

# NUDGE - NUtritional, Digital Games in Enable

**Hanna Schäfer**  
hanna.schaefer@tum.de

**David A. Plecher**  
plecher@in.tum.de

**Sophie L. Holzmann**  
sophie.holzmann@tum.de

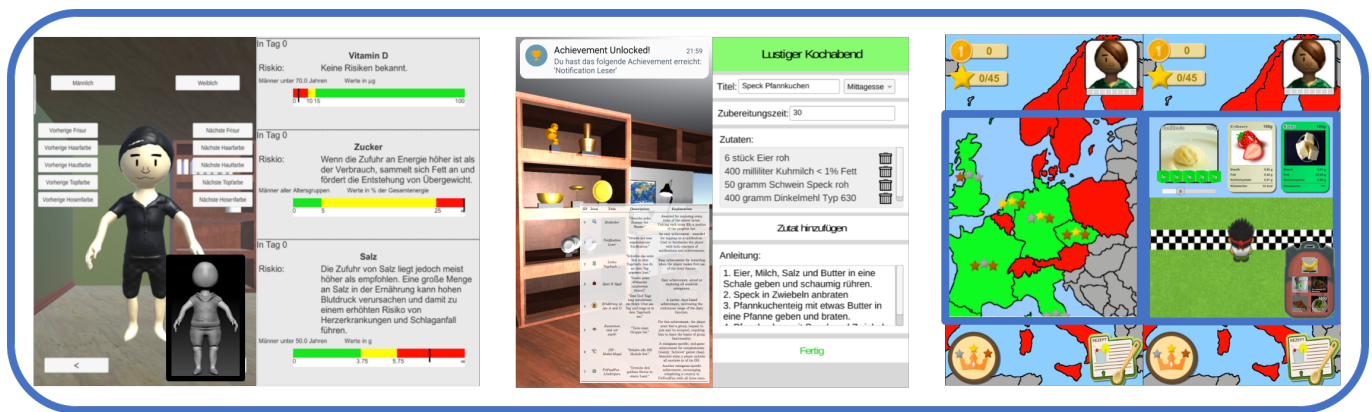
**Georg Groh**  
grohg@in.tum.de

**Gudrun Klinker**  
klinker@in.tum.de

**Christina Holzapfel**  
christina.holzapfel@tum.de

**Hans Hauner**  
hans.hauner@tum.de

**Technical University of  
Munich  
Germany**



**Figure 1. Teaser figure of the NUDGE platform. Left: Central avatar element and the nutritional feedback screen. Middle: Motivational nudges and social cooking events. Right: Preview of the serious game prototype "Fit, Food, Fun".**

## ABSTRACT

The digital games platform NUDGE (NUtritional, Digital Games in Enable) is one of the digital nutritional communication systems within the nutrition research cluster enable. NUDGE aims at changing the nutritional behavior of adolescents using different levels of persuasion. The central platform element is a personalized avatar representing the user's nutrition and game status as playful feedback. Additionally, real world interactions are integrated using tailored nudges, social connections, and real life challenges. Finally, different serious games, e.g. the "Fit, Food, Fun" prototype, are used to increase the user's knowledge and capabilities regarding nutrition. The NUDGE platform is going to be evaluated in a pilot study in spring 2018.

## Author Keywords

Nutrition; Health; Adolescents; Gamification; Serious Games; Persuasion; Personalization; enable-Cluster;

## INTRODUCTION

Overweight and obesity, especially in the younger population, are major health concerns worldwide (WHO, [34]). According to a European statistic more than 60% of children that are affected by overweight before puberty will maintain weight in young adulthood (WHO, [33]).

The interdisciplinary enable-cluster is one of four clusters about nutrition research funded by the German Federal Ministry of Education and Research (BMBF) [14]. In one of its core projects, enable investigates digital communication strategies to improve nutrition behavior. As a result, the NUDGE system is designed as an educative and preventive tool for adolescents to impart nutritional knowledge in a playful and motivational setting. To reach this goal, it promotes health-related outcomes using serious games [1] and different persuasive elements [27].

Besides the imparting of nutritional knowledge, NUDGE tries to accompany its users by creating positive feedback loops using both automated and real world input to ensure the users feel comfortable with their behavioral changes.

