Evaluation of a Serious Game promoting Nutrition and Food Literacy: Experiment Design and Preliminary Results

Konstantinos Mitsis
School of Electrical and Computer Engineering
National Technichal University of Athens
Athens, Greece
kmhtshs@biosim.ntua.gr

Konstantia Zarkogianni
School of Electrical and Computer Engineering
National Technichal University of Athens
Athens, Greece
kzarkogianni@biosim.ntua.gr

Kalliopi Dalakleidi
School of Electrical and Computer Engineering
National Technichal University of Athens
Athens, Greece
kdalakleidi@biosim.ntua.gr

George Mourkousis
Biomedical Simulations and Imaging Lab.,
National Technical University of Athens
Athens, Greece
mourkousis@gmail.com

Konstantina S. Nikita
School of Electrical and Computer Engineering
National Technichal University of Athens
Athens, Greece
knikita@ece.ntua.gr

Abstract— In this paper, preliminary results of the evaluation of a serious game promoting nutrition literacy (NL) and food literacy (FL) are presented. The serious game's effectiveness was evaluated in terms of educational value and user experience through a two-part evaluation strategy. In the first part, a quasi-experimental study was designed to assess the serious game's educational value compared to an alternative intervention based on the study of text-based material. Appropriate questionnaires were delivered prior to, immediately after, and one week after the intervention. In the second part of the evaluation strategy, the user experience was measured by means of the Game Experience Questionnaire (GEQ). Nineteen and 29 participants enrolled in the first and second part of the evaluation, respectively. The results of the study showed that both serious game and control intervention enhance user's NL and FL skills (p-value = 0.002, 0.025 respectively). Comparison between the two groups did not yield significant results (p-value = 0.25). Increased levels of competence, immersion, flow and positive affect were declared in the GEQ demonstrating the attractiveness of the serious game. Moreover, the study revealed an important association between the level of game interaction, as measured by the number of mouse clicks per second, and the user experience. Intermediate levels of mouse interaction indicate lower user engagement.

Keywords— *serious game, nutrition, in-game interaction, engagement, quasi-experimental, Game Experience Questionnaire*

I. INTRODUCTION

The onset of cardiovascular disease, cancer and diabetes has been linked to obesity and unhealthy dietary habits [1]. Malnutrition, one of the greatest challenges of our generation, is the cause of more adult deaths and disability than alcohol and tobacco [2]. Positive shift in dietary habits is often hampered due to lack of cooking skills and the necessary time to apply them [3]. Acquisition of cooking and nutrition knowledge, adoption of healthier dietary behavior and maintenance of normal body weight are key factors towards healthier lifestyle and chronic disease prevention and management [4].

Two important concepts, Nutrition Literacy (NL) and Food Literacy (FL), are critical in the development of proper dietary behavior, especially in young adults [5]. NL refers to the ability to comprehend nutritional information and apply it in everyday decisions [6]. FL is conceived as the capacity to incorporate nutrition knowledge in food preparation and cooking techniques, along with an understanding of food safety rules [7]. Development and improvement of NL and FL skills has been proven to lead to effective dietary changes [5].

Serious games have been widely recognized as effective means for training [8], raising awareness and driving behavioral changes within the context of primary and secondary prevention [9]. The use of serious games in promoting nutrition knowledge and dietary change has been investigated with a positive outcome [10].

Evaluation of serious games has attracted scientific interest and stimulated the development of various methods and techniques [11]. However, the effectiveness of serious games in terms of learning outcomes is considered to be understudied [8], taking into account that both the attractiveness and the educational impact constitute significant challenges in obtaining reliable outcomes. Therefore, user performance, experience and affect, along with information regarding user-game interaction prove to be of paramount importance in the assessment of the effectiveness of a serious game [8], [12].

The purpose of this study is to present the experiment design and the obtained preliminary results from the evaluation of "Express Cooking Train", a serious game that focuses on promoting NL and FL [13]. The effectiveness has been measured in terms of educational value, user experience and engagement. The present study attempts to provide insight regarding the association between the motivational capabilities of the serious game, the user's engagement levels and the learning/behavioral outcome. Data has been gathered

Fig. 1. Virtual kitchen in "Express Cooking Train".

Fig. 2. Tutorial screen in "Express Cooking Train".

Fig. 3. Review screen in "Express Cooking Train".

from a multitude of channels, including questionnaires, in-game interaction metrics, user annotated engagement levels, heart rate and heart rate variability, sitting position and movement. Preliminary results, based upon data from questionnaires and in-game interaction metrics, can pave the way to user profiling, player modeling and automated game content generation, with the ultimate goal of a personalized, adaptive version of "Express Cooking Train".

