Report of international distance learning for nutritional education between Japanese and Thai schoolchildren using HyperMirror

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We evaluated the effects of a nutrition education program using HyperMirror, a video-mediated communication system, on the acquisition of appropriate food and dietary choice skills among Japanese and Thai schoolchildren, and the applicability of HyperMirror for a nutrition education program. HyperMirror uses composite video images and mirrored self–images to make geographically remote individuals feel as if they are in the same room.

The nutrition program, assessed using a pre–post study design, was conducted in 2006 (wherein the target was food choices based on food groups) and 2007 (wherein the target was planning a well–balanced breakfast). Periodic newsletters were distributed between the yearly sessions to ensure knowledge retention. Subjects were students (aged 9–10 years in 2006) from urban areas of Japan (n = 70) and Thailand (n = 21) who participated in both the lectures in 2006 and 2007.

The study environment was evaluated after every year’s distance lecture.

We also assessed program impact in terms of changes in nutritional knowledge, attitudes and behaviors towards appropriate food and dietary choice. The following behavioral objectives were assessed; (1) making appropriate diet choices, (2) understanding and being interested in foreign dietary/food cultures, and (3) being concerned about their own nutrition after three weeks of distance learning in 2007.

The mean study environment scores were high overall for both sessions (3.8 for Japanese students, 4.4 for Thai), and changes in nutritional knowledge, attitudes, and behaviors were observed.

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Over 50% of Japanese and Thai students agreed on behavioral objective (1), while agreement rates for behavioral objectives (2) and (3) were greater among Thai than among Japanese students, partly because the periodical newsletters helped maintain students’ learning interest and retention. Our study showed that a distance-learning nutritional education program using HyperMirror effectively induced behavioral changes and improved knowledge of food culture. We also confirmed HyperMirror’s applicability to such programs.

**Key words**: Distance Learning, HyperMirror, Nutritional Education, Schoolchildren, Video Conference

### I. Introduction

Children must practice desirable eating habits to prevent future development of lifestyle-related diseases. These habits, such as selecting the proper foods to maintain a well-balanced diet, can be cultivated through nutrition education programs. The Ministry of Education, Culture, Sports, Science and Technology’s curriculum guideline has emphasized the importance of nutrition education for students since the Basic Law on Shokuiku (i.e., food and nutrition education) (Cabinet Office 2005) was enacted in Japan. Based on this law, the government initiated the Shokuiku Promotion Plan (Cabinet Office 2006), which aims to promote Shokuiku in schools in cooperation with parents and the local community. It is believed that the impact of nutrition education can be maximized through increasing students’ interest and motivation via hands-on and active learning strategies. Therefore, the introduction of distance learning programs via information and communication technology (ICT) could be suitable for promoting active and cooperative learning among youth. In particular, HyperMirror, used in the present study, is a new video image communication tool allowing participants in different places to learn by sharing and exchanging their knowledge and experiences, moreover engaging in cooperative activities such as pointing to an object on the HyperMirror screen, which is a shared space. Nutrition education programs can also provide children with knowledge regarding the dietary habits and food culture of their region, their country, and other countries; this serves to enrich children’s experience of food and nutrition, which further contributes to healthy eating habits. Therefore, this study focuses on whether HyperMirror can be effective in facilitating active and cooperative learning of food and nutrition on an international level. However, there are no existing reports on the use of HyperMirror for nutrition education. Moreover, all existing studies of HyperMirror have been cross-sectional. Thus, the present study is the first to examine the long-term effects of HyperMirror on nutrition education.

We selected Thailand as Japan’s counterpart for this study for the following reasons; (1) Japan and Thailand have similar food cultures, such as eating rice as a staple and using fermented condiments such as soy sauce. (2) There is only 2 hours’ time difference between the countries which makes it easier implement distance learning. (3) The prevalence of obesity is increasing among school children in both countries.

