"I Don't Want Parents to Watch My Lessons" – Privacy Trade-offs in the Use of Telepresence Robots in Schools for Children with Long-term Illnesses

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ABSTRACT

Telepresence robots offer great opportunities for children with long-term illnesses to continue attending school. Consequently, they are already used if children are absent for long periods. When designing such systems, the privacy of various stakeholders must be considered. However, conflicts often arise because the privacy requirements of different user groups cannot be fulfilled simultaneously. In this paper, we analyze the corresponding trade-offs that have to be made when designing telepresence robots under conflicting privacy requirements. We analyzed previous literature and held three workshops with different user groups (children, parents, teachers, head teachers, media educators, and supporting personnel) with and without experience with telepresence robots in schools. Based on the literature and the workshop results, we present four major privacy trade-offs we identified and discuss design approaches for them. With this work, we contribute to the design research on telepresence robots in schools by revealing the major privacy-related conflicts and potential design approaches to overcome the conflicts.

CCS CONCEPTS

• **Security and privacy** → Human and societal aspects of security and privacy; Usability in security and privacy; • **Human-centered computing** → Human computer interaction (HCI).

KEYWORDS

Telepresence, Robot, School, Design, Privacy

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1 INTRODUCTION

Since the COVID-19 pandemic, working from home has increasingly become part of our understanding of normality. The same applies to school lessons from home, especially for children who are struggling with long-term illnesses. Telepresence robots are one way of making lessons as interactive and immersive as possible for the children concerned. However, with this increase in freedom of action and increasing insights into lessons, the possibility of violating the privacy of individual actors also increases. People may not want to share their data or personal information with the telepresence robot, and they may not want to be filmed or interact with the child behind the telepresence robot. There are also reasons for the ill child at home not to show itself, or to avoid a conversation on the school grounds in order to maintain its social privacy. When these different needs co-occur, situations with potential for conflict arise that require a solution that respects the needs for privacy of all parties involved.

In this paper, we present four design trade-offs for private telepresence robot usage, which we derived from literature and empirical work. We understand privacy design trade-offs as relevant and legitimate but diverging privacy interests of different stakeholders in a certain situation. In such situations, the privacy interest of one group cannot be easily served without ignoring or violating the (privacy) interest of the other group, as both weigh equally. If, for example, in a phone call situation, one person wants others to reveal their caller ID to decide whether to answer the phone or not, and the other person does not want to reveal their identity generally for privacy reasons, we end up in such a trade-off. Overcoming the trade-offs for privacy regarding telepresence robots in schools presented in this paper is mandatory to apply them in practice and preserve the privacy of all stakeholders.

2 RELATED WORK

In this section, we briefly summarize the current state of research for telepresence robots in schools, related privacy aspects, and the different types of robots that are being used.

2.1 Telepresence Robots in Schools

After the end of the COVID-19 pandemic, video conference tools such as Microsoft Teams, Apple Facetime, or Zoom are still being used to enable remote participation of children in school, for example in the case of long-term illnesses. Compared to pure video conference tools, telepresence robots have additional properties that enable a distinctive type of remote interaction. Children who control the telepresence robot from home can look around the room freely and sometimes even move around. In addition, many telepresence robots have an anthropomorphic look that distinguishes them from any other mobile device [1].

The research on telepresence robots in school is limited to a few studies that mainly examine the usefulness, acceptance, and experiences of previous users in surveys [1, 2, 3] and field studies [4, 5, 6, 7, 8, 9]. The studies show that children accept telepresence robots and that telepresence robots can represent children in classes. It is reported that children in the class address the robot by the name of the connected child [8] and that the remotely connected children also feel present in the class through the robot [7]. The children's sense of loneliness is reduced due to the facilitated social interaction processes in schools [8]. As a side effect, the robots in the classroom lead to a positive and silent atmosphere [9]. Weibel et al. [8] emphasize that telepresence robots can successfully enable social inclusion for ill children. The aspect of social participation is one of the most important drivers to giving long-term ill children an alternative to going to school in person [3, 10].

