

Original Article

Development and evaluation of an English learning system using smartphones in Japanese dental hygiene education

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Abstract

Purpose: To develop and evaluate the effects of an English learning system using smartphones in Japanese dental hygiene education.

Methods: Forty-three third-year undergraduate university dental hygiene students took a preliminary examination and then were randomly divided into two groups, Group I or II, according to their results to make the English level of each group approximately equal. Group I took examination A as a pre-examination and examination B as a post-examination. Group II took examination B as a pre-examination and examination A as a post-examination. Each examination was composed of dental terminology and speaking sections. All participants studied English learning materials via a learning management system, which included a series of four subtopics related to dental caries prevention, as re- and self-learning.

Results: In the terminology section, both groups showed significantly higher post-examination scores than pre-examination scores, regardless of which examination (A or B) was taken as the pre-examination (Group I: $p < 0.0001$, Group II: $p = 0.0025$).

Conclusions: The English learning system using smartphones developed in this study effectively increased participants' dental English vocabulary. English speaking skills showed no improvement and another learning style should be evaluated in a future study.

Key Words: dental hygiene education, educational technology, e-learning, smartphones, English education

Introduction

Due to the increased globalization of dental hygiene education and research (www.ifdh.org/research.html, March 19, 2018), Japanese dental hygienists must develop better English skills to present their research to an international audience and collaborate with foreign researchers. Also, dental hygienists working at dental clinics would have more opportunities to communicate with foreign patients in English in a global society. Our previous research indicated that large differences exist in the average dental English vocabulary of students from various dental hygiene universities and most students do not have confidence in their English-speaking skills¹, which showed that English classes in dental hygiene education required to be improved. However, it is difficult to increase number of English classes since Japanese dental hygiene students are required to learn more professional subjects including oral care for elderly people. Actually, a core curriculum guideline of Japanese dental hygiene education is revised to match the demand of a super-aged society

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(http://www.kokuhoken.or.jp/zen-eiky/publicity/file/core_curriculum_2018.pdf, April 22, 2019). Thus, an efficient English learning system in Japanese dental hygiene education should be developed and utilized.

Information and communication technology and electronic learning systems (e-learning) have been gradually introduced by the Japanese government to improve the quality of education, especially English education (www.mext.go.jp/en/news/topics/detail/1372625.htm, January 15, 2018), and have been implemented in dental education^{2, 3}. There are some previous research using e-learning materials can only be accessed by a personal computer (PC) in dental and dental hygiene education^{3, 4, 5}. However, some research has shown that young people prefer to use their smartphones to access the internet⁶ (http://www.soumu.go.jp/johotsusintokei/tsusin_riyou/data/eng_tsusin_riyou02_2013.pdf, January 15, 2018), which means that they primarily utilize smartphones as information devices rather than PCs. In fact, 99.4% of Japanese adults in their 20s possess a smartphone (<https://www.e-stat.go.jp/stat-search/files?page=1&layout=datalist&toukei=00200356&tstat=000001102495&cycle=0&tclass=000001102516>, January 15, 2018), and this rate is also increasing in other Asian countries⁷ (www.mysinchew.com/node/73315, March 18, 2018). Moreover, previous research showed that learning materials that can be accessed using mobile devices were effective to increase students' motivation for learning^{8, 9}. There are few research using smartphones to learn English and evaluating those effects objectively in dental hygiene education. Therefore, e-learning materials that can be accessed by smartphones should be developed and evaluated.

The purposes of this study were to develop and implement an English learning system using smartphones for learning, submitting assignments, and taking examinations in Japanese dental hygiene education and evaluate its effects.

Materials and Methods

The study protocol was approved by the Ethical Committee of Tokyo Medical and Dental University (Approval No. D2016-089 in 2017).

