Exploratory Study into the Disability Awareness Through an Inclusive Application Development Process Driven by Disabled Children

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Abstract. 【Background】

"Digital Interactive Rehabilitation System" (Digi-Reha), developed by Non-profit Organization Ubdobe, is a support tool for pediatric rehabilitation. Digi-Reha is a platform of applications which utilize several sensors to detect physical information such as acceleration and joint movements, and generate interactions of digital art and sound effects. The aim of this interaction is to improve children's motivation for rehabilitation.

【Objective】

One of the unique aspects of Digi-Reha is the Digi-Reha LAB (LAB), where children's ideas are used as a starting point for the application development process. As a new approach, a child with a diagnosis of Autism Spectrum Disorder (ASD) has been included as a participant in LAB. The aim of this report is to explore whether involving disabled children in the process of application development contribute to positive influence on the children as well as improving the quality of applications.

【Intervention】

A total of four sessions of LAB were carried out in a month. Three children, including a boy with ASD were recruited as participants. They learned to develop their original applications by using Scratch, a programming language. The participants' words and actions during the Lab were recorded and exploratively analysed.

【Result】

During LAB, the boy with ASD expressed his opinions about universal design ("I want to add some sound effects for blind people") and the awareness of his own symptoms through application development ("By creating applications that I enjoy, I can make people with the same disease enjoy too").

【Conclusion】

Joining LAB can be an opportunity for disabled children to learn about their impairments and reasonable accommodation for people with different needs in addition to improving Digi-Reha applications' quality, within the process of application development. In the coming years, its effectiveness will need to be further tested.

1   Background

The Non-Profit Organisation Ubdobe is developing a supporting tool for paediatric rehabilitation, the "digital-interactive rehabilitation system" (Digi-Reha). The aim of Digi-Reha is to motivate children with impairments to engage in rehabilitation by using digital art with objects that they like. The interactions with digital art and sound are triggered by the children's physical movements, detected through sensors (e.g. accelerometers and laser-based sensors) (Fig. 1).

Fig. 1. The interactions with digital art and sound are triggered by the children's physical movements, detected through sensors.

One of the features of Digi-Reha is that it is inspired by children's ideas and perspectives in the development process. Ubdobe has organised "Digi-Reha LAB", a workshop where kids creators (children with skills or interests in computer programming, character design, etc.) design applications for rehabilitation by observing and interviewing players (children who receive rehabilitation regularly). The purpose of Digi-Reha LAB is to promote mutual understanding between non-disabled and disabled children, under the slow progress in inclusive education in Japan, which is known to be lagging behind internationally [1].

However, Digi-Reha LAB was previously a one-sided relationship, where children without impairments invited disabled children to the workshop to observe as a subject. This is an important opportunity for better application development, though, it can be criticised for its similarity to the situation of *Koryu-gakkyu* (exchange class) in Japan. An

exchange class is an occasion where children in a special education school/class have a chance to interact with children in a mainstream class. In Japan, it is common that a few disabled children visit mainstream class [2]. It is a similar pattern to that of Digi-Reha LAB. According to the contact theory [3], interaction among children from different groups is useful for them to develop an understanding of each other. However, it has been reported that simple interaction is not enough; the effects are more likely to be felt by non-disabled children and have less benefit for disabled children [4]. Therefore, it was necessary for Digi-Reha LAB to shift the method of welcoming a disabled child as the main participant in order to improve the quality of the relationship.

2   Object

Taking into account the challenges mentioned above, the Digi-Reha LAB has chosen to include a child with a diagnosis of ASD as a participant. The aim of this paper is to explore whether involving children with impairments in the process of developing applications for pediatric rehabilitation, have a positive impact on the children themselves, not only improving the quality of the applications.

3   Methodology

3.1   Participants

The targets of this intervention are shown in the table below. Participants were recruited at Day-care centre N, where provides rehabilitation service training for disabled children. Participant A and B attended the Digi-Reha LAB at Centre N and participant C joined online via zoom. Consent to participate in this research has been given in both written and oral form from the participants and their parents.

Participant A has a diagnosis of ASD. His difficulties include: lack of confidence in communicating his thoughts and opinions, often giving up before even trying it. And he often asks for frequent feedback from others because he is not confident in his decisions (Table 1).

Table 1. Participants' list

Participants	Age	Gender	Background
A	9	Male	Diagnosed as Autism spectrum syndrome
B	11	Female	Sibling of A
C	12	Male	Sibling of a child with physical and cognitive impairments

3.2   Implementation

Four sessions of Digi-Reha LAB were carried out during one month. The participants' behaviour and statements during the LAB were recorded and exploratively analysed (Fig. 2).

Fig. 2. Participant A and B are attending Digi-Reha Lab and coding on Scratch

4   Result

As shown in Table 2, the statements of the three participants collected in the Digi-Reha LAB were grouped into five main categories: Competitive thinking arising from collaboration, Computational thinking, Encouragement, Universal design and Self-understanding.

