MODU: A Story-Based Empathy Expression Training Game for Children with Mild Intellectual Disability and Borderline Intellectual Functioning

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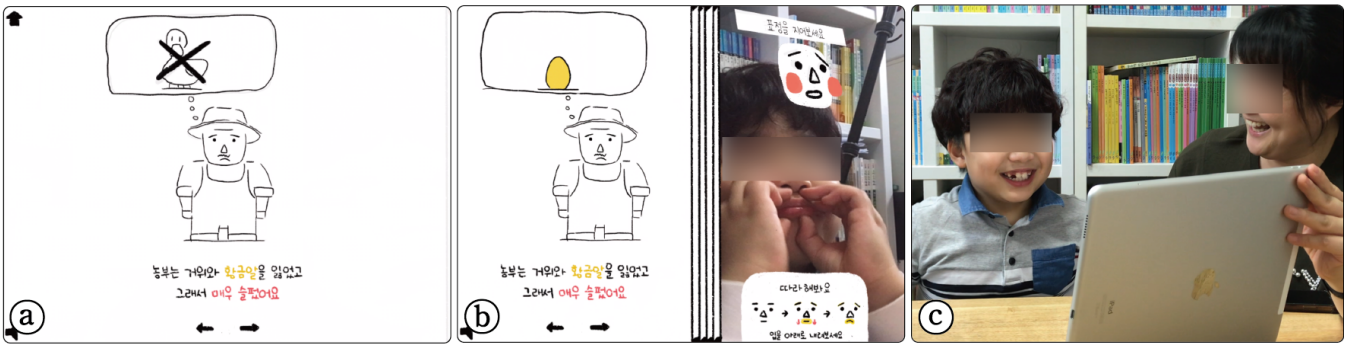

Figure 1: Overview of MODU ⓐ Story scene in MODU ("The farmer lost the goose and the golden eggs and was very sad") ⓑ The child try to make sad expression in the Empathy Game ⓒ The mother and the child are playing MODU

ABSTRACT

Children with mild intellectual disability (MID) and borderline intellectual functioning (BIF) have problems with adequate social behavior. Children with MID or BIF seem no different from typically developing children as preschoolers. However, from school age, children with MID or BIF begin to have problems with their social skills, requiring special education. In the special education, emotion recognition and empathy responses are important. Serious games using interactive design exist to help children with disabilities learn social skills, but little has been done for children with MID or BIF. To support emotion recognition and empathy behavior in children with MID or BIF, we developed a story-based serious game called MODU. We conducted a user study of a pair of siblings, one with MID and one with BIF, to explore the educational effects of MODU. Based on our findings, we investigated MODU's educational possibilities.

CCS CONCEPTS

• **Applied computing** → **Interactive learning environments**; • **Human-centered computing** → **Human computer interaction (HCI)**.

KEYWORDS

Serious Game, Intellectual Disability, Emotion Education, Empathy

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1 INTRODUCTION

According to the Diagnostic and Statistical Manual of Mental Disorders (5th ed.; DSM-5), children with mild intellectual disability (MID) and borderline intellectual functioning (BIF) have inadequate social behavior resources[12]. MID is the mildest level of intellectual disability (ID). Preschoolers with MID have few or no differences in social skills with typically developing peers, but differences begin to apparent after reaching school age[15]. BIF is located between typical development and MID. However, BIF's exact criteria is not provided in the DSM-5 and BIF was not addressed by social and health services[12]. As described above, children with MID or BIF might not differ significantly from their typically developing peers at preschool age, unlike children with autism spectrum disorder (ASD) and other IDs. However, upon reaching school age, children with MID or BIF have common problems with aggressive and inadequate social behavior requiring special education. The lack of social skills in children with MID or BIF is due to the lack of development of the ability to interpret and respond to social information. Previous research has noted focusing on and training

emotion recognition and interpretation functions in children with MID or BIF is important[15]. Training children with MID or BIF to respond empathically to emotions has been found to increase adequate social behavior[1]. Therefore, educating children with MID or BIF about emotion recognition and empathic responses is critical.

Serious games using interactive designs have been studied as a way to stimulate and support children with IDs and ASD in training their social skills because games have the advantage of stimulating attention and providing education for each child's individual level of understanding[4]. Various serious games such as You & I, Emo Galaxy, CopyMe, Let's Face It, and LifeIsGame have been developed for children with ID and ASD[2, 5, 7, 10, 11]. Most of the games mentioned focus on emotion recognition. Emo Galaxy and CopyMe train children to make facial expressions. In Emo Galaxy, children with MID perform an activity that involves making a facial expression for an emotion card[7]. In CopyMe, children with ASD mimic the facial expressions in a photo[10].

Although previous serious games have attempted to improve social skills in children with mental disorders, few studies of serious games have been attempted that focus on empathy behavior in children with MID or BIF. In the development of children's emotional abilities, it is important to apply emotion behaviors in social story[6]. However, in the previous research, the notion of story was not fully emphasized in games aimed at empathic responses, only the possibility of further development was mentioned[2]. Therefore, developing and experimenting with serious games that teach emotion recognition and empathy responses in stories adjusted to the understanding level of children with MID or BIF is necessary.

