Playful technology to help deaf children to speak: A case study using co-design method for designers to learn from speech therapists and parents

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ABSTRACT Every year approximately 500 babies are born deaf or hearing impaired in Australia. After a cochlear implant, young children can learn to speak with intensive speech therapy. A range of paper-based speech therapy programs exist, but there are few technology-based programs. The benefits of using technology to practice speech drills for busy parents is compelling, however there are few such tools for parents to use. This paper presents a case study questioning what design elements are appropriate for a speech therapy iPad application for parents of young children. Speech therapists and carers of young children were invited to co-design an iPad application with 15 Master of Design students from an Australian University. Two workshops trialled a variety of co-design activities, over a 12-week period to allow time for reflection and design prototyping. Case study method was used where a rich description of the context, co-design activities and findings were coded and analysed for common themes. When designing an educational iPad speech application for young children, the co-design process highlighted the following important requirements: (i) design for play rather than learning, (ii) gradual exposure to the application not to block interest, (iii) use a variety of imagery (dogs as the preferred animal), (iv) use popular culture cartoons and images, (v) develop lip reading as well as sign language games, (vi) allow space for getting it wrong while playing, (vii) design for privacy and personalized settings, (viii) send the young child’s learning progress to parents and speech therapists, (ix) design aged appropriate levels, and (x) focus on parents as role models for speech learning. We conclude co-design is useful for uncovering appropriate design elements when the activities are playful, colourful, and hands-on. When co-design activities ask indirect questions of the participants, a rich picture of the context emerges.

Keywords: co-design, participatory design, education, human-centred learning
Introduction

Speech development is a major milestone in every child’s development. It starts from the first utterances of sounds and cries when babies learn to communicate with their carers. Delays in speech development are known to be responsible for a range of associated problems in an individual’s overall psychological and cognitive development (McLaughlin 2011). These problems include language disorder, behavioural and socialization difficulties in school, and intellectual disability (Law, Garrett, and Nye 2004; Law, Boyle, Harris, Harkness, and Nye 1998; McLaughlin 2011).

Due to these consequences, hearing impairment of children needs to be addressed as early as possible. In the United States alone, there are approximately 10,000 infants born deaf every year (Mellon et al. 2015). Hearing impairment is also of large concern in Australia where approximately 500 hearing impaired and deaf children born each year. Much of the responsibility for addressing the problems of hearing impaired children is handled by parents (King 2006). Parents however, struggle to find solutions to helping their child practice speech therapy exercises and are constantly looking for the best communications and educational methods to use within the family environment. To date the main reliance has been on paper-based resources such as early language learning books and children’s story books. While a number of these are known to be effective (e.g. Hagen, Pellom, and Cole 2003), little research has gone into developing and monitoring the potential benefits of technology-based solutions in this area.

Great advancement has been brought in hearing impairment technology with Cochlear implants. However, technology advancements are just the beginning as children with Cochlear implants need intensive therapy for speech development to meet the levels of hearing children. Technological practices developed to assist the speech development for children born deaf with Cochlear Implants are lacking and are poorly understood. Parents are typically strongly engaged in and play a major role in the development of their children’s speech learning processes (Rice 2012; King 2006). Hence, the existing practices besides therapy sessions with pathologists include toolkits for parents to teach their born deaf children at home that require long hours of parent-child exercising everyday. Consequently, there is a need for technology tools that can be used by the children self-directed to free up time for parents to do other duties. To be engaging for children there is an opportunity for graphic designers to fill this gap in developing speech assistive technology-based tools to help parents teach their born deaf children to speak through appealing graphics and interaction mechanisms.

Interaction with digital games is known to have strong positive effects on children’s learning generally (Huber et al. 2016). These facts lead to a conclusion where designing an interactive digital game on an iPad application could assist in speech learning development of children born deaf.

Methods and materials

Co-design, involving facilitating input into the design processes by those who will use a design, is a growing area of interest for designers (Sanders and Stappers 2008; Taffe 2015). Co-design case study
was chosen as the method for parents of young children to give their insight in the design process of engaging digital games to support speech development. The following co-design case study took place in an Australian university with an established Master of Design program (60 students enrolled in two-year coursework building on their four-year Bachelor of Design degrees from overseas universities). The study took place in a unit, called ‘inclusive and participatory design’.

