The purposes of this study were to examine the effectiveness of the gamification-based intervention on health behavior change. Participants were 53 Japanese undergraduate and graduate students, of whom 30 were allocated to the intervention group and 23 were allocated to the control group. In the intervention group, daily physical activity and dietary behavior were assessed using a mobile phone application called *The Way of Health*. The application includes various functions, such as recording daily steps and checking the accomplishment of health behavior challenges. The program was conducted for 100 days from May 2016 to August 2016. ANOVA results for daily steps per week revealed a significant increase in daily steps only in the intervention group. Similarly, concerning the results of ANOVA for the diet behavior score, the intervention group was shown to be significantly higher than the control group along with time. Descriptive statistics revealed that 92.8%, 89.3%, and 82.1% of participants “agreed” or “somewhat agreed” that the points, badges, and leaderboards, respectively, were useful. This study indicated the possibility that gamification could work well for promoting healthy behaviors. Elements of gamification might be recognized as a facilitating factor for participant engagement in an intervention for health behavior change.

**Keywords**: eHealth, information and communication technology, behavior change, smart phone, mobile phone

**Introduction**

Although physical activity and a healthy diet play an important role in preventing chronic diseases, such as coronary heart disease, diabetes, and cancer, few people worldwide achieve adequate levels of these health behaviors (WHO, 2010). In recent years, the application of gamification has shown high potential for promoting health behaviors (Alahäivälä and Oinas-Kukkonen, 2016). The term *gamification* is defined as “applying game mechanics and designs to non-game contexts.” Indeed, gamification has received attention as a means of supporting user engagement (Hamari, Koivisto, and Sarsa, 2014). While the use of gamification can be characterized as aiming for self-purposeful and hedonistic use, it can ultimately be used with an aim to accomplish extrinsic, valuable outcomes (e.g., academic achievement, service profitability, health behavior changes) external to the gamification system (Hamari and Koivisto, 2015). In fact, many companies have applied gamification components to their businesses. Furthermore, an increasing number of published papers reflect the growing interest and popularity of gamification in an academic context. In fact, the term *gamification* has been increasingly used in paper titles (Hamari, Koivisto, and Sarsa, 2014). A review of 24 studies (Hamari, Koivisto, and Sarsa, 2014) concluded that gamification can work positively, although the positive effects greatly depend on the context in which gamification is implemented.

In fact, gamification includes various elements, with points, badges, and leaderboards being recognized as the most basic elements for enhancing user motivation. Points indicate numerical units of a participant’s progress. A badge is a visual icon signifying achievement. And, a leaderboard is a display of ranking for comparison among participants. The effects of each element have been studied separately. Attali and Attali (2015) examined the influence of points on mathematics test performance by assessing accuracy and response speed according to point manipulation. The results indicated that point manipulation did not influence accuracy; however, the speed of response was found to have improved. For two years, Hamari (2015) investigated the effectiveness of using badges on the web marketplace (i.e., on a website that shared economy services among users). By applying the badge system, the amount of posted trade proposals, accepted transactions, posted comments, and general usage activity increased significantly. Finally, Landers et al. (2017) explored the effect of a leaderboard on performance in a brainstorming class. They concluded that the presence of a leaderboard successfully motivated participants to appropriate performance levels because the leaderboard could motivate participants as
well as setting an effective goal.

Moreover, some studies have explored the process and mechanism of gamification-promoting behavior modification (Hamari, Shernoff, Rowe, Coller, Asbell-Clarke, and Edwards, 2016; Lister, West, Cannon, Sax, and Brodegard, 2015). Lister et al. (2015) reviewed samples of 132 health- and fitness-related applications (apps) in an applications store to determine the impact of gamification elements on changes in health behavior. Regression analysis revealed a correlation between health gamification elements and three behavioral constructs (i.e., capacity, motivation, and opportunity for behavioral change). Their results indicated that gamification was more closely related to motivation, rather than to capacity and opportunity, for impacting behavioral change.

As mentioned above, some studies have confirmed the utility of gamification elements. However, almost all eHealth studies have been conducted using common commercial mobile apps (e.g., Fitocracy) for examining gamification effects on behavioral changes. For this reason, we required an evidence-based eHealth program for improving the ease of apps use, user engagement, and sustained use.

This study aimed to examine the effects of an original gamification-based program on health behavior changes.