Determination of Sample Size

This study was conducted on 43 third-year undergraduate university dental hygiene students, all of whom consented to participate in this study. The sample size was determined by a power analysis. The terminology

section score was used for a power analysis as it was scored objectively. Mean intra-group differences in the terminology section score of 5 with a standard deviation of 5 would require 17 participants per group to detect an effect with $\alpha=0.05$ and $\text{power}=0.8$ (Statistical Discovery, SAS, Cary, NC, USA).

Participants

Forty-three Japanese third-year undergraduate university dental hygiene students participated in this study (mean age \pm standard deviation: 20.7 ± 0.8 years). This group was chosen as they had completed a course related to the learning materials developed in this study and they had not yet begun clinical practice. The trial was registered in the UMIN Clinical Trials Registry (ID: UMIN000025603). Informed consent was obtained from all participants.

English Learning Materials

English learning materials, which could be accessed by any type of information device, were created by three educators who teach at a dental hygiene school or university. The materials covered dental caries prevention. Participants studied a series of four subtopics: the mechanism of dental caries, a prevention program for dental caries, fluoridation, and pit and fissure sealing. Each subtopic had ten key phrases. Figure 1-A shows a screenshot of the learning materials, which were presented in question format. The questions were given in English and Japanese, while the choices were only presented in English. A sound file was included for each question. Participants tapped the play icon to listen to the question first in English and then in Japanese. Hence, if participants were unable to translate a choice into Japanese, they could still listen to the choice in Japanese. Figure 1-B depicts a screenshot of the description video, which participants could read and listen to in English and Japanese after answering the questions. These learning materials were delivered via the Learning Management System (LMS; WebClass®; DATA PACIFIC (JAPAN) LTD., Tokyo, Japan). Thus, participants were able to access these materials on their smartphones from anywhere and at any time. The time required to learn each learning material was about 15–20 minutes.

Speaking Assignments

Participants also submitted speaking assignments after studying each subtopic. The procedures for learning and submitting assignments were as follows. First, participants watched a video delivered via LMS and practiced the

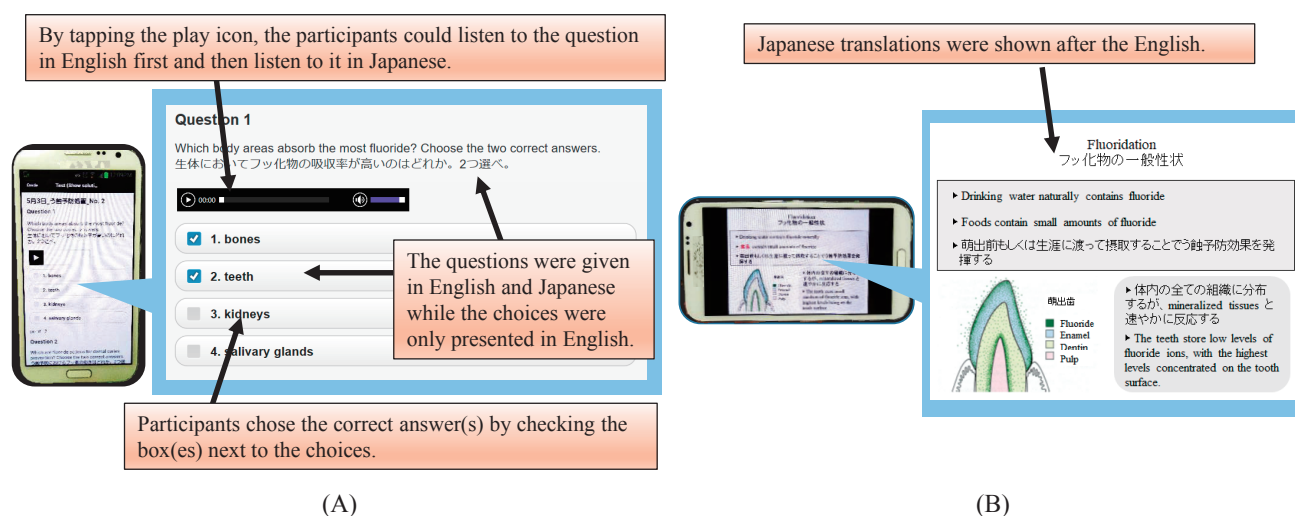


Figure 1. (A) Screenshot of the learning materials presented in question format. (B) Screenshot of the learning materials description video

