

Studying a Tele-Presence Robot Installed into a Hospital Classroom

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Recently, various technologies were released that have possibilities to improve educational settings. To help children who are in the hospital classroom, we introduced the tele-presence robot, OriHime, into a pilot classroom. It enables communication between the children who are isolated in the bedroom from their classroom to avoid becoming infected by others. However when we introduced OriHime to the hospital classroom, it was not automatically included in educational activities because there is a system that requires collective approval by other relevant persons, including other teachers and medical staff. In this case study, we tried to understand the situation that teachers in hospital schools confront when they attempted to integrate a tele-presence robot into their classroom. We arrived at two conclusions: 1) Proceed with the installation process deliberately, and 2) Adapt the tele-presence robot appropriately to the setting of each hospital classroom.

Keywords: tele-presence robot, hospital classroom, learning environment, social presence, accessibility

Introduction

The purpose of this study is to support hospitalized children's learning through a tele-presence robot. These children, who have to stay at hospital for long time, need to learn at the hospital classroom as same as healthy children in ordinary schools. Some children, however, cannot leave their bedroom because they need to avoid infectious viruses. The authors introduced a tele-presence robot for the children to access in the hospital classroom. Although the children stay in bed, they can participate in class activities through the tele-presence robot. This article is intended to show how researchers and developers cooperate with teachers who manage the hospital classrooms to construct these learning environments.

Research Background

Educational support for hospitalized children by robot technologies

The Japanese government provides 116 special need education schools for children who are hospitalized because of serious diseases such as child cancer and leukemia. Hopkins, Moss, Green, & Strong (2014) describe that there is a substantial body of research about educational risks and vulnerabilities for hospitalized children with chronic illnesses. It is a critical issue for educators to investigate how to build a learning environment and a flexible learning space for these children (McLaren, 2009). The interruption in the pace of academic study is one of the major concerns of hospitalized children and their parents (Shaked, 2014). A sense of connectedness with family members and friends helps hospitalized children keep a high level of motivation. The students, however, encounter many constraints to learning. If their illnesses are too serious, they cannot communicate with family members and friends face-to-face. They sometimes lie quietly in bed without any exercise. As a result, their anxiety increases and they lose self-confidence under stress. Then, motivation for learning is lost.

Nakai (2003) reported that digital technology can benefit hospitalized children. The authors stated that a

tele-presence robot may provide effective functions to achieve interaction between hospitalized children and others. A tele-presence robot is a device for distance communication. Figure 1 displays a basic communication system through tele-presence robots. The child in a bed operates a tele-presence robot (center of image) in a hospital classroom through a tablet device (right side of image). Children in the classroom communicate with the child in bed. They perceive the presence of the child in bed as if they are studying together in the same classroom (Tsui & Yanco, 2013). Various tele-presence robots are developed for different situations, such as business, medical, healthcare and education (Vermeersch, Sampsel & Kleman, 2015; Luevano, Lopez de Lara & Castro, 2015).

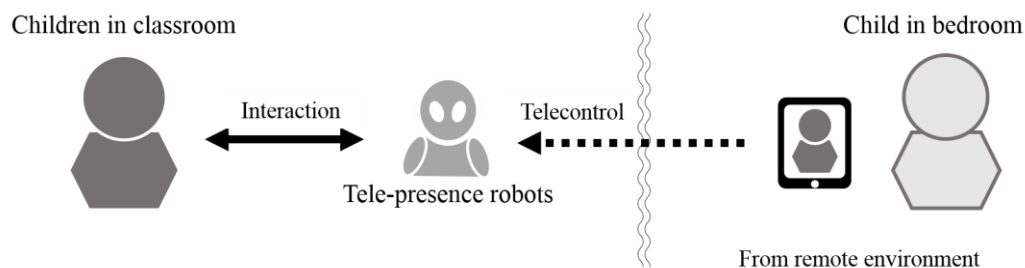


Figure 1. A basic communication system through tele-presence robots.

Tele-presence robot: OriHime

In this article, the authors selected the tele-presence robot, named “OriHime,” for the children in the hospital classroom to communicate others even if the child is in the bedroom. OriHime was designed for persons who cannot move themselves because of serious diseases such as amyotrophic lateral sclerosis (ALS) and muscular dystrophy. These patients cannot leave a hospital room. Moreover, there is a change in their physical appearance such as hair loss because of treatment. The characteristics of OriHime are that it does not display the user’s face and has arms to express non-verbal messages even if the user cannot move his own body.

