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Exploring English Language Development Assessment for Real-Time Interaction between Autonomous Robots and Children: A Preliminary Study*

On-Soon Lee, Heeok Heo and Yong Seon Moon**

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Despite attention by educators and researchers to the advancement of robotics research in education, little experimental research has been conducted on the use of robots in language education for young children. This paper reports on a study aimed at providing an improved English language development assessment questionnaire specifically for use in a project to bring autonomous social robots into English as a foreign language (EFL) classes for native-Korean-speaking children aged 3–5 years old. In order to examine the validity of questionnaire items, a focus group of 10 professors with expertise in child EFL learning was sent the questionnaire, which includes 127 items to be rated on a 5-point Likert scale and two open-ended questions. They were asked to judge whether each item was appropriate for children of the target age group, and whether any items were not appropriate to assess child L2 learners' English language development. The findings inform the selection of appropriate items for evaluating language development stages based on children's speaking performance in a robot-assisted language learning condition. The study's results provide a baseline for an English language assessment questionnaire for EFL teachers to evaluate 3–5-year-old children's language development in English speaking in the robot-assisted language learning (RALL) condition.

Keywords: social robot, language development assessment, focus group, robot-assisted language learning, interaction

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** First author: **On-Soon Lee**, Associate Professor, Sunchon National University
Corresponding author: **Heeok Heo**, Professor, Sunchon National University
Co-author: **Yong Seon Moon**, Redone Technologies Co.

1 Introduction

Technology is increasingly being applied in language teaching settings for both adults and children. One such technology is 'chatbots,' which can be classified based on their roles (such as information searching assistant [e.g., *Siri* by Apple] or human-like conversation [e.g., *Alexa* in Amazon Echo]) and on the mode of conversation (i.e., text or voice). Such systems are designed for human-computer conversational interactions, which can help foreign language teachers provide more opportunities to practice conversation in the target language (see Lee et al. 2020, for a review). With increasing emphasis on the computer-assisted language learning approach (CALL), recent research has suggested bringing robot-assisted language learning (RALL) into actual language classrooms, in particular for child EFL learning

Some research indicates the potential of using social robots to provide more practice in communicating with human-like interlocutors (Berghe et al., 2019; Engwall & Lopes, 2020; Lee et al., 2011; Lee & Lee, 2021; Randall, 2019). A social robot is "designed to socially interact and communicate with people" (Berghe et al., 2019, p. 260) through common social behavior, such as language, gestures, and facial expressions (Bartneck & Forlizzi, 2004). Thus, unlike general robots that, for example, build cars in factories, social robots exist in a physical space with people. Such social robots have been actively used for English language teaching, filling various roles including as teachers, teaching assistants, friends, and peers (e.g., Randall, 2019). However, the effectiveness of using autonomous social robots in educational settings, in particular for young children, remains unknown.

Despite much research on language assessment, particularly in language pathology contexts (e.g., Han & Yim, 2007), there is a lack of appropriate assessment questionnaires or measures for the L2 English language development of young children (e.g., 3- to 5-year-olds). A few researchers have adapted measures of general language development designed to check whether a child is at a normal cognitive, physical, or linguistic developmental stage (see Dollaghan & Horner 2011, for a review). However, such research typically does not investigate language development in depth, and moreover, is not intended to assess L2 language development. Other approaches to measuring child L2 development generally use vocabulary tests to examine number of words acquired, and sometimes extrapolate from vocabulary to general developmental stage (e.g., Movellan et al., 2009). On the other hand, a few studies have begun to address the effectiveness of using social robots in young children's language learning, but they have only looked at whether the children successfully completed role-playing activities in experimental settings; such limited research contexts cannot guarantee the effectiveness of using robots for child language development (e.g., Lee et al., 2011). Therefore, the present study suggests that, from the linguistic perspective, better measures to assess young children's language development in general are necessary, and

furthermore, an appropriate tool is needed specifically to examine whether using social robots is effective for young children's L2 development. The findings from the current study will contribute to the creation of guidelines for how to effectively use social robots in actual educational settings.

2 Literature Review

2.1 Effectiveness of social robots for language learning

Three recent studies have conducted systematic reviews examining the findings of research on robot-assisted language learning (RALL). To examine the effectiveness of using social robots for language learning, these research reviews covered studies related to the use of social robots in language learning regardless of language (e.g. English, Spanish, German, and Korean) or context (e.g. L1 learning and ESL/EFL learning). The first review study, by Randall (2019), included a total of 79 studies published from 2004 to 2017 and found by entering key terms such as "robot language learning," and "robot assisted language learning" into Google Scholar. The study describes seven characteristics of social robots used in language learning: (i) function (autonomous or telepresent), (ii) form (cartoon-like, zoomorphic, or mechanomorphic), (iii) voice (synthetic or pre-recorded), (iv) social role (teacher, teacher's assistant, peer, or learner), (v) verbal and non-verbal immediacy (smiling, gesturing, and calling students' name), (vi) non-verbal cues (nods or happy faces), and (vii) personalization. The study also reviewed findings on language learners' achievement in terms of vocabulary, grammar, pronunciation, speaking, oral comprehension, reading comprehension, and writing; affective variables (motivation and anxiety); and learner variables (age, language proficiency, and duration). Overall, the study found positive effects of using robots to improve learners' language learning. Randall called for more practical research to explore the use of social robots, suggesting that they might provide positive effects on learners' motivation and attitude, and she further suggested that for this purpose robots should be anthropomorphic with natural voices; that the robots' role should be as peers; and that robots should be capable of multiple non-verbal reactions to learners' utterances.

In the second study, Berghe et al. (2019) conducted a systematic review of studies on social robots for language learning. They reviewed 33 studies on word learning, reading, grammar, speaking, and sign language skills. The strongest effects of using social robots appeared in word learning. However, the overall findings indicate mixed effects of using social robots across language skills. For example, some studies showed no positive effect of using social robots on speaking skills (e.g., In & Han, 2015), whereas other studies showed social robots' significant effects on reading and speaking (e.g. Kanda et al., 2004; Lee et al., 2011). Despite the assumption that using a robot in the

EFL classroom should improve a child's speaking in an EFL setting, the effects of using robots are not consistent.

