterized by patterns, theory, and similarity. Specific representative situations from the data were identified for use in the analysis. The analysis and Messy map development was considered complete when all nuanced descriptions of the research questions were exhausted.

ETHICS

The study follows the Declaration of Helsinki II guidelines and was assessed by the Regional Ethics Committee of the Capital Region (file. H-19008107) and approved by the Danish Data Protection Agency (VD-2019-276). All participants provided written informed consent; with parents providing consent for a child under the age of 15. All personal data were treated confidentially, and all participants had the option to withdraw from the study at any time. For confidentiality purposes, detailed participant descriptions in the study are not provided and all names are pseudonymized.

FINDINGS

The data were divided into two groups during the coding process, for example, social connectedness and telepresence robot didactic. The connectedness aspects are presented in this article whilst the telepresence robot didactic findings will be discussed in a future paper. The analysis resulted in three themes and eight subthemes. The first theme, "Being apart together" presents the child's emotions that intra-act with having a cancer diagnosis and expectations of using a telepresence robot as a social tool that can bring him/her together from a distance with classmates

and teachers. The next theme, "Robot supported social inclusion" explores the intra-actions and dynamics that enforce social inclusion. The last theme, "Robot-mediated exclusion" explore intra-actions and forces contributing to exclusionary situations.

In the following sections, the children with cancer are referred to as the children, their classmates as classmates, and the class teachers as teachers (Table 4).

Theme 1: Being together apart

Challenged sense of belonging

The children explained how their disease posed long hospitalization periods or isolation at home; which impacted their ability to be present in the classroom. Fragmented school attendance created a void in their social life with classmates and led to loneliness, sadness and decreased well-being.

> "You start feeling really sad and miss them [classmates]. It feels like you're suddenly all alone... but with your parents." (Child, Elementary school, AV1 user).

They described the shift from regular school life to being alone with parents as difficult because they lacked the daily social and academic experiences. Similarly, the classmates described missing the child and that his/her absence raised questions about the child's well-being.

> "We really miss him [child with cancer] when he's away." (Classmates, Elementary school, Fable Connect user).

The children, their classmates and teachers explained how they saw the telepresence robot as a tool to bridge distance between them and the child and allow the latter to participate in their everyday lives. The children described how direct online streaming offered a new option for continuous communication with classmates:

> "You can see each other [through the robot]. When you can't see each other, it very quickly turns to not remembering each other." (Child, Elementary school, AV1 user).

TABLE 4 Themes and subthemes from the analysis.

Themes	Subthemes
Being together apart	Challenged sense of belonging
Robot-supported social inclusion	Returning to school Robot-connotation Maintaining friendship Socializing activities responsibility
Robot-mediated exclusion	Intra-disruption Socially nonresponsive

The teachers reflected on how the long periods of school absence caused the child to be forgotten by the school community and explained how the robot's spatial placement in the classroom helped to keep the child constantly in mind.

> "(..) I think so because, unfortunately, too much happens in their shared lives, and when one is absent it can quickly turn to 'out of sight, out of mind'... I hope that this [arrangement] can provide a way of keeping him close and in the class's collective mind." (Teacher, Middle school, Fable Connect).

The children's, classmates' and teachers' feelings and concerns thus intra-act while they perceive the robot as a tool to bridge the distance between them.

Theme 2: Robot-supported social inclusion

Returning to school

The children highlighted different aspects of attending school virtually by using the telepresence robot, including the opportunity it provided of seeing the facial expressions of their classmates, hearing their familiar voices and speaking with them. They recalled how happy and connected they felt on the first day that they used the robot. They also reflected on how the robot created a curiosity among their classmates that sometimes generated additional unwelcome attention and that made their presence feel unnatural.

> "It was weird [the first day back]. (..) Because I was not really used to doing it. (..) Everyone said: "What? Luna is a robot!" (Child, Elementary school, Fable Connect user).

As stated in the above citation and in others, the child and robot formed an entangled entity that caused some of the children to feel objectified. The classmates informed that it had been a long time since they last saw the child, and many wanted to speak with him/her and explore the robot's functionalities. To make the first day feel safer and fun for the children and their classmates, several teachers described using facilitative activities that supported telepresence attendance. For instance, one teacher made an obstacle course for the child to practice his navigational skills with the Fable Connect robot. Others informed having scheduled time to allow the child to speak about life at the hospital or to demonstrate the robot's functionalities.

From an Agential Realism perspective, the telepresence robot is considered a materiality with agency and that creates meaning for the children by allowing them to reintegrate into their class community. However, the intra-action between the child, the telepresence robot, and their classmates or teachers reinforce the sense of presence and safety on the first day back at school.

Robot-connotation

Classmates and teachers described the telepresence robot as personifying the child in the classroom. They addressed the robot using the child's name or giving it another personification. They waved to it, touched it, carried it around and included it in the annual class photo.