To support the learning of emotion recognition and empathy response of children with MID or BIF in terms of interaction design, we developed MODU (name from e'MO'tion e'DU'cation), a story-based serious game. To verify the educational effectiveness of MODU, an experiment was conducted on a pair of sibling children, one with MID and one with BIF, and their mother. Through this experiment, we were able to examine the three possibilities of MODU related to soical emotional education: (a) emotional recognition and empathic behavior experience, (b) the potential of story-based facial expression training, and (c) effect of simple UI and multi-sensory feedback in play experience.

2 MODU : FAIRY TALE-BASED FACE INTERACTIVE SERIOUS GAME

MODU is a tablet-based serious game that combines fairy tales and the Empathy Game(Figure 1). In fairy tales, the characters' emotional states are emphasized. In the Empathy Game, a child recognizes the emotions of the characters in the story and responds empathically by producing facial expressions. MODU recognizes the child's face by the tablet's front camera and classifies it according to the facial expression criteria (Table 2). Spark AR detects each facial landmark.

2.1 Interaction of the Empathy Game

The Empathy Game begins after a scene that informs the character's emotion. At the beginning of the game, MODU encourages the child to empathize by making facial expressions mimicking the emotion. If the child makes a correct expression, a compliment effect appears, acknowledging the child's accomplishment. If the child fails, MODU induces the child to make an expression again, giving another trial. After that, if the child fails more than three times, a guide for the facial expression is provided (Table 2). Even after that, if the child fails two more times, MODU suggests trying again next time. At each stage of the game, if the child is under stress, then the child can move to the next scene at any time.

2.2 Story

For children's engagement and emotional experiences in MODU, fairy tales that are child-friendly and contain a variety of emotions have become the criteria of MODU's story. Based on these criteria, we chose a well-known fairy tale, "The Goose and the Golden Egg." We abbreviated the story into seven scenes to emphasize the emotion of the character (Table 1). To enhance the child's engagement, the screen is composed of animation, text, and sound (Figure 1 ⓐ). Because children with ID recognize cartoons as a source of enjoyment[3], animation was produced as a cartoon-style line illustration. Text is arranged in a large font, and emotion words are expressed in different colors. In addition, the narration was played for each scene.

2.3 User Interface and Feedback

Based on the serious game design principle for children with IDs[13], we designed a simple and clear interface and sufficient feedback. The story screen shows home, next, and previous buttons for navigation (Figure 1 ⓐ), and for the home button, a warning message alerts children to accidental tapping mistakes. In the Empathy Game, instructions are displayed on the child's forehead (Figure 1 ⓑ) so that the information is within the child's main sight. In addition, information that is not always displayed in the game (e.g., the facial expression guide) is temporarily displayed at the bottom right of the screen (Figure 1 ⓑ). To provide real-time feedback on the child's facial expressions recognized by MODU, a 2D avatar is fixed to the position of the child's forehead. The avatar changes continuously, according to the child's face, and induces attention. (Figure 1 ⓑ)

3 STUDY DESIGN

The purpose of our study was to explore the educational possibilities of MODU, especially for children with MID or BIF. To observe children's natural use, we conducted our study at home. Children with MID or BIF and their mother were encouraged to use MODU naturally in a comfortable environment and then share their overall experiences with MODU in comparison with the previous learning experiences.

3.1 Participants

We recruited a pair of siblings, one with MID (aged 8) and one with BIF (aged 6), who were both eligible for special classes and accustomed to reading story books. We also recruited their mother. The children's diagnoses of MID or BIF were confirmed through their medical records. Both children have ADHD traits of inattention and impulsivity. These symptoms of ADHD are known to increase more in children with MID or BIF than in typically developing children[9]. Although the number of children is relatively small,

Table 1: Story of "Goose and the Golden Egg" in MODU

Scene	Story	Emotion
1	Once upon a time there was a farmer	-
2	One day, the farmer had a goose	-
3	The goose laid golden eggs and the farmer was surprised	Surprised
4	The farmer was happy to have golden eggs everyday	Enjoyment
5	The farmer thought that if he split the goose's belly, he would get more golden eggs	-
6	The farmer split the goose's belly, but he was angry because there was nothing	Anger
7	The farmer lost the goose and the golden eggs and was very sad	Sadness

Table 2: Criteria and guide for facial expression of emotion in MODU

Emotion	Criteria and Guide
Surprised	Open your mouth and eyes wide
Enjoyment	Make smile and open your mouth
Anger	Lower the corner of the mouth
Sadness	Lower inside of eyebrows

we aimed to explore the educational possibilities of MODU rather than generalize the interactions of children with MID or BIF, so we would be able to derive meaningful results even with fewer children.

3.2 Study Setting

To observe the natural interactions of children with MODU, we visited the children's home. We set up a study environment in a space where the children actually read and learn so they could experience MODU naturally. For the observation during the experiment, we recorded the children's behavior from three camera angles (Figure 2).