The purpose of the present study was to evaluate the effects of a nutrition education program using HyperMirror on the acquisition of skills concerning appropriate choice of foods for a well-balanced diet among Japanese and Thai schoolchildren. Furthermore, we sought to determine the applicability of HyperMirror for a nutrition education program.
II. Methods

1. Research procedure

The research procedure is shown in Figure 1. The distance-learning program was planned based on the results of a baseline nutrition survey conducted in 2005 and executed over two years (2006 and 2007). To adequately plan the program, we conducted nutrition surveys that assessed dietary knowledge, attitudes, and behavior; asked students, who were in fourth grade in 2005, to complete a 24-hour dietary recall procedure; conducted food concept mapping, wherein students evaluated their consciousness of their own diet and food preferences; considered the number of parental requests for nutrition education. The results of the food concept mapping indicated that schoolchildren from both countries were conscious of nutrition; however, the 24-hour dietary recall and the assessment of dietary knowledge, attitudes, and behavior indicated that they did not eat well, and did not possess sufficient knowledge of nutrition and diet. In addition, there were high percentages of underweight Japanese (32%) and obese Thai students (32%), who had unbalanced dietary habits and dietary patterns. Thus, a two-year (2006–2007) nutrition education program involving HyperMirror was devised to promote a balanced diet with consideration towards the culinary environment and culture of each country.

In the first year (2006), Japanese and Thai 5th grade students (10–11 years old) learned to categorize food choices based on a color-coded food-grouping system (red, yellow, or green). The three color-coded food grouping system is a nutrition education tool commonly used in Japan, particularly in elementary schools. In this system, foods are assigned one of three colors (red, yellow, or green) based on their nutritional characteristics. The red group comprises bodybuilding foods, (i.e., proteins) such as meat, seafood, poultry, bean/bean-based products, milk/dairy products, and

![Figure 1 Research procedure](image)
eggs. The yellow group comprises energy-giving foods (i.e., carbohydrates) such as wheat, rice, starch, tubers such as potatoes, fats or lipids, and sugar. The green group encompasses protective or regulating foods (i.e., vitamins and minerals) such as vegetables, fruits, and seaweed. The purpose of this system is that equal selection from each of the three groups results in a well-balanced diet. In the second year, children learned to plan a well-balanced breakfast by choosing foods from the same food groups. In addition to the lectures, newsletters were distributed 7 times after the first year of the program on an almost monthly basis. After the second year, program impact and behavior objective evaluations were conducted by using a non-comparative survey.

Note that the study design was a pre–post study because schoolteachers and students’ parents believed that all students should have equal opportunity to obtain an education in Japan and the school curriculum was rather tight at the time, which made it difficult to recruit control groups in the schools and set up a crossover design.

2. Participants

A public elementary school in an urban area (Gifu Prefecture) of Japan conducted the distance-learning program with a private elementary school in an urban area of northern (Chang Mai City) Thailand.

Data from 6th grade students (11–12 years old) who participated in the program for the full two years, including 70 Japanese students (boys: 34, girls: 36) and 21 Thai students (boys: 5, girls: 16), were analyzed. The reason for the difference in sample sizes was that, although all Japanese students in the school could participate in this study, only one class of Thai students in the school could participate because of capacity limitations in the room with Internet facilities.

3. Newsletters

The newsletters were intended to bolster students’ retention of the nutrition education content provided in the first year of distance learning, and to increase interest in Japanese and Thai dietary habits and culture. The contents of the newsletters are shown in Table 1. The newsletters were drafted by the researchers in both Japanese and Thai, and distributed to participants 7 times over the first year of distance learning (2006) to just before the second year of distance learning (2007). Participants’ reactions to newsletter content were assessed using a questionnaire rated on a 5-point

<table>
<thead>
<tr>
<th>Issue</th>
<th>Newsletter topics</th>
<th>Japanese (n=70) (%)</th>
<th>Thai (n=21) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>Feedback on content of the first-year distance lecture</td>
<td>81</td>
<td>100</td>
</tr>
<tr>
<td>Feb.</td>
<td>“Osechi”–a Japanese traditional new year’s dish</td>
<td>77</td>
<td>100</td>
</tr>
<tr>
<td>March</td>
<td>The three color-coded food groups of Japan and food guide of Thailand</td>
<td>74</td>
<td>100</td>
</tr>
<tr>
<td>April</td>
<td>Characteristics of rice eaten in Japan and Thailand</td>
<td>69</td>
<td>100</td>
</tr>
<tr>
<td>May</td>
<td>The different tastes, including sweet, salty, sour, bitter, and umami, and the taste characteristics of Japanese and Thai dishes</td>
<td>76</td>
<td>100</td>
</tr>
<tr>
<td>June</td>
<td>Festival foods and local foods of Japan</td>
<td>63</td>
<td>100</td>
</tr>
<tr>
<td>Sep.</td>
<td>Healthy lifestyle and dietary guidelines of Japan and Thailand</td>
<td>62</td>
<td>100</td>
</tr>
</tbody>
</table>
Likert-type (ranging from not interested at all to very interested). Additionally, students completed quizzes to assess their comprehension of the newsletters before the second distance learning session.

