

Towards Privacy-friendly Telepresence Robots for Schoolchildren with Long-term Illnesses – User Needs of Relevant User Groups

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Remote participation in school is possible today with the help of telepresence robots. Such technologies can offer great opportunities for children with long-term illnesses to continue attending school. Consequently, telepresence robots are already used in some schools when children are absent for long periods. However, despite their positive impact, such robots also create challenges for the privacy of people involved in such a setting. Therefore, in this paper, we discuss the user needs of such robots in this specific and privacy-sensitive application field. We held three workshops with different user groups with and without experience with the robots. Among them were formerly and currently ill children, parents, teachers, head teachers, media educators, and supporting personnel. We discussed their experiences (if any), ideas, expectations, and concerns with a focus on privacy aspects to find out about the user needs of different user groups. Our results reveal various interrelationships and conflicts between the individual actors. They serve as a basis to discuss the implications for the design of future telepresence robots for schoolchildren.

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) •

Additional Keywords and Phrases: Telepresence, Robot, Avatar, School, Privacy, User Needs



Figure 1: The telepresence robot AV1 from “No Isolation” is used in many schools to enable ill children to participate in classes remotely.

Image by Marius Vabo, CC BY-SA 4.0, Wikimedia Commons.



Figure 2: Impression of one of the three virtual sticky note boards that we used to create affinity diagrams to analyze our workshop results. The details are presented in this paper.

1 INTRODUCTION

During the COVID-19 pandemic, the use of video conferencing and telepresence technology has become popular to enable pupils to participate in class despite the circumstances at the time. What is often forgotten now, after the end of the pandemic, is the fact that there are many children who are unable to attend classes on-site due to various (physical or psychological) medical reasons. In these cases, remote participation in school is technically possible today with the help of telepresence robots and is already practiced in individual cases. The application of telepresence robots in school is usually subject to various legal and ethical issues, including those related to privacy, which often need to be individually clarified in advance of the use of such robots. In this paper, we discuss how a robot should be designed to fulfill certain privacy aspects by design. Based on the work of Burgoon [4] and Parrott et al. [16] we do not consider privacy exclusively from its informational dimension, but rather take a holistic approach to include its physical and social dimensions. To reach our goal, we held *two workshops* with stakeholders who had *previous experiences* with telepresence robots in schools, including teachers, parents, formerly and currently ill children, and an organization that supports the parents of children with cancer. We also ran *another workshop* with stakeholders *without previous experience*, including teachers, head teachers, and media educators. The latter aimed at investigating their expectations and potential preliminary concerns. Based on the results of the three workshops, we analyzed the user needs in the context of privacy-friendly robots for schoolchildren with long-term illnesses, which we present in this paper.

The remainder of the paper is organized as follows: Section 2 gives an overview of related work focusing on telepresence robots in schools and privacy in this context. Section 3 describes the method underlying this work, which we used to identify the user needs of different user groups. Section 4 discusses the user needs of different user groups, section 5 briefly states the limitations of our research approach and section 6 summarizes this work and gives an outlook on the future development of privacy-friendly telepresence robots in schools.

2 BACKGROUND AND RELATED WORK

In this section, we summarize the current situation of telepresence robots in schools for ill children and look at the various aspects of privacy in this context.

2.1 Telepresence robots in schools

During the COVID-19 pandemic, the use of telepresence software has increased massively in general acceptance and utilization even in schools [3]. Video conference tools such as Microsoft Teams, Apple Facetime, or Zoom can contribute to the participation of ill children in social interaction in school [7]. The combination with robotics adds further qualities to telepresence, as it integrates an anthropomorphic body into the school class as a proxy for the child at home. This combination allows freedom for both the remotely connected child (e.g., changing the direction of gaze) and the people in class (e.g., eye contact) [6].

