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Success Factors for the Social Inclusion and School Belonging of Children and Adolescents with Chronic Health Conditions Using Telepresence Robots

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Abstract

Belonging is a basic human need and one of the central factors of well-being for children and adolescents in everyday school life. In times of severe illness, pupils may be absent for extended periods of time, which can lead to several negative consequences, such as social isolation. To support pupils' sense of belonging among classmates and teachers, telepresence robots like the Avatar AV1 have been considered a means to prevent academic, social, and emotional issues arising from absenteeism by allowing pupils to participate in class. The aim of this research was to identify the effects of using the Avatar AV1 on school participation and feelings of social isolation and belonging of children with chronic illnesses. The research project investigated the school participation, social inclusion, and well-being of children and adolescents with chronic health conditions through two studies (qualitative and quantitative). The qualitative study consisted of interviews conducted with users, parents, teachers, and classmates. The interview data were analysed using qualitative content analysis. The quantitative study measured the user behaviour of children and adolescents with chronic health conditions using Avatar AV1, as well as pupils' sense of school belonging and participation. The data from both studies were contrasted to gain an understanding of the experience of using a telepresence robot. Key success criteria, as well as moderating factors, were identified and presented for discussion in this paper.

Keywords: sense of belonging, social inclusion, telepresence robots, school absenteeism, chronic health conditions

Points of Interest

- **Belonging as a central dimension of educational inclusion in contexts of chronic illness.** The article foregrounds students' sense of school belonging as a foundational yet often overlooked dimension of inclusion, arguing that educational participation under conditions of chronic illness cannot be reduced to academic continuity alone.
- **Telepresence as a pedagogical and relational practice rather than a technical solution.** Telepresence robots are conceptualised not merely as technological tools but as socially embedded practices whose effectiveness depends on relationships, attitudes, and interactional structures within schools.

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- **Multi-perspective insight through the integration of qualitative and quantitative approaches.** By systematically combining subjective experiences with standardised usage and survey data, the study enables a nuanced analysis of success criteria and moderating factors shaping telepresence use.
- **The role of school arrangements in enabling meaningful participation**. The findings highlight the importance of pedagogical and organisational conditions—particularly peer support structures and teacher attitudes—in transforming digital participation into experienced belonging.
- **Advancing inclusive education discourse at the intersection of illness, schooling, and digitalisation.** Situating telepresence technology within broader debates on inclusion and educational responsibility, the article offers theoretically informed and empirically grounded contributions for research, practice, and policy.

Introduction

A large number of children and adolescents (around 200,000 in XX) suffer from chronic illnesses that restrict their participation in school. Chronic illnesses, such as cardiovascular diseases, cancer, asthma, diabetes, and genetic disorders such as Down syndrome, as well as mental illnesses and learning disabilities, are long-lasting and affect daily life. They often lead to dependency on assistance, medication, and care. Definitions vary, but what these illnesses have in common is that they last for months, reduce quality of life, and can cause cognitive and social impairments. In particular, those suffering with chronic illness can experience a diminished sense of belonging, which is why it is crucial to take measures to strengthen and promote social integration.

Repeating a year or dropping out of school early can also cause social and emotional difficulties. A lack of personal contact with fellow students and teachers, as well as a lack of involvement in the classroom, can increase loneliness and social isolation among children and adolescents, which in turn reduces their sense of belonging at school. Studies have shown that this sense of belonging is an important protective factor that reduces the risk of emotional stress, bullying, and suicidal thoughts. At the same time, students who feel a sense of belonging at school are more motivated and less likely to drop out (Blum, 2005; Kirkpatrick, 2020). A lack of belonging, as is often the case for children with chronic illnesses, can lead to further negative consequences, such as reduced well-being, low self-esteem, and poorer disease management (Ginsburg et al., 2014; Maes et al., 2017). In the long term, these children's professional careers are often negatively affected, with poorer educational attainment and higher unemployment (Kirkpatrick, 2020). To prevent academic, social, and emotional problems caused by school absenteeism, telepresence systems, such as avatars, virtual classrooms, and mobile robots, have been discussed in recent years as a promising approach to improving the school participation of children with chronic illnesses (Zhu & Van Winkel, 2016). The use of these telepresence systems is intended to enable children to participate in lessons and interact with their schoolmates, thus reducing the negative effects of absence. Therefore, this paper explores which factors contribute to the successful use of telepresence systems for children and adolescents with chronic health conditions.

