Enhancing Inclusive Education Through Mobile Technology : A Mobile App for Supporting Parents, Teachers, and Childcare Providers of Children with and without Neurodevelopmental Disorders

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Objective : Neurodevelopmental disorders (NDD) affect a significant percentage of children, with 4.4 % diagnosed and an additional 12.3 % suspected in Japan. Inclusive education is essential to support these children, yet current teaching methods in Japan often fail to accommodate their unique needs. To address the educational and parental support needs of pre-school to early primary school children with and without NDD, we aimed to develop a mobile application.

Methods : Unstructured interviews with stakeholders, including preschool teachers, childcare workers, child psychiatrists, and parents, were conducted to understand the challenges faced by children with developmental concerns. A digital prototype was created based on initial feedback and further refined through additional interviews. The final application was evaluated through a post-release questionnaire.

Results : Stakeholder interviews revealed isolation among parents of "problematic" children, reluctance to accept NDD diagnoses, and communication challenges between teachers and parents. Parents expressed a need for reliable, relevant child-rearing information and concise advice. The developed mobile application, "Nobi-nobi TOIRO," addresses these needs through Q&A services, information sharing, and note-taking functionalities. As of May 2024, it has been downloaded approximately 36,000 times, with 92.2 % user satisfaction and 99.4 % of users recommending it.

Conclusion : The "Nobi-nobi TOIRO" application demonstrates the potential of mobile technology to provide inclusive support for children with developmental concerns. The user-centric development approach ensured its relevance and usability, making it a valuable tool for parents, preschool teachers, and childcare workers in promoting inclusive education. *Shinshu Med J 73 : 179—184, 2025*

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Key words : neurodevelopmental disorders, mobile application, child rearing, education

Ⅰ Introduction

Neurodevelopmental disorders (NDD) are congenital conditions that include autism, attention deficit hyperactivity disorder, and intellectual developmental disorders. In a study of pre-school children in Japan, 4.4 % of children were diagnosed with NDD, and another 12.3 % were suspected to have NDD by teachers[1]. Thus, the diagnosis of NDD has become challenging, and many children with developmental concerns do not have a definitive NDD diagnosis. Given these circumstances, the importance of inclusive education has been increasingly emphasised.

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Table 1 The demographics of the interviewed stakeholder groups

ID	description	number of people	Interview method	Recruitment method
#1	Professor of Child Psychiatry	1	online, face-to-face	Acquaintances of author's personal acquaintance (no relationship with author before interview)
#2	Self-help group for fathers of children with NDD	11	face-to-face, ethnography (participate in their 2-day camp)	Acquaintances of author's personal acquaintance (no relationship with author before interview)
#3	Kindergarten and nursery school teachers	5	face-to-face	Acquaintances of author's personal acquaintance (no relationship with author before interview)
#4	After-school day-care staff for children with NDD	2	face-to-face	Participants of the camp organized by ID #2
#5	Self-help group for caregivers of children with NDD	11	face-to-face	Acquaintances of author's personal acquaintance (no relationship with author before interview)
#6	Volunteer group for supporting children with NDD	6	face-to-face	Participants of the camp organized by ID #2
#7	Instructor at a tutoring school for elementary school students	2	face-to-face	Personal acquaintance of author.

NDD, neurodevelopmental disorder

An inclusive education approach ensures equal opportunities to learning and school participation for all students, including those with special educational needs. This involves an inclusive environment that supports students' diverse needs[2]. Inclusive education is particularly important for children with NDD, who may face additional barriers to learning and participation. The current curriculum in many Japanese schools relies on monotonous and undifferentiated teaching methods, with little consideration for the unique needs of each student[3]. In addition, children are forced to adapt to these methods instead of individualised teaching methods being devised by authorities, which can negatively impact their children's mental health. Japanese parents, teachers, and caregivers were encouraged to reconsider their interactions and educational approaches according to each child's circumstances.

In recent years, mobile applications have attracted attention as a means of providing information and bringing about behavioural changes[4]. They are cost-effective[5] and provide effective information on sensitive and private contents, such as sex education[5)6]. Mobile applications promoting communication skills in children with NDD have also been effective among parents[7]. However, currently reported mobile applications are not inclusive, as they only target those with a diagnosis according to available case studies.

Here, we report the development of a mobile application to deliver parental and educational support that comprehensively targets pre-school to early primary school children with and without NDD.

Ⅱ Methods

The social life challenges faced by children with developmental concerns were elucidated through a series of interviews with stakeholders, including pre-school teachers, childcare workers, child psychiatrists, after-school daycare staff for children with disabilities, and members of self-help groups for caregivers of children with NDD. Interviews were conducted in an unstructured focus group format and lasted for an average of one hour **(Table 1)**.