> Classmate 1: "He was also a part of our class photo [via the robot]".
>
> Classmate 2: "Yes. Then he was placed on Sofie's [classmate] lap." (Classmates Elementary school, Fable Connect user).

The entanglement of the child with his/her robot offered an opportunity to maintain a spatial place in the class photo for the child.

The children confirmed that acceptance by classmates and teachers of the telepresence robot allowed them a sense of social presence and they felt happy when being online.

> The teacher enters the class. The AV1 robot is charging on a table at the back of the classroom. She looks at the AV1 robot and says: *"Hi Emma"* and smiles at the robot. A classmate gets up and approaches the robot, picks it up and says: *"Hi Emma, now I will put you at your* [usual] *place."*. An X on the table marks the spot where the robot should be placed (Participant observation notes, Elementary school, AV1 user).

The telepresence robot was the physical substitute for the absent child in the classroom. It had its own desk on which a classmate automatically placed it. The anthropomorphism of the robot made teachers reflect on the need for a desk and chair for the absent child, to make their presence feel more natural in the classroom. The desk can be seen as materiality that enhances the child's presence and positions him/her as an "ordinary" student.

> " (..) I think it was clever of her [child with cancer] not to only use TEAMS but to have a representative in the form of a robot that could position her in the classroom." (Child, High school, Fable Connect user).

Teachers explained the importance of the child being placed next to a friend during class to make him/her feel more comfortable. Classmates described how they sometimes forgot about the child prior to introducing the telepresence robot. They added that placing the robot in the classroom acted as a reminder of the child's presence. The telepresence robot was the materiality that created an option for the child to maintain presence despite physical distance.

Personification of the robot was highlighted during participant observation in the classroom.

> *"Will you take the robot?"* asked Anders [classmates] and looked in my direction [first author MW].
>
> *"Yes, Magnus [the child with cancer] doesn't need it anymore"*, I replied.
>
> Another classmate, Mikkel, interrupted, *"Can we keep it?"*
>
> *"What, the robot?"* I asked.
>
> Mikkel and Anders both nodded. *"No, I have to take it with me"*, I replied and smiled at the boys.
>
> *"Can we keep the wrapping?"*, asked Anders.

"Are you sad that we are getting rid of it?" I asked.

"Yes, it was nice having it in the class", Mikkel replied.

"It will be much better to have Magnus back", their teacher interrupts.

"Yes, but we would like to keep them both." Anders added.

(Participant observation, Middle school, AV1 user).

In this instance, the classmates did not want to return the telepresence robot as they cared about it and found it fun to have in the classroom.

In the intra-action between classmates, the telepresence robot and the remotely connected child, the robots become a physical representation of the child, and is given personal properties. The personification of the robot is further created through intra-action with other materialities, example, tables and chairs, that promote, personifying and positioning the child as a regular student in the class.

Maintaining friendships

The children with cancer explained the challenge of maintaining friendships with classmates, claiming that treatment periods disconnected them from their daily conversations and activities. They indicated that the telepresence robot reduced the challenge by enabling them to communicate regularly with classmates. One child explained how he created new friendships in the class through the robot and compared this with making new friendships through online computer gaming.

> "There was a new guy who joined the class named Andreas. I've near never seen him in person; only once, I guess. (..) Well, it's like when you play computer games [online] and you meet new friends." (Child, Middle school, Fable Connect user).

The robot mediated intra-action facilitated the child in establishing friendships from a distance. Similarly, classmates explained how the telepresence robot allowed the child to speak with the entire class and stay connected.

> "Now that the robot is here, everyone says hello to him [child with cancer] and asks how he's doing, etc. but if he were to completely disappear then I think there wouldn't be as many [kids] wanting to talk with him." (Classmates, High school AV1 user).

Reaching out to the child during treatment was described as challenging for classmates, if they were not close friends. The classmates reflected on how the telepresence robot allowed them to have easy access to the child and to ask about their well-being, say hello, wave to him/her, and invite the child to different activities. It allowed classmates who did not usually interact with the child to show interest and empathy. The classmates described how the robot allowed them to follow the child's cancer treatment and routines and thus better understand the child's life at the hospital. This minimized

their concerns about the child's health, as intra-action via the robot assured them that the child was feeling well on that day. A teacher explained how the classmates were anxious about contacting the child before the telepresence robot was introduced because they were unsure how to act around the child.

> "He [child with cancer] had the possibility of saying hello to his friends. He spoke with them and updated them on his status – for instance 'This is what's going on and this is what I look like...' He lifted some of their anxiety about contacting him." (Teacher, Middle school, Fable Connect user).

Teachers explained how the telepresence robot supported the child's re-entry to the class during and after treatment.