Sense of Belonging

The sense of belonging is one of the fundamental needs of human beings (Ryan & Deci, 2000) and is a crucial factor in the development of oneself and identity building of children and adolescents (Haslam et al., 2009). Belonging is formed over one's lifespan through personality, interpersonal experiences, and internal and external circumstances. Researchers agree that a sense

of belonging correlates with a higher score of well-being and life satisfaction and less distress and mental illness (Hagerty et al., 1992; Maher et al., 2012; Allen & Kern, 2017).
Allen and Kern (2017) state that the sense of belonging does not solely depend on participation or physical closeness to others. Instead, it is contingent on one's perceptions and experiences of the quality of social interactions. In essence, belongingness mirrors an individual's assessment of his or her integration within a social framework or environment. This underscores the importance of comprehending others, empathising with them, and discerning their emotional states. A sense of belonging encompasses both emotional and behavioural components. Emotionally, it entails a sensation of connectedness to peers, activities, and collectives. Behaviourally, it involves actively engaging in and participating as a member of groups, pursuits, and associations (Allen & Kern, 2017). Another distinction can be drawn between trait belongingness (which pertains to the inherent psychological need for affiliation) and state belongingness (which relates to context-specific feelings of connection). While trait belongingness describes a stable, deep-rooted motivation to seek social bonds and feel connected to others, state belongingness refers to the immediate sense of belonging shaped by the current environment and social interactions.
Research indicates that state belongingness is affected by diverse daily occurrences and stress-inducing factors. Based on the variability of encountered situations and events, coupled with individual perceptions of these circumstances, an individual's personal feeling of belonging can shift as frequently as multiple times within a day, similar to the fluctuation of emotions such as happiness. Nevertheless, individuals can also maintain a relatively enduring sense of belonging experience when a strong feeling of connection is internalised (Ma, 2003; Walton & Cohen, 2011; Allen et al., 2021). Chronically ill children may still have a strong desire for social connection (trait belongingness), but due to frequent absences from school, they often experience a lack of state belongingness, as they miss regular social interactions and daily contact with peers. This imbalance can exacerbate feelings of social isolation and emotional distress.

School Belonging

Since everyday school life is a central aspect of life for children and adolescents, and because their group of peers becomes more significant for identity development as they grow older, school belonging is of great importance. Having strong friendships and feeling accepted and included in a peer group, such as a school class, is particularly important for young people and their psychosocial well-being (Allen & Kern, 2017).
The sense of belonging to school can generally be defined as the extent to which pupils feel cared for and part of their school (Osterman, 2000). In a similar vein, Goodenow (1993) conceptualises school belonging as a psychological experience of feeling accepted, respected, included, and supported by others in the school's social context. A sense of belonging to school has been associated with positive effects, such as increased school motivation, lower dropout rates (Allen & Kern, 2017), and a lower risk of depression or bullying (Kirkpatrick, 2020). Researchers agree that the sense of belonging to school plays an important role. This type of belonging can be divided into several components (Karcher & Lee, 2002; Lohmeier & Lee, 2011). For example, Lohmeier and Lee (2011) describe three levels of belonging: (a) general support or "affiliation" (support from other pupils and adults and the school system in general), (b) specific support or "relatedness" (support from specific persons, e.g., teachers and classmates), and (c) engagement or "connectedness" (enjoyment and motivation in school tasks and activities, appreciation and engagement in/with classmates or teachers). All three levels can also be important for the relationship with the school in general (e.g., premises, activities, and importance of teaching) but especially for the relationship with adults or teachers and with other pupils. Although teachers have a major impact on school belonging (Hattie, 2004), peer support seems to play a crucial role in daily school life. Peers can contribute to belonging by providing social and academic support, acceptance, trust, and simply being present. Positive peer influences during adolescence lead to positive decision-making and coping skills, which are associated with school belonging. Strong

friendships prevent feelings of alienation, foster a sense of community, and contribute to a reliable feeling of belonging in school. Reciprocated friendships are particularly important for adolescents, as they are linked to higher levels of school belonging, emphasising the significance of the quality of relationships over the number of friends.

Sense of Belonging in Times of Chronic Health Conditions

Epidemiological studies suggest that up to one in four children may have a chronic disease, with prevalence estimates ranging from 10% to 30%. This variation is mainly due to the fact that there are no standardised criteria for defining chronic diseases in children (Newacheck & Taylor, 1992). The biopsychosocial model – used by the WHO in the International Classification of Functioning, Disability, and Health (ICF) as an extension of the International Classification of Diseases (ICD) – expands the view of the individual and sees people as part of their environment. Accordingly, disabilities can arise not only from internal biomedical impairments but also from external environmental conditions (Kraus de Camago, 2020). Children and adolescents with chronic health conditions struggle to recover from their illnesses. At the same time, they miss school experiences and lose touch with everyday school life. As a result, a pupil's absence from school can lead to academic challenges (e.g., repeating grades or dropping out prematurely) as well as social and emotional problems.