A mobile application was designed based on repeated interviews with seven parents of pre-school to early primary school children with developmental concerns, who expressed interest in our project scope. First, the pain and needs of parents regarding childcare were explored through a 30-minutes semi-structured on-

Table 2   The demographics of the seven parents who co-designed the application

ID	Age of children	Children's status	Relationship with children	job	Interview method	Recruitment method
#1	2yo	Not in kindergarten/nursery school	Father	university student	online	personal acquaintance of author.
#2	0, 3yo	Not in kindergarten/nursery school	Mother	housewife	online	personal acquaintance of author.
#3	2, 4yo	nursery school	Mother	Sales administration in the architecture field. (works till 16：00, comes home at 18：00)	online	Acquaintances of author's personal acquaintance (no relationship with author before interview)
#4	2yo	nursery school	Mother	works at home	online	Acquaintances of author's personal acquaintance (no relationship with author before interview)
#5	4months	Not in kindergarten/nursery school	Mother	Service industry (on maternity leave)	online	Acquaintances of author's personal acquaintance (no relationship with author before interview)
#6	3, 10yo	3yo：kindergarten, 10yo：elementary school (normal class)	Father	Researcher at university	online	Acquaintances of author's personal acquaintance (no relationship with author before interview)
#7	3, 6, 7yo	3yo：kindergarten, 6yo/7yo：elementary school (normal class)	Mother	housewife	online	Acquaintances of author's personal acquaintance (no relationship with author before interview)

line interviews with each parent. Based on the results, the content to be included in the app was organised, and a digital prototype was created using Adobe XD (Adobe Inc, California, United States.). Using the digital prototype, interviews were conducted to obtain feedback on the mobile application's content, functionality, and structure. The demographics of the interviewed parents are summarised in **Table 2**. Field notes were taken during the interviews, and the interview results were analysed using an affinity diagram.

Incorporating interview feedback, a mobile application was developed. It was built using Flutter (Google, California, United States.) and deployed to Firebase (Google, California, United States.). We have also developed a closed web application deployed in Firebase through which organisers post Q&A contents.

A post-release questionnaire was administered to evaluate user satisfaction. We introduced the content of our app at a workshop sponsored by Shinshu University and asked participants to try it out. At the end of the workshop, survey forms were distributed and participants were asked to respond anonymously.

Ⅲ   Results

Interviews with stakeholders revealed several challenges faced by children with developmental concerns and their parents.

・Parents of children labelled as "problematic" tend to be isolated in the parents' community, leading to a lack of information.
・Parents who suspect their child to have NDD do not want to admit it, for fear of labelling their children "disabled".
・Preschool teachers and childcare workers who suspect children of having NDD find it difficult to share their concerns with parents.

These results suggest that the boundary between the presence and absence of NDD is complex and shaped by both social and medical factors. Therefore, an inclusive method that does not distinguish NDD is required to support parents of undiagnosed children that present with developmental concerns. Furthermore, the isolation of some parents suggests that accessibility is a key element, and therefore, online interventions would be effective. Based on these findings, we decided to create a mobile app that promotes inclusive education by encouraging parents to respond to their children's characteristics, regardless of whether they were diagnosed with NDD. The primary target audience for the app is parents of children from pre-

school and early elementary school with developmental concerns, regardless of NDD diagnosis. First, through semi-structured interviews, we explored specific pain and needs in child-rearing. The results revealed the following facts :

・In a society flooded with information on child-rearing, parents want access to reliable resources.

・Parents often feel that the information available online does not apply to their children.

・There are times when children do not act as parents expect, leading to struggles with understanding.

Based on these findings, we decided to position this application as a reliable source of information, with child psychiatrists and paediatricians providing the content. Furthermore, when addressing specific issues faced during child-rearing, we decided to mention the background reasons why a child might exhibit certain behaviours while suggesting appropriate responses. Next, we created a digital prototype using Adobe XD, then had the parents interact with the app and solicit feedback about its content, functionality, and structure. The feedback received included the following points :

・Parents want to share information with their partners.

・Parents are always busy and want to know briefly what to do.

Following these learnings from the interviews, our mobile application, "Nobi-nobi TOIRO", was developed. The name of the app combines the mimetic word "Nobi-nobi," which expresses the state of growing freely, with the idiom "juunin toiro," meaning that there are ten different tastes for ten different people. The application's main function is to provide Q&A services to address parenting concerns. Questions were continuously collected through a form within the application, and new Q&As were delivered every one to two weeks. These questions were answered by a team of ten volunteers who were either experienced child psychiatrists or clinical psychologists.

The Q&A begin with a summary of the topic, allowing busy users to quickly understand the content. Users can archive their favourite questions and easily access them when required. Additionally, there is a function for taking notes on everyday problems that can be shared with medical institutions. Archived questions and notes can be uploaded to the cloud and accessed from multiple devices, making it possible to share them with partners. **(Fig 1)**

The application was released in the App Store and Google Play in 2021. As of May 2024, it had been downloaded approximately 36,000 times. A post-release questionnaire survey of 541 users, which included 332 preschool teachers or childcare workers, 101 public health nurses, 3 parents, and 105 individuals from other professions, showed that 499 users (92.2 %) were satisfied with the application, and 538 users (99.4 %) would recommend the application to others.

