

Conversational Agent for Supporting Self-regulation in Children's Daily Activities in the Pandemic Era

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Abstract

Background COVID-19 has brought significant changes to the lives of young children. In particular, changes in school life have negatively impacted children's daily activities, and physical and developmental difficulties have been observed. This study confirms a newly found problem that children are facing due to COVID-19 and the effectiveness of a digital assistant that is developed to help them tackle the problem.

Methods Study 1 utilized interviews with school staff to identify problems. The interview data were analyzed based on thematic analysis. In light of the results of Study 1, Study 2 included a conversational agent prototype that would operate in a home to help children perform daily tasks. Study 2 was conducted as a field study with 11 children. A survey involving children was conducted to determine whether using prototypes was helpful for daily routine formation and self-efficacy among children. Interviews were conducted with parents and children. Quantitative and qualitative analyses were also conducted.

Results The results of Study 1 suggest that students have endured various difficulties due to the COVID-19 pandemic. Study 1 concludes that children required a more defined routine lifestyle during the pandemic. Study 2 establishes that the developed assistant improved daily routine task execution and self-efficacy. The post-study interviews confirm that children were supported in acquiring regularity and that they perceived the conversational agent as helpful.

Conclusions This study reveals the value required for target users, designs a prototype to deliver it, and confirms the prototype's effectiveness. The study proposes a new method for increasing the quality of life of children in unique environments, such as that caused by the COVID-19 pandemic.

Keywords Human-Computer Interaction, Empirical Studies, Conversational Agent, Self-regulation

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1. Introduction

1. 1. Rationale

The COVID-19 pandemic has caused problems for many people worldwide. Many individuals have had to deal with economic difficulties, such as the loss of their jobs (Qian & Fan, 2020), as well as physical and mental health issues (Duan et al., 2020; Rossi et al., 2020). The pandemic also had a significant negative impact on the lives of children by lowering their sleep quality (Zreik et al., 2021), causing difficulties in self-regulation (Di Giorgio et al., 2021), and creating significant deficiencies in their learning (Engzell & Verhagen, 2021).

During the early elementary school years, young children need to develop their self-regulation capacity via engagement in routine daily activities (Savina, 2021). Self-regulation is one's ability to motivate and control one's behavior to achieve desired goals (Bandura, 1988). However, COVID-19 has made it difficult for students to cultivate their capacity for self-regulation. For example, inconsistent living patterns have led to specific issues, such as decreased physical activity, an increased frequency of sleeping late, and inconsistent eating patterns (Hashem et al., 2020). This phenomenon explains that the unusual environment induced children's irregular lifestyle, which prevented them from forming a routine for life. Such problems are expected to be especially detrimental for lower-grade elementary schoolers who have not yet been properly exposed to in-person school life.

This study confirmed a newly identified problem that children face due to COVID-19 and the effectiveness of an assistant developed to help them tackle this problem. First, in-depth interviews were conducted with six school staff members. Subsequently, a prototype was developed to resolve issues for children. Finally, a field study explored whether the developed prototype could solve issues for children.

2. Literature Review

2. 1. Necessary Self-Regulation Enhancement for Lower Elementary School Grades

Self-regulation has been studied through the lenses of social, personality, and cognitive psychology (Hofmann et al., 2012). One study defined self-regulation capacity as the ability to pursue long-term goals at the expense of short-term benefits to follow socially defined rules and regulations (Baumeister & Heatherton, 1996). Another defined the term as the ability to control one's behaviors, thoughts, and emotions by canceling the dominant response (De Ridder et al., 2012). Although different perspectives assign varied meanings to the term, its meaning is rooted in one's ability to motivate and control one's behavior to achieve a desired goal.

Self-regulation is a core aspect of adaptive human behavior (Hofmann et al., 2012). Self-regulation gradually develops as children grow (Gralinski & Kopp, 1993). According to cognitive and neurophysiological assessments, self-regulation is reinforced throughout childhood and adolescence (Best & Miller, 2010). It develops through an individual's active interactions with their surroundings, and the quality of such interactions affect their

development (Kopp, 1982; Shaffer & Kipp, 2013; Piotrowski et al., 2013). Studies have addressed the importance of children's routine formation (Ren & Fan, 2019). One study found that children's daily routines can play a critical role in self-regulation development (Bater & Jordan, 2017) because the daily routine provides an opportunity to train appropriate child behaviors (Harris et al., 2014). Typically, elementary school students undergo adaptive training regarding socially defined rules in institutional settings. In other words, they familiarize themselves with self-regulation through their daily routines (Savina, 2021). Therefore, it is important for children to form a routine, that is, a lifestyle habit, through regularly repeated actions.