Therefore, hospital or sanatorium schools have been established in many countries to enable affected pupils to stay on track academically. Specially trained teachers come to the hospital and teach the affected pupils according to their individual capabilities with regard to the course of the disease. Preparations are also made for returning to home schooling. In many countries, there is no obligation to attend school in the case of illness, but there is the possibility of participating in academic life, at least partially.

Nap-Van der Vlist et al. (2020) emphasise the increased risk of social exclusion when opportunities with age-appropriate activities are disrupted. It is important that children and young people have the opportunity to actively shape their social interactions and stay informed about social processes. In addition, it is of great importance to feel that they can keep up with their peers, whether in education or leisure activities.

Social connections to the class community can be established with the help of online services and social media platforms. However, these are often delayed and represent only a small or fragmented part of daily life. In this respect, social isolation can only be remedied to a limited extent. Rather, this can lead to further negative consequences, such as secondary mental illness, reduced well-being, low self-esteem, and less successful coping with illness (Skog & Sodal, 2017).

Using the Telepresence System Avatar AV1 at School

Telepresence systems represent a diverse assortment of technologies with the common function of mimicking the presence of a human while being controlled from a remote setting. Telepresence systems, such as avatars, virtual classrooms, and mobile robots, have been discussed in recent years as a promising approach to improving school participation for children and adolescents with chronic illnesses (Gilmour et al., 2015; Soares et al., 2017). A common form of these telepresence systems is a robot that can transmit both images and sounds in both directions and can be controlled and moved by users. However, in one study, problems with the control system or internet connection were frequently described. Pupils also felt uncomfortable with video transmission due to their altered appearance as a result of the disease (Newhart et al., 2016).

One specific type of telepresence system is Avatar AV1. The Avatar AV1 connects to the child or young person's tablet via an app and can transmit sound in both directions, but the video transmission only works in one direction so that the child can see his or her class or classmates. The Avatar AV1 is portable and can be conveniently taken along on school trips, for example.

Although Avatar AV1 transmits sound and video, the associated data are not stored (Weibel et al., 2020). The recording function of both the Avatar AV1 and the tablet is suppressed throughout the use of the Avatar AV1 so that the transmission is only via livestream. Furthermore, the child or adolescent can control the facial expressions of the Avatar AV1 and thus communicate with classmates in addition to the voice transmission. The Avatar AV1 is a robomorph (Schouten et. al., 2022) avatar that allows the user to mask his or her appearance and communicate emotions through a limited range of communicative actions. This telepresence robot was chosen as a possible form of intervention for the present study. It should be mentioned here that only this product was available in XX at the time of the study. As described, Avatar AV1 offers a number of functions and possibilities that can have an impact on the sense of belonging.

Figure 1.
Telepresence Robot Avatar AV1 from the Norwegian Company No Isolation Inc.

Data on the Use of Avatar AV1

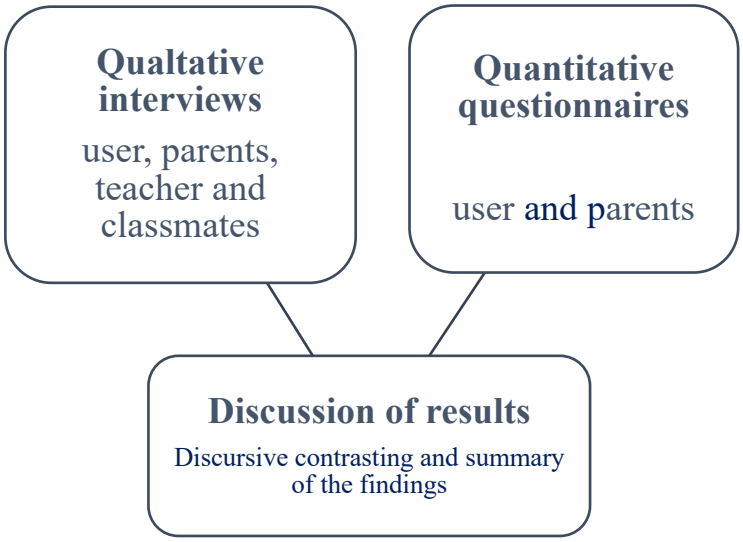
To date, a limited number of studies have focused exclusively on Avatar AV1 and its impact on children with chronic health conditions. Culén et al. (2019) primarily investigated the effects of the appearance and handling of Avatar AV1 by interviewing children both before and after using the system. In addition, the interaction with the Avatar AV1 in class was observed, and the assessments of classmates and teachers were collected with the help of questionnaires. Culén et al. described that the Avatar AV1 was taken to activities by classmates and that people were interested in it. According to the authors, the perceived "coolness" of the device contributed significantly to the acceptance and engagement of the Avatar AV1, both on the part of the children and young people and on the part of their classmates. Weibel et al. (2020) investigated whether Avatar AV1 enables young people with oncological diseases to not lose social and academic connections during their treatment. Similarly, this was a qualitative study in which the children and their parents, teachers, and classmates were interviewed and their interaction with the Avatar AV1 in the classroom was observed. It was found that the Avatar AV1 enabled classmates to care for pupils with chronic health conditions and improved the way ill pupils coped with their disease. For some young people, it improved perceived inclusion and reduced feelings of loneliness, but for others, it increased feelings of exclusion (Weibel et al., 2020). Participants from other studies also reported reduced feelings of seclusion and loneliness and increased feelings of belonging, resulting in improved psychological well-being, reduced distress and anxiety, and increased social and academic self-esteem (Ahumada-Newhart & Olson, 2019; Culén et al., 2019; Powell et al., 2021). Given the novelty of Avatar AV1 technology and the research field as a whole, our aim

