Let us read together: Development and evaluation of a computer-assisted reciprocal early English reading system

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A B S T R A C T
This study attempts to implement a cooperative reading environment for EFL early reading using a mobile-device-supported computer-assisted reciprocal early English reading (CAREER) system, and to evaluate its effect on the early reading skills and learning behaviors of elementary EFL learners. The design rationale of CAREER is based on the three essential components of effective reading instructions: balanced reading structure, immediate and specific feedback, and reciprocal learning scenario. Analytical results indicate that the CAREER system reduces the problems experienced by students in a conventional cooperative learning environment and effectively helps elementary EFL learners orchestrate their learning while completing individual reading tasks and pursuing group goals. The results also demonstrate that CAREER appears to be able to benefit elementary EFL learners in developing reading skills. In sum, with the support of CAREER, the early reading skills of elementary students are benefited by cooperating with each other.

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1. Introduction

Student reading ability has an important impact on academic achievement. A student with adequate reading ability typically performs better than students with less developed reading skills. Moreover, educators increasingly recognize that reading provides important opportunities for second language (L2) development (Day & Bamford, 1998), especially for those learning English as a foreign/second language (EFL/ESL) with limited L2 resources (Gehrard, 1996). Research shows that early training in linguistic skills improves the reading performance of children, especially those at risk for reading difficulties (Lovett, Warren-Chaplin, Ransby, & Borden, 1990; Lundberg, Frost, & Peterson, 1988). Consequently, early EFL/ESL reading heavily emphasizes developing effective reading instruction programs that benefit the development of early linguistic skills and prevent young children from developing reading difficulties.

To achieve this goal, this study constructs a computer-assisted reading system to assist elementary EFL/ESL learners while learning to read. This study first identifies the three essential features of effective instruction that helps children acquire early reading skills. One feature is to support two-way information processing, namely, from simple (i.e., low-level linguistic knowledge such as phonological knowledge and lexical knowledge) to complex (i.e., high-level linguistic knowledge such as syntactic and metacognitive knowledge and comprehension skills) and also from complex to simple (Carroll, 1999; Tomlinson & Kalbfleisch, 1998). Such an instructional approach should focus on skills related to phonemic awareness, phonics, and vocabulary, and those associated with fluency and text comprehension (Genesee, 2000). Since humans learn best by ‘doing’ rather than passively ‘absorbing’ (Pally, 1997), an effective instructional approach is needed that provides children with extensive opportunities to construct and consolidate their skills and knowledge (Tomlinson & Kalbfleisch, 1998). Such an approach should provide students with a learning scenario that immerses students in learning and promotes cooperation with others. The third feature is to provide interactive, specific and immediate feedback (Jensen, 1998) during the learning process to establish and facilitate links among information retrieval networks (Genesee, 2000).

The computer-assisted reading system constructed in this study focuses on achieving these instructional goals. To provide students with activities that promote two-way information processing, the balanced reading structure proposed by Lan, Sung, and Chang (2007) is
adopted in designing balanced reading materials. Based on the balanced structure, each teaching package includes reading materials that promote the development of phonological skills and phonics and simultaneously trains students in reading comprehension and fluency. And to meet the second goal, a balanced reading structure is embedded in a reciprocal learning scenario that allows individual elementary EFL learners to orchestrate individual and cooperative learning skills, as well as switching between the two different learning types harmoniously.

To help children learn individually and cooperatively by ‘doing,’ cooperative learning is generally the first method chosen. Cooperative learning is based on the constructivist theory of learning, which maintains that people are active learners and must construct knowledge for themselves (Geary, 1995) via interactions between individuals and the environment (Schunk, 1996). Because of the sophisticated features that permit learners to learn by doing rather than by simply absorbing, cooperative learning has been widely applied in reading programs in the EFL field (Ghaith, 2003; Greenwood, 1996; Hartup, 1992; Lan, Sung, & Chang, 2006; Nichols & Miller, 1994). Although cooperative learning is considered an effective method of teaching EFL reading, the pedagogical challenges (e.g., the wide range of reading abilities, class size, and limited teaching time) that exist in Asian EFL settings generally prevent EFL teachers from adopting cooperative learning for reading instruction in conventional elementary EFL settings (Lan, Chang, & Sung, 2004).