> "(..) It [the telepresence robot] should be understood as a social tool that enhances participation. One has a feeling of being together over there [in a different location]. It is the lesson that draws them together and [the robot] allows you to continue follow it. [It prevents] being absent for a few days and returning totally confused. And then there is the social aspect ... keeping up with what's going on." (Teacher, Middle school, AV1 user).

The telepresence robot had agency in the classroom, as it allowed updates for classmates and teachers regarding the child's health status and hospital routine and thus facilitated their intra-action with the child.

Socializing activities

The children, classmates and teachers explained how the telepresence robot created opportunities for the child's social inclusivity whereby the child could participate in activities during school breaks, including casual conversations, playing in the schoolyard, going to the shopping mall, and playing games (card games, hide-and-seek, and tag).

> "They took me out on breaks, for example.
>
> "Hey, do you want to go with us to the store?"
>
> "Yes, of course".
>
> So, they took me with them to the store... it was really fun. It's those kind of small, fun things [that matter]." (Child, High school, Fable Connect user).

Not all children participated in school breaks. Some had difficulty connecting to a cellular network, leaving the robot without WiFi when in the schoolyard. Others had trouble hearing what was going on because of too much background noise, rapid movements or they did not want to participate because they felt like an outsider observing others' activities. To compensate, some classes arranged that a few classmates stayed inside with the child (via robot) during breaks.

Social activity also occurred during lessons.

> Sebastian [child with cancer] and Leo [classmate] made funny signs to each other through the Fable Connect robot. Sebastian took out a banana and pretended to shoot Leo with it. *"Bang, Bang"*, he said. Leo laughed and pretended to be shot in the stomach. The two boys laughed. *"What are we doing?"*, asked Sebastian and laughed loudly. (Participation observation, Middle school, Fable Connect user).

A spontaneous social intra-action incident arose during a lesson. The child and his classmate played with each other. During that incident, the child was able to position himself in the class and found the opportunity to still have fun despite the distance and his illness. When the children participated in groupwork, the telepresence robot also created an opportunity of having informal conversations about everyday life:

> *"Mathias [classmate], do you want to play when you are off school?"* asked Frederik [child]. *"Yes, we can do that"* answered Mathias. *"Are you going to football practice today?"* Frederik asked. *"Yes"*, said Mathias. *"You're lucky"*, said Frederik. (Participant observation, Middle school, AV1 user).

The children explained how they liked the opportunity of inviting and being invited to school social activities as this made them feel part of their class. The telepresence robot provided the flexibility among the children to arrange playdates.

From an Agential Realism perspective, the telepresence robot can be seen as a means for the child to maintain contact with classmates during treatment. Temporality in this context can be understood as a force that impacts the contact, as both parties already have existing knowledge about the other that also potentially impacts the intra-action.

Responsibility

The children explained how they depended on classmates to help them to be online. For example, classmates carried the telepresence robot around the school; switched on the robot before each lesson; invite them to participate in break activities. In some classrooms, the teacher assigned specific classmates as 'robot buddies', who then assumed responsibility for it. Despite the variation in tasks assigned by each school, all fulfilled a unique and helpful role in supporting the child when online.

> The time is 07.55 hrs. The teacher goes up and spins a wheel [illustrating duties the students are assigned], after which she states that Charlie [classmate] will be responsible for the telepresence robot that day. *" Charlie, will you go get Mike* [child with cancer*] from the cupboard?"*. Charlie gets up, opens the cupboard, takes the AV1 robot out and places it between two classmates. (Participant observations, Elementary school, AV1 user).

The classmates were assigned different everyday duties, including tidying up, fetching milk and being a robot buddy. Everyone shared the duty of looking after the child and the robot. Teachers explained how responsibility for the robot could benefit classmates and created an opportunity for them to be seen as good and thoughtful friends.

> "(..) It gave some of Annas's closest friends a [meaningful] role. Anna is a good student they got help from her and in return they provided emotional support to her. (..) It's important for everyone to have a place/seat and voice in the class. I think that the robot acted as a visual reminder of Anna's place/seat. (..) the robot helped make it clear that here we take care of each other and there is room for Anna, for me and you... all of us." (Teacher, High school, Fable Connect user).

The presence of the robot in the classroom created a narrative that there was room for everyone and that we must take care of each other. Further, teachers described how the class culture requires tweaking when a child participates via a telepresence robot.

> "I think that while he was online, they [classmates] were really good about not talking or disturbing. I think they were more aware of the fact that it could be difficult for him to hear what was being said if they made too much noise (Teacher, Elementary school, AV1 user).

The telepresence robot's spatial placement in the class can alter the class culture. In the above citation it is the background noise that prevents the child from hearing what was happening in the room and strategic placement of the telepresence robot positively impacted how teaching was done and how teachers, classmates, and the child intra-acted.