Source: Willkins EM, Wyche CJ, Boyd LD. Clinical Practice of the Dental Hygienist. 12th ed. Philadelphia, Baltimore, New York, London, Buenos Aires, Hong Kong, Sydney, Tokyo: Wolters Kluwer; 2015.

appropriate pronunciations of key phrases, which they could read from a handout they received. They were instructed to perform 'shadowing'. That is, they first repeated what they heard as quickly as possible. Second, participants recorded their pronunciations of the key phrases using their smartphones. Finally, participants submitted sound files via LMS.

Examinations

Four different examinations, A-D, were used as English proficiency tests. All examinations were composed of different questions. Questions in examinations A and B were related to dental caries prevention and used to evaluate learning effects of the English learning system. Questions in examinations C and D were based on a wide range of English topics related to dental hygiene. Examination C was used to divide participants into two groups as to make English skills of each group approximately equal regardless of their knowledge of dental caries prevention. These examinations were delivered via LMS and participants completed examinations using their smartphones. Each examination was composed of terminology and speaking sections. The terminology section included a writing part (10 points) and a multiple-choice part (40 points). The maximum score was 50. In the writing part, there were 10 questions (maximum score of 10 points) and participants translated the English terminology into Japanese. In the multiple-choice part, there were 20 questions (maximum score of 40 points), and participants chose the correct

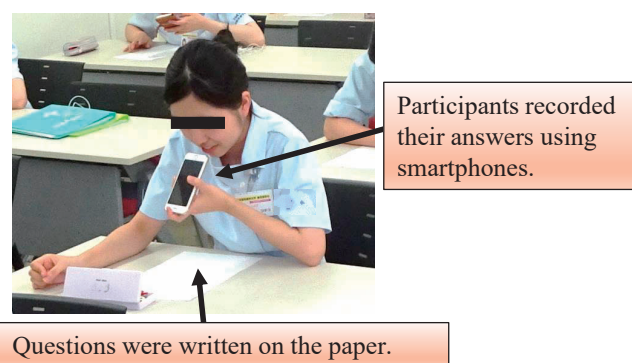


Figure 2. Photograph demonstrating a participant completing the speaking section

term to fill in the blank. Figure 2 shows a participant answering the speaking section. In the speaking section, participants had 1 minute to think about what they were going to say and 1 minute to answer. They recorded their answers using their smartphones and submitted sound files via LMS. Participants' pre- and post-examinations answers were given a unique identifier, answers were mixed, and then a blinded examiner scored all answers at the same time. There were five evaluation metrics: validity, understandability, fluency, accuracy, and vocabulary. Each metric was scored from 0 to 5, with a maximum score of 25.