Mobile technology is both a feasible tool of overcoming these obstacles, and an approach that can reflects the third feature of effective reading instruction by providing specific and immediate feedback. The unique features of mobile assisted language learning (MALL), such as portability, social interactivity, connectivity, individuality, and immediacy, have garnered increased attention in recent studies of language learning (Attewell & Webster, 2004; Chinnery, 2006; Godwin-Jones, 2007; Klopfer, Squire, & Jenkins, 2002; Lan et al., 2007; Soloway et al., 2001). The reciprocal scenario in this study has balanced reading materials embedded in a mobile environment. Most MALL research focuses less on teaching early reading skills than on teaching other linguistic skills, including those associated with speaking (Kukulska-Hulme, 2005), vocabulary (Thornton & Houser, 2005), phrases (Morita, 2003; Thornton & Houser, 2005), and grammar (Sung, Chang, & Huang, 2008). Furthermore, recent MALL studies have primarily focused on college students, and few have considered the role of mobile technology in promoting the reading skills of elementary students. One exception is the study by Lan et al., which used a mobile-device-supported peer-assisted learning (MPAL) system to facilitate peer-assisted reading for elementary students. Although students actively participate in peer-assisted reading activities via MPAL, students with lower reading abilities seldom contribute to the goals a group is pursuing. The reading system proposed overcomes this shortcoming and helps students become independent and responsible learners and, consequently, be able to contribute during cooperative reading activities. The findings of this study add to the existing literature on MALL, and improve the understanding of reciprocal reading behaviors of elementary EFL learners in Asia.

Briefly, this study presents a mobile cooperative reading system that meets the requirements of effective reading instruction, and assesses the effects of the proposed reading system on reading progress and the early reading skills of elementary EFL learners. The proposed mobile-device-supported computer-assisted reciprocal early English reading (CAREER) system was developed to achieve these objectives. A 10-week evaluation stage was used to assess the ability of the CAREER system to facilitate reading learning for EFL students. Evaluation results demonstrate that the CAREER system benefits the development of early English reading skills in elementary EFL learners. Furthermore, the CAREER system effectively stimulates elementary EFL learners to partake in both individual and cooperative reading activities, and significantly reduces problems associated with conventional cooperative learning that encountered by the control group during learning activities.

The following sections briefly describe the proposed CAREER system and study methodology, present analytical results, and discuss study implications and conclusions.

2. Computer-assisted reciprocal early English reading (CAREER) system

The CAREER system has three modules: a sight word module; a phonetic word module; and, a peer assessment module (Fig. 1). The design rationale underlying module content and the learning procedure in the CAREER system is based on the three essential components of effective reading instruction: a balanced reading structure; immediate and specific feedback; and, reciprocal learning scenario. The CAREER system is characterized in terms of these three dimensions.

2.1. The balanced reading structure

The learning content is structured based on the balanced foundation proposed by Lan et al. (2007). Each instructional package has two components: low- and high-level linguistic knowledge. The phonetic rules plus a set of common sight words form the low-level linguistic training, the phonetic word module and sight word module. Furthermore, based on the content of the low-level linguistic skills, a text containing several comprehension questions was produced for use in the peer assessment module and used in text reading activities to provide students with opportunities to master these low-level linguistic skills. Appendix A presents an example of the balanced reading packages in this study.

![Fig. 1. Modules of the CAREER system.](image-url)
2.2. Immediate and specific feedback

Workflow design for low-level linguistic skills follows a gradually fading scaffolding strategy. The workflow has the following stages: modeling; coaching; cooperative learning; and, independent learning. Both the phonetic and sight word modules have two sub-modules—practice and testing. Via modeling support, students can listen to and pronounce a sight word. After receiving coaching (with real-time feedback and modeling instruction when necessary), students complete a test and receive practical suggestions. Finally, students complete practice on demand based on system suggestions; that is, the system lists all words students incorrectly answer and encourages students to practice. Fig. 2 gives an example sight word learning activity for student No. 1.