Materials and Method

Participants. Participants were recruited from among students attending a Japanese national university in the Chugoku region via invitational posters displayed on campus for a month. Eligible participants were, enrolled in the university (or graduate school), possessed a smartphone, and were literate in Japanese. However, for the control group, it was not necessary to have a smartphone. Eligible participants included 30 Japanese undergraduate and graduate students (8 male and 22 female; average age ± SD was 21.0 ± 4.4 years). A control group comprising 23 students (17 male and 6 female; average age ± SD was 19.8 ± 1.8 years) enrolled in the same department of the university, received instructions to live as usual during the intervention period. Recruitment of the control group was voluntary and required each member’s consent. The control group completed some questionnaires and measured the number of their steps for one week before and after the intervention.

Program components. In the intervention group, daily physical activity and eating behavior were assessed using the “The Way of Health,” a mobile phone application based on the theoretical framework of gamification and social cognitive theory (Bandura, 1986). We used the Japanese version of this application. It was developed by the physical education and sports psychology laboratory at Yamaguchi University. The interface of the application is suitable for a touch panel and can also be operated easily from a smartphone. It includes various functions, for instance, (1) recording daily steps, (2) recording body weight, (3) checking health behavior challenge accomplishments, (4) integrating with a social networking service (SNS), (5) receiving information about physical activity and healthy eating, and (6) displaying badges onscreen. In addition, the application has gamification elements and three behavioral constructs (i.e., capacity, motivation, and opportunity for behavioral change). Their results indicated that gamification was more closely related to motivation, rather than to capacity and opportunity, for impacting behavioral change.

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Furthermore, we assessed the accomplishment rate of each health behavior challenge daily. The program usage rate was calculated by the number of recordings of daily steps for the program period (100 days) and the number of participants logging into the program page more than once a week.

We also measured participant program acceptance, which was divided into four categories: perceived ease of use (i.e., “It was easy to manipulate this program”), outcome expectancy (i.e., “I will be healthy if I continue using this program”), perceived usefulness (i.e., “This program was useful for my health”), and action self-efficacy (i.e., “I have the confidence to manipulate this program”), referring to Schwarzer’s (2016) model “Health Technology Adoption & Maintenance.” Participants selected options from disagree (1) to agree (5). For assessing the utility of gamification elements, we used a single item that asked whether gamification elements facilitated participant engagement in the program. Finally, we separately asked whether the three elements of points, badges, and leaderboards facilitated engagement in the program (e.g., “The point system facilitated my engagement in the program”). Participants selected answers from disagree (1) to agree (5).

**Statistical analysis.** For the outcome of program evaluation, a two-way analysis of variance (ANOVA) was employed to examine differences in both average daily steps and diet behavior scores by condition (intervention and control) and time (baseline, middle week, and last week). For the process evaluation, we estimated program acceptance using the percentages of perceived ease of use, outcome expectancy, perceived usefulness, and action self-efficacy concerning the program. Significance was set at 0.05. All statistical analyses were performed using SPSS 11.0J for Windows (SPSS, Tokyo, Japan).

**Ethical approval.** This research was approved by the Research Ethics Committee of the Faculty of Education at Yamaguchi University (No. 2016-001). We obtained informed consent from all participants both verbally and in writing. Participants were informed that personal data and responses would only be used for research purposes and kept confidential.

**Results**

**Daily steps.** ANOVA results for daily steps per week revealed a main effect of condition \[F(2,48) = 5.90, p < .05\] and an interaction between condition and time \[F(2,48) = 7.64, p < .01\] (Table 1). Furthermore, results showed a significant increase in the number of daily steps only in the intervention group.

**Diet behavior.** ANOVA results for the diet behavior score revealed a main effect of condition \[F(2,48) = 5.17, p < .05\], of time \[F(2,48) = 9.55, p < .001\], and an interaction between condition and time \[F(2,48) = 4.65, p < .01\] (Table 1). The score of intervention group increased significantly more over time than the score of control group.

**Health behavior challenge accomplishment.** The average number of health behavior challenges accomplished per day was 8.1 (SD = 2.8). Table 2 shows average accomplishment by participants per day. Challenges that many participants could accomplish were “I ate a vegetable” (84.5% of participants per day), “I ate by chewing thoroughly” (63.7%), and “I did not eat excessively” (63.0%). High rates of accomplishment in physical activity were “I walked with good posture” (57.1%), “I sat on a chair with good posture” (47.0%), and “I walked as much as possible while commuting” (41.8%).

