LEARNING DAILY CALORIE INTAKE STANDARD USING A MOBILE GAME

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ABSTRACT

Mobile games can contribute to learning at greater success. In this paper, we have developed and evaluated a novel educational game, named FoodCalorie, to learn food calorie intake standard. Our game is aimed to learn calorie values of various traditional Bangladeshi foods and the calorie intake standard that varies with age and gender. Our study conforms the finding of existing studies that game-based learning can enhance the learning experience.

Keywords Food game · Calorie intake standard · Healthy meal · Game-based learning · Women in Bangladesh · Mobile learning

1 Introduction

Food is one of the basic needs of humans. For a healthy life, balanced food is necessary. Proper calorie intake can positively contribute to energy and well-being. Most people have no idea about the nutritional values of food, particularly the calories contained in each food. They either rely on ravishing food items without knowing what harm is caused, unconsciously leading themselves to fatal diseases, or they are simply deprived of proper nutrition [1, 2, 3]. Improper nutrition can lead to health problems (e.g., obesity, malnutrition) caused by being overweight or underweight. A recent survey indicates that being obese or overweight may cause a devastating effect on health [4]. Carrying excess fat leads to significant health hazards such as heart disease, stroke, and type 2 diabetes. It can also cause musculoskeletal issues such as osteoarthritis and some cancers, which might lead to undeniable impairment or even death. Malnutrition is a major cause of death in children and women. In addition to causing individual tragedies like maternal and child mortality, malnutrition results in excessive costs within the health care system through excess morbidity, increased premature delivery, and elevated risks of heart disease and diabetes [5]. School-age children who suffered from early
childhood malnutrition have generally been found to have lower IQ levels, deficient cognitive functions, below average educational achievements, and greater behavioral problems [6].

The global number of moderately or severely underweight girls and boys was 75 million and 117 million respectively in 2016. If post-2000 trends continue, the levels of child and adolescent obesity will surpass those for moderately and severely underweight youth from the same age group by 2022 [7].

A study, conducted by the Imperial College London and the World Health Organization (WHO), stated that Bangladesh is facing the “dual burden” of both malnutrition and obesity [8]. According to a study, between 1975 and 2016, the weight problems (malnutrition and obesity) among boys in Bangladesh increased from 0.03% to 3%. Among girls, the rate increased from almost zero to 2.3% [9].

The prevalence of obesity increased from 2.7% to 8.9% among women [10]. Childhood obesity is a particular public health concern for Bangladesh because children who are overweight or obese have a higher risk of becoming overweight or obese adults [11][12] and overweight adults are at increased risk for mortality and morbidity with obesity-associated chronic diseases, which are already a burden to the struggling health system in Bangladesh [13][14].

At the same time, Bangladesh has the highest rate of malnutrition in the world. As per the Food and Agriculture Organization of the United Nations (FAO), among preschool-age children, a ratio of 54% is stunted (which is greater than 9.5 million), whereas 56% are underweight and more than 17% are wasted further [15]. Almost half of Bangladeshi women suffer from chronic energy deficiency for a long run and research suggests that little improvement has been made in woman’s dietary conditions over the past twenty years. Proper knowledge of the food values is essential for living a healthy life.

In Bangladesh, women hold the responsibility of cooking [16][17][18][19][20][21]. They must be given proper knowledge of calories and nutrition in each food item. Only then they can ensure a nutritious and balanced meal for each family member considering their age, gender, and activity. However, the traditional teaching approach is not fruitful since it’s notoriously monotonous. A new technique needs to be introduced to overcome this challenging problem.

In this paper, we have developed a game in which player will learn food calorie values. Specifically, we have designed our game, named “FoodCalorie”, for mobile phones and conducted an empirical study with 20 participants (Bangladeshi women) over two months period. Through pre- and post-intervention surveys, we studied how participants were acquired knowledge by playing the game. We have designed the game focusing on learning daily calorie intake standard for both male and female in different age, and calorie value of food items. Game has multiple levels, and in each level, a player is asked to choose food items for breakfast, lunch and dinner for a person with a specific age and gender. Food item and amount must be chosen according to age and gender. After the completion of each level, a reward is given. Thus, a player can learn calorie values of different food items, healthy meals for breakfast, lunch and dinner, and daily calorie intake standard for both male and female of different ages by playing our “FoodCalorie” game.

In particular, in this paper we have made the following three major contributions.

- We have developed a mobile game to learn calorie intake standard. Our game is aimed to learn calorie values of various traditional foods of Bangladesh and the calorie intake standard that varies with age and gender.
- We have proposed and evaluated our novel approach: learning food value by game-based learning.

The remaining part of the paper is organized as follows. A comparative analysis of relevant research is discussed in ‘Related Work’ section. ‘Food Calorie Game’ section presents game architecture, interface and play rules. finally, the last section concludes the paper and outlines the future work.

2 Related Work

Game-based learning (GBL) refers to the use of miscellaneous types of games such as digital or non-digital games, simulations, and electronic games (e-games). It has one or more specific learning objectives along with teaching & educational purposes [22][23][24][25][26].

Game-based learning has the ability to stimulate engagement, learning attitudes, and communication skills [27][28][29]. Additionally, it enriches the capability of understanding some critical concepts [30]. There are several studies which have proven success of game-based learning in primary, secondary and post- secondary education [31][32][33][34][35][36][37][38][39][40].