2.3. Reciprocal learning scenario

To facilitate individual learning and cooperative learning for elementary students and promote learner accountability, individual reading tasks (including sight words, phonetic words, and reading text) are devised as four partial subtasks. One subtask was randomly assigned to students based on their login ID. After logging in to the CAREER system, each student is randomly assigned a partial reading task and asked to complete this task with the support of the CAREER system. As shown in Appendix A, the task of each group member is listed under the heading “Today’s mission.” For instance, the reading tasks assigned to student No. 1 include a subset of sight words (morning, color, uses, bud, and colorful) that must be learned to complete the sight word module; the phonics rule pattern “o_e” must be learned to complete the phonetic word module; and paragraph A in the reading text (not the first paragraph of the text) must be completed to finish the peer assessment module. Soon after completing their assigned tasks, each student takes turns teaching their classmates, who contribute their learning results to the group during oral reading contests, which are carried out soon after the reading tasks in each module are completed. Fig. 3 shows the learning scenario.

The scenario mentioned above focuses on the effects in helping learners orchestrate their individual and cooperative learning skills and harmoniously switch between the two learning activities. For instance, in the peer assessment module (Fig. 3), each student is assigned a different paragraph from a text according to their login ID. The students try their best to understand that paragraph. While reading the text, students can look up words when necessary by clicking on those words in the word list (Fig. 4). Subsequently, once each group member completes their reading task, they first share their reading results with their group, after which the entire group cooperatively organizes the various paragraphs into a complete text (Fig. 5). If the entire group successfully reconstructs the paragraph, they then read the text again and answer comprehension questions together. Each student then has the opportunity to read a randomly selected paragraph to their group in preparation for the inter-group oral reading contest by choosing the “intra-group peer assessment” hyperlink (Fig. 6). While practicing reading, other group members carefully listen to and assess the oral reading ability of the group member by clicking on misread words (Fig. 6). The system then provides each reader with a real-time reading accuracy score based on peer assessment results. Soon after the intra-group reading and peer assessment practice, a representative from each group is randomly selected to read a randomly chosen paragraph to the class. At this time, the teacher and all students log into the CAREER system and assess the oral reading skills of each representative and click on misread words (by choosing the “inter-group peer assessment” hyperlink). The CAREER system then calculates accuracy scores and compares student assessment results with that by the teacher. Thus, the CAREER system is able to determine the best oral reader via student and teacher assessments; and help teachers gain a picture of student involvement in peer assessment activities as well.

3. Methodology

3.1. Participants

Experiment participants comprised 52 Grade four students attending two classes (each class has 26 students; 14 boys and 12 girls) at an elementary school in Taipei, Taiwan. Each class was randomly assigned to experimental or control group. The students were then administered early reading skills tests (Oral Reading Fluency and Retell Fluency) taken from the text, Dynamic Indicators of Basic Early Literacy Skills™ 6th edition (DIBELS) (Good & Kaminski, 2002). Students with scores classified as “established” were assigned to the high-level
Sight word module

**Individual Learning:** Introduce new words & practice

**Individual Learning:** Sight word test & practice-on-demand according to CAREER’s suggestion

**Cooperative learning:** Teaching & learning with each other

**Oral reading contest:** Peer assessment

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Phonetic word module

**Individual Learning:** Introduce new phonics rules & practice

**Individual Learning:** Phonetic word test & practice-on-demand according to CAREER’s suggestion

**Cooperative learning:** Teaching & learning with each other

**Oral reading contest:** Peer assessment

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Peer assessment module

**Individual Learning:** Assigned paragraph reading

**Cooperative learning:** Reading result sharing

**Cooperative learning:** Organizing story map & answering comprehension questions

**Oral reading contest:** Peer assessment

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Fig. 3. Learning scenario of the CAREER system.

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Fig. 4. Example of paragraph reading activities.
reading ability group, those with scores classified as “emerging” were assigned to the medium-level reading ability group, and those with scores classified as “deficient” or “at risk” were assigned to the low-level reading ability group. Thus, the experimental group comprised six students with high-level ability, 11 with medium-level ability, and nine with low-level ability. The control group had seven students with high-level ability, 10 with medium-level ability, and nine with low-level ability.