Although telepresence robots are already being used in schools, there is surprisingly little empirical research in this area. The acceptance of robots has been investigated in schools in only a few surveys [1, 15, 18] and field studies [6, 11, 12, 22, 23]. Some of these studies show that robots are successfully used to represent children in classes, e.g. it is reported that children in the class accept telepresence robots and address them, for example, by the name of the connected child [22]. Furthermore, it was reported that ill children feel present in the class through the robot [11]. Gallon et al. [5] reported how the telepresence of connected children had a positive effect on the atmosphere in the classroom, as the children in the

class spoke less to each other or whispered during the lesson so that the connected child could follow the lesson better. Weibel et al. [22] emphasize that telepresence robots can enable social inclusion for children with cancer, but also point out that this depends on the expectations of the people involved.

Concerning the privacy requirements, Johannessen et al. [6] point to a symmetry problem in privacy requirements: if no image of the remotely connected child is displayed to protect the privacy of the connected child, or if a robot is used that cannot display such an image, teachers and children in the class will not receive any feedback about who is watching, since other people could be present at the location of the remote child. In [1] and [11] the privacy concerns of participants in the same scenario in the USA are analyzed. Newhart and Olson [11] show that these concerns apply to both the school environment and the child being connected: while parents and children feared revealing too much about the home environment, teachers feared that they could be monitored by parents, that classroom content could become public and that the privacy of other students could be violated.

2.2 Privacy beyond data protection

While data protection is crucial for securing digital information, preserving privacy involves much more than just protecting data [4, 8, 16]. Burgoon [4] emphasizes that privacy encompasses four dimensions, each addressing different aspects of an individual's personal space and information: physical privacy, social privacy, psychological privacy, and informational privacy.

According to Burgoon [4], *physical privacy* aims at controlling access to one's physical space and body. The amount of perceived physical privacy may, therefore, depend on the type of territory (e.g., a crowded sidewalk) a person is located in, while protecting the space immediately surrounding the body is crucial for preserving a sense of privacy [9]. In the context of this work, for instance, telepresence robots should not invade the children's personal space by coming too close or moving inappropriately within their environment. This is vital in ensuring that physical boundaries are respected and personal space remains undisturbed to ensure sufficient levels of comfort [21].

Social privacy involves regulating social interactions and relationships to maintain personal boundaries and comfort [2, 4, 24]. In the case of telepresence robots, this means preventing the robot from disturbing one child's activity. More importantly, it ensures that the ill child at home is not forced into social interactions with children at school when they do not feel well due to their illness.

Psychological privacy concerns the control over one's thoughts, feelings, and internal states to ensure mental and emotional well-being [4]. Telepresence robots should be designed to avoid making the child feel constantly surveilled, which could cause significant stress and anxiety. Additionally, both the ill child and the children at school should not feel pressured by the presence of the robot. The technology should ensure that no one feels forced to perform or behave a certain way under the impression that they are being monitored, thus maintaining a stress-free environment.

Finally, *informational privacy* extends beyond merely securing data to include the ethical collection, storage, use, and sharing of personal information. It emphasizes transparency, consent, and the appropriate use of data, ensuring individuals know what data is being collected, how it is used, and that they have control over it [8].

While the term "data protection" often refers to either legal or security aspects in the context of informational privacy, Burgoon's four dimensions of privacy [4] highlight the need for a broader approach that includes ethical considerations and user autonomy to safeguard privacy in various contexts. This comprehensive approach ensures that privacy is maintained not just through technological safeguards, but also through respecting the individual's broader privacy needs.

3 METHOD

To learn more about the perception of telepresence robots in schools, we held three workshops and analyzed the results in affinity diagrams to derive the needs of different user groups. This section describes the methodological details.