Figures 2 and 3 show the specifications of OriHime and the interface of its controller on an iOS tablet. OriHime has a camera on its head. The controller displays a video picture taken by the camera. It has a swivel neck so that the user can pan and tilt the camera by swiping the controller. The camera movement that the user controls and the facial direction of OriHime are synchronized. It has a loudspeaker and arms to express both verbal and non-verbal messages. OriHime is operated from an iOS tablet device. The user can speak to internal microphone of the tablet device to communicate with children in classroom. For non-verbal communications, such as raising a hand, nod, nodding no, or hand clapping, the user taps the buttons.

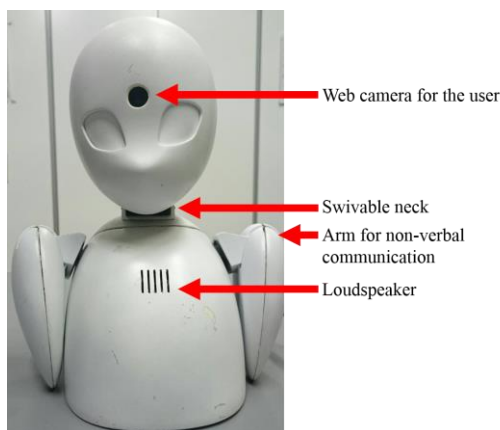


Figure 2. Feature of OriHime



①Main monitor, ②Gesture button, ③Facial direction indicator

Figure 3. OriHime controller screen on iOS application

Barrier at installation of new technologies into a school

Although a tele-presence robot has a possibility often encouraging a children in bed to study, it is difficult to install it into their learning environment because teachers play the role of gatekeepers who select appropriate learning resources for children. Teachers mainly control learning environments at school. Thus, it is depends on teachers to install OriHime into a hospital classroom.

There are previous studies about promotion of ICT as well as installing a tele-presence robot in a classroom. These results show that although new technologies effectively function for learning, teachers do not utilize them actively because of two factors. First, when teachers are satisfied with the current educational environment, they do not accept new technologies positively (Kihara, Horita, Yamauchi, Oyanagi & Miyake, 2002). Ordinarily, they do not accept new technologies without extrinsic pressure such as policies of ministry or education board, directed by a school principal, replacement of school equipment, etc. Second, teachers are not able to make a decision about installation new technologies into a classroom because decision-making authority is shared with other relevant persons in the school such as an education board, a principal, a vice principal, members of parent-teacher association and colleagues in the school (Cuban, 2001). The learning environment in school is developed cooperatively with such persons who have different concerns. Therefore, the teachers' purpose sometimes does not match with new technology.

The promotion of new technology has been implemented at ordinary schools as well as in hospital classrooms. Therefore, the hospital classroom has similar problems. Teachers in hospital schools are concerned not only with enhancing learning, but also with the treatment of children's mental and physical health. To handle this situation, they must cooperate with each other. Thus they are not able to construct their learning environment independently, and there is a collective decision-making process in hospital classrooms.

The authors then investigated what situations teachers in hospital schools confront when they install a tele-presence robot into their classroom for children involved in this case study. We focused on the interrelationship among relevant people such as other teachers, school administration and medical staff and its configuration.

Case Study: H Hospital Classroom

The authors investigated an initial classroom installation process of OriHime at H hospital located in Osaka, Japan. This hospital classroom was established as an extension classroom of a special needs education school that specializes in child cancer and other uncommon diseases. Approximately 10 students from grades 1-9 study in the H hospital classroom. They are hospitalized at the university hospital and transfer from an ordinary school. There are about 10 teachers in the H hospital classroom.

The authors have supported learning of hospitalized children in collaboration with administrators and teachers at H hospital classroom since 2008. Children separated from their families sometimes lose connectedness to the society and are discouraged having to fight against diseases. Therefore, the authors have tried to provide an opportunity for children to contact others outside the hospital in order to motivate them to overcome diseases. For instance, the authors introduced a video conferencing system to connect H hospital classroom with an ordinary school.

The support helps children, but some cannot participate in the hospital classroom because they have to stay in the room in order to avoid infections. Only a teacher is allowed to visit them to teach beside their bed.

To overcome this problem, the authors planned to employ the tele-presence robot, OriHime, to support learning in the hospital classroom. Children who have to stay in a bedroom cannot access lessons and communicate with their friends directly. The authors provided a tablet device for the children to control OriHime in the hospital room. OriHime is placed in the hospital classroom so that children are able to participate in learning activities. The children in the hospital classroom feel the presence of the other children because the child in a bedroom can operate OriHime not only by moving its neck and arms, but

also by voice. The children in a bedroom may acquire a sense of participation in the classroom community, and become motivated to study together.