2.2 Telepresence Robots and Privacy

In the context of this paper, we use the term *'privacy'* in the sense of the work of Burgoon et al. [11]. According to Burgoon privacy can relate to different aspects of an individual's personal space and information. Consequently, she distinguishes between four dimensions of privacy: physical, social, psychological, and informational privacy [11]. This definition of privacy goes beyond rules and rights on data protection, such as the General Data Protection Regulation (GDPR), as these can mainly be categorized as a part of the informational dimension.

Physical privacy involves controlling access to one's space and body and may depend on the territory (e.g., a crowded sidewalk) [12]. Telepresence robots, for example, should respect children's personal space to ensure comfort. Social privacy regulates interactions to maintain personal boundaries [11, 13, 14]. For telepresence robots in the aforementioned context, this means ensuring ill children at home aren't forced into interactions when unwell. Psychological privacy involves controlling one's thoughts and feelings for well-being, e.g., telepresence robots should avoid making children feel surveilled. Informational privacy involves ethical data collection, storage, use, and sharing, emphasizing transparency, consent, and control over personal information [11, 15, 16]. Burgoon's four dimensions of privacy highlight the need for a comprehensive privacy approach that includes ethical considerations and user autonomy, ensuring privacy through both technological safeguards and respect for individual needs.

2.3 Telepresence Robots for Classrooms

There have been multiple research projects in the context of the remote participation of school children in the case of long-term illnesses and consequently, various robots have been tested in this context. Given the utility of such robots, there are already telepresence robots for schools on the market. An early research system was the robot PEBBLES [17, 18, 19] which combined video conference software with a simple mobile robot.

A commercial system that is used in schools all over the world (and was also the system that the participants in our workshops used) is the AV1 robot by NoIsolation [20, 21]. It is relatively small, light [22], without a display and can be placed on any school desk. Further telepresence robots that differ in various characteristics are VGo [6], GoBe, Double 3, Ohmni Robot, PadBot P2, and UBBO Expert [23]; some of them can be seen in Figure 1.

3 METHOD

To identify situations in which the design of a telepresence robot is subject to different (opposing) privacy conflicts, we searched the literature and held three workshops with stakeholders who are or have been involved in the use of telepresence robots in schools.

The *literature review* had the character of a scoping review, to get first insight into privacy aspects of telepresence robots in school that conflict with each other. We started looking into general works on telepresence robots for long-term ill children on Google Scholar (search term: "telepresence robot children school"). We have reviewed the relevant works and carried out a repeated backward and forward search on relevant work. All relevant papers were reviewed in terms on privacy aspects and reported conflicts between different privacy aspects.

We organized and held *three workshops with stakeholders* to get inside into the privacy requirements of different user groups. On the one hand, we were interested in whether users of such systems experience privacy violations.

On the other hand, we wanted to know which concerns people have about their privacy before they are confronted with a telepresence robot for the first time. For this purpose, we ran two workshops and invited participants with previous experience with telepresence robots in schools; another workshop was run with participants without previous experience. In order to attract participants for the workshops, we contacted project partners of the project in whose context the research is being conducted and people from the extended private and professional networks. An overview of the participants is given in Table 1. The workshops took about 90–180 minutes each and contained focus group interviews moderated along two different question catalogues, one for participants with and one for participants without previous experience with telepresence robots (see Table A1, A2 in Appendix).

Figure 1: Selection of telepresence robots. Left: VGo [6], image source: Dmitry Suvorov, Wikimedia Commons, CC BY-SA 4.0. Center: AV1 [20], image source: Mats Hartvig Abrahamsen, Wikimedia Commons, CC BY-SA 4.0. Right: Double, image source: Steve Jurvetson, CC BY 2.0.

Table 1: Overview of the workshop participants

#	Focus group	Number of participants	Participant details
1	Professionals involved in the use of telepresence robots in schools (several years of experience).	3	Two employees of a charity organization that supports parents of children with cancer and organizes telepresence robots for children with cancer. Additionally, a medical contact person from the oncology clinic that worked together with the aforementioned organization.
2	School staff, parents, and children *with* prior experience with telepresence robots.	8	Three affected children (One under medical treatment and two recovered) with their father/mother/grandmother, a mother of a currently ill child (without the child), and a teacher of an affected child.
3	School staff *without* prior experience with telepresence robots.	5	A headteacher and his deputy from a primary school, two teachers from a grammar school and a media educator from the same school.