3.1 Workshops

We organized and held three workshops, to find out more about the user needs of telepresence robots in schools. On the one hand, we were interested in how users of such systems perceive the system and its privacy aspects. 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. Consequently, we ran the first two workshops with experienced users as well as one workshop with people, who had no previous experience with telepresence robots in schools. In the workshops, we held focus group interviews. Each workshop was structured as follows: first, we had a short introduction round to allow the attendees to get to know each other. We then gave each participant the chance to report on their previous experience with telepresence robots in schools (workshops 1 and 2 only) and wrote down the most important information visibly on a flip chart. The main part was the then following focus group discussion that was moderated along a question catalog, that contained multiple questions about each of the following five topics: (1) communication between remote child and class, (2) effects of the use of telepresence robots in the classroom, (3) operation of the telepresence robot in practice, (4) restrictions on privacy through the use of telepresence robot, and (5) organizational changes due to the use of the telepresence robot. While the questions in the first two workshops were focused on specific experiences, the questions in workshop 3 were formulated in a more hypothetical way to focus on perceived chances and fears. In all workshops, key points of the core statements were documented. The workshops took about 90–180 minutes each.

The workshops differed mainly in the different backgrounds and experiences of the participants. An overview of the participants is given in Table 1.

Table 1: Overview of the workshop participants

#	Focus group	Number of participants	Participant details (with acronyms)
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 (E1, E2). Additionally, a medical contact person from the oncology clinic that worked together with the aforementioned organization (E3).
2	School staff, parents and children <i>with</i> prior experience with telepresence robots.	8	Three affected children (C1–C3, C1 under medical treatment, primary school, and C2–C3 recovered, lower secondary school) with their father/mother/grandmother (P1–P3), a mother of a currently ill child (without the child; P4), and a teacher of an affected child (T1).
3	School staff <i>without</i> prior experience with telepresence robots.	5	A headteacher and his deputy from a primary school (S1, S2), two teachers from a grammar school (T2, T3) and a media educator from the same school (M1).

3.2 Data analysis and identification of user needs

During the focus group discussion, two researchers documented all the statements made in short written form. To analyze all this information, we created affinity diagrams [17, 19]. For this purpose, we created one virtual sticky note board with Miro¹ per workshop and copied all individual statements to virtual sticky notes. We used various colors for the

¹ www.miro.com

statements of different people to make sure that we still could trace the person who said a particular statement. We then sorted the virtual cards in an online session with two researchers and assigned them to groups of related statements. Finally, we assigned headlines to each of the groups and again grouped the individual groups topic-wise. In an online meeting, we discussed the results with other involved researchers and made minor adaptations to some specific assignments and headlines. To get an impression, one of the three created boards is shown in Figure 2. The non-readable details of this board are summarized in the result section.

With the help of the workshops, we developed a deeper understanding of the context of use and a basis for deriving the user needs. Two researchers reviewed each category identified in the workshop data and discussed the implications of the statements concerning the underlying user needs. The first version of user needs was discussed and refined with other researchers involved in the project.

4 USER NEEDS FOR PRIVATE TELEPRESENCE IN SCHOOLS

In the following, we discuss the user needs of the children, first based on the children’s comments followed by the perception of their parents. Last, we present the user needs of school staff. The user needs are summarized in Table 2.

Table 2: Overview of the user needs

#	User group	Needs
1	Children	Continuing school; Social participation; Social interaction; communication without interruptions; emotional connection to the robot; presence as human being in the lessons
2	Children (from the parent’s point of view)	Motivation; structured daily routine; simple and guaranteed application of the robot; display; flexible camera with high resolution; notification mechanisms
3	School staff	Low organizational effort; certainty that parents are not watching their lessons; well thought out technology; physical flexibility; control over the robot; sound quality; display; flexible camera with high resolution; hiding of sensitive data

4.1 Children’s needs

At the second workshop, we had the opportunity to speak directly with the ill (C1) and recovered (C2, C3) children and gained insights into their experiences, in this case with the telepresence robot AV1 from NoIsolation [13]. The robot is shown in Figure 1. It is relatively small (about 30 cm high) and light (1-1.5 kg) [20] and can be placed on the ill child's school desk. The robot is connected to a single mobile device (tablet or smartphone) of the remote child. An integrated camera and a microphone capture audio and video data in the classroom that is streamed to the remote child. While the audio channel is bidirectional the child cannot be seen in the class, since the robot has no display.