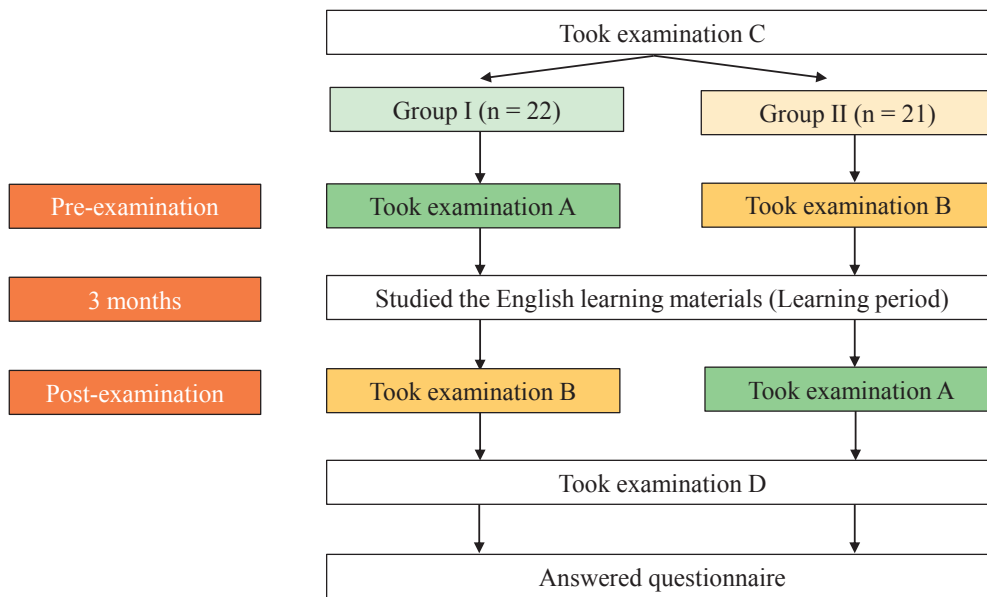


Figure 3. Flowchart of the study

Randomization

The 43 participants were systematically and randomly divided into two groups (Groups I and II) according to the results of terminology section scores of examination C. Systematic randomization was conducted by listing participant's scores of examination C in descending order, then systematically and randomly allocating each pair of participants into Group I or II from the top of the list, and ensured the average score for each group was approximately equal. There was no significant difference in examination C scores between the two groups.

Experimental Design (see Figure 3)

Participants were randomly divided into two groups, Group I or II, according to examination C results as described above. As a pre-examination, Group I took examination A and Group II took examination B. Both groups then studied English learning materials using smartphones outside of class. Additionally, all students had completed a course in dental caries prevention as second-year students; that is, they learned the learning materials as re- and self-learning. The learning duration was 3 months. Thereafter, all participants completed a post-examination; Group I took examination B and Group II took examination A. Both groups also took examination D to determine if there was a significant difference in learning capacity between the two groups. Additionally, participants completed a questionnaire related to the learning materials and the most frequently used device

to study them. The groups took different pre- and post-examinations because higher scores would be expected if they took the same examination as pre- and post-examinations.

Statistical Analysis

Non-parametric tests were used as the frequency of terminology and speaking sections scores did not exhibit normal distribution (Shapiro-Wilk test: $p < 0.01$). The Wilcoxon signed-rank test was used to evaluate the learning period effects on score distance between pre- and post-examination scores within groups. The Mann-Whitney U test was used for inter-group analysis of examination D scores. Spearman's correlation coefficient was used to examine correlations among each examination score and learning activity time. Statistical analyses were conducted using JMP version 11 for Windows (Statistical Discovery. From SAS., SAS Institute Inc., Cary, NC, USA). A p -value of < 0.05 was considered to be statistically significant.

Results

The total average learning activity time was 53.2 ± 9.3 minutes. All 43 participants submitted four speaking assignments each, which they completed outside of the classes. The access log recording showed that there was no particular time when participants accessed the learning materials.

