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Development of a Game Type Food Education System Using a Cell Phone Camera

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Abstract: This paper describes the development of a food education system that utilizes a cell phone camera. As eating habits have become rich, a lot of consequent problems have been pointed out. To overcome them, people need to monitor their eating habits and learn how to improve eating habits. The distinctive features of our system are as follows: (1) accumulation and understanding of meal records using photos and comments, (2) learning by reflecting on one's eating histories, (3) learning by comparing one's history with those of others, (4) knowledge acquisition by quizzes and explanations, and (5) increasing motivation by a point-based game system. The results of our experiment have confirmed that our system works as we expected and that participants could improve their eating habits by learning about food and meals, and by reflecting on their own eating habits through the learning activities in our system.

Keywords: Food education, Eating habit, Nutrition, Diet, Cell phone camera

Introduction

The ubiquity of accessible information through computer networks can be utilized in new ways to support everyday life. On the other hand, while eating habits have become rich, a lot of consequent problems have been pointed out, such as relying too much on eating out, overeating, nutritional imbalances and excessive dieting[1][2]. In many cases, health problems originate in eating habits. In order to live a healthy life, people need to learn good eating habits. In Japan, the National Basic Law on Food Education was enacted in 2005, and food education activities have been undertaken nationally[1][2]. Food education is also called nutrition education or dietary education.
In this context, we have developed a food education system that utilizes a cell phone camera[3]. Our system is designed to teach people about nutrition and meals in daily life in the form of a game. This paper describes the design and implementation of our food education system, along with an experiment to measure its effectiveness.

1. Related works and purpose

As concern about food and meals has arisen, studies on food education have utilized the cell phone and commercial services. Some systems help people to improve their eating habits by giving them expert nutritional instruction in response to meal photos taken by cell phone cameras[4]. Hands-on educational programs for parents and children using cell phones have been reported[5]. Other systems help people improve their eating habits as a cell phone

servicing[6][7][8][9]. In addition, there are researches of the system which focuses on collaboration in a community[10].
In our system, users can learn about food and meals in their daily lives as a game. Our system enables users to self-evaluate and improve their eating habits through activities in which they document their daily meals with photographs and comments via a cell phone camera, referring their own and other users' histories of meals and the results of other activities. Our system also helps people obtain and enhance their knowledge of food and meals through quizzes and explanations of the basics of food and meals. The purpose of our system is to help people enjoy learning about food and meals and to motivate people to improve their own eating habits through their daily life game activities.

2. Learning design

In this section, we describe the learning design and related functions of our system. They are summarized in Table 1

2.1 Self-recognition of eating habits by record

In our system, the user takes photos of his or her meals with a cell phone camera and uploads the photos, along with comments about the meals, and stores them in the server. We expect that this practice requires the user to pay attention to the daily meals, whereas ordinarily this would not be the case. This triggers reflection and improvement of the user's eating habits. Although many cell phones come equipped with a camera and the ability to upload data to a computer, we built these functions into our client program (i-appli[11]) in order to realize smooth and seamless operation.

2.2 Learning by reflecting on one's own history

The user can take a look back on his or her meal history with comments, all of which are stored in the server, whenever desired. In addition to motivating users to continue recording their meals by photos and comments, looking back upon meal histories encourages a deeper self-cognition of eating habits and thus to self-improvement of them.

2.3 Learning by contrast with others' histories

In our system, the user can refer to others' eating histories. Through comparison, they can see what's missing from his or her diet.

Table 1: Learning design and related functions of our system

Learning design	Functions
Self-recognition	Meal records (photos, comments)
Learning by reflection	Referring to own history
Learning by contrast	Referring to others' histories
Knowledge acquisition	Quizzes and explanations
Motivation increase	Point-based game

2.4 Knowledge acquisition by quiz and explanation

Our system helps users learn about food and meals continuously in daily life through sets of quizzes and explanations three times in a day (morning, daytime and evening). Through

these activities, we expect that users will enrich their knowledge about food and meals. We believe this also motivates users to improve their eating habits.

2.5 Increase motivation by point-based game

Most of the learning activities we mentioned above can be done alone. In activities performed alone, however, the user tends to lose interest easily. We are anxious about this. In order to prevent a drop in interest, we have introduced a point-game system, in which all participants compete for points. These points, which are specified beforehand, are given for such activities as taking photos of meals, reading explanations and free comment descriptions, when these are done in a predetermined period. The points given for correct answers in quizzes fluctuate. We believe the point-game design contributes to increased motivation in daily learning activities.