Games can develop healthy habits as demonstrated by one study [39]. Video games have shown useful for health and physical education [38]. Griffiths et al. surveyed several edutainment games for health and argued that video games can enrich the participants’ knowledge about food and influence them to lead a healthy life [40].
A game called “Squire’s Quest!” was developed as part of a study [41]. The study showed that games can enhance the fruit, juice, and vegetable intake of children.

The games discussed above were aimed at teaching different groups of people about healthy foods and nutrition values for different kinds of food. None of the above-mentioned games has considered food items with specific unit of measurement. Most importantly, none of the above aims to educate daily calorie intake standard of a person with different ages and gender. Compared to the above research, in our game, we consider food items that are appropriate to the specific meal such as breakfast, lunch, and dinner. We have also considered daily calorie intake standard for individual person considering age and gender. We are the first to study this game-based learning in Bangladesh.

3 FoodCalorie Game

In this section, we will discuss our game architecture and interface in detail, including ratings and rules for achieving each level of the game.

3.1 Game Architecture

Figure 1 shows the game architecture. Our game uses Google Firebase where food and calorie information is stored. Thus, an internet connection is required for playing our game. When the game is installed for the first time, a Login ID is generated by the Firebase, which is stored in the user’s mobile phone for automatic login on future game play. When a user opens the game, the stored Login ID is used to authenticate the user in the Firebase and retrieve game data to display on the game application interface.

Figure 1: Architecture of our FoodCalorie game

3.2 Game Interface

At the very beginning, the home screen will be shown (Figure 3). This screen shows the user the following options: Play – start to play the game; How To Play – short demo video on playing this game; Profile – total number of levels with how many levels tried and passed; About – information related to the creation of the game; and Quit – to exit the game (see screenshot Figure 2).

A person’s daily calorie intake requirements vary by gender and age. It also has a strong relationship with physical activity. For instance, a sedentary person usually requires fewer calories than a moderately active person does [42]. In our game, we have used the average calorie value of sedentary and moderately active levels (assuming that the person does some physical activities). For calorie calculation, we have used data from a reputable health website [43].

1 https://firebase.google.com/
In this game, users are required to select food that provides appropriate calorie intake for a person with a particular gender and age. Our game has 96 levels (each level is for a particular age) starting from 3 years to 99 years. We did not consider 1- and 2-year-old children as they have special meal requirements. Figure 4 shows the level screen of our game. At each level, foods need to be chosen for a person at a particular age. The meals are planned as – breakfast, lunch, and dinner. The meals are planned as – breakfast, lunch, and dinner. There are six individual identical windows on each level. The first three windows are for male breakfast, lunch, and dinner and the next three are for female of a particular age.

We have included seventy-two food items in this game that are classified into seven types. Eight items are rice (e.g., plain rice, biriyani, khichuri, etc.); five items are bread (e.g., roti, slice bread, naan, etc.); thirty-two items are curry (e.g., meat curry, fish curry, vegetable fry, etc.); eleven items are fruit (e.g., pineapple, jack fruit, mango, etc.); six items are dessert (e.g., kheer, pudding, halwa, etc.); four items are dairy (e.g., eggs and milk); and six items are classified as other (including fast-food, e.g., burger, haleem, etc.). In our game window, the user needs to select three food items out of six given items chosen randomly from 72 food items.
Every country has its own tradition of food. In Bangladesh, rice and bread are considered the main food staples for breakfast, lunch, and dinner. Thus, we have designed our food selection pool in such a way that there are always two items from rice and bread types. The remaining four items will be chosen randomly from the other five assortments.

### 3.3 Rating and Level Passing Rules

A level comprises six selection windows where a user selects breakfast, lunch, and dinner for a male and female. At the end of each level, a summary result is shown (Figure 5).

![Figure 5: Window for showing the result](image)

Based on the *acquired calories* (corresponding to the selected meals) for male or female we award zero, one, two, or three stars to the game player as shown below:

- If the \( \text{selected calorie} \leq \text{required calorie} + 5 \) and \( \text{selected calorie} \geq \text{required calorie} - 5 \), then the player will get 3 stars.
- If the \( \text{selected calorie} \leq \text{required calorie} + 10 \) and \( \text{selected calorie} \geq \text{required calorie} - 10 \), then the player will get 2 stars.
• If the selected calorie ≤ required calorie+20 and selected calorie ≥ required calorie−20, then the player will get 1 star.
• otherwise no star will be awarded

4 Conclusion and future work

In this paper, we have developed and evaluated a game for learning calorie intake standard. We have conducted an empirical study to investigate how this game can enhance food calorie knowledge of the players, in particular, women in Bangladesh. The results of our empirical study show that the calorie intake knowledge of all participants improved above 85% by playing our game. The t-test result of our study shows that the knowledge enhancement of participants (with p value << 0.001) was significant. The game also enhanced the conceptual understanding of all participants above 91%. 94% of participants found this game is useful for learning healthy food habits. 95% of participants have rated our game 4 stars and above. We have also found that participants who are a doctor in the profession have achieved higher learning experience compared to other professions and the participants with the highest smartphone proficiency level have a higher progression rate.

As future work, our aim is to run a longitudinal study to investigate how this game can gradually encourages players/women to make better food choices for their family. Besides, we will explore how this game change the eating habits of individual players over the time.

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Author Anik Das and author Sumaiya Amin have contributed equally to this paper. All the authors have agreed to acknowledge this information.

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