However, due to COVID-19, in-person classes were suspended, which disrupted children's life patterns and created a lack of exposure to daily routines. Therefore, in a pandemic environment, there is a need to help children develop self-regulation abilities.

2. 2. Improvement of Children's Self-Regulation during the Pandemic

The COVID-19 pandemic has led to school closures, online classes, and delayed school reopening. Accordingly, attempts have been made to enable children to cultivate self-regulation at home rather than at school.

In Portugal, the "COVID-19 in Trials and Tribulations" project was implemented during the home confinement and social isolation period, with the aim of enabling school-age children to regularize their daily routines (Pereira et al., 2022). The contents recommended for scheduling and implementation were "learn something new," "collaborate in domestic chores," "help someone," and "leisure time." The content was delivered to each household through Facebook and Instagram. This is a case in which attempts were made to overcome the difficulties of the pandemic by having the children work together with other family members.

Another study used a program based on cognitive self-regulation training to change children's eating habits and reduce obesity (Rezaei Niyasar et al., 2022). Obesity is associated with executive function and thus can be argued to be closely related to self-regulation. This study was also conducted during the pandemic, and it was meaningful in confirming weight loss as a result of the situation that inevitably led to a decrease in children's physical activity. Attention deficit hyperactivity disorder (ADHD) is a typical disorder related to self-regulation (Barkley, 1997; Shiels & Hawk, 2010). During the pandemic, children with ADHD spent more time using digital media due to difficulties in controlling usage, and they experienced increased feelings of sadness, depression, and loneliness (Sciberras et al., 2022). Children with ADHD have difficulty maintaining balance in everyday life. Since people with neurodevelopmental disorders such as ADHD are vulnerable to the distress caused by physical distancing measures, experts have provided support via COVID-19 response guidelines (Cortese et al., 2020).

The current study was also conducted with the intention of enhancing the self-regulation of children in the limited environment of the pandemic.

3. Study 1: Finding Research Opportunities

Interviews were conducted to identify what values children lack and therefore cultivate against the background of the pandemic.

3. 1. Research Method

3. 1. 1. Participants

Teachers were selected as participants because they could notice differences in children through environmental changes more quickly than others (i.e., parents, etc.). It is desirable to obtain a wide range of opinions about the COVID-19 pandemic situation. Therefore, a public educational official from a relevant organization was also included. Thus, five schoolteachers and one scholar were interviewed individually.

Table 1 Interview Participants

No	Age	Gender	Work Experience	Grade Taught (Class 2021)	Grade Taught (Class 2020)
T1	31	Female	8 years	Elementary school 1st grade	Elementary school 5th grade
T2	28	Female	6 years	Elementary school 3rd grade	Elementary school 3rd grade
T3	30	Male	3 years	Elementary school 4th grade	Elementary school 5th grade
T4	31	Female	7 years	Elementary school 1st grade	Elementary school 4th grade
T5	30	Female	1 year	Middle school 3rd grade	X
T6*	46	Female	22 years	-	-

* Inspector (public educational official)

3. 1. 2. Interview Process

Owing to the pandemic, individual semi-structured interviews were conducted online via Zoom. Each interview lasted approximately one hour and was recorded with the participant's consent.

Participants answered a combination of two different types of questions. Some questions were structured and applicable to everyone, while others were more situational and related to personal experience. Participants were asked what aspects of the academic environment had changed during the pandemic and any subsequent difficulties. Specific interview questions included, "How are students reacting to changes in teaching methods due to the COVID-19 pandemic, particularly in terms of flexibility?" and "What difficulties do teachers face in this new environment?"