4. HyperMirror system

HyperMirror can display images from different places on the same screen using the Internet. In this system, chroma-key mixing was conducted at both study sites to synchronize the delay in images. A blue background was used at the Japan side to allow for superimposition of images from Japan onto the images from Thailand (Figure 2).

5. Lecture content

At the beginning of the first-year lecture, Thai students introduced raw spring rolls, a traditional dish from Thailand, to Japanese students, while Japanese students presented “do-it-yourself” sushi rolls, a traditional dish of Japan, to Thai students. Then, the students selected foods for their partners’ traditional dishes. After they discussed their choices, they prepared their partners’ chosen meals while the partners watched on the HyperMirror screen (Figure 3).

Following this, a Japanese nutrition expert lectured the students on the three-color-coded food grouping system and well-balanced food choices and combinations in Japanese; an interpreter translated from Japanese to Thai to ensure that Thai students could understand the lectures. Specifically, they were taught that equal selection from each of the three groups results in a well-balanced diet.

In the second year, Japanese and Thai students...
planned their breakfasts and then discussed via HyperMirror whether the breakfast was well balanced and sufficient; if it was not, the students from the partner country discussed potential improvements. Lecture contents and the learning environment were evaluated via a post-lecture questionnaire (9 items) using a 5-point Likert scale at each year.

An interpreter participated in the lecture each year and helped students interpret Japanese and Thai.

6. Program evaluation

Three weeks after the second distance learning session, we performed a follow-up survey to evaluate the program impact and behavior objectives over the two-year period. The program impact evaluation was conducted in terms of changes in knowledge (food classification and nutrition) and self-management efficacy between the baseline and follow-up surveys. The proportion of changes in self-efficacy between the baseline and follow-up surveys was measured by examining changes in the proportions of participants who answered either “confident” or “sometimes confident” (on a 3-point scale, with the other option being “not confident”) for the following 6 items: “I can eat a lot of staple foods (rice, noodles, bread),” “I can eat a lot of main dishes (fish, meat, egg, soy beans/soy products, etc.),” “I can eat a lot of vegetable dishes,” “I can eat a lot of dairy products (milk, yogurt, cheese, etc.),” “I can eat a lot of fruits”, and “I can eat nutritionally balanced meals” (Table 2).

Behavioral objective evaluations involved assessing whether students could (1) select appropriate foods for a well-balanced diet, (2) understand and be interested in foreign food cultures, and (3) interest in their own nutrition (Table 3).

7. Statistical analysis

We assessed program impact evaluation in participants’ food classification knowledge and nutritional knowledge were analyzed using McNemar’s test. The chi-square goodness of fit test was applied to determine changes in self-efficacy of self-management. Behavioral objective evaluations were also analyzed using chi-square test for independence and residual analysis. The lecture contents and learning environment data were summarized as means and standard deviations and analyzed using Welch’s t-test or Student’s t-test. The levels of statistical significance were set up at p<0.05. SPSS Statistics 12.0J for Windows was used for all analyses.

8. Ethical considerations

This study was approved by the research ethics committee of the Faculty of Medicine, Chiang Mai University, Thailand (the approval code: 184/2006). All Japanese and Thai students’ parents provided their informed consent. We explained the ethical considerations and ethical approval of this study to Japanese and Thai teachers. Japanese and Thai teachers agreed to them. Then, Japanese and Thai teachers explained the purpose of the study to students at school and obtained their agreement to participate. Japanese and Thai students who agreed to participate with the consent of their parents participated in this study after submitting consent for participation in the study.

III. Results

1. Program evaluation

1) Impact evaluation

The program impact evaluation is shown in Table 2.