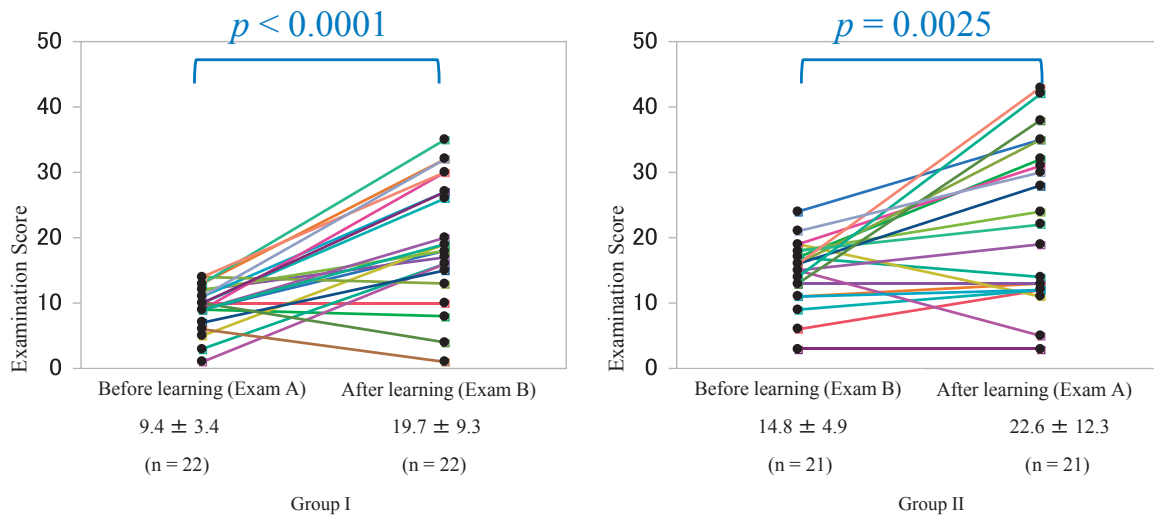


Figure 4. Changes in terminology section scores by group. Wilcoxon signed-rank test

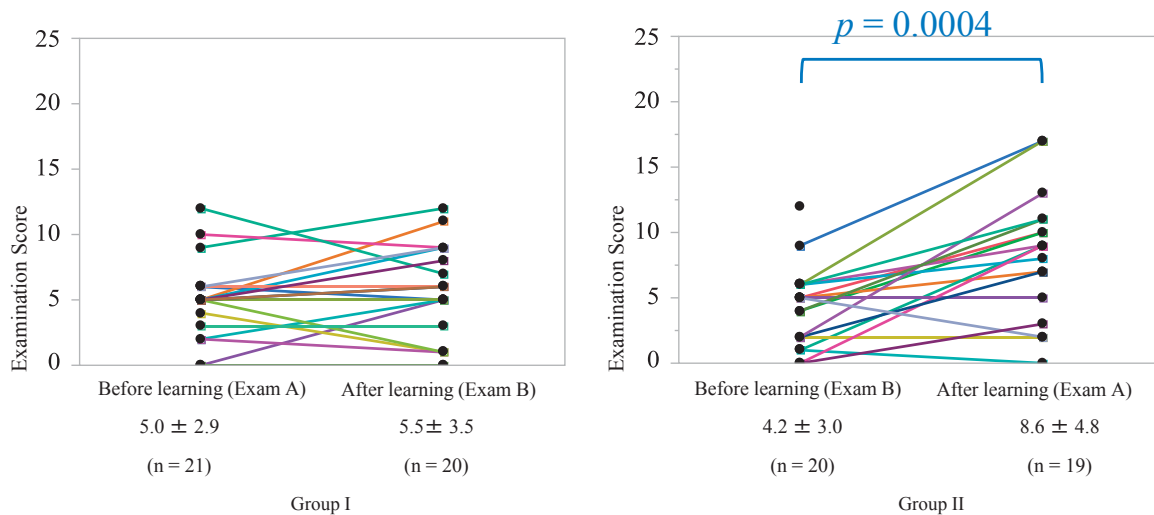


Figure 5. Changes in speaking section scores by group. Wilcoxon signed-rank test

Terminology Section (see Figure 4)

Both groups showed significantly higher post-examination scores than pre-examination scores, regardless of which examination (A or B) was taken as the pre-examination (Figure 4). No significant difference was found in examination D scores between the two groups. There were no significant correlations among examination scores and learning activity time.

Speaking Section (see Figure 5)

Three sound files in examination A and two sound files in examination B could not be scored because they were not uploaded as sound files. Thus, 5 of 43 participants

failed to successfully submit sound files at pre- or post-examination.