## PREVIOUS WORK ON HEALTH GAMES

There have been several studies on different types of games for health and fitness. [3] reviewed 25 video games and found that they were split into different outcomes such as knowledge increase and changes in attitude and behavior. Since NUDGE wants to encompass a holistic approach the following six well cited serious games were reviewed regarding their persuasive strategies and health-related goals.

One of the first digital nutritional games, 'Packy & Marlon', was designed for children and adolescents with diabetes [8]. The playing children had to manage the blood glucose levels of two elephants with diabetes by choosing adequate food and insulin quantities. A six-month randomized controlled trial (n=59; age=8-16 years) showed that after playing the user's knowledge about diabetes increased, while the amount of urgent hospital visits decreased.

The game 'HungryRedPlanet' [2] (age=10-15 years) used a similar approach for healthy adolescents by utilizing the USDA (U.S. Department of Agriculture) Pyramid Guide for a healthy and balanced nutrition. Similar to the game 'Packy & Marlon', the goal of this game is to manage adequate food quantities to win the game and stop earth's starvation.

The two serious games 'Escape from Diab' (2010) [32] (age=10-12 years) and 'PLAY, MATE!' (2010) [4] (n=180; age=9-12 years) focused on persuasion and behavior change in addition to the knowledge transfer. The study of [4] showed that games and persuasive elements could increase the physical activity without disturbing the enjoyment of players.

More health games are starting to integrate different persuasive concepts to address different target groups. For example, the National Mindless Eating Challenge (NMEC) [19] (n=2053; age=39,8 years in average) integrated comparisons, customization, rewards, personalization and suggestions. Finally, the game 'Move2Play' [5] (n=12; age=12-13 years) provides a setup for physical activity similar to the one NUDGE is implementing for nutrition. They integrated monitoring, goal-setting, a social component, achievements, rewards, and an avatar component. Their small study showed, that the children were able to understand all different components of the setup and enjoyed the customizing of the avatar and the social components.

## CONCEPTS OF GAMES FOR HEALTH

In addition to the games review, different theoretical approaches influenced the design of the NUDGE platform. The concept of serious gaming was applied to derive mini-games for nutritional knowledge and skill transfer. The theory of persuasive gaming was used to develop the interaction of the platform such as the avatar and the notification system. The concept of positive gaming was applied to furthermore improve the user's wellbeing during his behavior change.

### Serious Gaming

Gamification as a preventive tool for promoting health-related behaviors often lacks in efficacy. It mainly transfers game elements such as points or leaderboards to a non-gaming content [12]. In contrast to gamification, serious games offer the possibility for an active exploration of serious intellectual problems [1]. For example, a gamification approach would

be to give the user achievements, when he fills his nutritional diary. A serious game however would incorporate the nutritional knowledge and offer activities, that will transfer that knowledge actively to the user. At the same time the gaming character is stimulating the user's intrinsic motivation to play and to learn [36]. The primary purpose of a serious game is to transfer knowledge in a playful gaming context [11]. The NUDGE platform uses the concepts of serious gaming and motivational stimulation in different nutritional mini-games.

### Persuasive Gaming

Persuasive strategies are application components that are designed to influence the user's behavior or attitude towards a predefined goal [16]. [27] defined a framework with 28 different persuasive strategies. [35] reviewed the implementation of those different strategies in 44 papers from different domains. For the health domain, they came up with the following ten most used strategies: feedback, self-monitoring, suggestion, social role, simulation, tailoring, tunneling, reminders, reduction, and reward.

There are drawbacks to some of these strategies regarding their applicability to all user groups. Some strategies only work for specific selection of personality types. [28] and [20] describe how using generic persuasive strategies might even reverse the motivational effect for specific personality types. However, strategies such as competition, comparison, self-monitoring and suggestion seem to be effective on most personality types [30]. The NUDGE platform uses the concepts of feedback, self-monitoring, social role, simulation, tailoring, reminders, rewards and personalization.

### Positive Gaming

The concept of positive computing was defined by Calvo and Peters (2014) [9] and includes three different design approaches. The preventative design methodology excludes any negative influence of the systems towards the user, while the active design methodology tries to integrate elements, that specifically use positive influence on the user. Finally, the dedicated design approach focuses on applications that have wellbeing as their primary goal. To implement those design strategies [9] also suggest different factors such as positive emotions, motivation, self-awareness, and empathy that can be utilized when building positive applications. The NUDGE platform uses the concepts of preventative and active design using different intra- and interpersonal factors such as social components and a quantified-self avatar.