II. THE SERIOUS GAME – "EXPRESS COOKING TRAIN"

"Express cooking train" is a serious game targeting young adults, which aims to empower the user's NL and FL skills. The serious game's design and conceptual framework are presented in [13].

A. Description

"Express Cooking Train" is placed in a post-apocalyptic setting where the user takes control of a train transporting cargo. The world is filled with hungry monsters that chase the train and the user must prepare meals for them in order to delay them. "Express cooking train" features a virtual kitchen environment (Fig. 1) that is linked to a food and recipe ontology providing the user with a safe trial and error cooking simulation environment. The user is tasked with preparing healthy meals to satisfy the monster's appetite. By throwing a meal to the monster, the speed of the latter is affected; healthier meals result in lower speed. Experimentation in the kitchen is crucial for the discovery of healthier ingredients and cooking techniques. Through game progression, challenges,

rewards, and exploration in the virtual kitchen, NL and FL skills are enhanced and a healthier dietary behavior is promoted. The content of the serious game is based on guidelines and fact sheets from the World Health Organization (WHO) [14] and the American Heart Association (AHA) [15] to ensure reliability.

B. Implementation

For the purpose of this study, a trial version of "Express Cooking Train" for Windows operating system was implemented on the GameMaker Studio platform. This version consists of two stages. In the first stage, a detailed tutorial (Fig. 2) guides the user through the game interface and mechanics. During this stage, there is no monster chasing the train, thus adequate time is provided to the user to familiarize himself/herself with the user interface (UI) and
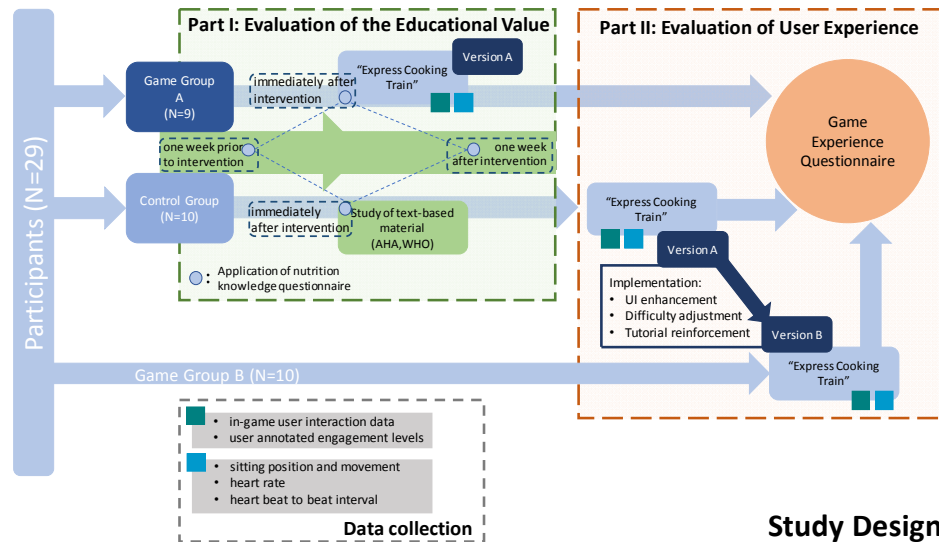

Fig. 4. Design of the evaluation study for "Express Cooking Train".

prepare meals in the virtual kitchen. In the second stage, the user has a limited amount of time to use recipes and ingredients at his/her disposal, experiment in the kitchen and produce healthy meals to fend off the monster. The second stage concludes if the train travels for a predetermined period of time or the monster catches the train. A review screen (Fig. 3) is presented after each stage, providing useful information regarding user's choices and assigning nutrition and cooking challenges.

Additionally, throughout the gaming session, a log consisting of in-game user interaction data is recorded. Such information can provide learning analytics and be employed to improve serious game design and validation [16]. Data collected includes average mouse clicks per second, average mouse click duration and average mouse movement. Furthermore, information regarding game score, progress, screen and text accessed, meals prepared, ingredients and methods used, as well as game difficulty are logged. These values can improve the understanding of user performance and characteristics and provide important recommendations for critical serious game features, such as game difficulty, user engagement, motivation and sense of self-efficacy [17]. Data is logged by the game engine during gameplay and exported in text files after the gaming session.