3. Outline of our system

Our system consists of a client program that works on a cell phone (an i-appli program[9]) and a server program for processing and storing data (Figure 1).
The client program downloaded from the server runs on the user's cell phone. It includes required data for daily tasks, such as directions for the user, questions and answers, specified points and explanations (text and images). The results of the activities are recorded on the cell phone and then uploaded to the server for storage. The data directory is divided for every user. Not only does the user have access to his or her data, but other users do as well.
The server is also equipped with an administration function. The administrator can manage users and tasks using a specialized Web-based managing screen. Table 2 shows the development environment of our system. Java2SDK, i-appli Development Kit for DoJa, and Eclipse were used to develop the i-appli of a client. Perl was used to develop the server.

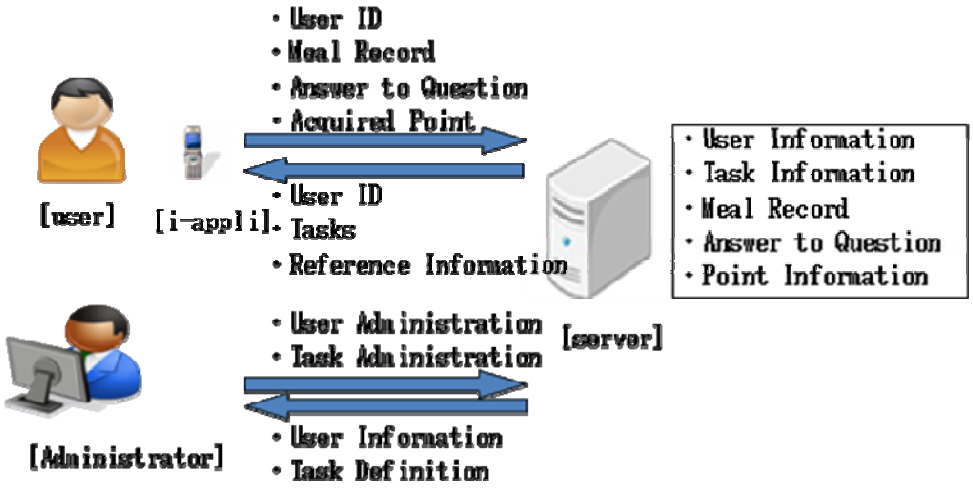

Figure 1: System outline

Table 2: Development environment

Development of i-appli	Windows XP Professional SP2 Java2SDK 1.4.2 i α ppli Development Kit for DoJa5.1 Eclipse3.3
Development of server	FreeBSD 5.4-RELEASE Perl 5.8.8

4. Client program (i-appli)

The client program (i-appli [11]) consists of three modules: a communication module, a task module, and a history module.

4.1 Communication module

The communication module controls communication between the client program and the server program, and between the client program and the scratchpad. The data transmitted and received include the user identifier, directions to the user, questions and answers, specified points and explanations (text and images).
The scratchpad saves the history of the questions, the answers and acquired points, etc. These data are useful and effective when the client program is terminated and started again. The user can immediately begin from the continuation at the terminated point.

4.2 Task module

The task module provides learning activities. They are a record of daily meals by a cell phone camera with comments, selection-type quizzes, free comment descriptions, and explanations of food and meals with text and images (Figure 2).
Nine tasks for one day are arranged in three rows of three lines on the screen. The image of a bird named Katti-kun, which is the official mascot of Saga University, is moved to choose a task. The first line includes tasks for morning, the second for daytime and the third for evening. The first row consists of the tasks of recording meals by a cell phone camera with comments. The second row is for quizzes (selection-type or free description-type) and the third is for explanations of food and meals. All tasks are associated with points.
All tasks except for selection-type quizzes have pre-determined points. In quizzes, if the user makes a mistake, a point is subtracted. The user can continue answering until he or she gives the correct answer. After every task, the user can read comments and confirm acquired points in the results display. We expect that this point-game system will help users stay motivated and interested in the activities.

Figure 2: An example of task selection

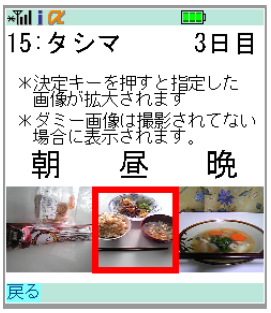

Figure 3:Examples of others' meals record reference

4.3 History module

The history module enables users to check and review not only their own activity histories but those of others as well. Contrasting one's own eating habits with other users' creates an opportunity to reevaluate those habits. Moreover, users can enjoy activities by watching other users' points being updated and by emulating each other. Figure 3 shows an example of a user checking other users' meal records.

5. Server program

In addition to communicating with the client program and managing data, the server program provides task administration and user administration functions.

5.1 Task administration function

The administrator can create new tasks and confirm or modify existing tasks. A task pattern, such as a meal record by a photo with a comment, a quiz, a free description or an explanation, is chosen from a pull- down menu to create a new task. An input form according to it is presented and a task can be created by inputting the necessary information there.