Theme 3: Robot-mediated exclusion

Intra-disruption

Participation via telepresence robot can sometimes be more excluding than inclusive. The children described how teachers sometimes forgot to switch the robot on or when online, overlooked their presence. The children spent time and effort preparing to participate in class, and when teachers forgot to switch on the robot, they felt disappointed, disconnected, and excluded from the class. The teachers were also aware of this issue.

> "It proved to be a challenge to use it [the robot] correctly. I think that it was a challenge for us because he really didn't participate enough and [moreover] we went and forget about [using] it." (Teacher, High school, AV1 user).

The teachers explained the challenges of getting the telepresence robot set up and working, especially if the child participated irregularly in class. The teachers highlighted the need for agreement on when and in which lessons the child would participate. The children further explained how their presence via the robot at the start of the intervention had created excitement and attention but, over time, the robot became part of the environment and made the classmates and teachers forget the child's presence.

> "At first, they [classmates] appeared to be very interested. Everyone asked about it but not long afterwards, it suddenly seemed that I [via the robot] was no longer present but became just another piece of furniture. If I said something no-one would reply." (Child, High school, AV1 user).

This child reflected on how classmates and teachers did not notice her when she was online and led her to feeling disconnected. The teacher explained how a child's class history and social position in the class could influence the potential success of using the telepresence robot.

> "She's [child with cancer] not the type to be good friends with everyone. Not at all. She's always been a little reclusive ... perhaps that's a little harsh. Perhaps that is also why it was a little difficult using this mode [robotics] of participation. I believe it would have been different if one was more popular in class." (Teacher, High school, AV1 user).

Teachers suggested that telepresence robots might not be the best solution for children who have a marginalized position in the class. From a teacher's perspective, class history (temporality) can affect the child's social inclusion via the telepresence robot. The temporality, example, the child's class history and social position, can thus be considered as forces that intra-act with the child's opportunities to position him/herself via the robot. Additionally, the children and teachers reflected on situations during which a child using the robot felt bullied.

> "*Dane [child with cancer] repeatedly felt that a few in the class, just for fun, put a finger over the camera so he couldn't see anything.*" (Teacher, Middle school, Fable Connect).

To avoid exclusionary situations, the teachers reflected on the importance of the children providing regular feedback to them about their robot experiences.

Socially nonresponsive

Social connectedness through telepresence robots required teachers to think of new ways to encourage social inclusion and challenges with robot-mediated intra-actions. Teachers explained how conversations with the children were taxing when they could not see their facial expressions.

> "(..)Yes, I do believe that it was a challenge for him because only his closest schoolmates took the time to sit and chat [with him] via the robot. You see, the fact that you can't see him but only the robot ... many don't feel like doing that. It takes a lot for other students to hold a conversation in that way because they can't see his facial expressions or gestures." (Teacher, High school, AV1 user).

This teacher explained how the child was passive when online, affecting the classmate's enthusiasm for the telepresence robot. They described how classmates lost interest in talking with the child if they were verbally inactive or non-responsive via the robot. The teachers explained that telepresence communication called for additional mental energy from the classmates, as they did not always get verbal or non-verbal responses from the child. Teachers suggested that the telepresence robot should have more non-verbal functionalities, example, eyes that could blink, allowing the children to respond non-verbally. This could potentially benefit children who did not like to speak aloud. Teachers further reflected on the difficulty of establishing social relationships with students via a robot.

> "I personally think that it's difficult to establish a relationship between her and me via a robot. Occasionally, I also feel that it's hard to establish a relationship between her and the other students and I can't quite judge whether it succeeded or not" (Teacher, Middle school, AV1 user).

The teachers explained the importance of establishing solid teacher-student relationships prior to initiating a telepresence robot intervention. Knowing the child's personality was a prerequisite because the teachers must understand how to interact with each child. As one teacher explained:

> "I think that it's important that there is a pre-established relationship between the teacher and the child. I have a hard time imagining [how the intervention could go] having a new child in the class or a change in teacher." (Teacher, Middle school, AV1 user).

The teachers also reflected on how some classmates found it odd interacting with a friend via a telepresence robot. In some classes, the teachers facilitated social activities and mediated conversations between the child and their classmates to make interactions feel more natural. Additionally, the teachers and classmates underscored how they would have preferred that the AV1 robot had a camera so they could see the child. Classmates added how they sometimes felt they were talking to someone else if they could not see the child's face. In contrast, classmates and teachers acknowledged the opportunity that a one-way camera offered a sick child:

> "I think Christian is happy that we can't see... that his friends can't see just how sick he really is but that he can just remain the old Christian. He really did look ill with dark circles under his eyes, and all swollen because of the steroids he had to take. That would have scared them away." (Teacher, Middle school, AV1 user).