III. MATERIAL AND METHODS

In order to evaluate the serious game's effectiveness in terms of educational value, user experience and engagement, a two-part study was designed and conducted (Fig. 4). Part I aimed at the evaluation of the game's educational value through a quasi-experimental approach. In Part II, the user's experience and engagement were measured. A total number of 29 participants were recruited (Table I); nineteen of them (Game Group A and Control Group) participated in both parts of the study while the remaining ten participants (Game Group B) enrolled solely in the second part of the study. Most participants were undergraduate and postgraduate students of the School of Electrical and Computer Engineering of the National Technical University of Athens (NTUA). All participants signed a consent form and the study was approved by the Ethics Committee of the National Technical University of Athens (NTUA).

A. Part I: Evaluation of the educational value

The serious game's educational value was compared to a control intervention based on the study of text-based material on nutrition basics/healthy diet, fats, salt consumption and food safety. The duration of both interventions was less than 20 minutes. Knowledge acquisition and retention were measured by administering a questionnaire a week prior to, immediately after, and a week after intervention. The Knowledge Questionnaire was based on the combination of a General Nutrition Knowledge Questionnaire [18] and a Food Safety Knowledge Questionnaire [19]; it consisted of 25 questions in the form of multiple-choice and multiple-choice grid, with a maximum score of 52 points. The questions evaluate knowledge on food measurement, food groups, food safety and label, salt consumption and nutrition related chronic-diseases, topics that are widely used in tools measuring FL and NL [7]. The questions were translated in Greek; slight modifications were applied in formulating particular questions and answers that did not apply in regular Greek cuisine. Participants were assigned in two groups (Table I):

TABLE I. PARTICIPANTS OF THE STUDY

| | | Part I | | |
| | | | Part II | |
	All (N=29)	Game Group A (N=9)	Control Group (N=10)	Game Group B (N=10)
Gender	male (19), female (10)	male (7), female (2)	male (4), female (6)	male (8), female (2)
Age	26 ± 4.08	28.67 ± 4.56	26.52 ± 4.70	22.81 ± 3.82
Frequency of playing video games	*All*	*Game Group A*	*Control Group*	*Game Group B*
Never	10	1	5	4
Once or less per week	7	2	2	3
More than once per week	12	6	3	3

1) Game Group A: The game group A included nine participants who were tasked to interact with the "Express Cooking Train".

2) Control Group: Ten participants were given specific URLs linking directly to the relevant fact sheets and guidelines of WHO and AHA and were instructed to read the educational material.

B. Part II: Evaluation of the user experience and engagement

The evaluation of user experience and engagement was measured by applying two modules of the widely used and validated Game Experience Questionnaire (GEQ) [20]. The Core module of the questionnaire assesses multiple dimensions of game experience, that is, competence, sensory and imaginative immersion, flow, tension, challenge, negative affect and positive affect. Likewise, the Post-game module deals with positive experience, negative experience, tiredness and returning to reality. Each dimension consists of a number of items/questions and receives a score based on the average value of its items, on a five-point scale (from 0 to 4).

After concluding Part I, participants of the Control Group played "Express Cooking Train" and responded to the GEQ (Table I, Fig. 4). Their feedback data along with feedback data collected from Game Group A (19 game sessions in total), were used to decide and apply specific improvements to the trial version (Version A) of the "Express Cooking Train". The resulting updated version (Version B) was used by Game Group B. Particularly, the following changes were implemented:

- Difficulty was reduced by lowering the starting speed of the monster.
- Positioning and functionality of the in-game buttons and messages were augmented resulting in a more consistent and attractive user interface.
- Tutorial was improved to facilitate user familiarization with game mechanics.

Authorized licensed use limited to: Università di Bari Aldo Moro. Downloaded on October 10,2025 at 10:19:51 UTC from IEEE Xplore. Restrictions apply.

- Text color, font size, game aesthetics and animations were enhanced to improve clarity.

C. Data analysis

Within the framework of Part I of the study, Knowledge Questionnaire scores were obtained by Game Group A and Control Group, one-week prior to, immediately after and one-week after the intervention. Paired sample t-test was employed on pre- and post-intervention scores to evaluate the educational effectiveness of both interventions. Two-sample t-test was used to examine significant differences between Game Group A and Control Group.

Within the framework of Part II of the study, the following analysis was conducted. In order to investigate potential improvement of version B over version A, in terms of user experience, the scores from both versions were comparatively assessed by applying the two sample t-test. Information acquired from the in-game log regarding mouse interaction (mouse click and mouse movement) was analyzed using the Pearson correlation coefficient. One-way ANOVA measurements were used to investigate possible association between mouse interaction and self-reported user experience.