4 DESIGN TRADE-OFFS FOR PRIVATE TELEPRESENCE IN SCHOOL

In this section, we present four trade-offs derived from literature and statements that were made in our workshops. These trade-offs may limit the interaction between children at home and people in school, and we propose and discuss potential design approaches that help to dissolve them.

4.1 Trade-off 1: Visual Representation of the Remote Child in the Telepresence Robot

Stakeholders: Teachers, parents, remote child, remote help system

Trade-off: Common telepresence robots like AV1 by NoIsolation [20] do not show a visual representation of the remote child. However, during our workshops, teachers mentioned that they would prefer to see the child and their background environment to know who is following their lessons, as otherwise "you can't control whether someone is watching" and their privacy could be violated when third parties are listening without consent. In particular, some felt uncomfortable with parents following their lectures. Same applies for teachers surveyed in the study by Newhart and Olson [7]. Beyond that, the visibility of the ill children would also help teachers to identify if the child at home is actively participating in the lessons and they would be able to analyze their nonverbal behavior to gather their capabilities to participate. *At the same time* workshop participants reported, that, especially for ill children undergoing cancer treatment, there are distinct reasons not to record and show a video of themselves. They might be exhausted from therapy, or they might have a sunken face and lost hair from chemotherapy, which they do not want to reveal to schoolmates [3].

Potential Design Approach: A possible design approach to the trade-off could be to provide the child with control of their privacy, as all of the interviewed workshop participants ranked the ill child's well-being above the privacy concerns of teachers. However, disregarding the needs of teachers might lead to a lack of acceptance of telepresence robots in class. Similarly, using a robot that does not show an image of the child may create distance to the child at home: one of the interviewed children stated that his classmates were only "talking to the robot" instead of him and that the interaction "was strange" as he was only "seen as a robot". To reveal more of the child controlling the telepresence robot, a design approach might be to selectively obscure or overlay the child's face with a personalized avatar, if they do not want to be seen [3]. A virtual twin creates less distance to the child for the people in class and makes the background clearly visible. This, however, affords real-time video processing capabilities in the robot, which are often not present. Lastly, a non-technical approach might be the creation of a contract for the application of the robot, in which the parents of the remote child assure that nobody will follow the lectures without signaling to do so.

4.2 Trade-off 2: Visual Exploration of the Classroom

Stakeholders: Remote child, children in class, parents, teachers

Trade-off: The workshops showed that children, parents and teachers have not been satisfied with the visual insights that the telepresence robot provided. Without a sufficient camera resolution and a zoom function, the children at home could not recognize relevant information on the blackboard and during group work. In addition, they have not been able to recognize the facial expressions of their classmates, which is of high priority as the main purpose of telepresence robots is seen in social inclusion and interaction with classmates [6]. Furthermore, without degrees of freedom of the camera, the view was strongly dependent on the placement of the telepresence robot in the classroom, limiting the ability to visually interact with classmates. *Contrary* to the need for visual flexibility, children in the classroom might not want to be filmed by the telepresence robot, preserving their social privacy. According to the teachers interviewed, a high-quality camera and zoom may also lead to more insights than intended, as it might show sensitive data such as class register entries or private notes from classmates.

Potential Design Approach: Regarding the visibility of other children in the classroom, one design approach could be to limit the view angle and position of the robot to see only certain areas of the classroom. However, this approach lacks flexibility, would afford a special room setup and organizational effort, and it might reduce acceptance among teachers and children. Children may also be hidden behind mobile walls, which are commonly used for exams if they do not want to be filmed by the robot. Alternatively, children in the classroom and private information could be selectively blurred in the video recording. This approach was seen as beneficial by the teachers interviewed in the workshops but creates high computational requirements for real-time video processing. In addition, it would afford a mechanism for children to decide when to be seen and not. Completely shutting the camera off to avoid violations of children's privacy is not a solution, as it diminishes the utility of the telepresence robot for the remote child.