It is possible for OriHime to help the children in a bedroom, however, it is difficult to install it. In order to install new technology into the school, the teacher must decide with colleagues in the school such as the school principal, vice principal and other teachers, but also the medical staff such as doctors, nurses and other relevant persons. To show how install a tele-presence robot into the hospital classroom, we had to find out how the teacher works with these people.

H hospital is designated as a hub medical institution for childhood cancer, cardiovascular, cardiac transplantation, etc. from several institutions. Therefore, the hospital classroom always has many child patients. Some of them have to learn in the bedroom to avoid affection from others. As stated above, H hospital classroom has typical problem for educating for hospitalized children. Therefore, the authors selected it as a case study.

Research Objective

In this paper, the authors investigated the principles for installing a tele-presence robot, a new technology for education, into hospital classrooms in a case study of the H hospital classroom. The authors especially focused on the relationships among stakeholders in the hospital classroom. These stakeholders collectively decide when new technologies are installed into the classroom. Teachers have to negotiate with others directly or indirectly to change the practice of the teacher's community, routine or common view of instruction for hospitalized children. The authors attempted to clarify these factors that affect a teacher's actions.

Methodology

Theoretical Framework

The action of teachers are guided by the environment which surrounds them. This idea comes from Activity Theory (AT) developed by Engeström (Engeström, 1987; Yamazumi, 2004). According to AT, when a subject participates in group activities, the artifacts such as the tools, composition of their community, rules and division of labor which were structured to organize the activity mediate their action. This environment which includes these mediating artifacts was developed through everyday and continual work. The environment forms a system that guides participants' action and thoughts. In the hospital classroom, teachers are guided by what appropriate lessons and learning activities for their children by the hospital system. The subject was affected by suitable action in their community by a system which was constructed from the mediating artifacts that are used by group members.

The subject is able to act suitably in the environment which is configured as a collective activity. On the other hand, the subject's action is constrained by the environment when new technologies or innovations that are unfamiliar for the participants are involved. The teachers are required to change their lessons, learning activities and preparation when a tele-presence robot is installed. However, the system does not allow for change that the teacher creates because the system is inflexible. Engeström shows contradictions between an existing and reformed system and struggles that the subject encounter in a medical setting (Engeström, 2008), a banking institution and a factory (Engeström, 2007). The three systems were changed with the help of the stakeholder. Therefore, to understand the actions of the subject's, we have to reveal details of the environment and how the environment relates to the subjects' actions.

In this paper, the authors focused on the three points:

- 1) Which stakeholders work with the teachers in the hospital classroom?
- 2) What kind of system was constructed in the hospital classroom?
- 3) How the teachers get overall that environment to install tele-presence robot?

From the result of these questions, the authors aim to show the specific attitudes and ways of using a tele-presence robot.

Data Collection and Analysis

The authors observed how the teachers work in the hospital classroom to suggest specific attitudes and ways of using OriHime, a tele-presence robot, in the hospital classroom. In particular, we collected and analyzed data to show what factors encouraged or constrained installation of OriHime.

The authors entered the H hospital classroom to collect field notes for data analysis. Field notes have advantages to identify the parts of the system and how it affects the participants. In order to take field notes, the first and second author joined the educational activities for three days (June 26, July 3 and July 16, 2015) in the classroom as a supporters for daily activities and OriHime installation. The roles of the supporters were, 1) finding suitable OriHime usage in the classroom, 2) introducing examples of OriHime utilization at other places, and 3) helping teachers' daily duties. They joined for two to four hours each day to help the teachers. Although they had not experienced previous OriHime installation, they were shared information about the case studies by the developers. The first and second authors took note while working at the classroom, and made field notes after their work. They earned a credit for qualitative research in graduate school before data collection.

In the analysis, first the authors used AT as a theoretical framework and focused on the system which is formed among stakeholders and how the teachers used OriHime in this system. Second, the authors described typical episodes from field notes. Finally, the authors will suggest attitudes and ways of using a tele-presence robot in a hospital classroom.