The most recent study, by Lee and Lee (2022), used a more fine-grained analysis method to explore the effectiveness of social robots. They conducted a meta-analysis of 16 previous empirical studies to compare the learning of groups with social robots (RALL condition) and groups without social robots (non-RALL condition). By integrating the findings of the previous studies, they showed a medium-sized average effect in the RALL condition compared to the non-RALL condition. In addition, they noted that experimental studies have mostly focused on word learning for upper elementary students with social robots in a peer role. In Korean EFL contexts, a study by Ban et al. (2010) that examined the effectiveness of using telepresence-type robots in schools indicated that such robots helped to facilitate elementary students' speaking ability in scripted situations. Another study, by Hyun et al. (2008), found that using intellectual robots as teachers facilitated 4-year-old children's word learning.

Taken together, the findings from previous studies on robot-assisted L2 learning show considerable positive effects in child EFL learning, in particular for word learning. However, some findings from previous studies are inconsistent; for example, while most of the empirical studies observed the effectiveness of social robots on vocabulary learning, the evidence is less clear in regard to speaking or reading. Given this background, there is call for further research on robot-assisted language learning as follows: First, there is a need for research on the application of robot-assisted language learning to adult learners to generalize the conclusion that using social robots is effective in language learning; second, current robot-assisted learning employs limited conversation, suggesting a need for further research to develop approaches to real-time utterance generation for more naturalistic interactions; third, more research is needed to develop empirically based linguistic measurement tools for assessing young children's language development in English as a second language[1]; finally, more attention is needed to how to establish personal relationships between social robots and language learners in order to maintain learners' positive motivation and attitudes toward language learning.

The current study addresses the lack of experimental research on real-time interaction between young children and autonomous robots. It focuses on the assessment of the effects of L2 English conversation between robots and children in natural settings, specifically with robots that can generate maps as well as stably following generated paths (e.g., Shahi & Lee, 2022), rather than

[1] One reviewer pointed out that many linguistic measurement tools already exist. However, while linguistic measurements can be good indicators of L2 children's English language developmental stages, the tools used in previous studies on robotics research and young children's language assessment have relied on raters' subjective evaluations (e.g. overall impressions), rather than on empirically based measurements.

on the assessment of participants' performance in pre- and post-tests in role-playing or scripted situations. Even though existing evidence argues for the effectiveness of social robots in language learning, how their use impacts young children's L2 English development, except for in vocabulary acquisition, is not clear. Therefore, the following section will explain the importance of using appropriate language assessment tools for young children by examining findings from related studies on RALL approaches.

2.2 English language assessment of L2 children's speaking ability

Despite the importance of using appropriate speaking assessment tools to measure young children's English language development (i.e. assessment for bilingual children), educators and researchers have no general agreement regarding what constitutes a reliable assessment tool for L2 (ESL or EFL) child studies[2] (see Espinosa & López 2007 for a discussion). The means utilized in L2 studies for assessing young children's English language development mostly rely on teachers' overall impressions, particularly in robot-assisted language learning conditions. For example, Lee et al.'s (2011) robotics research, which is among the few empirical studies on the topic, examined the effectiveness of robot-assisted language learning for two days a week with twenty-four elementary students (mean age = 10 years). In the RALL condition, students had a chance to interact with robots in two role-playing situations (at a fruit and vegetable store, and at a stationary store), where the two robots, named *Engkey* and *Mero*, acted as sales clerks and the students as customers. Students also completed one pronunciation training session with the robots. All participants completed pre- and post-tests before and after the interaction with the robots, and then their improvement in English speaking was evaluated in one-to-one interviews by using 10 assessment items, as Table 1 shows. Their teacher also took part in a one-to-one interview in which the teacher assessed the student participants according to an evaluation rubric for speaking. The rubric uses a five-point scale in four categories: pronunciation, vocabulary, grammar, and communicative ability; for example, "student actively engaged in conversation with high confidence and the response was clear and intelligible" or "student replied with relatively short answers, requiring encouragement" in the communicative ability category; and "student's response was well structured" or "student's response contained errors" in the grammar category (see Lee et al. 2011 for the complete rubric). Using such assessment items in their study, they found significant improvement of the

[2] Despite the theoretical difference between children's second language acquisition in foreign language (i.e., EFL) versus second language (i.e., ESL) contexts, the developmental stages with which we are concerned here would apply to both; hence, we discuss children's L2 development, using this as a cover term, when we are speaking in general.

participants' English performance in scripted situations, but the rubric, which is presented in Table 1, relies entirely on teachers' subjective evaluations. Furthermore, the few previous experimental robotics studies did not report inter-rater reliability, which suggests the need for caution in any attempt to generalize their findings (e.g., Ban & Jin, 2010).

Table 1. Assessment Items for Speaking Tests

Question No.	Items
1	Greeting, introducing oneself, and asking about present states
2	School name, transportation
3	Expressions related to learning English
4	Expressions related to item names, prices, and refunds
5	Expressions related to weather and recommendations
6	Expressions about item names and ordinal numbers
7	Asking for items and understanding confirmation
8	Comparative expressions
9	Expressions about getting back change
10	Expressions about item features

Another L2 study by Choi and Seo (2014) aimed to explore young children's language development assessment for evaluating effects of Robot Learning (R-learning) by interviewing kindergarten teachers (n = 30) with open-ended questions. They argued for the need to evaluate all four language abilities (i.e. listening, speaking, reading, and writing), but found that the language assessment items used in their study were too unclear to be effectively applied in educational settings. For example, one question, "Do they use the appropriate word in speaking?" lacks clear criteria. If the rater answered "yes," the answer only indicates whether the child successfully completed the task at hand. Accordingly, the researchers concluded that there was a lack of tools to assess the effectiveness of R-learning in L2 learning.

Despite research that suggests significant improvement in children's speaking ability after using robots for conversational practice (Randall, 2019), no attention has been paid to how to assess their speaking ability before and after such conversations. Some robotics research likely adopts items or rubrics designed to assess adult language learning (e.g., iBT or IELTS speaking rubrics), which might not be appropriate evaluation tools for children. In addition, some assessment items for assessing young children's speaking ability seem limited in accordance with the scenario in the particular study (e.g., stationary or vegetable stores). Due to these potential flaws in current language assessment practices, more appropriate assessment items should be proposed in order to better explain language developmental stages.