3.3 Procedure

3.3.1 Familiarizing the story of "The Goose and the Golden Egg". We asked the children to read a paper storybook that contained "The Goose and the Golden Egg" for a week before the experiment so that they could become familiar with the story. Although the children already knew the fairy tale well, repetitive reading for a week allowed them to increase their focus on the interaction with MODU rather than on understanding the story in the experiment. A week after letting the children read the fairy tale, the study was conducted.

3.3.2 Explaining how to use the MODU to parents. Prior to starting the experiment, we provided the mother with printed instructions and allowed her to try out MODU. This process aimed to help the mother guide her children as a way to enhance their engagement.

3.3.3 Experiencing MODU with children and parents. There were two sessions for children to experience MODU with their mother. Each session took about 10 minutes. In the first session, the mother guided the children to participate in MODU. In the second session, the children were allowed to experience MODU naturally and independently.

3.3.4 Evaluations and debriefing interview. After experiencing MODU, a survey was conducted on the overall experience. The mother rated their user experience (i.e., MODU's novelty, children's willingness to continue use, and the degree of children's enjoyment and engagement) on a 5-point Likert scale. Next, we conducted a debriefing interview based on the survey. We assumed that the children would have difficulty concentrating during interviews due to ADHD traits, so we conducted a survey and an interview focused on the mother, who understands her children's behavior well. The interview was conducted to compare the experience of an existing storybook with MODU. In addition, we asked the mother to focus on the change in children's behavior when they played the game.

4 FINDINGS AND DISCUSSION

Through the interview and experimental video analysis, we found the children showed high enjoyment and engagement overall. This result differed from previous results[14] that showed children with IDs were less engaged in reading children's books. The mother also mentioned the children exhibited behaviors that differed from previous storybook-reading experiences.

In addition to the above findings, we were able to find three distinctions between MODU and existing studies: (1) emotional recognition and empathic behavior experience, (2) the potential of story-based facial expression training, and (3) active engagement via a simple UI and multisensory feedback.

4.1 Experience of emotion recognition and empathy behavior

Behavior observations have found active participation of children in Empathy Game. In the game, children enjoyed making facial expressions by focusing on the screen where their faces appeared in real time. They actively and repeatedly tried to apply facial expression guides to their faces(Figure 1 ⓑ).

the children's experience in the game have been shown to be perceived by parents as a positive factor in their educational application. Parents were concerned about the negative effects of media (e.g. video), such as increased aggression, on children, limiting children's access to the media. However, parents mentioned that children's active experience in the games is distinct from traditional media. We assumed that the child's experience through

Figure 2: Observation camera angle from left to tablet screen, front and backside of child; .

interactive elements in MODU could reduce parents' reluctance to use digital media.

4.2 Potential of story-based facial expression training

Furthermore, through the interview, we were able to observe the strengths and applicability of MODU in daily life due to it being a story-oriented activity. The mother of the siblings who participated in the experiment said one of her children showed aggressiveness by misinterpreting the behavior of typically developing children. At the time, the mother scolded the child to teach him that his behavior was inappropriate. Based on the past event, she noted that if MODU taught children about emotions, then it would lead to a positive outcome because MODU is based on stories and thus children will not feel pressured by their surroundings. In addition, MODU's training method teaches each context-appropriate emotional meaning individually, a trait that it shares with traditional learning methods. Through these findings, we confirmed the possibility of applying MODU to emotional education in the daily lives of children with MID or BIF.

4.3 Effect of simple UI and multi-sensory feedback in play experience

Based on the observation, we found MODU's simple UI with multi-sensory feedback helped the children operate the tablet easily in the second session. In addition, we observed the children voluntarily used MODU, even in an environment where the mother did not intervene (Figure 3).

The results above have allowed us to assume MODU can facilitate the positive effects parent–child relationships provide. According to a parent interview and a previous study[9], children with MID or BIF have difficulty concentrating on learning due to the traits of ADHD. As a result, parents force their children to engage in education, negatively affecting parent–child relationships.

> *"If the children are not interested, they cannot read. Then, as I am a mother, there are a lot of situations in which I force my kids to do something.... Honestly, it's such a burnout on me and my child."* (Mother)

In the experiment, we observed that the mother and her children naturally enjoyed learning together (Figure 1 ©). Based on this, we assumed that learning through MODU could ease the burden of the mother and positively affect the parent–child relationship. A positive parent-child relationship is known to mitigate aggression in children[8]. Thus, it can be assumed that MODU has the potential improve social behavior in children with MID or BIF.

Figure 3: Children voluntarily learning through MODU without parental guidance.

5 CONCLUSION AND FUTURE WORK

Through this study, we were able to discover the user experience and educational potential of MODU. Children showed overall high enjoyment and engagement. In the game, children actively experienced emotion recognition and empathy responses through facial expressions. For the parent, this experiential activity was a positive difference from the existing educational content. The game also showed the potential for children to learn appropriate social behaviors they can apply to school life through stories. The simple UI and multimodal feedback features provided by MODU helped the children learn how to mitigate the forced intervention of the parent in the experiment.

Future studies will include experiments with a large number of children with MID or BIF over time to assess changes in their social skills. In addition, we plan to examine MODU's educational potential through interviews with experts such as teachers.

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