Findings and Discussion

Installation Process of OriHime

Even though OriHime was placed in a hospital classroom, teachers did not utilize OriHime in their daily instruction. Table 1 shows the process of OriHime installation. The authors and the principal of a special needs education school completed an agreement on April, 2015 to install and utilize OriHime in order to improve the learning environment for children who are isolated in a bedroom. In the faculty room of H hospital classroom, the authors introduced OriHime's functions and uses to the teachers. This experimental trial started in June 2015. After OriHime was located at the hospital school, it was not used in the classroom in July. Although the authors explained how to use OriHime, the teachers did not understand its benefit and had a negative feeling toward OriHime. The authors removed OriHime from H hospital classroom in August of 2016 because the teacher did not use it in the hospital classroom.

Table 1.
Installation process of OriHime in H hospital classroom.

Term	Event
April, 2015	- Discussed with the developer to install and utilize in H hospital classroom. - Explained OriHime's functions and possible utilization to the school principal, and made agreement.
May, 2015	- Explained OriHime's functions to the teachers.
June, 2015	- Installed OriHime to H hospital classroom - Provided instruction for the teachers.
July, 2015	- No use of OriHime in lessons.
August, 2015	- Removed OriHime from H hospital classroom.

Why did the teachers not use OriHime in their lessons? The authors analyzed a relationship among stakeholders, and discuss why teachers did not use OriHime.

A Process for Installation of OriHime at H Hospital Classroom

There are four significant features of teacher's action related among stakeholders.

(1) Absence of the principal who made decisions

The principal plays an important role when introducing new teaching methods. It is not easy for teachers to employ new ways of teaching without permission from the principal. The approval by the principal strongly pushes a teacher's actions at school. The principal, however, has difficulty managing a teacher's performances because the teacher actually teaches children in the hospital classroom. The teachers do not

use new methods of teaching if they did not think that the new way of teaching is better than the conventional one even if pushed by the principal. Figure 4 shows the organization chart of the special needs education school. It has 5 divisions that are located in different places of the head office at which the principal works. The teachers in hospital classrooms have to work based on the policy of the head office. However, the children at the hospital have different diseases and disabilities so that the teachers handle each child differently with others in the hospital such as medical doctors, nurses and other relevant persons. Thus, although the principal approved using OriHime as a new technology in the classroom, the teachers may choose not to follow the principal. It is the teacher that decides instructional methods in her classroom, even though the principal suggested introducing OriHime into the class. Then we will discuss what factors affected their decision-making from episodes recorded in field notes.

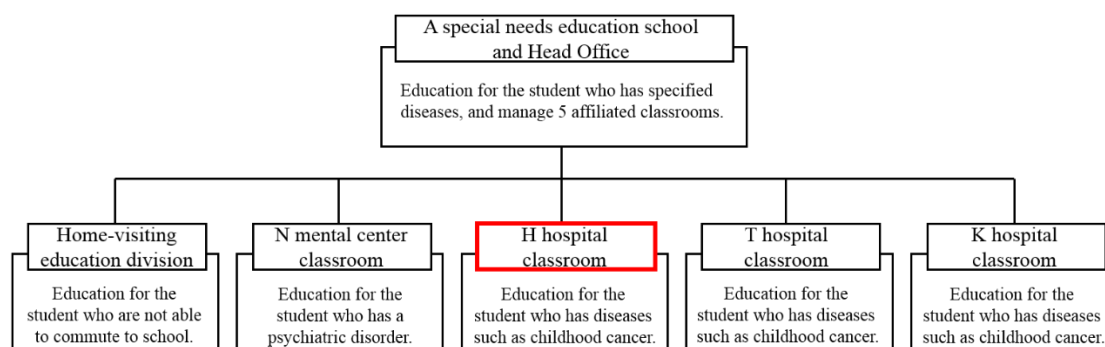


Figure4. The organization chart in a special needs education school.

(2) Cooperation for children's care with medical doctors, nurses and other relevant persons in hospital
For teachers, both learning and treatment of children in a hospital classroom are important. In order to conduct these duties, the teacher cooperates with medical doctors, nurses and other relevant persons in the hospital who take care of a child's condition. Thus, when the teacher in hospital classroom makes a decision, medical doctors, nurses and other staff are involved because they always observe the teacher. The following three episodes show their involvement or intervention in educational practices conducted by a teacher.

Episode 1: Location of H hospital classroom

Teachers in H hospital classroom are frequently observed by doctors and nurses because their classroom is placed in the pediatric ward. Children in H hospital classroom have serious diseases, so doctors and nurses always check on the children's condition and are ready to provide treatment.