To consider what might constitute good indices of young children's English language ability, we can turn to specific linguistic characteristics of

developmental stages described in theories of child language development. One well-established theory from the Universal Grammar approach suggests that L2 children and L1 children experience similar developmental stages, and show similar patterns of linguistic development (characterized by specific linguistic features and specific grammatical errors), despite individual variation (see Fromkin et al. 2014 for a review). Much research agrees with this theory, which is known as the full transfer/full access model (e.g., Schwartz & Sprouse, 1996).[3] Following this view, Hahn's (2000) dissertation considered the question of whether L1-Korean L2-English-learning children follow the same developmental stages as L1-English children. The study provides a picture of young Korean-speaking children's L2 English developmental stages, documenting frequent, usual errors by L2 child learners by stage. Table 2 summarizes the linguistic characteristics and gives examples of some errors at five stages by 3–4-year-old children. Overall, L2 children's syntactic developmental stages seem to share common characteristics with those of L1 children (see Fromkin et al. 2014 and O'Grady et al. 2010 for reviews).

Table 2. L1-Korean Child Learners' English Language Developmental Stages

Stage	Developmental stage	Example utterance (intended meaning)
1	Two-word sentences	No, small (No, it's small)
2	Pattern of subject + verb "be" + X Errors in verbs (e.g., regular past tense marker) Subject drop Errors of word order	Cat is big (This cat is big)
3	Grammatical sentence of SVO Errors in verbs (e.g., irregular past tense marker or progressive marker) Errors in yes-no questions (e.g., inversion errors)	He's have ball (Does he have a ball?)
4	Errors in subject-verb agreement Errors of negation	This boy don't have flower (This boy doesn't have a flower)
5	Errors in wh-phrase questions (e.g., inversion errors)	What she eat? (What does she eat?)

[3] One reviewer raised a concern about the applicability of the full transfer/full access model to the current study's context. Because this study only aims to examine the validity of items used in the questionnaire for an assessment of L2 children's English language development in robot-assisted language learning, assessing the model is beyond the study's scope. However, this issue should be addressed in future research.

Based on observations in the literature on child language development, the current study aims to explore language assessment items to evaluate young children's speaking ability in a robot-assisted language learning condition.

2.3 Research questions

The authors are engaged in ongoing research on real-time conversation between autonomous robots (e.g., *MoVol, Mother Volunteer*, created through a collaboration by Redone Technologies Co. and Kumoh National Institute of Technology) and 3- to 5-year-old children for educational purposes. The ongoing project will bring robots to schools. Figure 1 shows one of the robots, *MoVol*, which will be taken to visit a kindergarten, where it will be involved in interacting with children aged 3–5 years. The robot will communicate with the children in English by perceiving objects in given circumstances and automatically moving while generating a map of the space, avoiding obstacles at the time (e.g., Shahi & Lee, 2022). Compared to previous robotics research, this project aims to develop a robot that can recognize a three-dimensional environment by applying AI technology, help children develop language and cognitive skills, and interact with the surrounding environment. The research started in May 2021 and will be completed in December 2023.

Figure 1. *MoVol*

The current study will propose appropriate items for use in a teachers' evaluation questionnaire, which teachers would answer while observing real-time interaction between robots and learners in order to assess young children's English speaking skills, based on the specific linguistic characteristics of age 3–5 developmental stages. Based on observations from the literature on child language developmental stages of L1 and L2 children, four criteria will be considered for the assessment items: number of words (e.g., total vocabulary or parts of speech); sentence types (e.g., one word, two words, telegraphic stage, simple/complex sentences); morphological development (e.g., morpheme

errors); and syntactic development (e.g., errors in declaratives, negatives, yes/no questions, and wh-phrase questions). For the items, 127 questions were taken, with minor modifications, from the "Stages of Language Development Checklist." The current study explores which of these evaluation questions are appropriate to assess L2 children's speaking development by using a focus group method. The study will propose appropriate assessment items based on the participating professionals' comments and responses regarding the validity of the questionnaire items. The specific research questions are as follows:

(1) How appropriate is each survey item in the language development questionnaire to assess a child's L2 English speaking?
(2) What survey items should be revised and/or what kinds of items should be added to the questionnaire for the better measurement of children's L2-English language developmental stage?

3 Method

3.1 Participants

A total of 10 professionals, all professors (mean age = 45 years, *SD* = 5, range 39–51 years) who held doctorates in applied linguistics and child L2 language acquisition and had taught for at least eight years at a college in South Korea, completed the questionnaire. See Table 3.

Table 3. Participants' Profiles

Participants	Age	Expertise	Teaching experience (years)
1	42	Language acquisition	8
2	45	Language acquisition	11
3	39	Applied linguistics	7
4	39	Applied linguistics	7
5	48	Applied linguistics	10
6	40	Applied linguistics	8
7	51	Language acquisition	15
8	44	Language acquisition	11
9	51	Applied linguistics	15
10	51	Applied linguistics	15

3.2 Materials

Considering findings from previous studies on child language developmental stages, this study began with all of the questions (with some modifications) on the "Stages of Language Development Checklist (Kid Sense, 2021)". The rationale for using the child development checklist is that this questionnaire

was designed to describe young children's first language development from the ages of 0 month to 7 years, including questions to assess cognitive development by age group in order to meet the demands of educational environments. Even though this checklist included items related to language and cognitive development, for the practical reason of better understanding of the developmental stages, all questions were included. According to Schwartz and Sprouse's (1996) L2 child language acquisition theory, the L2 child developmental stages have a similar pattern to those of L1 child language development, so such a checklist provides a basic starting point to develop better indicators to show how child L2 English language development should look.

The questionnaire we gave to our participants has a total of 127 scalar questions: 2 questions for the 0–6 month group, 9 questions for the 6–12 month group, 11 questions for the 1–2 year group, 18 questions for the 2–3 year group, 26 questions for the 3–4 year group, 31 questions for the 4–5 year group, 21 questions for the 5–6 year group, 9 questions for the 6–7 year group, plus two open questions: (i) What items should be included or revised in a questionnaire? and (ii) Based on this questionnaire, we draw the following developmental stages (as Figure 2 shows); please provide any comments on it.

3.3 Procedures and data analysis

The 10 participants were informed that the questionnaire they would be judging was originally developed for L1 children, and they were asked to judge the appropriateness of each survey item in the questionnaire for assessing L2 child English language development in the context of interacting with social robots in a natural setting. Then we sent the questionnaire (Appendix A) via email to all 10 participants and asked them to return it within two weeks. They were instructed to judge the reliability of each of the 127 assessment items via the 5-point Likert scale (0 = "not very reliable" to 5 = "very reliable") in accordance with each age group, and to answer the two open-ended questions. All items in the questionnaire were presented in English. All 10 participants returned the completed questionnaire.