3.2. Design

This study adopted a mixed research approach (the concurrent triangulation approach) (Creswell, 2003) and collected both qualitative and quantitative data. In terms of qualitative data, all activities were recorded using three digital video cameras. Two cameras recorded two small reading groups (one on each group), while one recorded the entire class. Video data were analyzed for comparisons of differences between the experimental and control groups. For quantitative data, the experiment used a quasi-experimental design. Students from the two classes were randomly assigned to the control or experimental group, and their scores for the two early reading skills (Oral Reading Fluency and Retell Fluency, which are explained in the next section) were collected both before and soon after the experiment.
3.3. Instruments

3.3.1. Description of early EFL reading activities and teaching materials

Five teaching packages were taught in this study. Appendix A presents an example package. Each teaching package has two activities, each lasting two periods (160 min per package over 40 min periods). Generally, elementary school students in Taiwan receive two periods of English instruction per week; therefore, each teaching package was taught over a 2-week period. Thus, the five teaching packages were taught over 10 weeks. During the initial two periods of reading activities, students learned sight and phonetic words, whereas during the second two periods of activities, students applied the low-level linguistic skills learned during the previous period and engaged in text reading activities.

3.3.2. Observation checklists

Two observation checklists, learning-related and learning-unrelated checklists, were employed to observe and record learner behaviors during specific learning activities. The target learning-related behaviors were classified into four categories: (a) individual reading; (b) cooperative learning; (c) social interaction; and (d) teacher role. The individual reading category focuses on elementary EFL learner behaviors when reading an assigned text. The cooperative learning category focused on cooperation within a group, including sharing reading results, peer-assisted learning, and answering requests for help. Additionally, the social interaction category focused on such learner behaviors as negotiating, communicating, and discussing while developing strategies and decisions regarding the achievement of group goals. The teacher role category focused on teacher's intervention to assist individual students or a group in focusing on their reading tasks when needed.

Furthermore, behaviors not related to learning were classified as self-determined and passive. When learners were distracted due to physical needs or hardware difficulties (particularly for the experimental group), behaviors not related to learning were labeled passive, whereas other behaviors were considered self-determined.

3.3.3. Hardware: Tablet PCs

The computers used in this study were TravelMate C110 Convertible Tablet PCs.

3.3.4. DIBELS™

The DIBELS™ Oral Reading Fluency (ORF) test is a standardized test administered individually of accuracy and fluency with a given text and measures the ability of children to translate letters into sounds and into words. Student performance was measured by having students read a 1-min passage aloud. The number of words read correctly during the 1-min test period was taken as the oral reading fluency rate. The ORF test, having a check-up, used in this study was benchmark test 2 for Grade one students. Additionally, the content of this benchmark test differed from the teaching packages, which were developed by the authors to determine whether training was generalized to non-trained items.

When subject read ten or more words correctly in the DIBELS™ ORF test, then second test, the DIBELS™ Retell Fluency (RTF) test, was administered. This test assesses comprehension during ORF assessment and measures the ability of children to extract meaning from a text. Test subjects were asked to recount what they have just read. Only actual words were counted. The number of words students recount was deemed their understanding of the passage. Furthermore, all DIBELS™ measurement instruments can be downloaded for free at the official DIBELS™ website (http://dibels.uoregon.edu).

3.4. Procedure

Throughout the experiment, activities for implementing the reciprocal scenario were designed to assist elementary EFL learners in engaging in “doing” their learning. Five teaching packages were taught during the 10-week experiment, each comprising a pair of two-period modules. In the first two period activity, immediately after direct instruction by the EFL teacher, each student was randomly assigned a different subset of teaching materials, which focused on low-level linguistic skills. Students were then asked to individually read aloud the subset of words. After students completed their learning activities, they were asked to teach their group the words they had learned and learn other subsets of words taught by their groupmates. Finally, one student from each group was randomly selected to represent their group in the oral reading contest. The oral reading contest had 16 words (sight words or phonetic words) randomly chosen from training.
The interaction between group and test was insignificant ($F$ not differ between the two groups. The test is significant ($F$ group was 0–75. The range of scores for post-test was 0–89 for the experimental group, and 0–107 for the control group.

Expectations due to the large range of raw data. The range of pre-test scores of the experimental group was 8–88, while that for the control group was considered victory for the entire group. Following the contest, three prizes were given out: one was for all members of the winning team; one was for those providing support in each group; and the final prize was for the team that cooperated most effectively.