(July 16, 2015)

Episode 2: Briefing with a nurse for care of children

A nurse asks the teachers about the exact details planned for children's activities. The teachers in H hospital classroom plan a summer festival in the ward. The teachers share the timetable and activities with the nurses because it does not follow the regular timetable of a hospital classroom. The nurses must have knowledge of the schedule for treatment purposes. Thus, teachers must cooperate with medical staff who take care of the children's condition.

(July 16, 2015)

Nurses and medical doctors do not directly intervene in the educational practice at the H classroom, however, they always confirm activities that children participate in. The responsibility to take care of children is shared among teachers and medical staff. Therefore, the teachers are not able to plan their activities without the knowledge of the medical staff.

Episode 3: Testing OriHime by the section of medical information technology

In order to install new devices that connect to the internet, they must pass a safety inspection by the section of medical information technology before being placed into the classroom. This is to avoid negative effects since some devices may emit radio waves that interfere with medical equipment. OriHime requires connection to the internet, therefore, the teachers must bring it to that section for

inspection. This is an obstacle for teachers when installing new devices into a hospital classroom.

(June 26, 2015)

Teachers are not able to install new devices into their classroom without the permission to utilize them from a section in the hospital. It indicates that their educational practice is affected by children's condition. Much deliberation is necessary to avoid negative effects on the children when teachers use unfamiliar devices in the classroom

Medical staff indirectly intervene in educational practices because they take part in the treatment of children. The configuration, such as location of the classroom, briefings and testing of new devices at the H hospital classroom reminds the teachers about concern of medical staffs. Thus, they are not able to decide on their educational practice individually.

(3) Tendency to conduct previous practices verified as safe

Teachers primarily intend to conduct educational practices from previous experiences that are verified to be safe because of the medical staff's concern. Episode 4 shows what educational practice the teacher in H hospital classroom conducts for the children. Every year in H hospital classroom, the teachers provide a summer festival for the children to enjoy. The episode describes activities that they conducted.

Episode 4: Contents of summer festival at the H hospital classroom

The teachers conducted 5 activities: a shooting game, a badge hand-making, a floating ball scooping, a bookmark hand-making and a pinball. These activities were conducted in the previous summer festival. In general, when the teachers provide activities, they tend to follow previous ones that were verified as safe.

(July 16, 2015)

The teachers always repeated previous educational practices, which were verified to be safe. In fact, they followed previous activities for the summer festival. From this episode, it seems that they were discouraged to try activities with a tool that was never used.

(4) Consideration of suitable OriHime utilization in H hospital classroom

The next episode expresses teachers' concern for the appropriate utilization of OriHime at H hospital classroom. In particular, they changed the appearance of OriHime in order to avoid negative impressions among the children.

Episode 5: Decoration of OriHime

OriHime was placed in the faculty room with a 'TRIAL' tag on its body. It was then decorated with colored paper for its facial features. The teacher in charge of the OriHime installation explained to the authors that some teachers felt unsure about its appearance because of three factors. They discussed modifying the appearance of OriHime before introducing it into the classroom.

1) The teachers were afraid that children might dislike OriHime's "up-angle" eyes.

2) Children who were treated with anticancer drugs due to leukemia had lost their hair. Likewise, OriHime had no hair on head. The teachers were afraid that the children would feel sad when they saw OriHime.

3) The OriHime that the authors acquired had a small fracture since it was a prototype (Figure 5). The teachers were afraid that children with brain tumors would associate the fracture with craniotomy surgery.

The original feature of the OriHime is shown in Figure 5. OriHime, decorated by the teachers, is shown in Figure 6. They added hair and eyes with colored paper to make it look better. However, the teachers mentioned that OriHime had no fingers on its hand. They considered modifying its hand because there were children who wore splints on their hands. Also, they discussed the limited personification of OriHime, and the intent to change its appearance to an animal or a doll. Only then, did the teachers consider OriHime suitable for installation.

(July 3, 2015)

The teachers decorated OriHime in order to install it appropriately in H hospital classroom. The teachers made an effort to install OriHime by considering the negative mental effects upon children with various

diseases. The installation of a tele-presence robot as a new technology into the hospital classroom was not dramatically implemented because teachers' tendencies that are influenced by the hospital settings. Teachers attempted to use OriHime through try and error.

We retrieved OriHime two months after the installation since it was a pilot research project. The installation of a tele-presence robot into a hospital classroom requires a longer term in order to utilize it appropriately in the hospital setting.



*Figure 5.*Avulsed head of a prototype OriHime. Photo taken in a research laboratory on June 8 before bringing it to H hospital classroom.