3. 1. 3. Analysis Method

Voice-recorded data were analyzed based on thematic analysis (Throuvala et al., 2019; Park et al., 2017). The audio data were processed through transcription, open coding, and thematic analysis. First, the audio data were transcribed, and open coding was then conducted to divide the participants' answers. The purpose of this step is to distinguish and divide answers into those that are relevant to the research and those that are not. Finally, based on the minimized data pieces, thematic analysis was conducted to evaluate the participants' answers in more detail. A total of two researchers conducted open coding to identify recurring patterns and discussed ways to arrange the patterns into categories.

3. 2. Research Results

Based on the analysis, 454 examples were derived; 188 were deemed irrelevant, and 266 were subject to analysis. The examples subject to analysis were clustered into 15 sub-categories ((A)~(O)) and further abstracted into six categories (I–VI). Examples of categories and sub-categories are presented in Table 2.

Table 2 Categorization of data

Sub-category	Description	Examples
I. Distress of Teachers		
(A) Students that require attention	<ul style="list-style-type: none"> - Distracted students who cannot complete assignments - Disobedient students - Students with ADHD - Students who lack the care of parents - Students from a dual-income household 	<i>Students who were generally easily distracted and could not complete their work on time are even more difficult to manage when having remote classes as I could not visit their homes and tell them to complete the assignment. -T4</i>
(B) Problems remaining even after transitioning to face-to-face class	<ul style="list-style-type: none"> - Persistent tardiness 	<i>Students who have not properly formed routine lifestyle habits are more likely to end up in a situation where they wake up late at around 11-12 in the morning and take video classes in one go. This kind of lazy behavior also affects face-to-face classes, and they are often late. -T5</i>
(C) Concerns about learning deficits	<ul style="list-style-type: none"> - Accumulated learning deficits 	<i>Class materials are typically prepared based on the mean level, but students who cannot keep up eventually just blankly stare at the monitor. If necessary, those students should be given individual lessons; however, in cases where this is not possible, learning deficits can accumulate. -T1</i>
(D) Difficulties in managing student life	<ul style="list-style-type: none"> - Students who are late even to online classes - Students who cannot complete assignments - Absent-minded students 	<i>Only certain students proactively participate in class, and many of them just play [the videos] without paying attention. Some of them do not really listen to class but watch YouTube or play games instead. - T5</i>
(E) Lack of following ground rules in group life	<ul style="list-style-type: none"> - Nose picking - Taking off one's shoes - Focusing in class - Sitting still 	<i>Kids are young and pick their noses in class. These kids are not educated to understand what is socially unacceptable. -T4</i>
II. Needs		
(F) Form routines	<ul style="list-style-type: none"> - Tasks for a routine lifestyle (getting up and going to bed on time) - Tasks for hygiene (washing hands and brushing teeth) - Academic tasks (studying and reading) - Benefits of a routine lifestyle 	<i>A routine lifestyle is required to maintain psychological and emotional stability. In any situation, children must form such a lifestyle. -T5</i>
(G) Cultivate following ground rules	<ul style="list-style-type: none"> - Procedure in forming relationships - Caring for friends - Not causing damage to others 	<i>Because first grade is the start of social life, I think learning the basic rules that must be followed in a group setting is extremely important. -T4</i>
(H) Home and school raising children together	<ul style="list-style-type: none"> - Students who are brought up together by school and home - Parents who care about their children 	<i>Irrespective of the exceptional manner in which kids are taught something in class, many cases exist wherein it collapses again when they return [to school]. A world of difference exists between changing a child through education at school for a year and parents working hard on that child for a month. -T6</i>