For the data analysis, we conducted a quantitative analysis using the mean scores on each of the 127 assessment items to show the participants' judgment of the appropriateness of each item in the questionnaire for reflecting the correct stage of young children's language development. Next, we qualitatively analyzed their responses to the two open-ended questions, indicating how their suggestions could be reflected in developing a better assessment questionnaire, which will be used in the RALL condition. We consider the quantitative and qualitative results together to develop the most appropriate measurements, as proposed in Section 6.

4 Results

Table 4 presents a list of descriptive statistics, and Cronbach's alpha scales. The Cronbach's alphas show high or moderate internal consistency among survey items for each age group except for the 6–12 month age group, which was low (α = .441). The mean scores of the survey items for each stage of language development were calculated and used for further analysis. The first research question was answered by showing the mean scores of survey items per age group from 0 months to 7 years, which may reflect the validity of the survey items to evaluate the developmental stage per each group. The first research question explores the validity of the survey items, or how appropriate they are to evaluate the linguistic development of each age group. As Table 4 shows, the mean scores of survey items per age group ranged from 3.60 to 4.50, and the mean score for the items for the 0 to 6 month age group is highest (M = 4.50, *SD* = 0.70), while the mean score for the items for the 3 to 4 year age group is lowest (M = 3.54, *SD* = 1.12). For the six remaining age groups, the mean scores of the survey items, in descending order, are: 5–6 year age group (M = 4.03, *SD* = 0.87), 6–12 month age group (M = 3.94, *SD* =1.23), 4–5 year age group (M = 3.94, *SD* = 0.93), 1–2 year age group (M = 3.81, *SD* = 1.05), 2–3 year age group (M = 3.68, *SD* = 1.10), 6–7 year age group (M = 3.60, *SD* = 1.05), and 3–4 year age group (M = 3.54, *SD* = 1.12).

Table 4. Results of Reliability Scores on Items per Age Group in the Questionnaire

Age group	No. of items	α	M	*SD*
0-6 mos	2	.556	4.50	0.70
6-12 mos	9	.441	3.94	1.23
1-2 yrs	11	.791	3.81	1.05
2-3 yrs	18	.792	3.68	1.10
3-4 yrs	26	.506	3.54	1.12
4-5 yrs	31	.572	3.94	0.93
5-6 yrs	21	.607	4.03	0.87
6-7 yrs	9	.889	3.60	1.05

Note. mos = months; yrs = years

Based on Cronbach's alphas, the mean scores of three groups (1–2 years, 2–3 years, and 6–7 years) show the highest internal consistency among the survey items for their scale, indicating that the survey items for these three age groups seem appropriate to evaluate children's language development. However, the Cronbach's alphas of the groups in which the current research is interested – the 3–4 year age group (α = .506) and the 4–5 year age group (α = .572) – show lower consistency among the survey items. Furthermore, the

mean scores of survey items for these two groups are not very high: 3.54 for 3–4 years, 3.94 for 4–5 years.

The mean scores given by the professionals suggest that more research is called for to develop appropriate items to be used for the evaluation of 3–5-year-old children's developmental stages. For better survey items to assess young children's language development as a result of interaction with social robots in natural educational settings in English classrooms, this study examines the survey items more closely. In Table 5, the overall mean scores on each item for the 3–4-year-old age group are close to 3 out of 5. However the mean score on four survey items is particularly low: items no. 55, "using regular plurals"; no. 58, "using pronouns you, I, me, mine, he, she"; no. 59, "using the regular past tense"; and no. 60, "Using possessive's."

Table 5. Mean Scores per Survey Item for the 3-4 Year Group

No.	Survey items	M	*SD*
44	Understanding longer, more complex sentences	3.70	0.95
45	Understanding What, Where and Who questions	3.60	0.97
46	Comprehending position concepts: on; off; in; out; up; down; under; top; open; shut; bottom; behind; first; near	4.10	0.88
47	Comprehending size concepts: big; small/little; long; short (length) – emerging; short (height)	4.00	1.05
48	Comprehending quantity concepts: 1-3; every; none	3.80	1.14
49	Comprehending concepts: stop; go/start; loud; quiet; heavy; soft; fast; hot; cold; hard; slow; light (weight); many colors	3.60	0.97
50	Asking *What, Where, Why, When & How* questions	4.10	0.99
51	Using a minimum of 3-4 words in a sentence	4.00	0.94
52	Telling you what they are doing	3.60	1.07
53	Telling you the function or use of an object	3.50	1.18
54	Using nearly 1500 words in their vocabulary by 4 years	3.30	1.42
55	Using regular plurals (e.g., *1 dog, 2 dogs*)	3.20	1.03
56	Using articles 'a' and 'the'	3.40	1.17
57	Using progressive –ing (e.g., *The boy is jumping*).	3.80	1.03
58	Using pronouns *you, I, me, mine, he, she*.	2.80	1.40
59	Using regular past tense (e.g., *I climbed*)	2.70	1.42
60	Using possessive's (e.g., *Daddy's car*)	2.70	1.42
61	Using auxiliary 'is' (e.g., *The girl is skipping*)	3.30	1.16
62	Using connector 'and' (e.g., *I want a banana and an apple*)	3.30	1.49
63	Using 3rd person singular (e.g., *He wants the ball*)	3.30	1.16
64	Using contracted negative (e.g., *isn't, doesn't, haven't, shouldn't*)	3.10	1.37
65	Using contracted copula (e.g., *He's happy*)	3.10	1.10
66	Using past participle (e.g., *It's broken*)	3.80	0.92

Likewise, as Table 6 shows, looking at the overall mean scores of each survey item geared to the 4-5-year-olds shows that the mean scores of a few items are relatively low, including no. 68, "understanding longer, more complex sentences"; no. 69 "understanding questions"; no. 89 "using 3rd person singular"; no. 86 "using auxiliary 'is'"; and no. 97 "using irregular plurals." The first two items in particular, regarding the length and complexity of sentences, and the types of questions, seem too broad to evaluate children's English. These items may be clarified when teachers evaluate an individual child's English production.