IV. RESULTS

A. Evaluation of the educational value

All participants from Part I of the study (Game Group A and Control Group) filled the Knowledge Questionnaire one-week prior to and immediately after the intervention session. There were two drop-outs from the Game Group A and one from the Control Group for the week after intervention. The participants' scores on the Knowledge Questionnaire are summarized in Fig. 5. Paired t-test demonstrated statistically significant increase in score values before and immediately after the intervention for both groups (p=0.002 and p=0.025 for Game Group A and Control Group, respectively). The corresponding increase in the score value was 3.44±2.60 and 2.45±3.67 for the Game Group A and Control Group, respectively.

One participant from each group achieved the same score one-week prior to and immediately after the intervention. All other participants in the Game Group A scored higher immediately after the intervention, whereas two participants of the Control Group scored lower immediately after the intervention.

No statistically significant differences were observed between Game Group A and Control Group in terms of score difference in the Knowledge Questionnaire one-week prior to
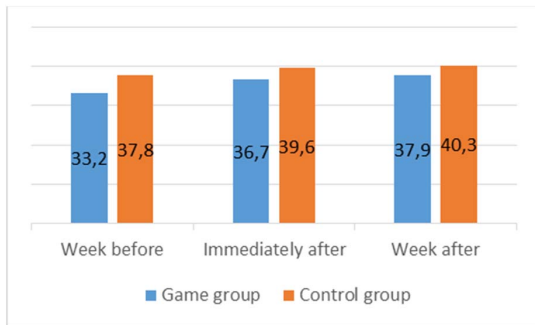
TABLE II. RESULTS FOR GEQ CORE MODULE

GEQ dimension (scale 0-4)	Mean ± Standard Deviation	
	Version A	Version B
Competence	1.98 ± 0.62	**2.53** ± 0.44
Immersion	2.79 ± 0.68	3.03 ± 0.44
Flow	2.49 ± 0.89	2.84 ± 0.65
Tension	0.51 ± 0.61	0.22 ± 0.44
Challenge	2.31 ± 0.76	2.22 ± 0.73
Negative Affect	0.42 ± 0.45	0.30 ± 0.37
Positive Affect	2.87 ± 0.65	**3.22** ± 0.45

TABLE III. RESULTS FOR GEQ POST-GAME MODULE

GEQ dimension (scale 0-4)	Mean ± Standard Deviation	
	Version A	Version B
Positive experience	1.53 ± 0.74	**2.28** ± 0.70
Negative experience	0.30 ± 0.34	0.32 ± 0.44
Tiredness	0.24 ± 0.34	0.31 ± 0.95
Returning to reality	0.70 ± 0.56	0.77 ± 0.72

and immediately after the intervention (p=0.25). Comparison between Knowledge Questionnaire scores administered immediately after and one-week after the intervention did not yield statistically significant results for both groups.

B. Evaluation of the user experience

Scores for the GEQ Core module dimensions are presented in Table II for both versions of the game. An increase across all positive dimensions except challenge was observed for version B over version A. Analysis of the results revealed statistically significant differences for competence and positive affect (p=0.006 and p=0.05 respectively). Comparison of versions A and B in terms of negative dimensions yielded no statistically significant differences.

Scores for the GEQ Post-game module dimensions are presented in Table III for versions A and B of the "Express Cooking Train". Comparison between the two versions for negative experience, tiredness and returning to reality yielded no statistically significant differences. Positive experience demonstrated a significant increase of 0.75 points (p=0.007) after the changes were implemented.

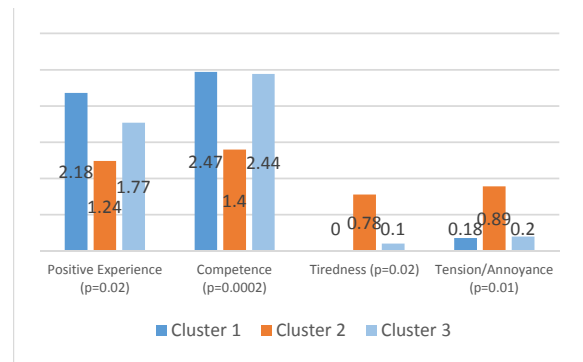Fig. 5. Scores (mean value) in Knowledge Questionnaire for Game Group A and Control Group, one-week prior, immediately after and one- week after the intervention.

Fig. 6. GEQ dimensions with significant differences among Clusters 1 (low interaction), 2 (intermediate interaction) and 3 (high interaction).