Overall, the impression among the children concerned was that the use of telepresence robots is a "good alternative" (C1) to classroom teaching, even if they would still prefer to go to school. For the children in the workshops, it was a relief to have the opportunity to continue taking part in lessons with such a telepresence robot and at the same time a great motivation to do so. These and further descriptions of the children interviewed show that the aspect of social participation is a crucial factor in their motivation to continue participating in lessons. It is therefore important for children that a telepresence robot enables and possibly even promotes social interaction on the school grounds.

Beyond the opportunity to get together with their existing classmates, getting to know completely new school class groups "was fun" for C2, as many schoolchildren had an enormous interest in the telepresence robot and therefore got in regular contact with C2. Remarkably, all interviewed children and their associated classmates gave the robot a name, gave it friendship gifts, and anthropomorphized it accordingly. C2 stated that the avatar is "a friend for life" and that the children

in the class sometimes used to fight over the telepresence robot. Many of these statements made in the workshop showed us that the children felt a need or at least an interest in forming a deeper emotional bond with the telepresence robot. Due to these emotional bonds with the robot and the fact that the children at home could not be seen, C2 felt as if his classmates were just "talking to the robot" instead of him, the interaction "was strange, you were seen as a robot". The potential to reinforce this feeling also arises from the fact that some teachers found it "strange" to "talk to the robot" according to C1. These statements underline the fact that the children at home want to be accepted as active human beings within the classroom and not just be switched on in the form of an observing robot.

During the lessons, the children were able to express their moods via the robot. In contrast, the remotely connected children reported that they had problems recognizing the facial expressions and moods of their classmates which affected their communication negatively. All three children agree that there were problems with the internet connection during lesson times, which limited the lessons to some degree. This demonstrates the children's need for uninterrupted and seamless communication via the telepresence robot, which gets as close as possible to face-to-face interaction, whether on a non-verbal or verbal level.

4.2 Children's needs from the Parents' point of view

For the children's parents (P1, P2, P3, P4), the use of telepresence robots was "generally very positive" (P1), in some cases it served as "a huge motivation" (P1, P3) for their children to continue participating in lessons and enabled social participation and a more structured daily routine. Therefore, the use of the telepresence robot was also a relief in the everyday lives of the parents as the lessons covered a part of the children's daily routine.

Before it was possible to get a telepresence robot for one's child, three out of four parents reported that they had to obtain a signed data protection declaration from all teachers and parents involved. This may cause problems, as for P2 at first one "teacher did not want to sign" (P2). These parents were concerned that a missing signature could prevent the use and that the organizational and educational effort would therefore have been useless. In this context, the interviewed parents would have preferred less uncertainty in the process and consequently less dependence on other parents.

During our workshop, telepresence robots were compared with videotelephony software (e.g., Microsoft Teams), but the difference in data protection and privacy was not clear to the parents. P1 noted that during the Covid-19 pandemic, it was also possible to use video conferencing systems without a declaration of consent, while P4 agreed with this, stating that "at the end of the day, Teams is no different". It should be mentioned that data protection and privacy were secondary issues for the parents, particularly because their children were struggling with serious health problems. When asked further about privacy, parents mentioned that the robot can only be paired with one mobile device and that access is password-protected. In addition, security features such as a black screen when taking screenshots are "well integrated" (P1). To prevent third parties from listening in during lessons, three out of four parents mentioned that the child used headphones at the clinic or home. Apart from this, it was not always ruled out that medical staff or the parents themselves accompanied the lessons. This illustrates that the parents were happy for any measures to be taken to ensure the children's data safety and privacy, but the focus when using the robot was not on these aspects.