Table 6. Mean Scores per Survey Item for 4-5 Year Group

No.	Survey items	M	*SD*
68	Understanding longer, more complex sentences	3.40	0.70
69	Understanding questions	3.60	1.07
70	Following the meaning of others' conversations	3.70	1.16
71	Understanding What, Where, Who and How questions.	4.10	0.99
72	Comprehending position concepts: bottom; behind; first; near; middle; around; away from; between; through; next to/beside; last by mid-late 4 years	3.90	1.37
73	Comprehending size concepts: short (length); short (height); tall; fat by mid-late 4 years	4.10	1.29
74	Comprehending quantity concepts: 4; most; few by mid-late 4 years	3.80	1.40
75	Comprehending position concepts: in front; in a line; corner; middle by late 4-5 years	4.30	0.67
76	Comprehending size concept thin by late 4-5 years	4.10	0.99
77	Comprehending quantity concepts 5 and pair by late 4-5 years	4.20	0.79
78	Comprehending concepts: same; different (size); different (function) by late 4-5 years	4.20	0.79
79	Asking Why, When and How questions	4.30	0.67
80	Asking the meanings of words	4.50	0.71
81	Using a minimum of 4-5 words in a sentence	4.40	0.52
82	Understanding color words (e.g., *red, green*)	4.30	0.82
83	Understanding shape words (e.g., *square, triangle*)	4.30	0.82
84	Sorting objects into simple categories (e.g., *animals, food*)	4.50	0.53
85	Talking about past and future events	4.00	0.67
86	Using auxiliary 'is' (e.g., *The girl is skipping*)	3.50	0.97
87	Using pronouns *he; she; his; hers; theirs*	4.00	0.94
88	Using connectors 'and' (e.g., *I want a banana and an apple*) and 'because' (e.g., *The boy was crying because he fell over and hurt his knee*)	4.10	0.88

89	Using 3rd person singular (e.g., *He wants the ball; It eats grass*)	3.40	1.26
90	Using contracted negative (e.g., *isn't, doesn't, haven't, shouldn't*)	3.70	1.06
91	Using contracted copula (e.g., *He's happy*)	3.70	1.06
92	Using past participle (e.g., *It's broken*)	3.80	1.03
93	Using comparative '–er' and superlative '-est' (e.g., *big, bigger, biggest*)	3.80	1.03
94	Using 'is' vs 'are' (e.g., *The monkey is eating a banana vs The monkeys are eating the bananas*)	3.80	0.92
95	Using past tense 'to be' (e.g., *I was running; They were running*)	3.70	1.06
96	Using adverb '–ly' (e.g., *quickly, slowly, quietly*)	3.70	1.06
97	Using irregular plurals (e.g., *mice, children, men*)	3.30	0.67

The second research question was answered by the responses to the open-ended questions answered by all of the participants[4]. For the proposed research, the target group would be 3- to 5-year-old children, so the responses for the 3–6-year-old groups are discussed in particular. Some of the participants' comments on particular items are presented below.

① *#45: I would like to give some comments on the concept of "understanding wh-questions and using or asking wh questions" used in the questionnaire. This item could be specified like "According to a understanding questions in accordance with the place of wh-word in questions, the developmental stage might be different.*

② *# 44: "understanding longer, more complex sentences" may be not clear. For example, 'longer' refers to the number of words or the degree of sentence complexity? Or 'complex' refers to simple or complex sentences? Such term should be more clarified when evaluating their produced sentences.*

③ *#55, #56, #60, #61: These questions were already asked for the 2 to 3 year group to evaluate their language development (See the Appendix A), so these question might not be appropriate to ask for 3 to 4 year child language development.*

[4] This study conducted a quantitative analysis with the mean scores of the survey items in the questionnaire and a qualitative analysis of the answers to the open-ended questions. However, the qualitative analysis was not in depth due to the limited number of answers by the 10 participants. Most of the answers to the open-ended questions were related to the inappropriateness of the items asking whether the child was able to produce regular/irregular past tenses, plural markers, and wh-questions. The responses to the question on the proposed development stages were too brief and undetailed to provide data for a full qualitative analysis. This limitation will be addressed in future research.

④ *# 57: "using nearly 1500 words in their vocabulary by 4 years" might not be clear. For example, it seems better to bring some example words to guess whether the child seem reaching up to 1500 words.*

⑤ *# 55, # 56, #57: Survey items related to "using regular plurals, articles" seem difficult to evaluate. For example, the child started to use regular plurals or articles, but some errors occurred. Then it usually takes time to correctly use functional morphemes (e.g., plural marker '-s', or past tense marker '-ed'). Such items ask whether the chid use them regardless of their correct usage or not for teachers? This point should be clarified.*

⑥ *#71: Using wh-questions at this age should be more clarified in order to evaluate their developmental stage.*

⑦ *# 95 #97: The correctness of using irregular plurals might not be high, the 4 to 5 year child still have gone through the overgeneralization of using regular plural. Therefore, such questions might be necessary to revise.*

⑧ *Before giving this questionnaire, it is better to provide the example sentences produced by 3 to 4 year group or 4 to 5 year group. Furthermore, some errors also can reflect the children's English language development, so the correct usage of English rules when producing sentences might not be important to see their developmental stage.*

⑨ *This questionnaire includes various linguistic phenomenon (using various morphemes such as '-s' or '-ed'), and the developmental stage of passives might be also one of indicator of their English language developmental stage.*

Based on these comments, several survey items related to particular language points should be revised or the details clarified. First, three items (i.e., #55, #56, #57) are related to acquiring morphemes (e.g. plural markers '-s,' regular/irregular past tenses). The majority of the expert participants were concerned about how teachers or researchers could objectively evaluate an L2 child's utterances because their utterances might have errors in speaking. Second, the majority of the expert participants raised questions about evaluating sentences including wh-questions. For this, the items in the proposed assessment questionnaire reflect the order of acquiring wh-questions; for example, if L2 child learners produce only questions including 'who' or 'what,' they could be evaluated as being at a development stage before the stage at which children produce wh-questions including 'where' or 'why.' The participants' comments indicate that more specific criteria should be reflected in these items in the proposed questionnaire. In particular, the participants were concerned about the use of specific morphemes by the relevant age group. These points are discussed further in the following section.

5 General Discussion

The current study, as a preliminary study, explores items for a child L2 English language development questionnaire in order to inform the creation of a questionnaire to evaluate 3- to 5-year-old children's speaking performance before, during, and after real-time interaction with autonomous robots (e.g., *MoVol*) in natural settings (without any instructions). All survey items in the questionnaire were evaluated by analyzing the mean scores of each item as judged by professional researchers who study child EFL learning. All items asking about children's cognitive development will be excluded for final assessment items. Given the participants' responses to the items asking about language development, it seems necessary to revise or rephrase some of them to be more specific.