(1) Food classification knowledge

Participants’ accuracy rate for questions regarding red and yellow food groups increased significantly at the follow-up evaluation (p<0.05). For questions pertaining to the green food group, the accuracy rate increased for Japanese participants; however, the accuracy rate for Thai participants
Table 2 The program impact evaluation

<table>
<thead>
<tr>
<th>1. Food classification knowledge</th>
<th>Japanese (n=70)</th>
<th>Thai (n=21)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>After first distance learning session and periodical newsletters</td>
<td>Follow-up</td>
</tr>
<tr>
<td>Red food group (e.g., eggs and tofu)</td>
<td>62.1</td>
<td>80.0</td>
</tr>
<tr>
<td>Accuracy rate (% correct) of classification of foods into the three color-coded food groups</td>
<td>Yellow food group (e.g., sliced bread, white rice, vegetable oil)</td>
<td>78.9</td>
</tr>
<tr>
<td>Green food group (e.g., cucumber, apple)</td>
<td>92.1</td>
<td>95.0</td>
</tr>
<tr>
<td>2. Nutritional knowledge</td>
<td>Baseline</td>
<td>Follow-up</td>
</tr>
<tr>
<td>Accuracy rate (% correct) of knowledge regarding physical functions of foods</td>
<td>83.3</td>
<td>77.5</td>
</tr>
<tr>
<td>3. Self-efficacy of self-management</td>
<td>Baseline – Follow-up</td>
<td>p&lt;sup&gt;0&lt;/sup&gt;</td>
</tr>
<tr>
<td>Changes in self-efficacy of self-management to choose the right foods and diet for a well-balanced diet between baseline and follow-up survey</td>
<td>Decrease (%)</td>
<td>27.5</td>
</tr>
</tbody>
</table>

<sup>1</sup>p: significance value by McNemar’s test, ns: no significance

<sup>2</sup>p: significance value by the chi-square goodness of fit test
decreased lightly. As the results, there was no statistically significant difference for both countries.

(2) Nutritional knowledge

The accuracy rate for questions on the nutritional profile and physiological functions of food increased in Thai participants (from 84.1% to 90.5%) but decreased slightly for Japanese participants (from 83.3% to 77.5%). There was no statistically significant difference between the baseline and the follow-up survey.

(3) Self-efficacy of self-management

Compared to 2006, Japanese participants exhibited a significant increase (p<0.01) in self-efficacy of self-management regarding the selection of appropriate foods and the maintenance of a balanced diet in 2007. In contrast, Thai participants showed no such increase.

2) Behavioral objective evaluations

The results of the behavioral objective evaluation are shown in Table 3.

(1) Behavioral objective 1

Behavioral objective 1 comprised two questions (Q1 and Q2). The percentages of participants who indicated “agree” for Q1 were same 57.1% for Thai and Japanese. There was no significant difference between the countries. The percentages of participants who indicated “agree” for Q2 were 61.9% for Thai and 58.6% for Japanese; again, there was no significant difference between the countries. Notably, more than 50% of Japanese and Thai participants indicated “agree” for this behavioral objective.

Table 3  The results of the behavioral objective evaluation

| Behavioral objective 1: Can make appropriate food choices and well-balanced diet choices. |    |    |
|---------------------------------|---|---|---|
| Q1 Are you eating foods while considering the amount of food? |    |    |
| Disagree | 5.7 | 0.0 |
| Neither disagree/agree | 37.1 | 42.9 |
| Agree | 57.1 | 57.1 |
| Behavioral objective 2: Can understand and shows interest in/concerns about the food environment and culture of the surrounding region and foreign countries after participating in the distance lecture and reading the monthly newsletter. |    |    |
| Q3 Are you interested in the food culture (festival foods and local foods, etc.) in your living area? |    |    |
| Disagree | 11.4 | 4.8 |
| Neither disagree/agree | 65.7 | 47.6 |
| Agree | 22.9 | 47.6* |
| Q4 Are you interested in the other countries cuisine? |    |    |
| Disagree | 11.4 | 0.0 |
| Neither disagree/agree | 52.9* | 23.8 |
| Agree | 35.7 | 76.2* * |
| Behavioral objective 3: Are you interested in nutrition, foods, and your eating habits after participating in the scheme program? |    |    |
| Q5 Have you begun to take interest in nutrition, foods, and your eating habits? |    |    |
| Disagree | 7.1 | 0.0 |
| Neither disagree/agree | 55.7** | 14.3 |
| Agree | 37.1 | 85.7** |

Statistical testing performed using chi-square test for independence and residual analysis.
Significance level of chi-square test and residual analysis  ** p <0.01  * p <0.05
Behavioral objective 2

Behavioral objective 2 also comprised two questions (Q3 and Q4). The percentages of participants who indicated “agree” for Q3 were 47.6% for Thai and 22.9% for Japanese \((p = 0.08 < 0.1)\). The percentage of participants who indicated “agree” for Q4 was 76.2% for Thai and 35.7% for Japanese \((p < 0.01)\). Taken together, the results showed that a greater number of Thai students than Japanese students met behavioral objective 2.