Teachers further reflected on how the Fable Connect camera offered them a possibility to observe how well the child looked. However, they described how it would be beneficial if the Fable Connect had a larger screen that clearly captured all the child's facial expressions in more detail. The children assigned the Fable Connect robot agreed that it was nice to have a camera they could switch on and off. Some explained the benefit of using the Fable eyes if they had to vomit or suddenly felt sick. Those assigned the AV1 robot had varied attitudes towards using a camera. Some embraced the inability to show their faces; explaining that they were embarrassed because their disease had caused their appearance to change. They were relieved not having to worry about whether to opt for the camera or not. Others pointed to the importance of showing their face to facilitate more natural intra-action in the class.

DISCUSSION

This study explored experiences with using telepresence robots to support social connectedness in hospitalized children with cancer, their classmates and teachers, and more specifically intra-actions via telepresence robots. This study demonstrates that using telepresence robots can create inclusive situations that promote and encourage social connectedness and can reintegrate children with cancer into their school community. However, the results also show that telepresence robots can aggravate exclusionary situations, promoting a feeling of being forgotten

or overlooked. It is notable that being included or excluded is situationally dependent for all children.

Søraa et al. (2021) found that robot designs, e.g., size, mobility, and materials, significantly influence children's perceptions. A central study finding is how the telepresence robot became the personification of the child and this facilitated inclusivity. The classmates and teachers tinkered the robot by, for example, addressing it by the child's name, patting it and including it in the annual class photo. Likewise, Søraa et al. (2021) shows how children have positive perceptions of the AV1 telepresence robot, with most children finding the robot to be "cute". This present study show that the robots had agency, as the mutual entanglement between it (non-human materiality) and the child's (human) personality benefited the child's social positioning in the class (Barad, 2007). The human qualities attributed to the robots further encouraged the classmates to think more about the child during his/her treatment. Schouten et al. (2022) similarly found that students using telepresence robots compared with video conferencing experienced a stronger feeling of social presence. This study also shows how the telepresence robots increased the children's sense of social connectedness and that the spatial presence of the robot in the classroom created inclusive processes. These findings are in line with those of Newhart and Eccles (2020). Conversely, this study shows how some children felt disconnected while using the telepresence robots and how some classmates described how they did not feel that the telepresence robot personified the child if it did not have a camera or if the child was a silence robot user. Likewise, Schouten et al. (2022) argues that robot interactions may underplay humanlike qualities. The present study shows how classmates can lose interest in speaking with the child if the latter was passive when online. Thus, the lack of a robot user's verbal response decreased humanlike qualities and demoting the robot to being dehumanized materiality in the class. This underscores the need for telecommunication that supports children and their classmates with difficulties intra-acting when using telepresence robot technology.

The present study results provide new knowledge about how the children and their classmates felt connected when using the telepresence robot in the class. Findings by Powell et al. (2021) also confirm that telepresence robot participation reduces distress and school related anxiety. Helms et al. (2016) and Ingersgaard et al. (2021) argue that school re-entry programmes can strengthen the classmates' knowledge about the child's cancer disease, leading to less fear about and a more positive attitude towards children. The study demonstrated how telepresence robots allowed the children to maintain friendships with classmates and facilitated playdays. The teachers used various activities to increase the social presence of the child and togetherness with classmates. For instance, including the child in academic and social activities, encouraging classmates to interact with the child during breaks, maintaining the child's desk in the class, facilitating conversations, and assigning robot buddies. The findings reinforce prior study results showing that the telepresence robot cannot facilitate inclusion on its own (Ahumada-Newhart & Olson, 2019; Weibel et al., 2020). This study shows that situational conditions, example, class social history, illness status, technology, teachers/classmates, spatiality, all influence the child's experience of inclusion.

Conversely, the present study's intervention demonstrated how the telepresence robot can have the opposite effect by causing exclusion in some situations as confirmed in findings by Powell et al. (2021) and Newhart et al. (2016). For example, the present study shows that the teachers sometimes forgot to switch on the robot, causing the absent child to feel overlooked and disappointed. This is similar to the finding by Powell et al. (2021) that telepresence robots sometimes intensify the sense of disconnectedness. This study highlights the need for more transparency about when and which classes the child will attend remotely. This will also ensure

that teachers remember the child and activate the robot. It is understood that the child's remote school attendance must remain flexible during hospitalization. Similar to Newhart et al. (2016), the present study confirms that the children in some class situations felt bullied while online. The entanglement of the child's personality with the robot made teasing personal, and this aspect must be taken seriously. As the children have a limited array of actions available to them through the telepresence robots, adult supervision is necessary to avoid exclusionary situations from occurring. Another study finding was that the child's social position in the class influenced the potential of the telepresence robot. Accordingly, new students or children, using the robot and who have exclusionary positions in the class, may require higher facilitation. This study emphasizes the need for a holistic understanding of the child, their classmates and the teacher's situation prior to introducing telepresence robotic technology.