In the second two period activity, six activities were performed as follows. First, students reviewed the materials (sight words and phonetic words). Second, a different paragraph from a written text was randomly assigned to each student; each student was required to read the paragraph aloud. Then, after completing their individual reading tasks, students were asked to share what they had read with their group. Students were then asked to cooperatively organize the different paragraphs into a complete story (story map) and then answer comprehension questions. After that, students completed the intra-group reading assessments. Each group member took turns reading a paragraph to the group and their classmates assessed their reading performance. Finally, one student from each group was selected randomly to represent their group in the oral reading contest. Following this contest, three prizes were given.

Each student in the experimental group was given a Tablet PC with a stylus and headset for use in individual and cooperative reading activities supported by the proposed CAREER system. When involved in these activities, except for direct instructions from the EFL teacher, students in the experimental group logged into the CAREER system and cooperatively completed the other activities with their group. Additionally, the CAREER system can assign specific reading materials to individual elementary EFL learners. Thus, different materials were displayed on the PC screens of individual students had led to the cooperative learning behaviors necessary to complete the learning tasks assigned to individual students and groups. To learn an entire word set (sight and phonetic words), figure out a story map, answer comprehension questions, and win the inter-group reading contests, group members must interact by discussing, sharing, and learning.

The control group students were provided the same reading materials as the experimental group and performed the same activities, with the exception that training materials paper-based. Fig. 8 shows the reading materials used by student No. 1 in each small reading group in the control group. Via these materials, all members in one small reading group discussed and cooperatively constructed the story map. Moreover, the EFL teacher moved from one group to another to determine whether students needed help and helped each group focus on their learning activities. Furthermore, during peer assessment activities, the EFL teacher and all students used the paper-based paragraph chosen to assess student oral reading performance.

Upon completion of the treatment, students were administered a post-test of the two early reading skills—Oral Reading Fluency and Retell Fluency.

4. Results

Both quantitative and qualitative data were collected during treatments. The quantitative data consist of student scores in the two early reading skills, Oral Reading Fluency and Retell Fluency. The qualitative data were obtained by videotaping students; two observers carefully observed and analyzed that behavior. The experimental results are as follows:

4.1. Comparison of early English reading skills

Before and following the treatment, all students were administered individual tests to assess their early reading abilities. A two-way mixed design analysis of covariance was conducted to determine how students in experimental and control groups differed in terms of various dependent variables. The independent variables were the group (experimental or control) and test (pre- or post-test). Furthermore, the dependent variables were scores for early reading skills (Oral Reading Fluency and Retell Fluency). The covariate was student EFL scores from the previous semester. Statistic significance was set at $\alpha = .05$.

For the Oral Reading Fluency scores, the homogeneity test of regression coefficients was insignificant ($R(1, 48) = 1.45, p > .05$). Table 1 lists the means and standard deviations for scores for early linguistic ability in ORF. The standard deviations for the two groups exceeded expectations due to the large range of raw data. The range of pre-test scores of the experimental group was 8–88, while that for the control group was 0–75. The range of scores for post-test was 0–89 for the experimental group, and 0–107 for the control group.

Two-way (test $\times$ group) analysis of covariance reveals that group was insignificant ($F(1, 49) = 0.59, p > .05$), indicating that scores did not differ between the two groups. The test is significant ($F(1, 50) = 22.63, p < .05$), suggesting that pre- and post-test scores differed significantly. The interaction between group and test was insignificant ($F(1, 50) = 0.03, p > .05$), meaning that no level varying differences
exist. Although training achieved good results for both groups, the standard deviation of the control group is much larger than that of the experimental group (Table 1). A careful analysis of raw scores indicates that the high-level ability students accounted the majority of improvement in the control group. Notably, the improvement in ORF in the experimental group was relatively evenly distributed among all students.

Comparison of Retell Fluency scores between the two groups reveals that the homogeneity test results for regression coefficients were insignificant ($F(1, 48) = 0.07, p > .05$). Table 2 shows the means and standard deviations for the scores of early linguistic ability in RTF. The large range in raw data led to standard deviations for the two groups that markedly exceeded expectations. The range in pre-test scores of the experimental group was 0–30, and that for the control group was 0–33. Furthermore, the range of post-test scores was 0–33 for the experimental group, and 0–35 for the control group.