**Table 1.** Mean and standard deviation (SD) of daily steps per week and diet behavior scores

|                | 1st week (baseline) | 8th week (middle) | 14th week (last) | condition \(F\) | time \(F\) | condition × time \(F\) |
|----------------|----------------------|-------------------|------------------|-----------------|-----------|----------------------|
| **Daily Steps** |                      |                   |                  |                 |           |                      |
| Intervention   | 6125.86 (2489.01)    | 7214.87 (2470.53) | 8668.30 (3425.37) | 5.90*           | 2.47     | 7.64**               |
| Control        | 6344.57 (1963.21)    | 6037.87 (2744.62) | 6180.80 (3445.27) |                 |           |                      |
| **Diet Behavior** |                    |                   |                  |                 |           |                      |
| Intervention   | 35.57 (6.39)         | 39.00 (6.90)      | 40.96 (8.20)     | 5.17*           | 9.55***  | 4.65*                |
| Control        | 33.96 (6.88)         | 33.72 (6.38)      | 35.13 (8.83)     |                 |           |                      |

\((\_\_\_) = SD\)  
* \(p < .05\), ** \(p < .01\), *** \(p < .001\)
Usage rate of the program. The average rate of recording daily steps during the program period (100 days) was 64.0 times (SD = 16.6) per participant. The highest rate was 92% while the lowest was 24%. Moreover, 12 of 30 users continued logging into the program page more than once during the last week.

Acceptance of the program. Table 3 presents results of positive responses concerning perceived ease of use, outcome expectancy, perceived usefulness, and action self-efficacy of the program. It shows that 78.6%, 78.5%, 92.9%, and 59.2% of participants, respectively, answered positively (sum of answers on “agree” and “agree a little”). Although positive answers to self-efficacy were almost 60%, almost all participants reported that they found this program to be useful for health promotion.

Utility of gamification elements. Regarding the usefulness of points, badges, and leaderboards, descriptive statistics revealed that participant ratios of positive answers (sum of answers on “agree” and “agree a little”) were 92.8%, 89.3%, and 82.1%, respectively (Table 4).

Discussion

This study aimed to assess the effect of gamification on the promotion of physical activity and healthy eating. Results indicate the possibility that elements of gamification can support user engagement in the program. The main result of this study was that participants in the gamification-based intervention group significantly increased their daily steps and healthy diet behavior scores in the middle and at the end of the program. In other words, gamification showed the potential to effectively promote health behaviors. A program using only some gamification elements (e.g., using only a point system; not using a point system) did not show obvious positive effects (Coombesa and Jonesa, 2016; Hanus and Fox, 2015). In the pres-

| Health behavior challenge items                                      | Accomplishments (%)* |
|---------------------------------------------------------------------|-----------------------|
| I ate a vegetable.                                                   | 84.5                  |
| I ate by chewing thoroughly.                                         | 63.7                  |
| I stretched.                                                        | 63.6                  |
| I did not eat excessively.                                           | 63.0                  |
| I walked with a good posture.                                        | 57.1                  |
| I sat on a chair with a good posture.                                | 48.0                  |
| I walked as much as possible while commuting.                        | 41.8                  |
| I did household chores.                                              | 39.8                  |
| I used the stairs instead of the escalator.                          | 38.1                  |
| I enjoyed a sport.                                                   | 37.2                  |
| I ate fruits.                                                        | 30.5                  |
| I omitted or decreased the source with a salad.                      | 29.7                  |
| I ate a fish.                                                        | 26.6                  |
| I stood and worked for a long time.                                  | 25.1                  |
| I walked to the place where I usually rode a bicycle.                | 24.2                  |
| I walked outside while taking my break.                              | 21.8                  |
| I parked my car in the farthest parking lot.                         | 20.8                  |
| I selected foods by first checking their calories.                   | 13.8                  |
| I walked to the stores.                                              | 12.8                  |
| I prepared equipment for exercise.                                   | 11.4                  |
| I enjoyed window shopping.                                           | 11.3                  |
| I chose low-fat or fat-free food.                                     | 9.7                   |
| I used a bicycle instead of a car for commuting.                     | 9.6                   |
| I bought new exercise equipment.                                     | 7.3                   |
| I removed the fat from the beef or pork.                             | 7.0                   |
| I take care of my child in the outdoors.                             | 5.1                   |
| I stood in the train or bus.                                         | 4.0                   |
| I walked outside with my pets.                                       | 0.3                   |

*Accomplishment = Average accomplishment; participant’s rate per day
ent study, however, applying all basic elements of gamification seems to have clearly provided a positive effect on promoting physical activity and healthy dieting behavior.

Moreover, the most popular healthy dieting challenges that participants completed during the program were eating a vegetable and a fruit and eating by chewing thoroughly. Similarly, the popular physical activity challenges were stretching, walking, and sitting with good posture. These results revealed that participants tended to select behaviors they could change instantly and easily, rather than those that needed some effort, such as “I walked to the place where I usually rode a bicycle.” In other words, recommending easy behavioral changes for health promotion seems more effective.