was to further investigate the success criteria and moderating factors of users with chronic health conditions when using a telepresence robot in terms of sense of belonging.

Methodology

This study examined the use of telepresence robots, such as the Avatar AV1, using a multi-perspective approach by highlighting and comparing data from a qualitative interview study as well as data from standardised questionnaires on usage behaviour, sense of school belonging, and school participation. The two studies were conducted in parallel in a research collaboration between two research teams. Data were collected separately, but there was conceptual and methodological coordination in advance to work with both sets of data in contrasting ways in further studies. Regular research workshops provided space for conceptualisation and analysis. First, the qualitative study is presented in terms of sample, procedure, and results. Then, the quantitative study is presented in the same steps. Finally, the findings are analysed and summarised into the core observations derived from both studies (see Figure 2).

Figure 2.
Phases of Data Collection and Comparative Analysis



Qualitative Interview Study

Sample

The qualitative interview study (n = 27) elucidates the use of telepresence robots from a multi-perspective view, including pupils, parents, the class community, and teachers. The focus is on the possibilities for social interaction for children and adolescents with chronic diseases with their classmates and teachers.
Semi-structured interviews were conducted with pupils with chronic diseases, their parents, and teachers on a voluntary basis from a retrospective perspective (Avatar AV1 use of at least six weeks). Only pupils who had been attending a class at their current school for at least half a year were included in the sample. This was to ensure that a group feeling and sense of belonging could already be present. The interview guidelines were designed and tested in a pilot study. Accordingly, the interview guidelines were tailored to the age group of the pupils and adapted for

parents and teachers. The sample for the qualitative study consisted of 24 individual interviews with pupils as well as with their parents and teachers. Furthermore, three group discussions were conducted with classmates. Due to COVID-19 measures, only three group discussions took place in class during the study period of April 2021 to October 2021.

Procedure

To assess the subjective significant success criteria and moderating factors in the use of a telepresence robot, the transcripts were analysed according to qualitative content analysis (Kuckartz & Rädiker, 2023). This method is suitable for an inductive analysis of themes and subthemes, as well as for the systematisation and analysis of interrelationships. The study proceeded according to these parameters. First, the data were examined by two researchers from the team to obtain an overall understanding of the data. Second, the researchers marked significant sections with regard to the research questions. Third, after reviewing the data several times, a category guide was developed according to the methodology. The categories and subcategories were described and continuously adjusted intersubjectively by the research team.

Results

For the present interview study, a semi-structured guided interview was chosen as the data collection method (Helfferich, 2014). This form of guided interview is suitable for the research design due to the combination of a pre-designed and tested guide and the openness during the interview. The guide serves as a reference point and ensures the comparability of the data. Narrative-generating questions allowed a great deal of openness and invited the interviewees to talk as freely as possible about their experiences with the telepresence system (Kleemann et al., 2009). During the interview, the interviewees were asked for specific examples and scenes with the Avatar AV1 to get a vivid impression of their experiences. The interview guide was tested in a pilot interview and then adapted in terms of language and content to the students' age group. Likewise, the guidelines for parents and teachers were adapted and supplemented accordingly. Teachers were asked about the changed conditions in relation to their lesson planning, class management, and teacher–student relationships. The interviews were anonymised and transcribed verbatim.
The qualitative data were evaluated using the content-structuring qualitative content analysis method, according to Kuckartz (2016). Through coding and thematic analysis, the interview responses were systematically organised into key categories, reflecting the core themes identified in the participants' experiences. After an initial review of the data, deductive category formation was carried out along with the guiding questions. In order to reconstruct latent structures of meaning, inductive category formation was subsequently carried out on the data. The results of the study present the category guide developed from the analysis of the interview data. An exemplary overview related to the comparison of qualitative and quantitative data is presented in Table 1, including category names, code definitions, anchor examples, and coding rules.