The two-way ($\text{test} \times \text{group}$) analysis of covariance results reveals that the scores of the two groups did not differ significantly ($F(1, 49) = 0.63, p > .05$). The test results were significant ($F(1, 50) = 4.36, p < .05$), indicating a possible difference between pre- and post-test scores for group. The interaction between group and test was also significant ($F(1, 50) = 7.87, p < .05$), meaning that the magnitude of difference varies according to level.

Simple main effect analysis demonstrates that no statistically significant difference exists between the two groups in the RTF pre-test scores ($F(1, 98) = 1.23, p > .05$), and post-test scores. Thus, the two groups did not differ significantly in pre-test and post-test scores. Simple main effect analysis revealed pre- and post-test scores for the experimental group differed significantly ($F(1, 50) = 11.97, p < .05$), but not for the control group ($F(1, 50) = 0.26, p > .05$). This analytical finding indicates that training only resulted in significant progress for the experimental group.

### 4.2. Comparison of cooperative learning behaviors

Following completion of the experiment, two observers analyzed the videotapes of all group reading sessions. The observers were instructed to record and classify all target behaviors. Rather than simply measuring the frequency of each target behavior, this study focused on time span of observed behaviors. Observations focused on (a) individual reading (IR), (b) cooperative learning (CL), (c) social interaction (SI), and (d) the teacher’s role (Appendix B). To confirm that the two observers decoded the video record consistently, the observers first determined the time span of each target behavior from the video data of a teaching package. The Spearman coefficient of concordance was then computed from decoded results obtained from the two copies of records. The Pearson correlation was 0.908 (significant at the 0.01 level). After the two observers attained consistency, they continued decoding the videos. Table 3 lists observation results.

Table 3 lists the average time students spent on the following activities: (a) individual learning of sight words (SWI) and group learning of sight words (SWG); (b) individual learning of phonetic words (PWI) and group learning of phonetic words (PWG); (c) vocabulary review (VR); (d) paragraph reading (PR); (e) story telling (ST); (f) story map organizing (SM); (g) reading comprehension (RC); (h) intra-group peer assessment (Intra GPA); and (i) inter-group peer assessment (Inter GPA).

Additionally, the symbols used in Table 3 have the following meanings: (a) IR, individual reading; (b) SI, social interaction; (c) CL, cooperative learning; (d) TI, teacher intervention; (e) PLU, passive behavior unrelated to learning; and (f) SDLU, self-determined behavior unrelated to learning.

The upper part of Table 3 lists the cooperative reading behaviors in the control group, whereas the lower part lists those of the experimental group. This study found that the control group had problems during group reading activities. The first problem was teacher-dependant. Students were expected to learn independently in a cooperative learning context, however, students in the control group failed to cooperate. Rather than learning independently, the control group exhibited many teacher-dependent learning behaviors. In the SWI and PWI activities, the control group spent much more time on teacher intervention (i.e., receiving teacher instruction) than on individual learning (more than 40% of time proportion was spent on teacher intervention and less than 20% on individual learning). Furthermore, the phenomenon of teacher-dependence can be identified for most learning activities. The second problem was poor interdependence. When students were asked to perform group reading activities (SWG, PWG, VR, PR, and ST), the control group exhibited poor cooperative learning, and the poor interdependence was based on the small proportion of time devoted to cooperative learning. Inefficient social interaction was the third problem experienced by the control group. In the SM and RC activities, social interaction was essential to reconstructing the full story and answering comprehension questions; however, the control group displayed almost no social interaction among group members, and was heavily dependent on teacher assistance. The fourth problem was inefficient peer assessment. Although peer assessment is commonly used in cooperative learning, the EFL teachers had difficulty ensuring an effective assessment process and results in a conventional