In retrospect, the parents would have liked a display for the telepresence robot (which the used robot AV1 did not have), as it is an advantage for the child to be able to decide for themselves whether and when they want to show themselves. In addition, all parents were missing a zoom function, the children could not recognize relevant information or the facial expressions of their classmates from home, and the view was strongly dependent on the placement of the telepresence robot in the classroom. Even in group work, the camera's degrees of freedom were not sufficient to exchange all relevant

information and interact properly with classmates. Since, according to P4, the telepresence robot is not sufficiently noticed by the teachers in some cases, she furthermore suggests an "emergency flashing" for situations that require special attention.

Overall, the parents surveyed were excited that they were able to enjoy utilizing a telepresence robot for their children, although they suggested that some features should and need to be added in the future. Privacy-related features and mechanisms were interesting for the parents, but neither a focus nor strongly relevant for the use in the context of cancer treatment.

4.3 Needs of the school staff

In addition to the discussions with affected parents and children, on one hand, we talked to a teacher (T1) about her impressions and experiences with the AV1, and on the other, we interviewed school staff (S1, S2, T2, T3, M1) that had no experience with telepresence robots at all.

Before using the telepresence robot, T1 initially had concerns that the utilization of the robot involves many organizational problems, but these concerns were quickly dispelled. According to her, "it all depends on the teachers", but at her school, the teachers were open to using the telepresence robot, partly because they, including herself, were able to benefit from the experience themselves. Even though things went relatively smoothly at T1's school, M1 thinks that there will always be teachers who want to "double- and triple-check" the security of a new technical system, which can be a potential point of conflict and lead to clarification effort.

For the head teacher of the elementary school (S1), it is clear that the parents will be present during the lessons, as this was often the case with video conferences. Accordingly, in his view, it requires "acceptance so that lessons are made accessible to parents". He also believes that the fact that teachers may feel that they are being watched and never know "who is seeing what is being streamed" speaks against this. The deputy head teacher also shares this opinion and adds that "it is more pleasant for teachers if parents are not present" (S2), as they are also not present during conventional lessons. According to her, the presence of parents influences the teachers and she wonders whether it is even possible to behave naturally in front of the telepresence robot, especially considering that "you can't control whether someone is watching" and that having a robot in class appears "spooky". It is important to her that the technology is well thought out and that the use of a telepresence robot makes no difference to the actual lesson.

Even for physical activities, S2 thinks that acceptance is only possible "if there are few organizational and didactic differences" to regular lessons. According to her, it "has to be possible" to "spontaneously go to another room" or "go out to the schoolyard for a few minutes" when the weather is nice. T2 and S1 agree on the aspect of mobility, however, S1 believes that teachers should be given control over the telepresence robot.

For the built-in microphone, S1 thinks that a "clear focus must be heard", as it is not always quiet in the classroom. T1 shares the same fundamental thought, in her experience background noise should be filtered; this was probably not sufficiently the case with the AV1. Similarly, T2 believes that the filtering of background noise is necessary for understanding everything during group work. In the context of privacy, these statements point out a relevant topic, as there may be situations, where possibly private conversations in class should not be heard by the child at home.

Even if the desire of T1 for better camera quality sounds reasonable, according to S1 and T2, there may be problems that arise. Since there is sensitive data such as class register entries or private notes from classmates in the classroom, a high-quality camera could lead to the ill child having more insights than intended. Especially in combination with a zoom function of the camera, which according to T1 is necessary for sufficient insights into the lesson, such as the facial expressions of their classmates or videos and films that are shown in class, the increased visibility can get problematic. In

this regard, S1 and T2 agree with the suggestion to show information in a blurred form if it should not be visible to the child at home.

From a purely technical point of view, according to T1 and T3, the rotation of the robot is an advantage over conventional video conferencing systems. However, just like the parents of the children concerned, T1 would have liked a display for the telepresence robot, as communication with the child "often felt like a one-sided interaction". S2 and T2 agree with that statement as they want to make sure that the child at home is actively participating and as it is easier to assess whether you can pick the child to answer. Nevertheless, T2 thinks that it must remain flexible for the ill child to show a picture of itself, depending on the physical and mental condition.