Ⅳ **Discussion**

Diagnosis is often beneficial as it clarifies the targets of intervention. However, a person placed within a disorder framework may be classified as a "patient" discriminated from the rest of the population[8]. It is often emotionally difficult for individuals with NDD to accept a diagnosis or seek support due to social stigma. Therefore, providing support to these populations requires an inclusive approach, without differentiating between them based on the presence of a disorder.

The study primarily included children with developmental concerns. Interviews with stakeholders emphasised the effectiveness of providing inclusive support through online media irrespective of NDD and non-NDD children. Accordingly, we developed a mobile application that delivers parenting advice to adjust their interactions and educational approaches depending on each child's circumstances. Although parents are the main target demographic for our application, it has also been widely accepted by preschool teachers and childcare workers when facing challenges in childcare.

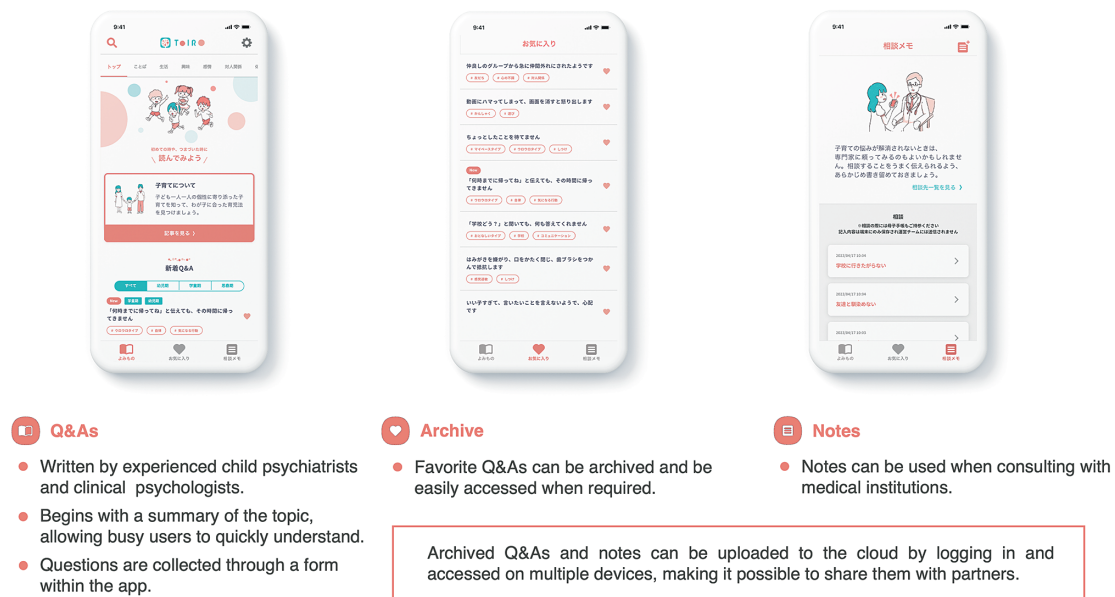The strength of our study is that we adopted a user-centric approach to application development. We

Q&As
- Written by experienced child psychiatrists and clinical psychologists.
- Begins with a summary of the topic, allowing busy users to quickly understand.
- Questions are collected through a form within the app.

Archive
- Favorite Q&As can be archived and be easily accessed when required.

Notes
- Notes can be used when consulting with medical institutions.

Archived Q&As and notes can be uploaded to the cloud by logging in and accessed on multiple devices, making it possible to share them with partners.

Fig. 1　Three main functions of the mobile application "Nobi-nobi TOIRO".
This application provides Q&As written by experienced child psychiatrists and clinical psychologists to answer parenting concerns. Users can archive their favourite Q&As and easily access them when needed. Finally, users can take notes on everyday problems, which can be used when consulting with medical institutions.

began interviewing stakeholders and entering relevant communities to understand the environment surrounding the children and explore the challenges and appropriate intervention targets. Following this, we co-designed the application with target users using digital prototypes for the usability test. It has been reported that perceived usefulness and ease of use are key factors in technology acceptance[9]. Defining the correct problem is important to improve perceived usefulness. We defined the problem based on a deeper understanding of the background through repeated stakeholder interviews, and sometimes by participating in their activities. The importance of usability tests has been reported[10]. We conducted an online usability test using a digital prototype and obtained efficient and effective feedback. Limitations of our study include its limited scalability. Currently, Q&A sessions are created by volunteer medical professionals. In future, the appropriate way to respond to increasing numbers of Q&A requests has to be considered. Additionally, the post-release survey had a limited number of responses from the primary target audience, parents, while most respondents were educators and public health professionals. Although these groups are also important stakeholders of the app, feedback from parents, who were the main target during the app design process, is not well reflected in the data presented in this report.

Our study revealed that mobile technology, when developed with a thorough understanding of the community and co-designed with target users, can be accepted and is useful in situations where inclusive education is required.

V　Conclusion

We have developed a mobile application, "Nobi-nobi TOIRO", to inclusively support those raising children with and without NDD. Our study reveals the potential of mobile technology to build a better society for children with such disorders.

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work.

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