III. Changed Class		
(I) Support from home	<ul style="list-style-type: none"> - Parents assist in classroom activities - Households having difficulty in providing parental support 	<i>Children who do well on their own are, in many cases, well supported by parents at home. Therefore, considerable difference does not exist between holding classes remotely or at school. -T4</i>
(J) Livelihood guidance	<ul style="list-style-type: none"> - Livelihood guidance has become important - The amount of guidance required varies depending on the student 	<i>Currently, classes are half delivering lessons and half guiding livelihood. -T2</i>
IV. Student Condition		
(K) Individual differences in ability	<ul style="list-style-type: none"> - Differences in comprehension - Differences in concentration - Differences in achievement levels - Differences in habit formation 	<i>First grade is when children adapt to the school environment and learn school rules. Last year, however, the students could not receive that kind of training and went into the second grade. Many displayed a lack of basic life habits, such as staying still in their seats for a set duration or concentrating in class, which made me think that they were different from students in the past. -T1</i>
V. Lifestyle Formation		
(L) Importance of habit formation	<ul style="list-style-type: none"> - Closely related to school life - Closely related to learning habits - Positive self-image - Establishment of autonomy - Self-help - Help with time management 	<i>Among the basic lifestyle habits, waking up on time and tidying up appear to be closely related to school life and family life. -T1</i>
(M) Period of habit formation	<ul style="list-style-type: none"> - Importance of early years 	<i>Based on observing higher and lower grades, clearly, lower grades form habits quickly. Things like tidying up become a habit after they are performed a few times. -T1</i>
VI. Awareness of Remote Classes		
(N) Break time	<ul style="list-style-type: none"> - Awareness of time off - Awareness of doing homework quickly and resting - Relaxed awareness on preparing for life tasks 	<i>As children remain at home, the concept of getting ready for school becomes relaxed for them. There may be students attending classes in their pajamas, turning their computer on even without getting properly washed to join classes as soon as they wake up. This might have something to do with them thinking that they are more "at home" than "at school online," but it seems like they don't seem to comprehend that doing so is weird or wrong. -T4</i>
(O) Other activities	<ul style="list-style-type: none"> - Other activities during class 	<i>Owing to the many distractions such as smartphones, sometimes, as observed through the zoom screen, children who have not formed habits are easily exposed and unable to concentrate for a long time. -T1</i>

3. 3. Research Discussion

The findings suggest that students have experienced various difficulties during the COVID-19 pandemic.

3. 3. 1. Children who were unable to develop lifestyle habits and behaviors

T4 highlighted that the action of going to school is not the only thing that has vanished; the processes surrounding preparation for school have also been removed (VI-(O) in Table 2). Before COVID-19, "going to school" was not simply classified as the act of students commuting to school, but it also played a role as a fixed event that repeatedly occurs throughout young children's lives. To achieve this repeating fixed event promptly, children must repeat several other events, including waking up, washing, and eating breakfast. However, in a virtual learning environment, the act of going to school is not normalized, which in turn can obstruct their daily life patterns. This situation is also expected to be observed in other daily activities. Essentially, COVID-19 has virtually eliminated routine lifestyle habits and patterns from children's lives.

3. 3. 2. Negative impact of irregular lifestyle patterns resulting from virtual learning on learning in the classroom

As T5 mentioned, children who did not have a routine lifestyle exhibited problems such as recurring tardiness, even after returning to a face-to-face learning environment (I-(B) in Table 2). It was also revealed that children who developed irregular lifestyle patterns due to inconsistent sleeping and waking hours could not adapt to the frequently changing class environment.

3. 3. 3. How unestablished/ill-timed life patterns and social skills have created challenges extending into the following year

T1 discussed examples of children who failed to develop behaviors and habits that they otherwise could have adopted in lower grades, if not for the difficulties in the academic environment due to COVID-19 (IV-(K) in Table 2).

A lack of proper lifestyle habits and behaviors impacted children's lives even in the year following 2020, when COVID-19 was prevalent. Children who had not developed these qualities went beyond simply being unable to form a routine but also failed to learn socially appropriate behaviors. The transition period that takes place during the early part of the first grade of elementary school is vital because it is when children learn about rules and social life after leaving kindergarten (La Paro et al., 2000). However, children who entered this stage during the pandemic were seemingly unable to learn how to internalize these rules.

3. 3. 4. Difficulties in reacting to problematic behavior brought about by a remote learning environment and its subsequent impact on children's lack of self-regulation

In a remote learning environment, children are expected to manage their own learning by watching and studying the learning materials provided. However, it is often difficult for young students to overcome the temptations of virtual media without supervision (I-(D) in Table 2). The ability to manage and control one's own behaviors is strongly associated with self-regulation. This suggests that children with low self-regulation capacity experience more difficulty concentrating when taking online classes.