Success Factors

In terms of success factors, four categories were identified. The first category involves the connection between the use of a telepresence system and the sense of belonging to the school through the personalisation of the telepresence robot. This category included the way the device was designed and named. In the qualitative study, almost all pupils personalised the Avatar AV1 to some extent. The younger children especially enjoyed painting and decorating the Avatar AV1. In the higher grades of secondary school, less attention was paid to it. It should be noted that the Avatar AV1 was also decorated in cooperation, partly by pupils with chronic illness and partly by classmates.

The second category explores the implementation and meaning of a buddy system for pupils with chronic diseases. A network of helpers and responsible persons in the class can increase smooth running and thus participation in school life. The data showed that good cooperation is essential for the successful use of the Avatar AV1. The technology is a tool, but the sense of belonging is shaped by interactions with the telepresence robot. This includes people who reliably charge the device, position it appropriately in the classroom, and do not forget to take the Avatar AV1 to different rooms or the schoolyard. This also includes informing the pupil about procedures that are not in the field of vision. For example, it can be irritating to be moved without notice or to be left standing. The data also showed that a team of buddies works well. In this way, the tasks can be divided among two to three pupils. In primary schools, class teachers play a central role, while in higher grades, the administration of Avatar AV1 is often organised by classmates.
The third category deals with the attitudes of teachers and classmates towards the Avatar AV1. Only a positive, benevolent, and supportive attitude can promote the successful use of the Avatar AV1. This includes consent to use the Avatar AV1 regularly in class and for teachers to make teaching materials available electronically. In primary schools, teachers sometimes adjust lessons to the participation of pupils with chronic illnesses. For example, they would organise the school day in such a way that the pupils could participate in group work via the Avatar AV1. This also included coordination with parents about therapy plans and doctor's appointments. The interviews showed that attitudes were positive across the board, especially in primary school and Secondary 1, on the part of the teachers and in all schools on the part of the pupils.
The fourth category captures the different interactions in school life that can confirm participation and strengthen the sense of belonging to the group. In this respect, a number of possible interactions were described in subcategories in the analysis of the study. The subcategories include the following aspects: participation in class, interaction with teachers and classmates, interaction during breaks, school trips, and school events. In the data analysis, it was noted that in some situations, the pupils with chronic illnesses simply wanted to listen and were less involved in direct interaction. The pupils also experienced these situations positively when it was their intention. In contrast, a lack of interaction was experienced as exclusionary and offensive. Categories 1 to 3 can be described as the essential basis for Category 4. In particular, Categories 2 and 3 are directly related to the successful interactions that support the sense of belonging.

Moderating Factors

With regard to moderating factors, two main categories were identified based on the data. The first category includes factors related to technical requirements. Participants reported that a stable internet connection, a functioning device, or an adequately charged battery were critical for maintaining their sense of belonging. It was found that these factors could be managed to some extent, but when they failed, they had a significant negative impact. For example, pupils shared that they felt excluded if the internet connection dropped, the device battery died, or the device was forgotten. Conversely, they expressed that stable technology and reliable support greatly enhanced their sense of belonging and facilitated more meaningful interactions.
The second category pertains to the pupil's current state of illness. Participants indicated that the need to participate in school activities fluctuated depending on the course of treatment, illness progression, and daily health condition. This, in turn, appeared to influence their sense of belonging. Some pupils mentioned that when their sense of belonging was deeply internalised, temporary absences had little effect on how connected they felt, and their sense of belonging remained stable despite physical absence. Table 1 shows the central categories, code definitions, essential anchor examples, and coding rules.

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Table 1
Categories, Code Definition, Anchor Examples, and Coding Rules