Poor WiFi and cellular network connectivity and audio capabilities as well as lacking cameras limited the children's use of the robot during breaks. This finding is supported by Ahumada-Newhart and Olson (2019) and Powell et al. (2021) and Johannessen et al. (2022) and underscores the importance of ensuring stable network connectivity and audio capability. Non-human forces such as cellular networking, WiFi and audio have agency in the school as they can reduce the children's ability to be actively social in the classroom and on breaks. This is similar to findings by Johannessen et al. (2022) that show poor internet connection as problematic for engaging in conversations that requires responsivity. This study highlights that optimal connectivity must be ensured when using telepresence robots in school settings.

The research shows that prolonged school absenteeism negatively influences peer relationships and nearly 50% of children with cancer experience social, emotional, or school-related problems when returning to school (Helms et al., 2016; Winterling et al., 2021). This study demonstrates how telepresence robots can be a supportive social intervention tool for children with cancer prior to returning to school in person.

Agential Realism contributed to understanding social connectedness as influenced by many impacting forces that intra-act and create opportunities or limitations for the child's sense of inclusion or exclusion. In addition, Agential Realism helped to focus the analysis on all the non-human forces intra-acting in the child's environment (Barad, 2007; Hein, 2012). This study advocates how the human forces, that is, classmates and teachers, influence the children's experience of social inclusion like the classmates' ways of intra-acting with the telepresence robot, teacher-student relationships and the teachers' social pedagogical initiatives. Non-human forces also intra-act example, robot features, WiFi, spatiality, temporality (class history). However, Agential Realism has been criticized for its focus on the many impacting forces and possible shift away from the subject (Rosfort, 2012). Nonetheless, according to Barad, Agential Realism should not be understood as a write-off of the subject but rather as a support to understand the subject as a multi-facetted phenomenon (Juelskjær & Schwennesen, 2012).

CONCLUSION

The findings of this study contribute to the literature regarding how telepresence robots can benefit children with cancer and their classmates. During cancer treatment, telepresence robots enable the children to remain connected with their classes but using this technology in that setting requires close monitoring and mediation as classmates can lose interest in interacting with it. Further research is needed on telecommunication support for children and classmates who find it difficult to

intra-act via telepresence robot technology. This study exemplifies the need to rethink how children undergoing cancer treatment in hospital or at home can maintain their presence in the classroom.

AUTHOR CONTRIBUTIONS

Mette Weibel: Contributed to the concept/design, data collection, data analysis and manuscript drafting. Sofie Skoubo: Contributed to the concept/design, data collection, data analysis and manuscript drafting. Kjeld Schmiegelow: Contributed to the concept/design, data analysis and manuscript drafting. Inger Kristensson Hallström: Contributed to the concept/design, data analysis and manuscript drafting. Hanne Bækgaard Larsen: Contributed to the concept/design, data analysis and manuscript drafting. All authors provided final approval of the published version. Hanne Bækgaard Larsen and Mette Weibel holds overall accountability for the work; ensuring that questions related to the accuracy or integrity of all parts of the work were appropriately investigated and resolved.

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CONFLICT OF INTEREST STATEMENT

Rigshospitalet has been involved in the development process of the Fable Connect robot. As such a cooperative agreement was established between the involved parties (Rigshospitalet and Shape Robotics) to ensure transparency and independence. The agreement states that Rigshospitalets research group owns the publication rights for alle research results and has no financial gain from the collaboration. Further, the Company No Isolation has contributed to the funding of co-author Sofie Skoubo's Ph.D. project “My Avatar.” An agreement on the Industrial Ph.D. project was established between the involved parties (Aarhus University; Public Health and No Isolation) to ensure transparency and independence in the research project.

DATA AVAILABILITY STATEMENT

In compliance with Danish legislation and approvals obtained for the current study, audio-recordings and written transcripts will remain unavailable to protect and ensure participant privacy and confidentiality. Other information can be requested from the corresponding author.

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REFERENCES

Adrian, S. W. (2016). *Nymaterielle teorier: Karen Barad*. Hans Reitzels Forlag.

Ahumada-Newhart, V., & Olson, J. S. (2019). Going to school on a robot: Robot and user interface design features that matter. *ACM Transactions on Computer-Human Interaction*, *26*(4), 1–28.

Barad, K. (2007). *Meeting the universe Halfway*. Duke University Press.

Bonneau, J., Lebreton, J., Taque, S., Chappe, C., Bayart, S., Edan, C., & Gandemer, V. (2011). School performance of childhood cancer survivors: Mind the teenagers! *The Journal of Pediatrics*, *158*(1), 135–141.