5.2 User administration function

In user administration, the administrator can watch the learning status of all users in real time. The administrator can also check more detailed records of the activities of specific users. In addition, the administrator can delete users and modify user information (user registration is performed at the request of a client).

6. Experiment

6.1 Outline of the experiment

Table 3 shows a schedule of the experiment. We conducted an evaluation of the developed system for seven days from December 15 through 21, 2009. Ten cell-phone SH905i were prepared for the experiment. Ten students (six males, four females) of Saga University participated in the experiment.

Table 3:Schedule of the experiment

Day	Experiment description
Day 1 (December 15, 2009)	● Operation instruction and practice ● Check of eating habits ● Pretest
Day 2-Day 6 (December 16-20, 2009)	● Food education with our system A) Meal record (breakfast lunch, dinner) B) Quiz or free comment（three per day） C) Bits of knowledge（three per day）
Day 7 (December 21, 2009)	● Posttest ● Questionnaire on system ● Questionnaire on food, meals and eating habits

One the first day, each participant was given a cell phone. The participants were instructed on how to operate the phone and practiced operating it. Furthermore, they checked their eating habits and pretested food and meals. From the second to sixth days, they performed the specified tasks every day. On the last (seventh) day, they took a posttest, which was exactly the same as the posttest and questionnaire for system operability, function and consciousness about food and meals.
These tests and questionnaires follow the Learning Materials on Eating Habits published by MEXT (Ministry of Education, Culture, Sports, Science and Technology)[12], The Well-balanced Diet Guide published by MAFF (Ministry of Agriculture, Forestry and Fisheries)[13] and the Dietary Reference Intakes for Japanese (2010 edition) published by MHLW (Ministry of Health, Labour and Welfare)[14].

6.2 Results and discussion

In comparing pretest and posttest scores, 9 of the 10 participants scored better in the posttest (Figure 4). The average percentage of correct answers improved by 15 points, from 72% to 87%. The tests asked users about the roles of nutrients and about their knowledge of food color groups and so on. The test consisted of 31 questions and a perfect score was 31 points. The average pretest and posttest scores were 22.4 and 27.0, respectively. After the pretest, the participants are not told their scores or the correct answers.
We investigated which items were improved from the pretest to the posttest. We found that users improved their scores on questions about food color groups. We believe that this improvement stems from the users learning about food and meals by using the cell phone system, specifically by acquiring information about nutrition, such as from receipts obtained from the dining room of a university co-op.

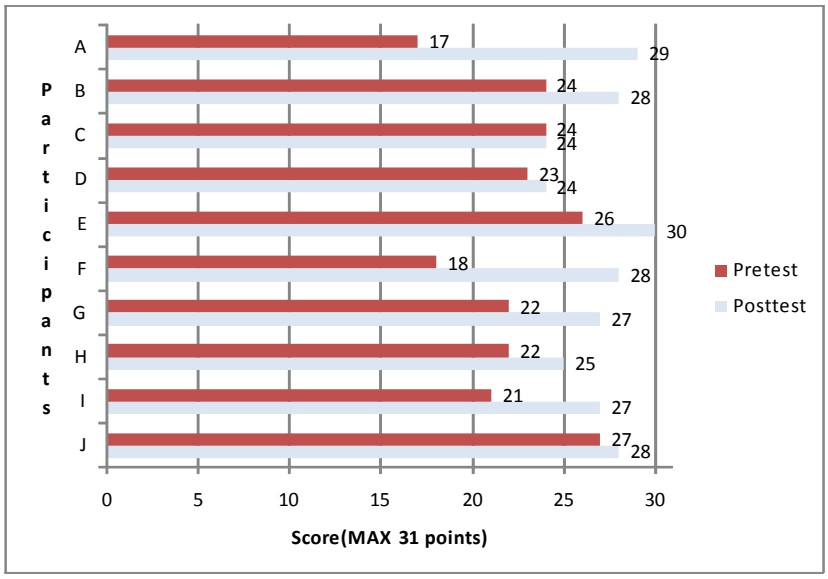

Figure 4: Comparison of scores between pretest and posttest

On the questionnaire about the operability of our system, the average score was 4.5 out of a total of 5(Figure 5). Although the operability of task selection and the history screen were evaluated slightly poorly, all the items received a score of 4 or higher. This is a result of our improvements to the interface design and implementation.