Based on the mean scores of all professionals' judgments, some survey items might be revised for L2 children in the 3–5 year age group. The overall impression is that the survey items of the questionnaire seem appropriate, except for some items related to using morphemes (e.g., regular or irregular past tense marker, regular/irregular plural marker, or understanding wh-questions) and understanding longer, more complex sentences (e.g., how long or how complex are the sentences?). The criteria for whether an L2 child correctly uses a morpheme or what types of questions they understand or use should be specified in more detail for better evaluation of their speaking performance in natural settings. Such criteria related to the acquisition of inflectional morphemes could be good evidence for judging young children's language development (Shin, 2004). Based on the responses to the open questions, the participants also believed that teachers might find it easier to evaluate L2 child speaking performance if they are provided with some frequent examples produced by children in the different age groups.

The current findings are useful for providing more practical measurements of L2 child English language developmental stages across different educational settings. Based on the findings from this study, we propose the developmental stages for assessing 3- to 5-year-old children's English language shown in Figure 2.

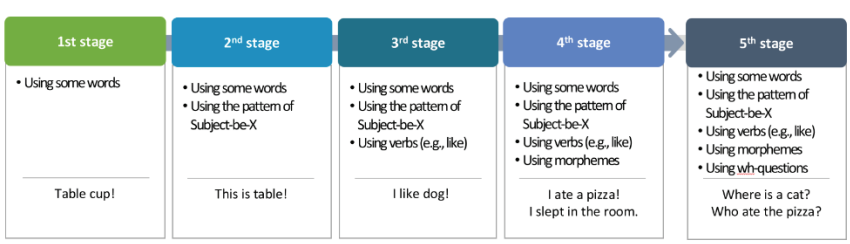

Figure 2. The proposed stages of children's L2 English language development

Considering the L2 developmental stages of children, we furthermore propose a simplified version of a questionnaire, in particular including linguistic development as an indicator of developmental stage, so that our current robotics research will be able to use the questionnaire to assess young children's English language development from using social robots in natural educational settings without any explicit instructions.

Table 7. The Proposed Questionnaire for Assessing a 3- to 5-year-old Child's English Speaking Level via Conversation with Social Robots

No.	Items
1	Following simple instructions (e.g., *Go to your room and get your shoes*).
2	Following the second simple instructions (e.g., *Point to the cat, the dog and the monkey*)
3	Comprehending position concepts: on; off; in; out; up; down; under; top; open; shut; bottom; behind; first; near
4	Comprehending size concepts: big; small/little; long; short (length)
5	Understanding questions with what, who in subject position Understanding questions with what, who in object position
6	Using a minimum of 3-4 words in a sentence Using regular plurals (e.g., 1 dog, 2 dogs) Using the articles 'a' or 'the'
7	Using progressive '–ing' (e.g., *The boy is jumping*) Using pronouns *you, I, me, mine, he, she* Using regular past tenses '-ed'
8	Using irregular past tenses Using irregular plurals marker Using Yes-No Questions
10	Asking 'who' or 'what' questions
11	Asking 'Where,' 'Why,' 'When,' & 'How' questions

The items concerning L2 children's speaking shown in Table 7 could be included in the questionnaire as an assessment tool for the current robotics research. Showing the experimental scenario of an interaction between autonomous robots and young children in a natural educational setting as described in Figure 3, one to four items would ask whether the autonomous robots themselves seem to correctly perceive the surrounding circumstances as well as whether the children seem to cognitively understand the social robots' English speaking. Then five to eight items, drawn from the current study's findings, could be used to assess the developmental stage of the young children's English speaking. The questionnaire described in Table 7 would be difficult to generalize to cover all the L2 developmental stages of children, but we hope to continue to revise it or add to it through testing and verifying survey items for better measurement.

Figure 3. Experimental scenario of an interaction between social robots and a child

With the burgeoning interest in assessing children's L2 speaking ability, the findings of the present study suggest some pedagogical implications for L1-Korean children's L2 classroom settings using social robots. For example, using social robots in ELT classrooms might have positive effects on English learners' affective variables, for example, motivation and attitude (e.g., Hong et al., 2016). Using social robots, in particular speaking robots, seems to lower learners' language anxiety. On the other hand, as described in previous robotics research, using social robots might facilitate the improvement of learners' achievement in ELT contexts. Through involving social robots as peers in classrooms, children can raise questions regarding the responses of the robots. Such activities lead to increased motivation and give some type of scaffolding.

Compared to measures used in other robotics research (e.g., Ban et al., 2010; Lee et al., 2011), the questionnaire includes more specific items asking about linguistic development as an indicator of developmental stage. This questionnaire would provide children's developmental information to educators and parents, which would help them be able to provide immediate feedback to children's utterances by correcting their specific errors. Furthermore, such a measure could be used in other, different EFL contexts in addition to robotics contexts.

6 Concluding Remarks

This study provides a preliminary exploration of an appropriate measure to assess 3- to 5-year-old children's English language development in robotics research. Further research should investigate the question of whether interaction between autonomous robots, as friends, and L2-acquiring children facilitates the development of the child's L2-English speaking ability. The

current study's findings provide a practical tool, as a preliminary step, to evaluate a child's English by asking teachers to complete an easy, more objective evaluation, and furthermore suggests ways for both teachers and parents to easily and clearly judge children's English language developmental stages. However, the findings from this study of the validity of survey items in the questionnaire should be taken with caution before being generalized as a tool to identify the developmental stage of a child's L2 English. Further research should also include more participants and further examine the reliability of the items as a measurement tool by using a more fine-grained method (e.g.,, the Delphi Method) with different expert groups (e.g., educators and teachers in classrooms). Using social robots in ELT classrooms also might lead to positive effects on learners' affective variables (e.g., Hong et al., 2016; Alemi et al., 2017), and some correlations between child learners' cognitive development and language have been found (e.g., Lee et al., 2009). Considering these points, some social-cognitive-variable-related items might be appropriate to be included in the measurement for better understanding of children's language development. To this end, the current study hopes to shed light on appropriate measurement of L1-Korean-speaking children's L2 English language development, beyond their teachers' overall impressions.

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Appendix A
L2 child's English language development questionnaire

Instructions: Please judge the reliability of each item, asking Korean children's cognitive and English language development, via the 5-point Likert scale (1 = "not very reliable" to 5 = "very reliable" in accordance with each age group.