As a process evaluation, we examined the usage rate and acceptance of the program, and the utility of gamification elements. In the present study, the average percentage of users recording daily steps was 64.0%. During the last week of the program, 60.0% of users (18 of 30) logged into the program page more than once. Norman et al. (2007)\(^4\) indicated that the unclear effects of information and communications technology (ICT)-based inter-

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**Table 3.** Descriptive statistics of acceptance for gamification based program

|                  | n (28)* | %  |
|------------------|---------|----|
| **Perceived ease of use** (It was easy to manipulate this program.) | | |
| 1. Disagree      | 1       | 3.6 |
| 2. Disagree a little | 2     | 7.1 |
| 3. Neither agree nor disagree | 3     | 10.7 |
| 4. Agree a little | 12      | 42.9 |
| 5. Agree         | 10      | 35.7 |
| **Outcome expectancy** (I believe that I remain healthy if I keep using this program.) | | |
| 1. Disagree      | 0       | 0.0 |
| 2. Disagree a little | 3     | 10.7 |
| 3. Neither agree nor disagree | 3     | 10.7 |
| 4. Agree a little | 13      | 46.4 |
| 5. Agree         | 9       | 32.1 |
| **Perceived usefulness** (This program was useful for your health.) | | |
| 1. Disagree      | 0       | 0.0 |
| 2. Disagree a little | 1     | 3.6 |
| 3. Neither agree nor disagree | 1     | 3.6 |
| 4. Agree a little | 12      | 42.9 |
| 5. Agree         | 14      | 50.0 |
| **Action self-efficacy** (I have the confidence to manipulate this program.) | | |
| 1. Disagree      | 1       | 3.7 |
| 2. Disagree a little | 4     | 14.8 |
| 3. Neither agree nor disagree | 6     | 22.2 |
| 4. Agree a little | 7       | 25.9 |
| 5. Agree         | 9       | 33.3 |
| **Intention** (I want to keep using this program.) | | |
| 1. Disagree      | 1       | 3.6 |
| 2. Disagree a little | 1     | 3.6 |
| 3. Neither agree nor disagree | 3     | 10.7 |
| 4. Agree a little | 5       | 17.9 |
| 5. Agree         | 18      | 64.3 |

*Two cases are missing data.*
Effects of gamification-based intervention for promoting health behaviors

Voluntarily, with high motivation, and this could bias the results. Also, the sample was limited to just one university. In further research, we need to collect data from other populations. Furthermore, in this study, there was a difference in the ratio of characteristics (i.e., gender and age) among the participants between the intervention group and the control group. It would be better to equalize the ratio of these characteristics by increasing the number of participants in the future.

Conclusion

Overall, this study revealed partially that the gamification-based program effectively promoted physical activity and healthy eating. Elements of gamification (points, badges, and leaderboards) might be recognized as being facilitating factors for participant engagement in the program. In addition, almost all participants positively accepted the program, especially with respect to its ease of use, usefulness, outcome expectancy, and self-efficacy. Even though the study had several limitations, its findings could potentially contribute to future health promotion study. In future research, we should apply this gamification-based program to elderly people who have a greater need for health promotion. Gamification concepts are likely to be more familiar to younger, rather than elderly, people and that ease of use of gamification declines with age. However, elderly people could more easily use a gamification-based program with a simplified system (e.g., easy user interface, simple point manipulation, de-

| Table 4. Descriptive statistics on the utility of gamification elements |
|---------------------------------|-----|-----|
|                                | n  | %  |
| **Point** (The point system facilitates my engagement with the program.) |
| 1. Disagree                     | 1  | 3.6 |
| 2. Disagree a little            | 0  | 0.0 |
| 3. Neither agree nor disagree   | 1  | 3.6 |
| 4. Agree a little               | 9  | 32.1|
| 5. Agree                        | 17 | 60.7|
| **Badge** (The badge system facilitates my engagement with the program.) |
| 1. Disagree                     | 1  | 3.6 |
| 2. Disagree a little            | 0  | 0.0 |
| 3. Neither agree nor disagree   | 2  | 7.1 |
| 4. Agree a little               | 6  | 21.4|
| 5. Agree                        | 19 | 67.9|
| **Leaderboard** (The leaderboard system facilitates my engagement with the program.) |
| 1. Disagree                     | 0  | 0.0 |
| 2. Disagree a little            | 1  | 3.6 |
| 3. Neither agree nor disagree   | 4  | 14.3|
| 4. Agree a little               | 9  | 32.1|
| 5. Agree                        | 14 | 50.0|

*Two cases are missing data.
increased competitive factor). In summary, gamification has the potential to be an innovative method for promoting health behavior changes.

Conflict of Interests

The authors declare that they have no conflict of interests.

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