3. 4. Research Summary

Due to COVID-19-induced changes in how school classes are delivered, children have failed to develop routine lifestyle habits and behaviors. This failure, which is primarily caused by a remote learning environment, has begun to manifest in face-to-face learning environments in the form of tardiness and other problematic behaviors. Students continue to exhibit a lack of social skills and lifestyle habits that they have failed to learn when they need to, and this issue has become evident to the students themselves. Children had trouble focusing on lessons and were likely to engage in irrelevant activities, such as watching YouTube unbeknownst to their teachers in virtual classroom settings, which could signify a lack of self-regulation.

In conclusion, Study 1 reveals that in an environment that does now allow for school commutes, the level at which children continue to conduct lifestyle patterns and habits must be reinforced, at least to some extent.

4. Study 2: Pilot Study for Problem Solving

A prototype was developed, which, as an assistant, aimed to help familiarize children with common life routines. A field study was conducted with children as subjects.

4. 1. Hypothesis

A “habit” is defined as an automatic behavior that is acquired through repetitive processes (Verplanken & Aarts, 1999). A basic principle of habit formation is that certain behaviors are repeated in the same circumstances (Lally et al., 2010). Previous studies describe habits as cue-response associations (Mazar & Wood, 2018) and indicate that the associations of habit memory form as people repeat behaviors and obtain rewards (Gardner, 2015). In the current study, it was expected that habits would be formed by the benefits that children receive from performing daily tasks according to the cues notified by the agent. Because the children were asked to repeat the same behavior at the same time each day, it was expected that they would form habits. We therefore formulated the following hypothesis:

H1: Using a prototype increases the habit intensity of the child's daily tasks.

“Self-efficacy” is defined as the perceived capability to perform a behavior (Williams, 2010). Even within the same stressful environment, individuals may perceive stress factors differently based on their level of self-efficacy (Bandura, 1988).

Children's self-efficacy has been described using the terms “self-confidence,” “self-regulatory efficacy,” and “task difficulty preference” (Kim, 1997). “Self-confidence” is defined as how much confidence or faith an individual has regarding their value and capabilities. “Self-regulatory efficacy” implies the expectations of people's efficacy about how well they can control themselves to achieve a goal. Self-regulatory efficacy can also be defined as how effectively a person believes they can apply self-observation, self-judgment, and self-reaction. Furthermore, “task difficulty preference” gauges the level of difficulty that an individual prefers when setting goals in a situation that forces them to undertake a certain task. Thus, it can be inferred that task performance and completion experience with prototypes can enhance children's self-efficacy. We therefore formulate the following hypotheses:

H2: Using a prototype increases children's self-confidence.

H3: Using a prototype increases children's self-regulatory efficacy.

H4: Using a prototype increases children's task difficulty preference.

4. 2. Prototyping

4. 2. 1. Prototype Development

The prototype was designed to support children in performing their daily tasks through conversations with a chestnut-shaped agent (ForMe) in an Android application designed for children to use at home. The conversation was realized using the NAVER CLOVA chatbot builder.

4. 2. 2. System Structure

This study involved collaboration with a pediatric psychiatrist to develop a prototype that could guarantee safety and efficacy for children. Characteristics such as the inability to

manage time, problems maintaining focus or concentration, and a lack of self-regulation are all easily noticeable traits in ADHD patients (Barkley, 1997; Dobson & Shaw, 1988).

Meichenbaum suggested that a Goal-Plan-Do-Check strategy supports metacognitive thinking (Polatajko et al., 2001). Previous research developed a voice assistant for children with ADHD by using the strategy to apply self-instruction training to the use of the application (Park et al., 2020; Park et al., 2023).

The Goal-Plan-Do-Check process and the main screens that users encounter are illustrated in Figure 1. In the goal phase, children selected three tasks and entered the durations for each task with their parents. In the plan phase, children identified the task and its specific steps in detail while performing tasks. In the do phase, children went through the detailed steps and completed the tasks. Finally, in the check phase, they assessed the tasks completed during the week and selected tasks for the following week with their parents.