Categories	Code definition	Anchor example	Coding rule
I. Success factors			
Category 1: Personalisation	The Avatar AV1 is personalised by the affected pupil.	"So, my very first idea was that I stick eyelashes on it, because that is so typical for me, and then my dad bought me lots of things and brought them to the hospital, including eyelashes and glitter stones, such [as] adhesive rhinestones, which I then stuck on it – very, very many – and I also put my name with adhesive letters on it and in the end, it was then very colourful".	It describes how the Avatar AV1 is personalised and who does it (affected pupil, classmates, parents).
Category 2: Buddy system	In the class, there are buddies who are responsible for the Avatar AV1. The buddies ensure that everything runs smoothly during the school day.	"There were two girls in my class who always carried me around; they also charged the avatar, and they took care of me after school and before school, and they also reminded the teacher, 'You have to get Lidia out now', and they also carried me around and they never forgot, so I was always carried into the room where we had class, and it actually worked well."	The Avatar AV1 is charged, brought to the classroom, and positioned there by responsible classmates. It is also carried to other rooms or taken to break by the buddies.
Category 3: Attitude towards Avatar AV1 **Category 3a:** Teachers **Category 3b:** Classmates	The teachers agree to the use of the Avatar AV1 in their lessons. The classmates agree to the use of the Avatar AV1.	"Yes, everyone agreed. I also attended every class except for gymnastics and handicraft. I think I listened twice or so, but there I just had no material and, in the gym, the Wi-Fi doesn't work so well, […] but otherwise, everyone agreed." "Yes, the teachers and the students make sure that I'm always in a group and that I can work with them and that everything fits and that I get the material, and so they make sure that I'm there when there's group work."	It is clear from the statement that the teachers agree with the use of the Avatar AV1. It is clear from the statement that the classmates agree with the use of the Avatar AV1.

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Category 4: Interactions to support a sense of belonging Participation in class Interaction with teachers Interaction with classmates Interaction during breaks Interaction during school trips Interaction at school events	A variety of interactions are possible with the Avatar AV1 to foster a sense of belonging.	"I gave a presentation with Avatar AV1 about the lion. That was actually my first presentation; before we always did book presentations." "So, when I didn't have appointments at the hospital, but I went to chemotherapy, I actually did school with the Avatar AV1 all the time." "I didn't feel like I was any different from the other kids in the room. […] the teachers asked and involved me, just like the other pupils." "That you're kind of included in the class community again, that you're there live, that's a great feeling." "And then during break, everyone came over to me and wanted to know what the Avatar AV1 could do and if I could turn and point and what the blue light of the Avatar AV1 looks like. Then they wanted to see how I could turn 180 degrees." "There was an experience just before summer break when we went hiking, and I was there live via the Avatar AV1 in a backpack, which was really great because I was there and not alone at home and didn't do nothing. So, I was there, and that was really nice." "Yes, at the Christmas party, they were allowed to bring cookies and juice, and I was there via the avatar, so to speak, and they put the box of cookies in front of me, and I was able to be there. I thought that was very nice."	Examples are used to describe interactions in everyday school life that illustrate a sense of belonging.

Categories	Code definition	Anchor example	Coding rule
II. Moderating factors			
Category 5: Technical aspects **Category 5a**: Facilitators **Category 5b**: Barriers	There are no technical problems with using Avatar AV1. There are technical problems with using Avatar AV1.	"Well, I might have thought that it wouldn't work the way I imagined, that maybe it would disconnect more often than it does now, that it would be related to the internet connection, that the battery wouldn't last as long, it would fail after an hour and then I wouldn't be around anymore, or stop so abruptly, but that actually wasn't the case, thank God, with a few exceptions." "So, if the internet connection is low there, then it says, 'connection to AV1 lost' and then maybe they don't know how to fix it in class when it turns red."	Positive experiences are described in terms of the technical aspect. Negative experiences regarding technical aspects are described.
Category 6: State of health and course of disease	The pupil's state of health or course of their disease act as moderating factors in the use of the Avatar AV1.	"If I don't feel so well after chemo, for example, or if I still have a headache, I'll just not turn it up." "If I'm not there, for example, I text my colleagues to tell them that they don't have to take it with them so that it won't be in the classroom unnecessarily."	Examples are given where the pupil's state of health or course of disease influence their use of the Avatar AV1.

Quantitative Study

Sample

The study involved children and adolescents aged 6 to 18 who were living with chronic illnesses and who indicated that they would be unable to attend school for an extended period. These individuals were referred to the research team through project partners (including hospital schools and the official representative of the telepresence robot) and healthcare professionals (such as psychologists and doctors) between November 2020 and January 2023. Prior to participating in the study, both the children and their parents provided informed consent. Baseline assessments using questionnaires were conducted before assigning the Avatar AV1, and the follow-up evaluation took place after six months of usage.

Procedure

The questionnaire on the use of Avatar AV1 was employed at the follow-up assessment to gather data on various aspects of Avatar AV1 usage, including, for example, frequency of use, satisfaction with technical components, situations of use, and overall satisfaction. The questionnaire was administered in German and was distributed to the participants either by mail or in person. Ratings for the items were collected on a scale ranging from 1 to 5, where a rating of 1 indicated low agreement or no use of the Avatar AV1 in particular situations (e.g., during classes), while a rating of 5 indicated strong agreement or frequent use of the Avatar AV1 in those situations.
Due to the small and heterogeneous sample—typical for research involving children and adolescents with chronic or rare illnesses—the quantitative analysis was limited to descriptive statistics. This was both a methodological decision and a practical necessity: the sample size did not permit reliable inferential testing or subgroup comparisons without risking statistical artefacts. Descriptive statistics therefore provided an appropriate and transparent overview of usage patterns and satisfaction ratings, while avoiding overinterpretation and ensuring alignment with methodological standards for small-sample clinical and educational research.