Behavioral objective 3

Behavioral objective 3 comprised only Q5, as shown in Table 2. Significantly more Thai students 85.7% than Japanese students 37.1% \((p < 0.01)\) responded with “agree” to this question.

2. Evaluation of the periodical newsletter

More than 60% of Japanese and Thai students read the newsletter, indicating that they were interested in the dietary habits and food culture of Japan and Thailand (Table 1). However, the Thai students showed more of an interest in the contents of the newsletter than the Japanese students.

The accuracy rates for the quizzes on the content presented during the first year of the distance-learning course—the nutritional profile and physiological functions of food—were high among both Japanese and Thai students. Specifically, the accuracy rates of the quizzes on the nutritional profile of food were 64% in Japanese and 81% in Thai students, while those of the quizzes on the physiological functions of food were 77% in Japanese and 67% in Thai students. However, the accuracy rate was relatively low for the quizzes on the newsletter material unrelated to the contents of the first distance-learning class. Therefore, the periodical newsletters facilitated retention of the material presented in the first part of the course until at least the beginning of the second part of the course.

3. Evaluation of the curriculum content and learning environment

Thai students gave higher ratings to the curriculum content (Q1–Q4) and learning environment (Q5–Q9) than did Japanese students. In 2006, Thai students had significantly higher scores for items Q4 \((p < 0.05)\) and Q1, Q5, Q6, and Q7 \((p < 0.01)\). In 2007, Thai students had significantly higher scores for item Q2 \((p < 0.05)\) and all other items \((p < 0.01)\) (Table 4).

IV. Discussion

Our results suggest that the distance-learning program increased students’ knowledge of appropriate food choices for the maintenance of a well-balanced diet. Furthermore, self-efficacy of self-management in selecting the proper foods for a well-balanced diet increased from the first to the second year of the program for both Thai and Japanese students. The high accuracy rate on the “knowledge” component of the second-year pre-test indicates that the periodical newsletter contributed to the retention of the first-year content.

Thai students evaluated “behavioral objectives 2 and 3” more positively than did Japanese students. Furthermore, Thai students exhibited greater interest in both the Thai and Japanese food cultures, as well as the distance-learning program in general. The newsletters also appeared to increase Thai students’ desire to learn to a greater degree than Japanese students, possibly because the majority of newsletter topics pertained to Japanese dietary culture and nutrition. Thus, Thai students may have exhibited greater interest than Japanese students simply because the material was more novel.