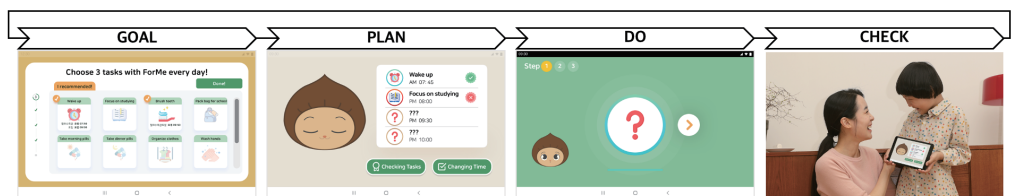


Figure 1 The screen and experience children encounter at each stage

The task selection available in the prototype was based on findings from previous studies for improving the basic lifestyle habits at home of children with ADHD (Park et al., 2020; Park et al., 2023). Users selected three tasks from a list, which included waking up on their own, brushing their teeth for three minutes after dinner, packing their school backpack for the following day, changing their clothes, washing their hands for 30 seconds, taking their medicine, and organizing their shoes when they get home.

4. 2. 3. Interaction Design

Each task includes one to three detailed steps, which allows children to carry out complex tasks step by step. The goal was to increase the completion rate of tasks that involved multiple small steps by instilling participants with the sense that they were undergoing these tasks with the agent. For example, “Brushing my teeth after dinner” consists of 1) deciding to brush one’s teeth, 2) doing so for three minutes, and 3) wiping one’s hands with a towel.

The tasks can be fulfilled in two ways. First, at a preset time, the ForMe agent provides an alarm saying, “What should we be doing right now?” so that the child can complete the task. Second, the child can start the task by tapping on “ForMe” in the application.

The dialogue for each step has five or more different paraphrased variations for the same scenario, from which one is randomly selected and displayed. Visuals show changes in the screen at each stage. Changes in the steps and the agent’s expression represent the user’s progress in the current task.

4. 3. Research Method

4. 3. 1. Participants

Child participants were recruited through an online community board. Children whose mother tongue is Korean were selected to avoid any problems with communication through verbal interaction.

A total of 11 children (five males, six females) were recruited; the youngest was a preschool child (5.7 years old), and the oldest were in the fourth grade (Table 3). The average age of the participants was 7.7 years. None had any cognitive or emotional challenges. All procedures were conducted with the voluntary consent of the children and their parents.

Table 3 Field study participants

Child				Parent			
No	Gender	Age	Grade	No	Gender	Age	Occupation
C1	F	7.0	1st grade	P1	F	45	Bank clerk
C2	F	7.8	2nd grade	P2	F	35	Model
C3	M	5.7	Preschool	P3	F	35	Employee
C4	F	9.7	3rd grade	P4	F	38	Housewife
C5	M	6.8	1st grade	P5	F	38	Housewife
C6	F	8.2	2nd grade	P6	F	43	Housewife
C7	M	9.8	4th grade	P7	F	43	Housewife
C8	M	5.9	Preschool	P8	F	44	Housewife
C9	F	7.4	2nd grade	P9	F	36	Hairdresser
C10	F	7.5	2nd grade	P10	F	38	Counselor
C11	M	9.5	4th grade	P11	F	41	Singer

* P1 refers to parent C1.

4. 3. 2. Experimental Methods

This study was a pre-post-test for a single group. The experiment was conducted from April to May 2021, and each participant used the prototype for two weeks.

A researcher visited each child's house the day before they began to use ForMe (Day 0) and distributed tablet PCs with the developed prototype installed. After receiving instructions from the researcher, children and their parents selected tasks to complete together. From the following day (Day 1) until Day 14, the child selected tasks and used the ForMe prototype (Figure 2).



Figure 2 Children using ForMe at home

Questionnaires and interviews were conducted on Day 0 and Day 15 (i.e., the day before and after participants engaged with ForMe). The questionnaires were completed with assistance

from the researcher, who read each question aloud to the children to account for potential difficulties that they may have faced in understanding them.

Children and their parents participated in an in-depth interview. On Day 0, the interviews covered topics related to changes in children's everyday lives and learning during COVID-19, as well as topics related to daily tasks that were too difficult to be tackled by the individuals themselves. Interviews on Day 15 focused on the differences in children's lives. All interviews were audio-recorded with the participants' consent.