Results

Out of the initial 40 study participants, 20 (50%) were excluded from the analysis because they had not yet completed the follow-up assessment, which included the questionnaire on the use of the Avatar AV1. Among the remaining 20 participants, who had an average age of 13.3 years ($SD = 2.93$) and 70% female representation, some responses in the questionnaire were missing for two participants.
Table 2 presents the means and standard deviations of the results obtained from the questionnaire on the use of Avatar AV1. Considering the technical aspects, the children and adolescents tended to be sometimes satisfied with the stability of the internet connection ($M = 3.15$, $SD = 0.875$) and mostly satisfied with the control of the Avatar AV1 ($M = 4.10$, $SD = 0.968$). There was significant agreement regarding the buddy system, indicating that most children had a buddy in class who took care of the Avatar AV1 ($M = 4.58$, $SD = 1.017$), and they mostly believed that these individuals took good care of the Avatar AV1 ($M = 4.67$, $SD = 0.767$), ensuring, for example, that it was charged in the morning ($M = 4.50$, $SD = 0.827$). The children and adolescents used the Avatar AV1 most frequently during classes/subjects ($M = 4.25$, $SD = 0.851$) and sometimes during breaks ($M = 3.70$, $SD = 1.342$). Additionally, the children were sometimes involved in conversations with peers through the Avatar AV1 ($M = 3.63$, $SD = 1.116$) and in classroom activities facilitated by teachers ($M = 3.95$, $SD = 1.268$). However, according to their self-reports, the children rarely or never participated in school trips ($M = 1.53$, $SD = 1.172$) or school activities ($M = 2.16$, $SD = 1.573$) with the telepresence robot. Overall, there was a high satisfaction level with the use of the Avatar AV1 ($M = 4.47$, $SD = 0.772$).

Table 2
Measures, Means, and Standard Deviations of Questionnaire Data

Measures	***n***	***M***	***SD***
Technical aspects			
Stability of internet connection	20	3.15	0.875
Satisfaction with Avatar AV1 control	20	4.10	.968
Buddy system			
Existence of buddies	19	4.58	1.017
Buddies took good care of Avatar AV1	18	4.67	0.767
Avatar AV1 was charged in the morning	20	4.50	0.827
Situations of use			
During classes	20	4.25	0.851
During breaks	20	3.70	1.342
Peer interactions	19	3.63	1.116
Involvement by teachers	19	3.95	1.268
Participation in school trips	19	1.53	1.172
Participation in school activities	19	2.16	1.573
Satisfaction with Avatar AV1	19	4.47	0.772

Discussion

According to the present study, sense of belonging did not decrease when a telepresence system was used during school absences. This contrasts with the existing literature, which suggests that illness and prolonged absence from school typically lead to a diminished sense of belonging, as discussed in the earlier section on belongingness. The following factors may explain this discrepancy, as they align with the findings from the qualitative study.

Teacher and Peer Attitudes

First, the data demonstrate that a good attitude and secure social network when using the telepresence robot are important for successful interactions, which subsequently support a sense of belonging. In previous studies, Weibel et al. (2023) and Johannessen et al. (2023) emphasised the importance of teacher attitudes and an existing social network before using the telepresence robot. According to the findings of Johannessen et al. (2023), children and young people who did not know their classmates in advance found the robot's participation in school unpleasant, and their fellow pupils seemed to perceive it as a creepy and unwelcome presence. In contrast, when such a social network was already in place, the robot effectively promoted social interactions between classmates and paediatric patients (Johannessen et al., 2023). The data for the present study were collected from users who had been part of their class community for at least six months. Thus, it was assumed that the classmates knew each other and that there might be an existing sense of community. Both the qualitative and quantitative data showed that attitudes towards the telepresence robot and supportive social climates may be a central factor contributing to successful telepresence use.

Personalisation and Emotional Connection

Second, the results indicate that the personalisation of the telepresence robot helps both children and young people with chronic health conditions present themselves in class and gives the machine a

personal touch. At the same time, it was found that decorating the Avatar AV1 at the beginning was an important aspect for the class to consciously engage with the chronically ill pupil. Furthermore, the pupils reported that they experienced this process in a fun and creative way. Thus, personalisation can strengthen understanding and empathy for the absent pupil and, in this respect, can contribute to the experience of inclusion. These forms of personalisation can foster empathy and recognition, helping the device shift from being perceived as a technical object to functioning as a relational proxy of the pupil. In this way, the small relational rituals around the robot can soften the machine–human divide (Zhao, 2006) and enhance its meaningful integration.