## PRELIMINARY WORK

The target group of the NUDGE platform are adolescents aged from 14 to 17 years. In preparation of the nutritional game design a survey was conducted. The aim was to describe needs, wishes and motives of German adolescents regarding nutritional and digital games, in order to design a target group-specific serious game fostering an improved nutrition. Literature [13][15] indicates that nutrition information in adolescents is deficient and needs to be promoted. In 2010, the nutrition report of the German Nutrition Society (DGE) revealed that only about 50% of adolescents are adequately informed about nutrition [13]. The questionnaire was developed

through an interdisciplinary team of nutritionists and computer scientists. Socio-demographic and anthropometric data were obtained as well. The 43-item questionnaire has been carried out in the form of hard-copy and could be completed in 15 to 20 minutes. In total, 339 adolescents aged from 13 to 18 years (46% female), participated in the survey, which has been conducted in six general secondary schools of the city and administrative district of Rosenheim between June 2016 and June 2017. The survey revealed that the nutritional knowledge in German adolescents is deficient. At same time, most adolescents play digital games and desire nutrition information in digital games. Results are in line with findings of another survey (2016) [15]. According to this survey two third of the 12 to 19 years old participants play digital games daily or several times a week. Taken together, a serious nutritional game seems to be a potential educative and preventive tool to impart nutritional knowledge in order to promote a healthy lifestyle in adolescents.

## SYSTEM DESIGN

The NUDGE platform is built as a system connecting multiple intervention bricks. The core of the platform is a digital avatar. It represents the health state of the user based on a digital nutrition diary. The body composition of the avatar reflects weight gain and loss. In addition to the physically adaption, the avatar also expresses moods such as hungry, lonely or excited. These moods should motivate the user to perform specific platform actions such as filling his nutrition diary, interacting with groups, or playing serious games. The avatar can enter different serious mini-games such as the game prototype "Fit, Food, Fun", which focuses on macro-nutrients and energy content of food. Other platform games address physical activity or micro-nutrient effects. Additionally, the user is motivated by a social network and real life challenges, such as group cooking events. He receives nudges about progress events and social comparisons. The following components try to include the before mentioned persuasive or positive strategies.

### Avatar as Central Platform Element

Within the avatar different persuasion concepts are combined. First, the avatar can be adapted to the user's appearance using different hair, clothing and color schemes. The designs were specifically chosen to create an emotional connection. This design should increase the caretaking motivation between the users and the avatar using a schema of childlike characteristics [17]. At the same time the avatar visualizes the nutrition status of the user based on a dietary record. If the user eats healthy for more than three days, the avatars bodyweight will decrease and new clothing designs will be available. To prevent weight gain from causing negative psychological effects, the body sizes are limited to 5 stages and were carefully selected in a way that positively depicts even the heavier avatar versions. Besides this visual feedback, the user can also experiment with nutritional effects using a fast forward scenario. This scenario shows the nutrient contents and their implications, in the given future dietary situation [25]. Both approaches utilize the self-quantification and simulation strategies of the persuasive system design. Regarding positive computing the avatar should externalize the user's emotions concerning his

healthy/unhealthy behavior and thus ease negative feedback given by the system, while still giving motivation through positive feedback. Finally, the avatar serves as a bus between the different serious games. For example, the avatar spends energy by playing the serious mini-games to limit the screen time for the participating adolescents. While the user's nutrition based on the dietary record affects the avatars' body composition, the user's real life physical activity measured by Google Fit API impacts the avatar's energy level [24]. This physical activity is used to increase the avatar's energy and thus represents another real-life connection. Further avatar characteristics, such as the current nutrient level will be integrated in future serious games e.g. by decreasing visibility or slowing movement. Besides the simulation state of the avatar regarding real life values such as nutrition and activity, the avatar also shows the platform status. For example, the avatar will show hunger, if the user has not updated the diary, and it will be excited, if the user has not played any games in a certain time frame. This status feedback serves as a nudge based on the user's motivation through self-competition [10].

### Social and Motivational Elements

Since the NUDGE platform tries to encompass real-life behavior change, the virtual avatar and serious games components might not be sufficient to guide the users in their transition. Additional persuasive and positive elements that were incorporated are personality dependent nudges, social support groups and real-life challenges.