*Figure 6.*OriHime decorated by the teacher in H hospital classroom with a 'TRIAL' tag on its body. Photo taken in the faculty office at the hospital classroom on July 16.

Principles for Installation of OriHime into Hospital Classroom

As mentioned above by the authors, teachers in hospital classrooms do not always follow decisions made by a principal. Also, they did not easily adapt to using a tele-presence robot because of concerns from the medical staff. The teachers did not create educational practices individually, and primarily intended to avoid the negative effects from children because they always cooperated with medical staff to take care of the children in the classroom. Some tele-presence robots do not have adaptable forms. Thus, they are difficult to install in a classroom. On the other hand, the teachers' behavior showed that they tried to adapt a tele-presence robot by trial and error. In particular, they utilized it by appropriately modifying the robot's appearance.

The authors' observations suggested key principles for installing a tele-presence robot into a hospital classroom: 1) proceed with the installation process deliberately, and 2) adapt the tele-presence robot appropriately to the setting of each hospital classroom. First, a teacher developed suitable use of new devices through his own lessons in the classroom. However, the teacher must not proceed by trial and error in a lesson because the error may negatively influence the children. Additionally, the teacher cooperated with the medical staff on children's treatments as we indicated in Episodes 2 and 3. Thus, the installation of a tele-presence robot into a hospital classroom is not implemented rapidly. Researchers and developers must recognize these settings.

Second, there are children afflicted with various diseases and different conditions. For instance, in H hospital classroom, there were children who lost hair due to anticancer leukemia drugs and others who were awaiting craniotomy surgery due to brain tumors. The teachers were afraid that the children would associate the appearance of the tele-presence robot with their own diseases and conditions. In this case study, we introduced OriHime. Its appearance, as designed by the developer, was not suitable for the H hospital classroom setting. In order to introduce a tele-presence robot, we must understand the situations that teachers work in and their concerns.

Conclusion

Recently, various technologies have emerged that have possibilities for improving educational settings. In this study, we acquired a tele-presence robot to help children in hospital classrooms. These children are often isolated in their bedrooms to avoid infections. In order to improve this setting, we introduced OriHime, a tele-presence robot that enables communication between the children in bedrooms and other

children. However, when we brought it to the hospital classroom, it was not automatically integrated into the educational activities because a system existed that had evolved from previous work by teachers, other relevant persons, and medical staff. We then attempted to learn what teachers in hospital schools were confronted with when they installed a tele-presence robot into their classroom and discovered principles related to the installation process. From this case study, we arrived at two conclusions: 1) Proceed with the installation process deliberately, and 2) Adapt the tele-presence robot appropriately into the setting of each hospital classroom.

The teachers cannot easily install OriHime into their practice because the existing system even in the H hospital classroom which has many children who were confronted to bedroom. In particular, the children's condition was a sensitive matter to the medical staff. In this setting, although the teacher tried to bring a new educational practice with new equipment, the existing system did not accept it.

However, installing a tele-presence robot proceeded with difficulty to adapt it into the system. The teacher carefully installed a new educational tools because they are unable to test in the classroom to avoid negatively affecting the children, especially since the H hospital classroom has children with serious and uncommon diseases. In order to protect them, the teachers and the medical staff shared common concerns about keeping positive attitudes for students' health condition as a rule. Even in this setting, the teacher tried to find a usage of tele-presence robot if it gave positive educational profits. The teachers considered the compatibility between the rule and educational profits of the tele-presence robot for the children. In particular, the teachers developed an appropriate the use of OriHime that the developer did not suggest by decorating OriHime (see Figure 6) to include it into the hospital.

The teachers were confronted with a dilemma between a rule as a component of the system that was structured by stakeholders in the hospital and the installation of OriHime to enhance children's learning. According to previous studies, there were no suggestions about roles of the researchers and the developers. In other words, this compatibility issue of the installation process of would proceed only through the teachers' efforts. In order to achieve resolution, outside personnel such as researchers and developers also take on important roles. For instance, the researchers may play a role to analyzing the existing system that makes it difficult for the teachers in the hospital classroom and also intervening to help reconfigure the system. The developers also take on important role to customize the tele-presence robot to adjust easily into the intended system. As mentioned above, the installation process has achieved through the collective efforts of all stakeholders.

This study focused only the settings in the hospital classroom in a single case study. We must conduct additional case studies to confirm our findings. Also, we must analyze perspectives, such as focusing on teachers' thought processes when they take on the installation of new technologies into a hospital classroom.

Acknowledgment

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