A senior lecture at the university (a specialist in media and communication) had the vision for the development of technology-based iPad app after her daughter was born partially deaf and experiencing the intense speech therapy program required. She briefed the masters’ students on the need for a playful game to assist deaf children’s speech learning, challenging the students to design an interactive solution to engage children and parents in the speech learning process. A team of lecturers taught the students the latest theory and practice on co-design principles, where designers work with end-users rather than for them, co-creating outcomes together, suiting end-user’s needs and preferences. Two speech therapists, five parents, five design academics and 16 multi-discipline design masters’ students took part in two workshops divided into 4 teams of 4 students. The students devised a range of co-design activities to trial at the workshops. Figure 1 shows an example of the prototype games used as interaction prompts in the workshops. The four co-design games were:

1. *Chirp It* focuses on making each game interactive, fun, informative and challenging for the participants.
2. *Clumsy Joey* tells a story about a clumsy and friendly baby kangaroo who needs the children’s’ help to find his things.
3. *Storyland* involved the participants in a story scenario related to speech and language acquisition.
4. *The Adventure of Maggie The Monkey* is a prototype tool to allow participants to learn about basic words with rhyming through songs and word repetition.
The students followed a process of developing and refining co-design toolkits to meet the needs and preferences of the end-users with several weeks in between for reflection, based on their findings and feedback from the co-design workshops. All participants completed a reflection questionnaire after each workshop and the design students were interviewed to share their experiences from their twelve weeks of study.

Findings

The findings from the two co-design workshops by the design students will eventually form the basis of the design recommendations to be developed further into a speech learning game. The four prototype games are as follows: 1) Chirp It concept helps the speech learning development with interactive games between parents and children, with the use of learning basic sign language; 2) Clumsy Joey expressing the interest of children by creating a finding items game with a clumsy character to engage with the children; 3) Storyland approaches the needs of children from multicultural background with the perspective of various language used in the story with themes; 4) The Adventure of Maggie The Monkey solves the speech learning through rhymes, songs, and appealing character.

Chirp It

Chirp It toolkit aimed to improve the bond of parents and children while playing speech learning games. Each word selected in the game was categorized as per the co-design toolkit. The words are split into categories of different environments, making it easier for the child to understand. The
participants were asked to play three games, 1) Guess It; 2) Say It; and 3) Sign It (Figure 2). While one child played together with his mother, he was able to learn to give clues through acting with his body, learn lip reading and choose the right item prompted by the game, and learn the basic AUSLAN (Australian Sign Language). Through this activity, the designer understood that sign language was found to be very informative and helpful for young children to learn before they learn how to speak. Each participant was intrigued to learn sign language. They found out that a guessing game is highly interactive and fun, it creates an interaction between two players and allow parents to be involved in the children’s speech learning process. The lip-reading game also came across as a challenging game. In response to this, the students created an iPad app for Chirp It, a speech learning game for children, that would allow them to play the games on screen (Figure 2).

Clumsy Joey

Clumsy Joey is a hidden objects game consisted in creating a forest scenario and a main character that was going to guide the children through a story to ask the children for help in finding his
misplaced objects. The aim of this game is to keep children engaged and entertained in the game. The co-design toolkit is created as a forest with 16 different items hidden in it. With the help of a fishing pole and magnets, participants were to role a dice that told them which item to find and they have one minute to find as many objects as possible (Figure 3). From this activity, the designers found that participants agree with making the learning process with children more interactive and fun. The findings revealed that parents like the hidden objects game and think it is appropriate and educating for children to play. In response to these findings, the students designed a prototype by translating this game into a digital app called Clumsy Joey, where the children will be able to play the game on screen (Figure 4).