According to [29] 6 of the 21 reviewed persuasive games for nutrition include a social support strategy. In the NUDGE platform, social support is given by groups of 5-10 people, that share challenges, a leaderboard and access to social games, such as the ISS space game. In case of missing social contacts with similar problems, the system will recommend groups based on age, location, gender and BMI. The group system including the group size, group management and leaderboard was evaluated in a small focus group with five participants and a usability test with five further participants was conducted as well [23]. Both evaluation methods revealed a positive feedback on the general approaches, while the game design and usability were still criticized.

It has been shown that tailoring nudges and personalizing achievements can strongly increase the motivational effect [28]. Our personality dependent nudges are based on seven gamer types identified by the BrainHex model [26] and the Big Five personality types [18]. Those types are used to select the type of nudges users receive. For example, someone who is a seeker in the BrainHex model, would receive praise nudges on diary entries, physical activity or weight loss. In addition to event nudges, there are achievement nudges such as playing all games, or regularly filling the dietary diary.

The real-life group challenges are integrated in the form of social cooking events. This kind of challenge solves multiple issues of real-life challenges. First, it validates the user's action by the social feedback. Secondly, it offers social motivation for the user to win the challenge. Finally, it opens a platform for exchange about the received nutritional knowledge and other platform elements. These real-life group events were evaluated in a small user study [23] with nine participants,

that conducted six different group cooking events within two weeks. The study showed, that young people are interested in such events. The most effective motivational elements are the leaderboard list, showing the best cooking event/host of each group, the motto (e.g. Blue Titanic Dinner), giving each cooking event a creative aspect, and the ingredient challenges, telling the host to e.g. involve salmon in his dinner.

### "Fit, Food, Fun" as a Serious Game

The NUDGE platform combines different serious games such as an ISS space game or a role-play exergame. This chapter exemplarily describes one of the serious game prototypes called "Fit, Food, Fun" [37]. This game concentrates on improving the nutritional knowledge and on strengthening skills in using that knowledge to change dietary behavior. The knowledge transfer is embedded in a journey through Europe. In every country the user has to succeed in three minigames:

The *Card Game* offers the player two different cards with a sort of food each. The challenge is to find the card with the highest or lowest value in a certain category like carbs, fats, proteins and calories.

In the *Estimation Game* the user has to guess the amount of sugar or fat (displayed as cubes of sugar and drops of fat) that is contained in a specific type of food.

In the *Backpack Game* the player must fill a backpack with food which should supply enough energy for a certain activity like swimming or running. Without enough energy, the player won't make it to the finish line. Choosing too much energy slows down the player resulting in a lower score.

The first two games impart knowledge about the nutrients of food whereas in the third game the user learns about the equivalence between physical activity and these nutrients.

In addition to the link of nutritional knowledge and gaming strategies, this serious game also integrates different educational concepts [6]. For example, the transition between countries as well as the transition within the mini-games of one country were designed along the AVIVA [31] model for teaching. Additionally, the game elements have been checked against the ARCS model [21] and redefined to cover at least one of the four motivational design elements. For example, the different country levels were restructured into a travel route through Europe and complemented with information about each region to increase the curiosity of players.

### CONCLUSION AND FUTURE WORK

The NUDGE platform is research project in progress. It tries to encompass a holistic set of persuasive and positive measures into a serious game platform for health. While the major design and implementation steps are concluded, each component still needs to be improved through small focus group interviews. Also, the results of the preliminary survey will be included until the final evaluation. The final NUDGE platform is going to be evaluated in a pilot study in spring 2018. Different outcomes like nutrition knowledge and motivation will be assessed using appropriate questionnaires. To compare the characteristics of participants, the Big Five types [18] and the BrainHex gamer types [26] will be derived. Additionally, phenotypic data (gender, age, body weight, body height, hip and

waist circumferences) will be obtained. The study outcome will be assessed with different validated questionnaires such as the User Experience Questionnaire [22] and the System Usability Scale [7]. Additionally, a domain specific survey will be used to evaluate the knowledge and skill gain in nutrition. Finally, motivational questionnaires will be used pre and post study to show any changes in the users attitude. We expected the pilot study to show how knowledge gain and behavior change can be increased through persuasive and positive game elements. Furthermore, we want to show that the users feel safe and motivated during their behavioral transition due to the social and motivational platform framework.

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