We also noted that Thai students rated the curriculum content and learning environment higher than did Japanese students. This difference may have resulted from long interruptions and delays in data transfer between the schools due to insuffi-
<table>
<thead>
<tr>
<th></th>
<th>2006 Japanese (n=70) Mean ± SD</th>
<th>2006 Thai (n=21) Mean ± SD</th>
<th>2007 Japanese (n=70) Mean ± SD</th>
<th>2007 Thai (n=21) Mean ± SD</th>
<th>p</th>
<th>2006 and 2007 Japanese Mean points</th>
<th>2006 and 2007 Thai Mean points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The curriculum content</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q1 Did you enjoy learning with students in a remote place?</td>
<td>4.6 ± 0.7</td>
<td>4.9 ± 0.3</td>
<td>**</td>
<td>4.1 ± 1.0</td>
<td>4.9 ± 0.4</td>
<td>**</td>
<td>4.35</td>
</tr>
<tr>
<td>Q2 Was it easy to understand the contents of the lesson?</td>
<td>4.2 ± 0.8</td>
<td>4.2 ± 0.7</td>
<td>n.s.</td>
<td>4.0 ± 0.9</td>
<td>4.4 ± 0.5</td>
<td>*</td>
<td>4.10</td>
</tr>
<tr>
<td>Q3 Were you interested in the contents of the lesson?</td>
<td>4.2 ± 1.0</td>
<td>4.5 ± 0.6</td>
<td>n.s.</td>
<td>3.7 ± 1.0</td>
<td>4.7 ± 0.5</td>
<td>**</td>
<td>3.95</td>
</tr>
<tr>
<td>Q4 Was it helpful to you that you participated in the lesson with students in a remote place?</td>
<td>4.5 ± 0.8</td>
<td>4.8 ± 0.4</td>
<td>*</td>
<td>4.0 ± 1.0</td>
<td>4.8 ± 0.4</td>
<td>**</td>
<td>4.25</td>
</tr>
<tr>
<td><strong>Learning environment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q5 Did you feel as if you and the students in the remote place were participating in the lesson at the same place?</td>
<td>4.0 ± 1.0</td>
<td>4.7 ± 0.5</td>
<td>**</td>
<td>3.5 ± 1.2</td>
<td>4.5 ± 0.5</td>
<td>**</td>
<td>3.75</td>
</tr>
<tr>
<td>Q6 When you or your classmates pointed at a kind of food in the remote place, did you see it clearly?</td>
<td>3.3 ± 1.2</td>
<td>4.1 ± 0.5</td>
<td>**</td>
<td>3.6 ± 1.1</td>
<td>4.1 ± 0.6</td>
<td>**</td>
<td>3.45</td>
</tr>
<tr>
<td>Q7 When you, your classmates, and the students in the remote place greeted or talked to each other side by side, did you see the students in remote place clearly?</td>
<td>3.6 ± 1.1</td>
<td>4.2 ± 0.5</td>
<td>**</td>
<td>3.5 ± 1.0</td>
<td>4.4 ± 0.7</td>
<td>**</td>
<td>3.55</td>
</tr>
<tr>
<td>Q8 Did you hear the voices of the students in the remote place clearly?</td>
<td>3.8 ± 1.0</td>
<td>4.1 ± 0.7</td>
<td>n.s.</td>
<td>3.6 ± 1.1</td>
<td>4.2 ± 0.6</td>
<td>**</td>
<td>3.70</td>
</tr>
<tr>
<td>Q9 Would you want to participate in another lesson like today’s lesson?</td>
<td>4.6 ± 0.7</td>
<td>4.8 ± 0.7</td>
<td>n.s.</td>
<td>4.0 ± 1.2</td>
<td>4.9 ± 0.3</td>
<td>**</td>
<td>4.30</td>
</tr>
</tbody>
</table>
| **Mean of evaluation points to learning environment (Q5-Q9)** | 3.86 | 4.38 | 3.64 | 4.42 | 3.75 | 4.40 |}

Statistical test of the difference between two means, SD: Standard Deviation, **p<0.01, *p<0.05, n.s.: no significance
Statistical testing performed with using Student’s t-test for Q2 and Q9 in 2006, all other questions use Welch’s t-test.
cient network capacity, and due to the presence of a lecture supporter. Specifically, lecture implementation during 2007 in particular was wrought with less stable network conditions and longer durations of interruption than in 2006. A Japanese–to–Thai interpreter was present in the Thai school during the lectures and assisted the students in understanding the material. Even during extended interruptions due to network conditions, the interpreter conveyed the lecture content to the students, thus reducing the effect of the interruption on learning activities. Conversely, an interpreter was not present in the Japanese schools; as such, learning activities were halted entirely by the network interruptions. Therefore, effective nutrition education with HyperMirror appears to depend greatly on a secure network capacity and the presence of a lecture supporter. Overall, the findings that network conditions and periodical newsletters influence the educational effects of distance-learning nutrition programs using HyperMirror points to the necessity of proper planning of supplemental teaching materials and an adequately designed learning environment.

Distance learning, such as e-learning, has been found to increase knowledge, skills, self-efficacy, satisfaction, motivation, and perception.\(^6\)\(^-\)\(^9\) Reports on the health/nutrition education and care through video conferencing indicate that distance learning is effective for deepening participants’ interest in and motivation for engaging in healthy dietary behaviors, and provides a good alternative to face-to-face learning and communication for participants living in remote areas.\(^10\)\(^-\)\(^12\) Unlike traditional video-conferencing systems, HyperMirror provides a shared activity space wherein participants in different places can actively engage in interactive communication and collaborative activities. Thus, participants can easily perform physical activities together and compare learning material, which ultimately augments their learning. HyperMirror thus makes full use of the characteristics of a good educational setting, and indeed, it has proven beneficial for education on cultural exchange, ethics, science as well as teaching manual skills involved in medical education.\(^3\)\(^,\)\(^13\) The present study adds nutrition education to this list.