In the speaking section, Group II showed significantly higher post-examination scores than pre-examination scores ($p = 0.0004$). Group II had significantly higher examination D scores than Group I ($p = 0.016$). There were no significant correlations among examination scores and learning activity time.

Questionnaire (see Figure 6)

In the questionnaire, 79% of participants showed positive responses to 'These learning materials were helpful for relearning'. More than 67% of participants showed

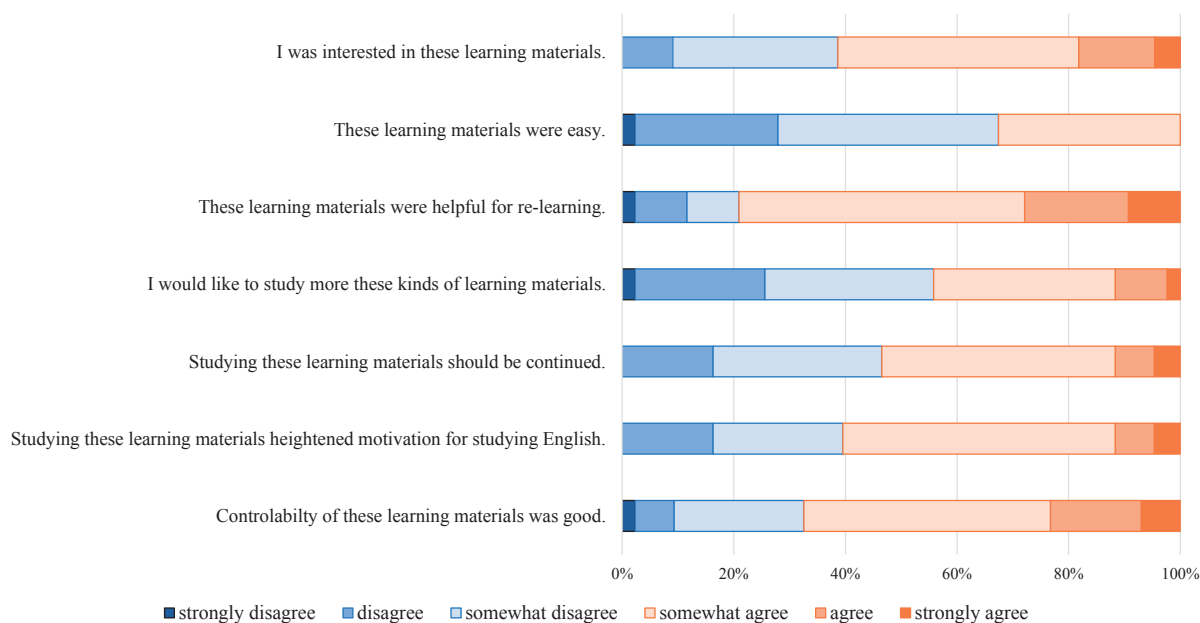


Figure 6. Results of the questionnaire related to the learning materials (n = 43)

positive responses to 'Controllability of these learning materials was good'. Additionally, 93% of participants chose 'smartphone' as the most frequently used device to study the learning materials among 5 choices of 'smartphone', 'tablet type computer', 'laptop', 'desktop computer', and 'others'.

Discussion

In this study, an English learning system using smartphones for re- and self-learning for 3 months including submitting assignments and taking examinations was developed and utilized in Japanese dental hygiene education and its effects were objectively evaluated. Our results showed that the learning system effectively increased participants' dental English vocabulary. There were few English learning materials using smartphones for dental hygiene students or few previous studies evaluating the effects of e-learning materials using smartphones with a long-term follow-up^{3, 4, 5}. Furthermore, almost all participants successfully completed re-learning with the materials, submitting speaking assignments, and taking examinations using smartphones, which indicated that introduction of this English learning system in dental hygiene education would be feasible. We observed three main considerations from our data.