<p>| Table 1 |
| Means and standard deviations for early linguistic ability scores in ORF. |
| Test | Experimental group ($N = 26$) | Control group ($N = 26$) |</p>
<table>
<thead>
<tr>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
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<tbody>
<tr>
<td>Pre-test</td>
<td>33.00</td>
<td>25.43</td>
<td>38.43</td>
</tr>
<tr>
<td>Post-test</td>
<td>40.35</td>
<td>26.86</td>
<td>46.35</td>
</tr>
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<p>| Table 2 |
| Means and standard deviations of early linguistic ability scores in RTF. |
| Test | Experimental group ($N = 26$) | Control group ($N = 26$) |</p>
<table>
<thead>
<tr>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
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<tbody>
<tr>
<td>Pre-test</td>
<td>2.40</td>
<td>6.54</td>
<td>2.83</td>
</tr>
<tr>
<td>Post-test</td>
<td>5.56</td>
<td>9.09</td>
<td>2.37</td>
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EFL environment. This study found that the control group spent very little time on the target behavior (CL) during intra- and inter-group peer assessments. The final problem was that control group members were absent-minded. That is, the amount of time spent on behaviors unrelated to learning was so large that the control group was inhibited from effective cooperative learning in group reading activities.

The analytic results (lower part in Table 3) show that reading behaviors of the experimental group contrast sharply with those of the control group. With the support of the CAREER system, the magnitudes of the five problems encountered by the control group were significantly reduced in the experimental group. During the SWI and PWI activities, students focused on individual learning, and behaved independently when asked. Additionally, when instructed to read cooperatively with their groupmates (in the SWG, PWG, VR, PR, and ST activities), they displayed considerably greater interdependence with peers than the control group. Furthermore, during the SM and RC activities, they exhibited strong social interactions in understanding the story and answering comprehension questions. As the experimental group devoted most of its time in learning-related behaviors, the problem of absent-mindedness was completely resolved via support by mobile technology.

Comparing the proportions of time used in learning-related and learning-unrelated behaviors, chi-square analysis shows significant differences between the two groups. Such analysis demonstrates that for all reading activities, learning-related behaviors in the experimental group are significantly more common than those in the control group. Thus, the CAREER system clearly reduces the magnitude problems experienced by the control group students during individual or cooperative EFL reading activities and, thus, benefits both individual and cooperative learning for elementary EFL learners.

### 5. Discussion and conclusions

Numerous studies have suggested that cooperative learning is an effective method that provides learners with opportunities for learning by doing, and thus helps EFL learners develop reading skills. However, much remains to be learned about the practical application of mobile technology for elementary EFL reading, teaching and learning. This study established a mobile-device-supported computer-assisted reading environment by increasing the efficiency of cooperative learning in a small reading group and boosting awareness among EFL learners of their individual accountability during cooperative learning.

Based on analytical results of early English reading skills, the CAREER system promotes the development of oral reading skills for most EFL learners rather than only benefiting this with high-level abilities. Furthermore, the experimental group achieved significant progress in their reading comprehension ability (RTF) as a result of training, while the control group did not. However, both groups have RTF scores that are lower than expected. Further subject interviews underscore an urgent need to develop standardized measurement instruments specifically for Taiwanese EFL learners. Most students reported that they understood the text, but were unable to easily retell the story or completely unable to retell the story in English. Thus, weak English speaking skills among students are a bias against the validity of the RTF measurement. Experimental results demonstrate the need to redesign a set of measurement instruments for Taiwanese EFL learners to avoid biases that likely influence measurement validity.

Based on video data observations, via the support of the CAREER system, elementary EFL learners were responsible for their reading tasks (word learning or paragraph reading) and were actively involved in cooperative learning activities. Observational results for the experimental group (with technological support) reveal that students could orchestrate their individual and cooperative learning. Furthermore, this study also found that the experimental group switched seamlessly between completing individual tasks and pursuing group goals.

However, without technological support, the distribution mechanism for learning responsibility, which was implemented by dividing reading materials into four reading tasks and randomly assigning these tasks to individual students to stimulate cooperation among groupmates, did not achieve its pedagogical goal of encouraging cooperative reading, as was achieved in other studies. Furthermore, this finding contradicts that obtained by Nichols and Miller (1994) and Ghaith (2003), who argued that low-level achievers are more comfortable working in small groups with relatively more capable peers. The learning behaviors of those with low- and medium-level abilities in the control group were alienated from their groupmates, particularly when performing individual learning activities. Because of their lack of ability to
complete assigned tasks, those students often needed help from groupmates with high-level reading skills. Even most of the students with high-level reading skills were willing to help others accomplish the assigned reading task some were not. Moreover, some of those students who always needed help were sometimes teased and criticized by their groupmates due to time constraints, each individual’s task requirements, and the oral reading contest results.