Table 2. Statements of participants

Categories	Statements
A sense of competition arising from collaboration with others	• B has beat me to it (Participant A)
Computational thinking	• If you reduce the size (of an object). It's now 70%, you may reduce it to 40% (to make it harder). And to make it easier, you reduce it to 100% (Participant A) • We made the alien and the robot bigger, so that the area against the robot was bigger and made the robot move slower. That way it would be easier to clear (Participant B) • It would be nice if you could reset the thickness of the lines when you press the spacebar (Participant C)

(*continued*)

Table 2. (*continued*)

Categories	Statements
Encouragement	• I think it's a really good idea (Participant C) • I hope we can make and publish the Digi-riha application together (Participant C)
Universal design	• So what about the blind people? (Participant A) • If you put in a recorded sound, like"I got you!" (even blind people can hear) (Participant B)
Self-understanding	• I don't know that much (about my impairments), even though I know the word (Participant A) • I just need to make a game that's fun for me (in order to make people with same disease fun)! (Participant A)

In the following section, the differences in the tendency of each participant's statements in the Digi-Reha LAB is described. Firstly, participant A, who has a diagnosis of ASD, made more statements related to universal design and self-understanding than the other participants. For example, in relation to self-understanding, participant A stated that he was not sure about his own impairments. On the other hand, when the facilitator asked "What do you enjoy about Scratch?", he responded as;

I study alone at home, so I don't hear any sound. It is boring. But scratch is good, I don't know what's good about it. I don't know. (Participant A)

He identified computer programming as enjoyable in comparison to the general subjects. However, he is not able to clearly articulate the reasons for this. He also describes what is necessary to develop applications for people with similar impairments to himself as follows;

I just need to make a game that's fun for me. (Participant A)

In this way, it seems difficult for Participant A to fully understand his own personal traits. On the other hand, he expressed a willingness to contribute to others by understanding his own impairments. Second, in terms of participant B, who is A's sibling, she commented about computational thinking and universal design when discussing the applications with participant A. For example, when they were talking about sound effects in the application, she suggested that even visually impaired people could enjoy playing it by adding sound. In addition, participant C, who has programming skills, gave many words of encouragement to participants A and B. For example, he praised A's app idea as follows;

I hope we can make and publish the Digi-Reha application together. (Participant C).

5 Discussion

5.1 The Potential for Self-understanding Through Inclusive Design

Many approaches have been taken to support children with ASD through computer programming [5, 6]. These are mostly therapeutic and educational initiatives aimed at improving language and social skills through interaction with others. This suggests that computer programming is an accessible tool for children with ASD. In addition, this study employs an inclusive design approach in which collaborate with disabled users to develop the application. Inclusive design is a method of incorporating the user's point of view from the early stages of development [7]. This is expected to improve the quality of the products.

Furthermore, understanding one's own impairments and necessary reasonable accommodations is an important basis for self-advocacy for disabled children [8]. In this study, Participant A, who has a diagnosis of ASD, was unable to explain his own impairments and why he enjoys computer programming. This is consistent with reports that children with impairments such as ASD, especially younger children of primary school age, often find it very difficult to explain their impairments in words, and even when interviewed they are unable to give clear answers [9, 10]. Thus, it was very difficult for Participant A, a child with ASD, to face to his own personal traits.

However, with the clear aim of developing a more enjoyable application, the participants engaged in detailed and thoughtful discussions. In particular, Participant A expressed a willingness to contribute to children with similar conditions to him, by developing applications that he finds enjoyable. In order to achieve this, it is necessary to understand his own preferences and needs to translate it into the application more deeply. It is also important to explain them verbally to the team members. Therefore, it is expected that participating in the process of application development in the Digi-Reha LAB promotes children's self-understanding, especially children with impairments.

5.2 Limitation of This Research

Since the aim of this study is an exploratory analysis, a very small number of participants have been recruited. In addition, all the data analysed were collected through observation of behaviours and statements in Digi-Reha LAB, not through structured interviews with each participant. Therefore, it is highly difficult to generalise the findings of this paper. For example, the phenomena observed may be different if participants had other impairments (e.g., physical or intellectual impairments).

In further research, existing assessment methods like the Behavior Assessment System for Children [10] and the What I Am Like/Self-Perception Profile for Children (SPPC) [9] are needed to be adopted according to the impairments of the target groups as well as to verify the results in a larger number of children.

5.3 Challenges and Suggestions to Involve Disabled Children

As mentioned above, Digi-Reha LAB has the potential to promote a better understanding of children's impairments. However, there are significant challenges. For example, there

is a risk of a child with a diagnosis may be required to disclose his or her impairments to other children. Disability is socially stigmatised in a strong way, so avoiding disclosure of one's own impairment may be a rational choice [11]. The content and purpose of the Digi-Reha LAB should be discussed and carefully agreed upon with the participating disabled children. Focusing too much on the name of the child's disorder may lead to promoting the individual model of disability [12]. It assumes that disability is caused by the individual's condition and that it is in the individual's best interest to resolve it. Instead, it is important to look at how the child's difficulties can be addressed through reasonable accommodations for conducting inclusive activities or/and studies.

6 Conclusion

Digi-Reha has developed applications with kids creators in order to address the gap between non-disabled and disabled children and disabled children. For this research, a disabled child was recruited as one of the main members of Digi-Reha LAB rather than a guest. The three participants worked together to develop an original application using the Scratch programming software. Throughout the process, it was observed that participant A, who is a child with impairments, deeply thought about his own impairments, preferences and other aspects that were difficult to understand. It is suggested that the willingness to contribute to oneself and to children with the same disease may promote self-understanding. Further research is needed to examine the practicality of this method, including the differences in impairments children have.

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