Buddy Systems and Practical Support

Third, the qualitative and quantitative data showed that a buddy system can contribute significantly to the success of supportive interactions. In the interviews and questionnaire data, it was found that the Avatar AV1 was charged and treated with care. As explained previously, this ensures that the Avatar AV1 runs as smoothly as possible. Although modern communication, such as WhatsApp messages or social media platforms such as Snapchat and Instagram, form a range of contact options, these often involve time delays (e.g., during breaks) and offer limited opportunities to be fully "present" in the moment (Skog & Sodal, 2017). Through direct participation and involvement, the synchronous experience of school and teaching was confirmed by the successful use of telepresence robots. These organisational and educational practices create "opportunities to belong" (Allen & Kern, 2017) and emerge as a practical mechanism that supports conditions for successful telepresence use.

Opportunities for Meaningful Participation

Fourth, it was found that direct participation strengthens the sense of inclusion and belonging and thus meets the fundamental need of children and young people to feel valued and integrated in their social environment. In particular, this was shown in the qualitative data in the form of participation in festivities and outings. Even if these are rarely the case in everyday life, as the quantitative data show, it can be stated that it is precisely these social interactions that add value to the sense of belonging. This emphasises the significance of participation in age-related interactions, as noted by Lohmeier and Lee (2021) and Nap-Van der Vlist et al. (2020), representing another key factor linked to successful implementation.

Technical Stability and Illness Dynamics

Lastly, in terms of moderating factors, the results showed that if the sense of belonging to the class is strong, unexpected technical problems or temporary changes in the course of the illness are less disruptive to the pupil's sense of belonging (Allen & Kern, 2017) and do not generally challenge the perception of participation in events. However, if technical failures accumulate without further explanation or contact, this can affect the pupil's sense of belonging and cause them to no longer want to participate in school activities. Similarly, the absence of the chronically ill pupil over a long period of time may cause upset or irritation among classmates. On the one hand, there is concern for the ill pupil when they do not participate; on the other hand, a lack of participation can lead to classmates no longer switching on the Avatar AV1. This shows that the use of telepresence robots also poses a number of challenges and threats to social inclusion for children and adolescents with chronic health conditions. Technical stability and illness dynamics therefore function as important moderating conditions influencing the sustainability of successful telepresence use. In this regard, further research is needed to accompany these aspects in a pedagogically helpful way.

Limitations

The present sample was able to provide important insights, but the limitations of the study must also be acknowledged. While the items used in the quantitative component were originally derived from validated questionnaires, they were adapted for the specific context of telepresence robot use, and no renewed psychometric validation was conducted. This approach is suitable for an exploratory study involving a small and hard-to-reach population, but it limits the formal interpretability of the scales. In the qualitative component, no formal inter-coder reliability coefficient was calculated; instead, category development was iteratively and intersubjectively discussed within the research team, which aligns with interpretive qualitative methodology but reduces transparency regarding coding consistency. The reliance on descriptive statistics is also attributable to the small and heterogeneous sample and represents an appropriate strategy to capture usage patterns without overstating statistical inference. These limitations do not diminish the value of the insights gained but underscore the need for future research with larger, more diverse, and internationally comparable samples.

Conclusion

The success of telepresence robots in creating virtual inclusion experiences for pupils with chronic health conditions is closely tied to the quality of the social interactions they receive while using these robots. The way pupils perceive the robot as an extension of themselves can vary from school to school and is influenced by factors such as exposure to the technology, informal interactions with peers, and personalisation of the robot. Additionally, acceptance, social integration, and support from peers, teachers, and parents play a crucial role in shaping pupils' experiences with telepresence robots. While the majority of participants reported positive experiences, there were also stressful factors to consider. These include teacher or pupil disinterest, unreliability, and poor internet connections. These stressors have also been observed in other studies that have reported instances of bullying and verbal harassment. This underscores the need for a comprehensive approach to the use of telepresence robots in education – one that considers not only technology but also a pedagogical framework to support pupils with chronic health conditions in the classroom. Further research is needed to develop pedagogical approaches for the use of telepresence robots to strengthen children's and adolescents' sense of belonging to their schools and among their peers.

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Disclosure Statement

The authors have no competing interests to declare. The study was conducted after approval by the Ethics Committee of MedUni Vienna.

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Data Availability

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