Age	No	Skills	Reliability				
			very reliable		←		not very reliable
0-6 months	1	Attending to sounds and voices	⑤	④	③	②	①
	2	Recognizing facial expressions and tones of voice	⑤	④	③	②	①
6-12 months	3	Attending to sounds and voices	⑤	④	③	②	①
	4	Recognizing facial expressions and tones of voice	⑤	④	③	②	①
	5	Responding to familiar requests (e.g., come here)	⑤	④	③	②	①
	6	Responding to their own name	⑤	④	③	②	①
	7	Understanding gestures (e.g. wave for 'bye')	⑤	④	③	②	①

	8	Understanding simple questions (e.g., Where's daddy?)	⑤	④	③	②	①
	9	Babbling (e.g., ma-ma, da-da)	⑤	④	③	②	①
	10	Taking turns vocalizing with others	⑤	④	③	②	①
	11	Recognizing the names of a few objects	⑤	④	③	②	①
1-2 years	12	Responding to familiar requests (e.g., come here)	⑤	④	③	②	①
	13	Responding to their own name	⑤	④	③	②	①
	14	Taking turns vocalizing with others	⑤	④	③	②	①
	15	Understanding simple questions (e.g., Where's daddy?)	⑤	④	③	②	①
	16	Following simple instructions (e.g., Give ball to daddy)	⑤	④	③	②	①
	17	Understanding approximately 50 words	⑤	④	③	②	①
	18	Comprehending one key word in a sentence (e.g. Where's your nose?)	⑤	④	③	②	①
	19	Saying some simple first words (e.g., mine, no, mum, dad, ta)	⑤	④	③	②	①
	20	Pointing to common objects when named	⑤	④	③	②	①
	21	Having approximately 50-100 words in their vocabulary by 2 years	⑤	④	③	②	①
	22	Joining 2 words together (e.g., car go, bye daddy) by 2 years	⑤	④	③	②	①
2-3 years	23	Following simple instructions (e.g., Give ball to daddy)	⑤	④	③	②	①
	24	Following 2 part instructions (e.g., Go to your room and get your shoes)	⑤	④	③	②	①
	25	Pointing to main body parts, clothing items, toys and food when asked	⑤	④	③	②	①
	26	Understanding and asking What and Where questions	⑤	④	③	②	①
	27	Comprehending position concepts: on; off; in; out; up; down; under; top; open; shut	⑤	④	③	②	①
	28	Comprehending size concepts: big; small/little; long	⑤	④	③	②	①
	29	Comprehending quantity concepts 1 and 2	⑤	④	③	②	①
	30	Comprehending concepts: stop;	⑤	④	③	②	①

		go/start; loud; quiet; heavy; soft; fast; hot; cold					
	31	Naming actions (e.g., go, run)	⑤	④	③	②	①
	32	Using at least 50-100 words in their vocabulary	⑤	④	③	②	①
	33	Using a minimum of 2-3 words in a sentence (e.g., Daddy go work)	⑤	④	③	②	①
	34	Talking about present events	⑤	④	③	②	①
	35	Using regular plurals (e.g., 1 dog, 2 dogs)	⑤	④	③	②	①
	36	Using articles 'a' and 'the'	⑤	④	③	②	①
	37	Using progressive '–ing' (e.g., The boy is jumping)	⑤	④	③	②	①
	38	Using pronouns: you, I, me, mine.	⑤	④	③	②	①
	39	Using regular past tense (e.g., I climbed)	⑤	④	③	②	①
	40	Using possessive's (e.g. Daddy's car)	⑤	④	③	②	①
3-4 years	41	Following 2 part instructions (e.g., Go to your room and get your shoes)	⑤	④	③	②	①
	42	Following 3 part instructions (e.g., Point to the cat, the dog and the monkey)	⑤	④	③	②	①
	43	Pointing to main body parts, clothing items, toys and food when asked	⑤	④	③	②	①
	44	Understanding longer, more complex sentences	⑤	④	③	②	①
	45	Understanding What, Where and Who questions	⑤	④	③	②	①
	46	Comprehending position concepts: on; off; in; out; up; down; under; top; open; shut; bottom; behind; first; near	⑤	④	③	②	①
	47	Comprehending size concepts: big; small/little; long; short (length) – emerging; short (height)	⑤	④	③	②	①
	48	Comprehending quantity concepts: 1-3; every; none	⑤	④	③	②	①
	49	Comprehending concepts: stop; go/start; loud; quiet; heavy; soft; fast; hot; cold; hard; slow; light (weight); many colors	⑤	④	③	②	①
	50	Asking What, Where, Why, When & How questions	⑤	④	③	②	①

	51	Using a minimum of 3-4 words in a sentence	⑤	④	③	②	①
	52	Telling you what they are doing	⑤	④	③	②	①
	53	Telling you the function or use of an object	⑤	④	③	②	①
	54	Using nearly 1500 words in their vocabulary by 4 years	⑤	④	③	②	①
	55	Using regular plurals (e.g., 1 dog, 2 dogs)	⑤	④	③	②	①
	56	Using articles ‘a’ and ‘the’	⑤	④	③	②	①
	57	Using progressive ‘–ing’ (e.g., The boy is jumping)	⑤	④	③	②	①
	58	Using pronouns you, I, me, mine, he, she	⑤	④	③	②	①
	59	Using regular past tense (e.g., I climbed)	⑤	④	③	②	①
	60	Using possessive’s (e.g., Daddy’s car)	⑤	④	③	②	①
	61	Using auxiliary ‘is’ (e.g., The girl is skipping)	⑤	④	③	②	①
	62	Using connector ‘and’ (e.g., I want a banana and an apple)	⑤	④	③	②	①
	63	Using 3rd person singular (e.g., He wants the ball; The rabbit eats grass)	⑤	④	③	②	①
	64	Using contracted negative (e.g., isn’t, doesn’t, haven’t, shouldn’t)	⑤	④	③	②	①
	65	Using contracted copula (e.g., He’s happy)	⑤	④	③	②	①
	66	Using past participle (e.g., It’s broken)	⑤	④	③	②	①
4-5 years	67	Following 3 part instructions (e.g., Point to the cat, the dog and the monkey)	⑤	④	③	②	①
	68	Understanding longer, more complex sentences	⑤	④	③	②	①
	69	Understanding questions	⑤	④	③	②	①
	70	Following the meaning of others’ conversations	⑤	④	③	②	①
	71	Understanding What, Where, Who and How questions	⑤	④	③	②	①
	72	Comprehending position concepts: bottom; behind; first; near; middle; around; away from; between; through; next to/beside; last by mid-late 4	⑤	④	③	②	①