First, an English learning system that allows the participants to re-learn professional courses in English

using smartphones as self-learning should be introduced in dental hygiene education. The learning materials were implemented 1 year after participants took the course in Japanese, which allowed them to relearn dental caries prevention information by studying the English learning materials. Even if they did not have high-level English skills, participants could still comprehend English sentences because they had already finished learning the information in Japanese, which enabled them to increase efficiently their dental English. Additionally, participants of the present study could read and listen to descriptions in English and Japanese using their smartphones and could practice listening to English at their own pace, which enabled them to improve their English skills. This learning method would be efficient as some previous research has emphasized the importance of first improving English-listening skills to improve overall English skills^{10, 11}. In Japan, technical schools and junior colleges offer dental hygiene as a 3-year program and universities offer dental hygiene as a 4-year program¹² (<http://www.mhlw.go.jp/stf/shingi/2r9852000002i2md-att/2r9852000002i31p.pdf>, March 19, 2018). It is difficult to increase the number of English classes in these programs, regardless of educational duration, because Japanese dental hygiene students are required to learn more professional subjects including oral care for elderly people and to improve their critical thinking skills to match the demands of a super-aged

society^{13, 14}. Furthermore, because of the globalization of dental hygiene education, Japanese dental hygienists must cultivate their English-speaking skills to be able to present their research to an international audience as well as to communicate with foreign patients in English. Therefore, dental hygiene educational programs should supplement professional courses with English learning system/courses for re- and self-learning related to these subjects to improve students' English skills.

Second, more learning materials that can be accessed by smartphones should be developed and introduced in dental hygiene education. Although the learning materials developed in this study could be accessed not only by smartphones but also by other kinds of information devices, 93% of participants used smartphones. As shown in Figure 6, more than 67% of them said controllability of the learning materials was good. Most Japanese students are smartphone users (<https://www.e-stat.go.jp/stat-search/files?page=1&layout=datalist&toukei=00200356&tstat=000001102495&cycle=0&tclass1=000001102516>, January 15, 2018). Although five sound files could not be submitted successfully, the other 81 sound files were submitted following verbal instructions, which may be explained by the fact that these students are part of the 'smartphone generation', which is familiar with the use of smartphones. Also, learning materials that are accessible by smartphone enable students to learn from anywhere and at any time and encourage them to learn the materials by themselves. Furthermore, these types of learning materials can be applied to various education programs because schools can utilize these materials as long as students have smartphones, even if schools do not have a computer lab.

Finally, additional randomized controlled trials are required to identify the effects of an English learning system using smartphones in dental hygiene education. In this study, one of the two groups did not show improvements in speaking section scores. Furthermore, there was a significant difference in examination D scores among the two groups, which would designate that one of the two groups was composed of more participants who actively studied English or who have high potential to improve their English speaking skills within a short period as they were divided into two groups according to their terminology scores. The results of this study showed that the English learning system was effective to increase participants' dental English vocabulary, however, it is difficult to conclude that this learning system was also effective to improve English speaking skills. Most Japanese have poor English speaking skills

and few opportunities to practice, so they tend to be nervous while speaking English¹⁵. It would take a longer time for all participants to improve their English speaking section scores than their terminology section scores. Additional trials are required to identify how this learning system should be improved to have positive effects on the English speaking skills of all types of students. A trial should initially be carried out to clarify what types of students significantly improved their English speaking skills by utilizing this learning system.

Limitations

It is difficult to conclude that the English learning system was effective for improving English speaking skills since one of the two groups did not show improvements in English speaking skills and there were significant differences in speaking section scores in examination D between the two groups.

Conclusion

The developed English learning system using smartphones for learning, submitting assignments, and taking examinations effectively increased participants' dental English vocabulary and was positively evaluated by the participants.

Conflict of Interest

The authors have declared that there are no conflicts of interest to disclose in relation to the publication of this research.

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