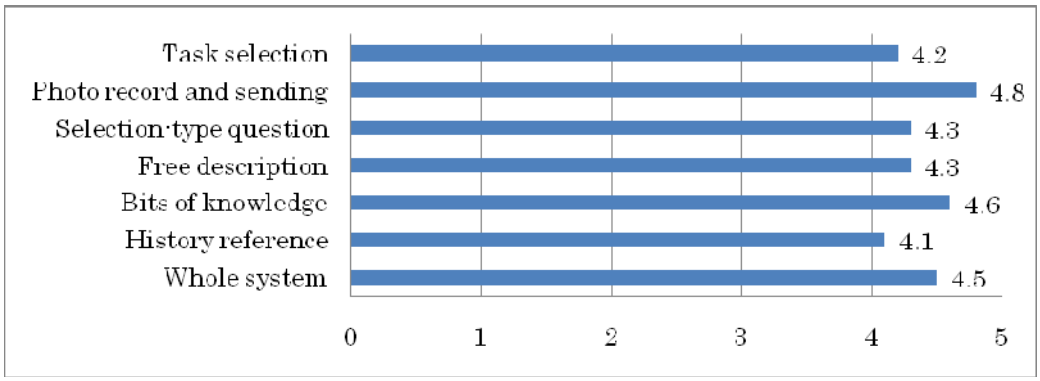

Figure 5: Evaluation results of operability on a five-point scale

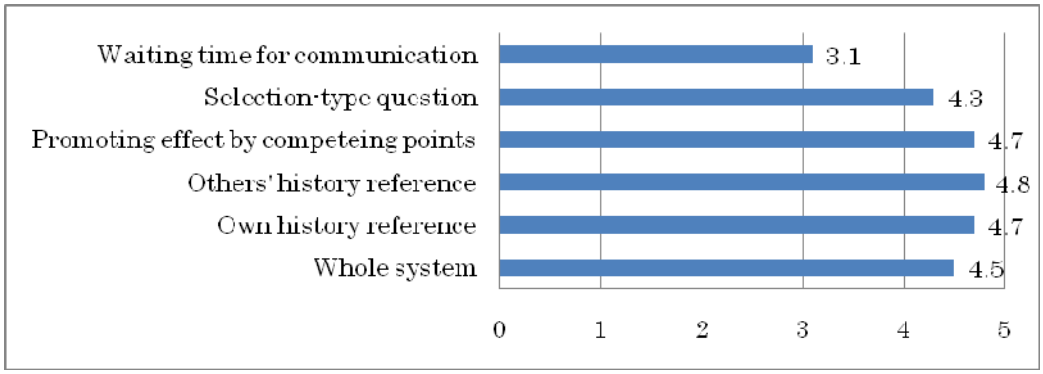

Figure 6: Evaluation results of functionality on a five-point scale

The results of the questionnaire confirmed changes in consciousness about food and meals. Some participants said, “I came to understand the necessity of balance in my daily meals.”, “My consciousness about diet changed after I saw photos of friends who had adopted a well-balanced diet.”, and so on. Through this experiment, many participants looked back upon their eating habits, noticed the importance of balance in their meals, and strove to improve their eating habits.

In the questionnaire about the function of our system, participants gave very high scores (4.5 out of 5) to the function of competing for points and to the function in which users could see their own histories as well as those of other participants(Figure 6).

Also from the results of the description-type questionnaire, we confirmed that motivation is increased by checking other users' information. These results demonstrate that the participants were motivated and enjoyed learning by competing for points. This is an effect of the game-based feature introduced in the system.

At the same time, issues were also found. One is forgetting to photograph meals. Another is the amount of time required to communicate with the server. There were some cases where communication was slow. The former issue can be solved with a sort of reminder function. The latter can be solved by optimizing the transmission and reception of data. The data processing algorithm in a server will be improved. The waiting time for communication will also be improved.

Furthermore, we received a request to add functions to the system, specifically the ability to attach comments to other users' histories for discussion rather than the mere ability to view those histories. We expect that such a function will increase mutual evaluation in addition to self-evaluation.

7. Summary and future works

In this paper, we have developed and evaluated a game-type food education system utilizing a cell phone camera. The system has five main features. (1) Users can recognize and be conscious of their own eating habits. (2) Users can acquire and enrich their knowledge of food and meals. (3) Users can reflect on and improve their eating habits by monitoring and recording their meals. (4) Users can reevaluate their eating habits by comparing those habits with others'. (5) These activities can be performed as a game, so that users enjoy learning.
Through the experiment, we have demonstrated that our system is helpful for food education. Nine of the 10 participants improved their scores on the basics of food and meals. The average percentage of correct answers improved by 15 points, from 72% to 87%. Changes in consciousness about food and meals were confirmed by the questionnaire. The results of the questionnaire about the operability and the functions of our system showed that the system was easy to use and helpful. Furthermore, we found that playing together with other members and competing against one another increase motivation to learn.
Adding a communication function between users for mutual evaluation and discussion, along with improvements in the data processing and administration functions in the server, remain as issues to be resolved. After such improvements are made, we will verify the usefulness and effectiveness of our system over periods of several months.

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