Figure 3. A child playing with the Clumsy Joey activity (Author photos of workshops, 2018)
**Storyland**

In order to make the activity interesting and engaging with the participants, the designers made the activity based on teaching foreign languages besides English – Indonesian, Chinese and Danish. The aim of this activity is to get a sense of how the game works with interruption and frustration with words that needs to be repeated. There were three story themes to choose from with one foreign language each for participant to play with (Figure 5). The designers uncovered that participants responded well as the story progressed. More importantly, participants show excitement when they see movements happening on the storyboard after they successfully repeated the word. This showed that interaction and providing a visual reward is very important. Based on these findings, the designers developed this game further into an iPad app prototype (Figure 6).
Figure 5. Storyland co-design toolkit game (Author photos of workshops, 2018)

Figure 6. Prototype design for the Storyland iPad app game  
(Screenshots from student team class report 2018)
The Adventure of Maggie The Monkey

The initial idea for The Adventure of Maggie The Monkey was ChatterBox, a co-design toolkit as a major trigger for deaf children to learn how to speak and express (Figure 7). However, after the second workshop, the designers found out that the speech therapists who were participating in the co-design activity advised that the ChatterBox is more suitable for children with autism disorder rather than to help deaf children’s speech learning. Hence, after long consideration and discussion, the designers came up with a new idea, The Adventure of Maggie The Monkey. Due to time limitation, they were able to developed a video prototype of how the game looks like on screen by using stop motion technique. During the final showcase, the stop motion prototype received a very good response from the lecturers and design peers as it is very entertaining and the rhyming words and songs used in the video was very catchy.
Participant reflections

Design student perspectives

Students learned how to develop and use co-design tools throughout this unit. They received ongoing feedback on the development of their co-design tools which gave them the confidence to feel excited about presenting their work to others. Interestingly, many students discovered that the most ‘fun’ activities didn’t necessarily generate the most useful data. Instead, the activities that created opportunities for talking and asking open ended questions were more valuable for gathering deep insights from participants. Significantly, students found that less defined activities, or activities that allowed participants to come up with their own ideas, rather than simply rate a selection of pre-existing ideas, were the most useful.

End-user perspectives

After observing and interacting with end-users we found that the three key insights of design elements to be included in the speech learning technology are (1) sound and emotions; (2) colours for similar or rhyming words (3) phonetics. Additionally, learning by narrative appeared to be a promising idea. The use of story line and narrative in the speech learning app is something that engages children and encourages them to stay playing the game. Interestingly, one participant had a daughter who learned sign language from six to nine months old. Sign language reduced her daughter’s frustration in communicating what she wanted (e.g. she would make signs when it was her snack time). On the other side, her son didn’t learn sign language at all, he never attempted to do any sign at all, so it took longer for him to be able to communicate with his parents. She wished her son had learned sign language, he was always like this angry little boy because no one understood him. Learning by narrative is a fantastic idea. The use of storyline and narrative in the speech learning app is something that would distract children and engaged them to stay playing the learning game.

Design educator perspectives

The design educators approached the unit with both curiosity and a degree of concern around how deeply the students would engage with the co-design process. What we discovered was that the students were more than competent in taking the lead; from setup, to running the activities, to engaging with the participants, the students excelled at creating an energetic, engaging learning environment that exemplified the fun, democratic nature of co-design. Upon reflection, better organization of the room in which the workshops were held, and a more systematic way of allocating participants to activities, could help streamline the activity and improve student and participant experience the next time around.
Conclusion

This paper reports a case study questioning what design elements are appropriate for a speech therapy iPad application for parents of young children. Speech therapists and carers of young children were invited to co-design an iPad application with Master of Design students from an Australian University. Two workshops trialled a variety of co-design activities, over a 12-week period. This paper demonstrates that when co-designing an educational iPad speech application for young children with hearing impairment the following requirements are preferred: (i) design for play rather than learning, (ii) gradual exposure to the application not to block interest, (iii) use a variety of imagery (dogs as the preferred animal), (iv) use popular culture cartoons and images, (v) develop lip reading as well as sign language games, (vi) allow space for getting it wrong while playing, (vii) design for privacy and personalized settings, (viii) send the young child’s learning progress to the parents and speech therapists, (ix) design aged appropriate levels, and (x) focus on parents as role models for speech learning. We conclude co-design is useful for uncovering appropriate design elements when the activities are playful, colourful, and hands-on.

Acknowledgements

We would like to thank Belinda Barnet, and the speech pathologists for investing their time and industry knowledge in our co-design master class. We would also like to acknowledge the parents and all the student teams and staff for their co-designed ideas presented in this paper.

Declaration of interest statement

There is no potential conflict of interest in the research presented in this paper.

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