4.3 Trade-off 3: Social Interaction with Schoolmates

Stakeholders: Remote child, children in class, parents, teachers

Trade-off: Considering that social inclusion and interaction are the main purposes for using telepresence robots in classrooms as laid out above, the remote child needs to be able to talk to classmates. Beyond that, the autonomy to decide over potential interaction partners is required to keep one's own social privacy [11]. Nevertheless, it is not guaranteed that the respective children want to talk to the remote child or the robot at that time, preserving *their* social privacy, and the remote child might not be ready to engage in social interaction when they are forced into certain situations. Weibel et al. (2020) highlight a situation where the teacher allowed the classmates to take the robot on a tour around the school, while the child behind the robot did not want to take part in this social initiative [8]. To avoid these violations of the children's social privacy needs solutions that make it easy for every involved actor to withdraw themselves from social interaction.

Potential Design Approach: Solutions for this trade-off could be found on process levels. While it is clear that verbal and social interaction should be limited to the times foreseen for this in schools, there could be additional social protocols. Remote children may signal their desire to make contact either specifically with certain children or with the class in general. Children in the class may then decide if they are ready for the interaction or not. For the child at home, request for interaction can be done via visual or auditive signals as well as the speech transmission of the robot. Technical design approaches could also include local control of the robot for the children in school. For example, if the robot comes close enough to a child, the child may decide whether it enables or respectively disables verbal communication on the robot or not (e.g., using a button on the screen). For interactions that do not occur within physical reach, gestures could be a potential approach to neglect social interaction. As mentioned in the trade-offs above, this interaction design equally affords real-time video processing capabilities.

4.4 Trade-off 4: Intimate Conversations and Human-robot Relationship

Stakeholders: Remote child, children in class, teachers

Trade-off: In our workshops, teachers, parents, professionals and the children told us about the emotional relationships between children and the robot. One child even called the robot a "a friend for life" and made him a friendship present. These statements clearly indicate that the robot was seen as a social agent, which bears the risk of increased sharing of personal and intimate thoughts [24]. Even though it is important to keep interactions as natural as possible, recording these sensitive conversations can threaten the children's and teachers' privacy [25]. While a certain degree of exchange about private and emotional conversations is desirable and part of normal social interaction, emotional exchange can also unintentionally reach third parties such as hospital staff, parents of the ill child, or other actors this information is not intended for.

Potential Design Approach: One important aspect of dissolving this trade-off should be to educate the children, staff, and parents involved. It is important that all stakeholders know that confidential information can be shared via the telepresence robot and that interactions with the robot should not be unconditionally broadcast to others. However, technical solutions may also be utilized to facilitate private conversations. A possible design approach to prevent third parties from unintentionally listening to private conversations could be a simple light signal indicating that the conversation is not meant for the public. Similarly, expert interviews in Lutz et al. (2019) emphasize the importance of designing robot characteristics that signal the collection of data, which in this context is the recording of sensitive communication [24]. Furthermore, an implementation of a manually adjustable "private mode" for private conversations may be useful, in which the transmission is immediately interrupted, if there is any suspicion that third parties are listening in.

5 SUMMARY AND CONCLUSION

The above-mentioned trade-offs provide several situations that require (technical) approaches to meet the needs regarding social, physical, and informational privacy of involved stakeholders. Switching off major functions or the telepresence robot as a whole would cause the reduction of interaction capabilities and therefore produce subsequent privacy violations and restrict an immersive school experience.

We propose that the visibility of the children in class and at home requires dynamic options that do not ignore the importance of bilateral video transmission. Simply enabling or disabling the video stream does not consider the specific needs of children with long-term illnesses and their teachers and schoolmates.

When children want to visually explore the classroom and verbally interact with schoolmates, technical mechanisms are required that make the different desires of all involved stakeholders salient. Assuming children do not want to socially interact or show themselves they have to be able to perform certain actions like gestures or pressing buttons to signal the remote child that they want to avoid the interaction. Equally, the child at home has to be able to make clear when it is forced into social situations, which is possible through a visual or auditive signal. Mechanisms like these are important to make people in class aware of the remote child and its needs and vice versa.