Clarke, A. E. (2005). Doing situational maps and analysis. Situational analysis grounded theory after the postmodern turn. *SAGE Publications*, *26*(4), 553–576.

Danske-Patienter. (2016). *Skoleliv med sygdom: Hvilken støtte får børnene? En rundspørge blandt forældre*.

Fletcher, M., Bond, C., & Qualter, P. (2023). User perspectives of robotic telepresence technology in schools: A systematic literature review. *Educational Psychology in Practice*, *39*, 117–134. https://doi.org/10.1080/02667363.2022.2155932

Galán, S., Tomé-Pires, C., Roy, R., Castarlenas, E., Racine, M., Jensen, M. P., & Miró, J. (2021). Improving the quality of life of cancer survivors in school: Consensus recommendations using a Delphi study. *Children*, *8*(11), 1–11. https://doi.org/10.3390/children8111021

Gallon, L. (2019). *Using a telepresence robot in an educational contex*.

Halkier, B. (2015). Fokusgrupper. In S. T. L. Brinkmann (Ed.), *Kvalitative metoder og tilgange* (pp. 121–135). Hans Reitzels Forlag.

Hein, N. (2012). *Forældrepositioner i elevmobning., Institut for Uddannelse og Pædagogik (DPU)*. Aarhus Universitet.

Hein, N. (2018). *Situationsanalyse: forældrepositioner i elevers mobning som eksempel*. Samfundslitteratur.

Hein, N., & Søndergaard, D. (2020). *Social Theory and Health Education* (pp. 56–70). Routledge.

Helms, A. S., Schmiegelow, K., Brok, J., Johansen, C., Thorsteinsson, T., Simovska, V., & Larsen, H. B. (2016). Facilitation of school re-entry and peer acceptance of children with cancer: A review and meta-analysis of intervention studies. *European Journal of Cancer Care*, *25*(1), 170–179.

Ingersgaard, M. V., Fridh, M. K., Thorsteinsson, T., Adamsen, L., Schmiegelow, K., & Bækgaard Larsen, H. (2021). A qualitative study of adolescent cancer survivors perspectives on social support from healthy peers—a RESPECT study. *Journal of Advanced Nursing*, *77*(4), 1911–1920.

Johannessen, L. E. F., Rasmussen, E. B., & Haldar, M. (2022). Student at a distance: Exploring the potential and prerequisites of using telepresence robots in schools. *Oxford Review of Education*, *49*(2), 153–170.

Johannessen, L. E. F., Rasmussen, E. B., & Haldar, M. (2023). Educational purity and technological danger: Understanding scepticism towards the use of telepresence robots in school. *British Journal of Sociology of Education*, *44*, 703–719. https://doi.org/10.1080/01425692.2023.2203360.1-17

Juelskjær, M., & Schwennesen, N. (2012). *Intra-active entanglement—An interview with Karen Barad*. Copenhagen University.

Koch, S. V., Kejs, A. M., Engholm, G., Johansen, C., & Schmiegelow, K. (2004). Educational attainment among survivors of childhood cancer: A population-based cohort study in Denmark. *British Journal of Cancer*, *91*(5), 923–928.

Lum, A., Wakefield, C. E., Donnan, B., Burns, M. A., Fardell, J. E., Jaffe, A., Kasparian, N. A., Kennedy, S. E., Leach, S. T., Lemberg, D. A., & Marshall, G. M. (2019). School students with chronic illness have unmet academic, social, and emotional school needs. *School Psychology*, *34*(6), 627–636.

Newhart, V., & Eccles, J. (2020). A theoretical and qualitative approach to evaluating Children's robot-mediated levels of presence. *Technology, Mind, and Behavior*, *1*, 1–30.

Newhart, V., Warschauer, M., Jones, M., & Eccles, J. (2018). *Telepresence robots improve social connectedness for homebound pediatric patients*.

Newhart, V., Warschauer, M., & Sender, L. (2016). Virtual inclusion via telepresence robots in the classroom: An exploratory case study. *International Journal of Technologies in Learning*, *23*(4), 9–25.

O'Rourke, H. M., & Sidani, S. (2017). Definition, determinants, and outcomes of social connectedness for older adults: A scoping review. *Journal of Gerontological Nursing*, *43*(7), 43–52.

Page, A., Charteris, J., & Berman, J. (2020). Telepresence robot use for children with chronic illness in Australian schools: A scoping review and thematic analysis. *International Journal of Social Robotics*, *13*, 1281–1293.

Petersen, N. N., Larsen, H. B., Pouplier, A., Schmidt-Andersen, P., Thorsteinsson, T., Schmiegelow, K., & Fridh, M. K. (2022). Childhood cancer survivors' and their parents' experiences with participation in a physical and social intervention during cancer treatment: A RESPECT study. *Journal of Advanced Nursing*, *78*(11), 3806–3816.