4. 3. 3. Survey Tool

The extent to which the children formed routines or habits was analyzed through the Self-Report Index of Habit Strength (SRHI) (Verplanken & Orbell, 2003), which the children answered. The SRHI is a tool consisting of 12 questions that quantitatively measure the habit strength of certain behaviors. The areas covered are repetition, automaticity of behaviors, and relevance to self-identity. Each question was designed to be answered on a scale from 1 to 7, with higher scores reflecting more intense habits. Participants were to respond to the stem "Using ForMe behaviors is something...", which was followed by the 12 items of the scale (e.g., "...I do frequently").

The change in children's self-efficacy was confirmed through the Korean General Self-Efficacy Scale (KGSES) (Kim, 1997), which the children also answered. The KGSES was developed based on early theory of self-efficacy and consists of three subscales: self-confidence, self-regulatory efficacy, and task difficulty preference (Bandura et al., 1999). Items were measured using a 5-point Likert scale, with higher scores for each factor indicating higher self-efficacy. The self-confidence subscale consists of seven items, including "I often feel like I'm going to fail when I start a task." Self-regulatory efficacy was measured based on answers to 12 questions, including "I try constantly even though there are obstacles." Finally, task difficulty preference was confirmed via five questions, including "If it is possible to choose from a range of tasks, I would rather choose easy tasks than difficult ones."

4. 3. 4. Analysis Methods

A reliability analysis was conducted on the SRHI and the three sub-factors of self-efficacy. Depending on the results of the normality test, either a paired sample t-test or Wilcoxon signed-rank test was employed for analysis. SPSS Statistics 25 was used for data analysis.

The recorded interview data were analyzed based on qualitative summaries. The children's and their parents' opinions on the improvement of the habits and self-efficacy of former were analyzed. The discussion continued until the two researchers reached a unanimous agreement.

4. 4. Research Results

The reliability of evaluation is considered appropriate when the Cronbach's alpha value is higher than 0.7 (Nunnally, 1978). The Cronbach's alpha values for the current study were as follows: SRHI=0.857, self-regulatory efficacy=0.844, task difficulty preference=0.767, and self-confidence=0.744, indicating satisfactory reliability.

A Shapiro-Wilk analysis of the before-and-after values of each factor confirmed that the sub-factors of self-efficacy failed to satisfy the normality test. As a result, SRHI was analyzed via

a paired sample t-test and self-efficacy via a Wilcoxon signed-rank test.

There was a significant difference in the SRHI factor between the pre-test (M=4.58, SD=1.20) and post-test (M=5.57, SD=1.03); $t(10)=2.697$, $p=0.022$ (Table 4). The results provide adequate confirmation that using the prototype positively affects habit formation.

Table 4 Comparison of SRHI difference before and after using the prototype

	M (SD)		t	p
	Pre-test	Post-test		
SRHI	4.58 (1.20)	5.57 (1.03)	2.697	0.022

Self-confidence ($p=0.005$), self-regulatory efficacy ($p=0.016$), and task difficulty preference ($p=0.036$) increased significantly (Table 5).

Table 5 Analysis result of detailed factors for Self-Efficacy

	M (SD)		(-)		(+)		Z	p
	Pre-test	Post-test	Mean Rank	Sum of Ranks	Mean Rank	Sum of Ranks		
Self-confidence	2.84 (0.75)	3.82 (0.70)	0.00	0.00	5.50	55.00	2.809	0.005
Self-regulatory efficacy	3.67 (0.72)	3.98 (0.61)	4.00	4.00	5.67	5.00	2.398	0.016
Task difficulty preference	2.80 (0.56)	3.42 (1.18)	5.00	5.00	5.00	40.00	2.092	0.036

Based on these findings, H1, H2, H3, and H4 were accepted.

4. 5. Research Discussion

We explored our hypotheses via data collected from interviews with parents and their children who used the prototype.

4. 5. 1. Confirmation of the ability to develop a routine lifestyle

Although the test duration was only two weeks, the experience that children had with the agent had a significant impact. For example, C7 developed the habit of getting up early with continued repetition. P6 mentioned that if they had used the prototype for a longer period, they would have also developed certain habits.

Waking up at 7:30 a.m. became a habit for me. My eyes open automatically when it's time -C7, 9-year-old boy.