When conversations happen through the robot, they can get intimate and private and should be treated as confidential. Telepresence robots eventually should be able to recognize private conversations through situational awareness [25] and automatically act in favor of the vulnerable person. Making the environment aware of the private conversation that is held via the robot might be a first step to reduce unwanted audience from outside of the classroom.

To summarize, some trade-offs require technical solutions such as real-time video processing to meet the different privacy needs of all individuals involved. Other trade-offs may be addressed by organizational interventions, such as comprehensive education. Future research should focus on these challenges to facilitate the development of privacy-sensitive telepresence opportunities for children with long-term illnesses.

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Table 2: Items of the question catalogue for participants with previous experience with telepresence robots in schools

Dimension	#	Item
Communication between child and class		
	C1	How did the communication between the ill child and the class work?
	C2	Who communicated with and through the robot? (from the classroom and from other places)
	C3	What anomalies/difficulties/incomprehensibilities arose during (verbal) communication?
Effects on the lessons		
	L1	What effects did the use of robots have on lessons?
	L2	Were there any specific methodological challenges/changes in teaching that occurred as a result of using a robot?
	L3	Which didactic methods could be implemented with the robot and which could not?
	L4	Did the robot have an influence on the learning success or the participation of the children, did the ill child possibly lack certain insights?
Using the robot in practice		
	U1	How was the robot operated in practice? Was it easy to understand?
	U2	How was the robot accepted by the different actors?
	U3	What physical characteristics did the robot have and how were the operating options used inside and outside the classroom?
	U4	How was the robot's navigation space? Was it fully utilized? Or was the robot mainly used stationary?
	U5	At what points did the participants wish for more/different control options for the robot?
Restrictions on privacy		
	P1	What restrictions on privacy result from the use of robots?
	P2	Were there any concerns regarding data protection/privacy on the part of those involved?
	P3	What data was collected and processed? Who has access to the data?
	P4	What mechanisms/functions were in place to create transparency about data protection aspects?
	P5	What happens in the event of a data protection problem?
Organizational changes		
	O1	What organizational changes has the robot brought with it?
	O2	What responsibilities did the various stakeholders have, were there any organizational difficulties?
	O3	How were those involved (teachers, parents, children, medical staff) trained in handling the robot?
	O4	Who was responsible for the robot from an organizational point of view?
Further		
	F1	Which other topics that we have not dealt with in depth today do you think are important for the use of telepresence robots in a school context?

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A A APPENDICES

Table 3: Items of the question catalogue for participants without previous experience with telepresence robots in schools

Dimension	#	Item
General		
	G1	What questions do you have?
	G2	How do you feel about the use of a telepresence robot?
	G3	How does the use of the robot impact the lessons?
Opportunities		
	OP1	What are the opportunities for the participating child?
	OP2	What are the opportunities for the lessons and the class?
	OP3	What actions does the robot enable the child to perform?
Worries, concerns, risks		
	W1	What would you be worried about? (didactically, organizationally, technically)
	W2	In your opinion, what would be the reasons that would threaten the acceptance of the robot?
	W3	What anomalies/difficulties/incomprehensibilities might arise during communication?
	W4	Which didactic methods can be implemented with the robot and which cannot?
	W5	What insights is the ill child missing?
Restrictions on privacy		
		Do you have any concerns about privacy. . .
	P6	. . . of the ill children?
	P7	. . .of the classmates?
	P8	. . .of the teachers?
	P9	. . .of the parents?
	P10	. . .of other people involved (e.g. medical staff)?
		In the proposed scenario, do the people involved have control over ...
	P11	. . .when and to what extent personally stored data is made available to others?
	P12	. . .withdrawing from social contact with others?
	P13	. . .keeping physical distance from the robot?
Further		
	F1	Which other topics that we have not dealt with in depth today do you think are important for the use of telepresence robots in a school context?