Previous reports\(^3\)\(^,\)\(^11\) further indicated that education with HyperMirror helps participants in both participating countries feel that they are studying together in the same room because they can see each other and collaborate in interactive activities on the same screen. This ensures that participants can easily perform interactive physical activities and thereby expand their understanding of the educational material. The present study showed that participants in both countries could perform interesting interactive activities, such as making each country’s traditional foods (e.g., raw spring rolls or sushi) in the first year of distance lectures, at the same time in a shared space. Participants could also share bulletin boards and post information on those boards and could share screens to help each other in meeting the learning objectives, such as formulating plans for a well-balanced breakfast. All of these interactive activities helped participants feel like they were studying together in the same classroom, which, as indicated in the learning environment results of evaluation points 3.8 (Japanese) and 4.4 (Thai) of Table 4, enhanced their learning by ensuring that participants felt connected to each other. Japanese and Thai students could also communicate by showing each other friendly gestures, such as tapping their partner’s shoulder on the HyperMirror screen upon their first meeting. Taken together, our results indicate that distance-learning programs such as HyperMirror could be integrated into international nutrition education more frequently in the future.

This study had several limitations—namely, the lack of a control group and the discrepancy in the
The number of participants between the comparison groups—that make it difficult to identify the educational effects of HyperMirror clearly. In a future study, we must set up another school as a control group and ensure equal group sizes for comparison in order to reconfirm the impact of nutrition education with HyperMirror.

V. Conclusions/Recommendations

The present results suggest that the inclusion of HyperMirror in nutrition education programs will improve nutrition learning and increase the likelihood that students will ultimately maintain a well-balanced diet. However, a reliable network environment appears necessary for optimal results. Periodical newsletters that supplement lecture content also appear to effectively promote material retention. Thus, future studies should examine how to establish continuing education programs for behavior changes and improve technical problems such as network environment. In conclusion, HyperMirror appears to enhance nutrition education programs that incorporate collaborative activities such as learning about the food culture of other countries.

VI. Acknowledgments

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Declaration of Conflicting Interests

The author(s) declare no conflicts of interest with respect to the authorship and/or publication of this article.

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Report of international distance learning for nutritional education between Japanese and Thai schoolchildren using HyperMirror

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和文抄録

本研究は、日本・タイ国児童を対象に「適切な食品・食事の選択・組み合わせ」スキルの向上を目指した、視覚対話システムの超鏡（HyperMirror）活用の食育プログラムの教育効果と超鏡の食育への適用性を検討することであった。超鏡は、遠隔地の相手像と自己の鏡像とを合成し、同一画面上に表示して相手と同室感覚を作りだすことができる。

食育プログラムは、前後比較デザインを用いて、2006 年（テーマ：食品群から食品を選択する）と 2007 年（テーマ：食品群から食品選択し、栄養バランスの良い朝食を計画する）に実施した。また、初回の食育の学習内容を対象児童に保持させるために教育支援教材（ニュースレター）を、2 回目の食育授業実施前まで定期的に配布した。対象者は、2006 年と 2007 年の両年とも食育授業に参加した日本都市部（70 名）とタイ国都市部（21 名）の児童（2006 年時 9 歳から 10 歳の小学生 5 年生）である。

各年の食育授業終了後に学習環境調査を実施した。また、2007 年の遠隔食育授業の約 3 週間後に食育プログラムの“影響評価”（適切な食品・食事選択に関する知識、意識、および行動の変容）と“行動目標評価”（目標 1：適切な量と食品の組合せの食事を摂取できる、目標 2：外国の食環境・食文化を理解し、興味・関心をもつことができる、目標 3：自分の食生活に関心をもつことができる）を実施し、検討をおこなった。

超鏡の学習環境については両年平均で日本 3.8、タイ国 4.4 で児童の評価は高値であった。また両国の児童に適切な食品・食事選択に関する知識、意識、および行動の変容が確認された。行動目標 1 は両国の児童の 50％以上が「できる」と回答した。行動目標 2 と 3 はタイ児童の方が日本児童より「できる」の回答率が高く、教育支援教材による効果もみられた。

本報告では超鏡による食育の教育効果と適用性が確認できた。