If we had used ForMe a little longer, I believe the child would have developed a sense of "It's time for me to do this," and because the child has repeated a routine, I feel there's a chance that they will make it a habit. Even now, the child goes to ForMe at set times, which shows me that they understand that it's time for them to do something. -P6, Mother of 8-year-old girl.

Although the test was relatively short, we established the concepts of promise-keeping and time-setting in children's minds through repetition. The current study demonstrated that using ForMe helps children remember promises they have made.

4. 5. 2. Self-efficacy development through completion of daily routine activities

C10 explained that conducting tasks with ForMe allowed them to engage in more difficult tasks, such as studying, more easily. P6 explained that providing feedback to the child that they had independently completed their tasks had a positive result.

When I get home from school, I'm usually alone until mom arrives. I should have done my homework during that time, but I didn't want to do it by myself in the past, especially if it was hard. With ForMe telling me things like "Let's do it together" or asking me if I had done my tasks, it made me think that studying is actually fun. -C10, 7-year-old girl.

It was great to say positive things like "You did really great!" or "You kept your promises today again!" even if they were done subconsciously. Normally, we wouldn't be able to say things like that. Even as a parent, you can't say things like that to your children very often. I suspect that children say that to themselves even less. But, since we began saying that every day, I think our child has gained more confidence – P7, Mother of 9-year-old boy.

C10 was a latchkey child. Even though nobody was home, the agent assisted the child in tackling difficult tasks. After a routine task, even if it was small, the experience of having completed something and the ability to compliment oneself positively impacted their self-efficacy.

4. 6. Research Summary

Study 2 was conducted with 11 children without any noticeable cognitive or psychological disabilities. The prototype ForMe effectively helped the children improve their formation of daily habits and self-efficacy. Although the current study lasted only two weeks, we determined that children saw ForMe as a friend figure with which they could interact on an emotional level.

5. Conclusion

This empirical study created and tested a tool for a select group of elementary school students facing difficulties during the COVID-19 pandemic.

Study 1 involved interviews with six school officials to identify which values were not properly developed among young elementary school students due to the pandemic. Children exhibited negative aspects of school life because they did not form daily life habits on time. The results revealed that daily life routines needed to be taught. This need for daily routine development was especially urgent in children with low self-regulation capacity.

Study 2 aimed to develop an Android-based application. Based on previous studies, a non-drug treatment method for ADHD known as self-instruction training was implemented into the system. Study 2 was conducted with 11 elementary school students during a two-week field study period to determine the effects. The results suggest that the prototype increased children's self-efficacy and aided the development of daily lifestyle habits.

This study has several limitations that can be addressed by future research. First, the total

sample size may be too small to determine whether the findings can be generalized to a broader audience. Further large-scale research on children is planned to understand the agent's capabilities and other subsequent effects in supporting habit formation. Second, the test trial duration of two weeks can be considered a limitation. Previous studies indicate that, on average, an individual requires approximately 66 days to develop a habit (Lally et al., 2010); future studies will need to consider this information. A future study will monitor the usage of the prototype to determine how long the intervention should last for young children. Nevertheless, the current study provides several valuable findings. First, habituation and improvement in self-efficacy in children after using the application raise the expectation of the potential impact of its application in the post-pandemic era. Much has changed due to COVID-19, and many aspects of daily life may not return to normal. However, COVID-19 will not change the importance of young children's development regarding their daily routines, habits, and subsequent assistance in said development. It is vital to apply new technology to everyday life and add the necessary values to today's life. Furthermore, through discussions with academic officials, we identified the key values and lifestyles of young children who have been affected by COVID-19. Based on this, future studies regarding the design of daily routine and habit development for children who lack immediate care from their parents or who are uninfluenced by and inattentive to their teachers can be conducted. Finally, the interaction design of a conversational agent that implemented both voice and visuals was found to be appropriate for the target segment. Currently, technologies that combine smart speakers and smart displays, such as Google's Nest Hub or Amazon's Echo, are in development. If the interaction method of the agent described herein can be integrated into a smart display, it may improve relationship development among young children while providing an experience that differentiates itself from pre-existing options. Future studies will focus on the clinical effects of the developed application on children with low self-regulation.

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