Overall, the teachers interviewed have several uncertainties and things that they feel are necessary for the acceptance of telepresence robots in classrooms. Despite the skeptical statements, the teachers agree that the use of telepresence robots can offer advantages for teaching children suffering from long-term illnesses.

5 LIMITATIONS

Our results are subject to limitations, that we like to discuss briefly. First of all, the method of obtaining focus group interviews is subject to various biases as a result of group dynamics [14]. As a consequence, a single person might dominate or shape the discussion [14]. In our setting, this could be especially problematic in the context where children participated with their parents as the children's statements might be influenced by the opinion of their parents. During the workshops, we tried to question all participants equally and to give all participants the same amount of speaking time. We also generally interviewed the children before their parents. All in all, however, we cannot guarantee that there were no mutual influences in this setting. Further limitations come from the fact, that we only had a limited sample size. This sample size was limited in terms of the ages of the children (elementary school to lower secondary school), a regional focus (Lower Saxony and North Rhine-Westphalia, Germany), and special health-related conditions (children with cancer). Having a broader sample in terms of age, region, and illness might have changed the results.

6 SUMMARY AND CONCLUSION

The results of the workshops provide an outlook on the user needs of different user groups regarding telepresence robots in schools for allowing the remote participation of children with long-term illnesses. As privacy is a broad and sensible topic, many of these user needs might conflict directly or indirectly with the fulfillment of different privacy aspects for each of the persons involved.

The interviewed children stated that social participation and their acceptance in class are very important to them. They prefer to attend lessons in person as there is more frequent and intensive contact with other children, while the telepresence robot does not seem to entirely fulfill their need for social recognition. Nevertheless, some children do not want to be seen during their cancer treatment, which makes social interaction difficult and might create a possible area of tension. Parents also see the need for social participation, but more from the perspective of a structured daily routine. For the use of telepresence robots, a simple and secure onboarding process is important to them. To ensure this process and to take into account the privacy needs of all parents, teachers, and children, a privacy-sensitive telepresence robot is required that takes the different needs of all involved persons into account. In addition, parents would like to see more freedom of action and more insights into the lessons for their children, which can also mean a restriction on the privacy of all actors involved. For the interviewed teachers it became clear that they prefer a minimum of organizational effort and sufficient data security. They furthermore do not want to be surveilled by anyone outside of the classroom and worry about the recording of their lessons. Nevertheless, they want to see the child at home and its environment, which can also be seen as an area of conflict.

They expect the telepresence robot to be mobile and that sensitive data that can be seen through the use of the camera should not be visible to children at home or anyone in their respective environment.

Tensions arise between the user groups, as many of the needs conflict with each other. The teachers interviewed expect the child to be visible to be able to check whether the children are working in lessons and to see whether third parties are listening to their lessons. However, ill children must be treated sensitively according to their situation; they often do not want to show their faces. Similarly, some of the teachers do not want to be seen remotely during lessons, even though the child at home has a clear desire to be integrated into the lesson at all sensory levels. These and more conflict situations need to be addressed in further research to prevent potential areas of dispute when using telepresence robots in the future (see also [10]).

As there are many reasons and perspectives for aspects that should be seen or not seen during the lessons, it is important to design telepresence robots that enable users to choose their preferred privacy settings. Topics that require special attention regarding the implications for the privacy of the involved user may be the visibility of the child at home, the visibility of information and people in the classroom, the access to lessons for third parties as well as the agreement on data protection within the telepresence robot. All these areas have to be addressed to create a simple plug-and-play solution for telepresence robots that considers the need for privacy of all involved stakeholders. With the availability of such a privacy-friendly telepresence robot, all children who are affected by long-term illnesses could be given the chance to remotely take part in school lessons without other stakeholders being ethically disadvantaged by its use.

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