The problem of teasing was a surprising and unexpected behavior that is worthy of careful attention. Numerous studies concluded that cooperation learning improve student social status and many students learn more when working in a group (Gaith, 2001; Gaith & Bouzineddine, 2003; McMaster & Fuchs, 2002); however, few studies identified the problem found in this study (i.e., that low-level achievers were sometimes ‘teased’ and ‘criticized’ by their peers). The potential drawbacks of heterogeneous groups in cooperative learning should be considered an important issue. Therefore, during the experimental period, the EFL teacher expended considerable effort to help students work in small groups effectively (this is described in the following paragraphs that discuss the role of teachers in cooperative EFL reading activities). Furthermore, to prevent mistreatment of students who need special learning aids, some potential approaches can be applied. For instance, students can be trained in the behaviors and skills needed to work in groups during cooperative learning in traditional classrooms. Teachers can also have the entire class establish its own cooperative reading rules before the cooperative learning activities and then ask them to follow their own rules (Goodwin, 1999; Johnson & Johnson, 1992). Additionally, revising the reward structure used in this study may be another approach that encourages those students with high-level reading ability to help others. While more students with very low reading ability are detected, more cooperative reward structure (positive reward interdependence) and fewer competitive reward structure will be applied to emphasize that any individual’s success helps another become successful (Slavin, 1980). For instance, in addition to the three prizes offered at the end of each reading activity, the highest reward, “superior reading aids” can be awarded to students who are always willing to help others.

The role of teachers in cooperative EFL reading activities also deserves consideration. Experimental results indicate that the roles of EFL teachers in this reciprocal scenario differ depending on whether mobile technology is utilized. Given mobile technology support, EFL teachers can simply provide the necessary instruction or guidance to students, and simply monitor student behavior, acting as managers and learning facilitators. Conversely, in the control group, the role of the EFL teacher was more like a transmitter of knowledge. Although the control group received the same training as the experimental group in terms of cooperative learning skills and was given a group goal, the EFL teacher spent much more time on classroom management than on managing and facilitating learning.

The analytical results for the experimental group are consistent with those obtained by Suthers, Toth, and Weiner (1997), who developed a comprehensive method that supports teacher learning when implementing computer-supported cooperative inquiry in classrooms, and found that teachers adopted the role of a facilitator for student inquiry, moving among workstations, guiding students and offering individual help. However, the findings obtained for the control group did not meet the expectations of researchers regarding the role of a teacher in cooperation (Davidson, 1990).

The experimental and control groups had different cooperative learning behaviors. Most students in the experimental group behaved actively, responsibly, and cooperatively; however, control group students (except those with high-level skills) did not; that is, they behaved passively, irresponsibly, and anti-cooperatively.

In summary, owing to the lack of the basic skills necessary to complete assigned tasks, without technological support, students with low- or medium-level abilities have difficulty cooperating with peers. Thus, these students miss an opportunity to learn by “doing” or by “teaching.” Furthermore, some additional approaches should be applied, such as skill training for working in groups, and the reward structure reorganized to prevent students from picking on those with low-level reading ability and encourage all students with high-level abilities to help others accomplish their learning goals. The use of mobile devices in cooperative EFL reading activities improved individual learning abilities of low- and medium-level students, and helped them accomplish their assigned tasks. The opportunity to be responsible allowed students to experience “doing” and “producing,” not simply “absorbing” and “consuming” while learning to read. This stimulates positive cooperative learning behaviors of students and reasonable progress in early reading skills by most students, not only those with high-level ability.

We conclude that the proposed mobile reading system, the CAREER system, reduces the problems encountered by students in a conventional cooperative learning environment and provides cooperating students with support via mobile technology. In addition to the necessary learning support, the CAREER system provides learners with immediate and specific feedback. Moreover, it can encourage individual EFL learners to be accountable for their learning. Thus, the CAREER system can provide elementary EFL learners and teachers with an effective learning and teaching environment.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.compedu.2009.06.002.

References


Engaging and supporting mobile learners.


Extensive reading in the second language classroom.


Qualitative, quantitative, and mixed approaches.

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