		years					
	73	Comprehending size concepts: short (length); short (height); tall; fat by mid-late 4 years	⑤	④	③	②	①
	74	Comprehending quantity concepts: 4; most; few by mid-late 4 years	⑤	④	③	②	①
	75	Comprehending position concepts: in front; in a line; corner; middle by late 4-5 years	⑤	④	③	②	①
	76	Comprehending size concept thin by late 4-5 years	⑤	④	③	②	①
	77	Comprehending quantity concepts 5 and pair by late 4-5 years	⑤	④	③	②	①
	78	Comprehending concepts: same; different (size); different (function) by late 4-5 years	⑤	④	③	②	①
	79	Asking Why, When and How questions	⑤	④	③	②	①
	80	Asking the meanings of words	⑤	④	③	②	①
	81	Using a minimum of 4-5 words in a sentence	⑤	④	③	②	①
	82	Understanding color words (e.g., red, green)	⑤	④	③	②	①
	83	Understanding shape words (e.g., square, triangle)	⑤	④	③	②	①
	84	Sorting objects into simple categories (e.g., animals, food)	⑤	④	③	②	①
	85	Talking about past and future events	⑤	④	③	②	①
	86	Using auxiliary ‘is’ (e.g., The girl is skipping)	⑤	④	③	②	①
	87	Using pronouns he; she; his; hers; theirs	⑤	④	③	②	①
	88	Using connectors ‘and’ (e.g., I want a banana and an apple) and ‘because‘ (e.g., The boy was crying because he fell over and hurt his knee)	⑤	④	③	②	①
	89	Using 3rd person singular (e.g., He wants the ball; It eats grass)	⑤	④	③	②	①
	90	Using contracted negative (e.g., isn’t, doesn’t, haven’t, shouldn’t)	⑤	④	③	②	①
	91	Using contracted copula (e.g., He’s happy)	⑤	④	③	②	①

	92	Using past participle (e.g., It's broken)	⑤	④	③	②	①
	93	Using comparative '–er' and superlative '-est' (e.g., big, bigger, biggest)	⑤	④	③	②	①
	94	Using 'is' vs 'are' (e.g., The monkey is eating a banana vs The monkeys are eating the bananas)	⑤	④	③	②	①
	95	Using past tense 'to be' (e.g.' I was running; They were running)	⑤	④	③	②	①
	96	Using adverb '–ly' (e.g., quickly, slowly, quietly)	⑤	④	③	②	①
	97	Using irregular plurals (e.g., mice, children, men)	⑤	④	③	②	①
5-6 years	98	Comprehending position concepts in front; in a line; corner; middle	⑤	④	③	②	①
	99	Comprehending size concepts short (length); short (height); tall; fat thin	⑤	④	③	②	①
	100	Comprehending quantity concepts 5; most; few; pair	⑤	④	③	②	①
	101	Comprehending concepts: same; different (size); different (function)	⑤	④	③	②	①
	102	Comprehending time concepts: yesterday; tomorrow; morning; afternoon; later	⑤	④	③	②	①
	103	Understanding color words (e.g. red, green)	⑤	④	③	②	①
	104	Understanding shape words (e.g., square, triangle)	⑤	④	③	②	①
	105	Using How & When questions	⑤	④	③	②	①
	106	Using more complex sentences	⑤	④	③	②	①
	107	Sorting objects into categories (e.g., animals, food)	⑤	④	③	②	①
	108	Using imaginative language in play – likes to pretend and act out stories	⑤	④	③	②	①
	109	Telling several attributes about an object	⑤	④	③	②	①
	110	Talking about past and future events	⑤	④	③	②	①
	111	Using pronouns his, hers, theirs (e.g., It is his/hers/theirs)	⑤	④	③	②	①
	112	Using comparative '–er' and superlative '-est' (e.g., big, bigger,	⑤	④	③	②	①

		biggest)					
	113	Using ‘is‘ vs ‘are‘ (e.g., The monkey is eating a banana vs The monkeys are eating the bananas)	⑤	④	③	②	①
	114	Using past tense ‘to be’ (e.g., I was running; They were running)	⑤	④	③	②	①
	115	Using connectors ‘and’ (e.g., I want a banana and an apple) and ‘because’ (e.g., The boy was crying because he fell over and hurt his knee)	⑤	④	③	②	①
	116	Using adverb ‘–ly’ (e.g., quickly, slowly, quietly)	⑤	④	③	②	①
	117	Using irregular plurals (e.g., mice, children, men)	⑤	④	③	②	①
	118	Using irregular past tense (e.g., fell, broke, ate)	⑤	④	③	②	①
6-7 years	119	Comprehending position concepts left and right	⑤	④	③	②	①
	120	Comprehending concepts: same; different; season; time of day	⑤	④	③	②	①
	121	Understanding the difference between reality and fantasy	⑤	④	③	②	①
	122	Making predictions, justifying decisions, providing solutions & giving explanations	⑤	④	③	②	①
	123	Classifying objects according to more specific traits (e.g., form, color, use or composition-what it is made of)	⑤	④	③	②	①
	124	Giving short oral reports	⑤	④	③	②	①
	125	Using language at a higher level to make jokes, tease, engage in sarcasm, argue point of view, explaining complex situations, talking about movies or past events in detail	⑤	④	③	②	①
	126	Writing descriptive paragraphs and stories	⑤	④	③	②	①
	127	Using appropriate grammar (e.g., presents with immaturities)	⑤	④	③	②	①

On-Soon Lee, Associate Professor
Institute of General Education, Sunchon National University
255 JungAng-ro, Suncheon-si, Jeollanamdo, South Korea
Phone: 061-750-3808
E-mail: oslee@scnu.ac.kr

Heeok Heo, Professor
Department of Computer Education, Sunchon National University
255 JungAng-ro, Suncheon-si, Jeollanamdo, South Korea
Phone: 061-750-3343
E-mail: hoheo@scnu.ac.kr

Yong Seon Moon, Technical director
Redone Technologies Co., LTD.
186-16, Nanosandan-ro, Jinwon-myeon, Jangseong-gun, Jeollanamdo, South Korea
Phone: 061-395-9911
E-mail: moon@urc.kr

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