Pini, S., Gardner, P., & Hugh-Jones, S. (2013). The impact of a cancer diagnosis on the education engagement of teenagers - patient and staff perspective. *European Journal of Oncology Nursing*, *17*(3), 317–323.

Plauborg, H. (2018). Towards an agential realist concept of learning. *Subjectivity*, *11*, 322–338.

Powell, T., Cohen, J., & Patterson, P. (2021). Keeping connected with school: Implementing telepresence robots to improve the wellbeing of adolescent cancer patients. *Frontiers in Psychology*, *12*, 749957.

Retsinformation. (2014). *Bekendtgørelse om sygeundervisning for elever i folkeskolen og visse private skoler*.

Rosfort, R. (2012). Different kinds of matter(s) – Subjectivity, body and Ethiscs in Barad's materialism. In *Kvinder, Køn & Forskning*. Copenhagen University.

Sandeberg, M., Johansson, E., Bjork, O., & Wettergren, L. (2008). Healthrelated quality of life relates to school attendance in children on treatment for cancer. *Journal of Pediatric Oncology Nursing*, *25*(5), 265–274.

Schouten, A.,. P., Portegies, T.,. C., Withuis, I., Willemsen Lotte, M., & Komala, M.-D. (2022). Robomorphism: Examining the effects of telepresence robots on between-student cooperation. *Computers in Human Behavior*, *126*, 106980. https://doi.org/10.1016/j.chb.2021.106980

Soares, N., Kay, J. C., & Craven, G. (2017). Mobile robotic telepresence solutions for the education of hospitalized children. *Perspectives in Health Information Management*, *14*(Fall), 1e.

Søraa, R., Nyvoll, P., Grønvik, K., & Serrano, J. A. (2021). Children's perceptions of social robots: A study of the robots pepper, AV1 and Tessa at Norwegian research fairs. *Ai & Society*, *36*, 205–216.

Szulevicz, T. (2015). *Deltagerobservation*. Copenhagen Hans Reitzel forlag.

Tanggaard, T. B. (2015). Interviewet: samtalen som forskningsmetode. In Tanggaard STBL (Ed.), *Kvalitative metoder: En grundbog* (pp. 29–54). Hans Reitzels Forlag.

Tavory, I., & Timmermans, S. (2014). *Abductive analysis: Theorizing qualitative research*. Chicago University of Chicago Press.

Weibel, M., Nielsen, M. K. F., Topperzer, M. K., Hammer, N. M., Møller, S. W., Schmiegelow, K., & Bækgaard Larsen, H. (2020). Back to school with telepresence robot technology: A qualitative pilot study about how telepresence robots help school-aged children and adolescents with cancer to remain socially and academically connected with their school classes during treatment. *Nursing Open*, *7*(4), 988–997.

Weibel, M., Skoubo, S., Handberg, C., Bertel, L. B., Steinrud, N. C., Schmiegelow, K., Hallström, I. K., & Larsen, H. B. (2023). Telepresence robots to reduce school absenteeism among children with cancer, neuromuscular diseases, or anxiety—The expectations of children and teachers: A qualitative study in Denmark. *Computers in Human Behavior Reports*, *10*, 100280.

Wilkie, K. (2012). Absence makes the heart grow fonder': Students with chronic illness seeking academic continuity through interaction with their teachers at school. *Journal of Special Education*, *36*(1), 1–20.

Winterling, J., Delilovic, S., Dervish, J., Gunarsson, M., Åhström, M., & Hasson, H. (2021). Exploring experiences of implementing standardized cancer patient pathways within investigatory units—a qualitative study. *BMC Health Services Research*, *21*(1), 933.

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APPENDIX 1

THE AV1 TELEPRESENCE ROBOT

The AV1 telepresence robot

AV1	
Face screen	✗
Speaker	✓
One-way camera	✓
Two-way camera	✗
Display emotions	✓
Rotate (360°)	✓
Drive	✗
Raise a hand	✓
Passive mode	✓
Two-way auditive communications	✓
User, assistant and admin app	✓
Head movement (up and down)	✓
Battery time	8 hours
Price	3.224 euro

FIGURE A1 Functionalities of AV1. Adapted from Weibel & Skoubo et al. (2023).

THE FABLE CONNECT TELEPRESENCE ROBOT

The Fable Connect telepresence robot.

Fable Connect	
Face screen	✓
Speaker	✓
One-way camera	✗
Two-way camera	✓
Display emotions	✓
Rotate (360°)	✓
Drive	✓
Raise a hand	✓
Passive mode	✓
Two-way auditive communications	✓
User, assistant and admin app	✗
Head movement (up and down)	✗
Battery time	6 hours
Price	579 euro

FIGURE A2 Functionalities of Fable Connect. Adapted from Weibel & Skoubo et al.(2023).