500

TABLE IV.   EVALUATION REPORTS OF SERIOUS GAMES APPLYING GEQ

| Serious Game	Rehabilitation game [22]	Adventures in Sophoria [23]	SimSe [23]	Ilha dos Requisitos [23]	Game Bridge [24]	Express Cooking Train
Participants	48	26	12	12	50	29
Age group	20-43	7-19	19-25	19-25	-	20-34
Game genre	Exergame	Massively multiplayer online role-playing game	Simulation	Role-playing game	Multiplayer puzzle	Roguelike, simulation, puzzle
Game purpose	Upper limb stroke rehabilitation	Facilitating intercommunication during cancer treatment	Company simulation	Survival skills	Problem solving in human sustainability	FL and NL skills
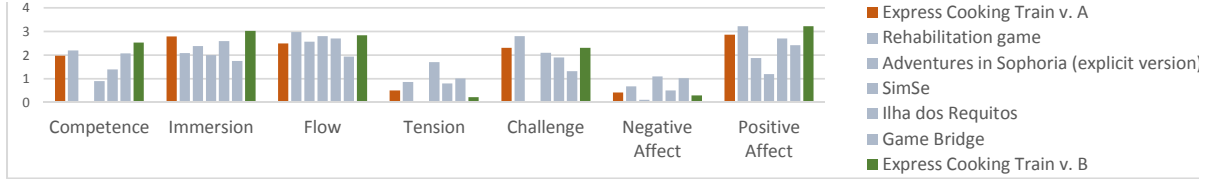
Fig. 7. GEQ Core module dimensions for version A and B of "Express Cooking Train". Comparison with five serious games reported in the literature

C. In-game user interaction data

Preliminary analysis of in-game user interaction data focused on mouse clicks and mouse movement. Relevant information was collected from 25 participants (logs were incomplete in four game sessions).

A strong positive correlation between average mouse clicks per second and average mouse movement per second was observed (r=0.88, p=0.0001), as expected. Additionally, a weak negative correlation between average mouse clicks per second and average click duration was found (r=-0.35, p=0.084).

Based on the level of user's interaction in terms of clicks per second, three different clusters were identified:

- Cluster 1 (low interaction): clicks/sec < 0.3, N = 11
- Cluster 2 (intermediate interaction): 0.3 < clicks/sec < 0.4, N = 9
- Cluster 3 (high interaction): clicks/sec > 0.4, N = 5

where N is the number of participants in each cluster. ANOVA test demonstrated statistical significance in four dimensions (positive experience, competence, tiredness, tension) of the GEQ (Fig. 6) for cluster 2. The clusters of participants with the highest and lowest mouse interaction levels (cluster 1 and 3) scored significantly higher in the positive experience and competence dimensions, and significantly lower in the tiredness and tension dimensions compared to participants of cluster 2.

V. DISCUSSION

Knowledge Questionnaire score results demonstrated that both serious game and traditional study through internet web pages are effective in terms of food and nutrition knowledge procurement. These preliminary results are in line with previous reports demonstrating serious game effectiveness as an educational tool [21]. No statistically significant difference was observed, in terms of educational value, between the two interventions. However, it should be stressed that all participants of the Game Group A achieved higher or equal score after intervention, while two participants of the Control Group scored lower, thus, implying the potential of

"Express Cooking Train" to demonstrate higher educational value. Administration of the Knowledge Questionnaires one-week after the intervention did not produce statistically significant results regarding knowledge retention, in both Game Group A and Control Group. Further investigation is needed to determine proper time intervals between intervention and assessment of retention.

Differences in GEQ score results observed between game version A and B, indicate that the latter produces a more enjoyable and fun experience amongst participants. The introduction of changes based on user feedback had an immediate effect on user experience, thus, highlighting the importance of participatory user-driven game design for serious games.

In order to assess user experience in "Express Cooking Train" against available serious games [16], GEQ scores of "Express Cooking Train" versions A and B were compared with corresponding results reported in the literature [22]-[25] for five serious games for the GEQ Core module and three serious games for the GEQ Post-game module (Table IV.). The scores are comparatively shown in Fig. 7 and 8, for the Core and the Post-game module, respectively. Version B of "Express Cooking Train" achieved the highest score in four positive dimensions (competence, immersion and positive affect and positive experience), and the lowest in two negative dimensions (tension and negative affect). However, comparison between serious games of different genres, designed for different target groups and purposes, is not expected to provide a solid indication of user acceptance but rather to serve as a tool to investigate the effect of different design choices.

Data from user interaction proved to contain valuable information that can lead to improved personalization solutions. User characterization and clustering can provide unique insight to user specific needs [12]. Within this context, an important finding of the present study was that the users that displayed intermediate levels of mouse interaction (cluster 2) declared significantly lower satisfaction in terms of user experience. This can be considered as preliminary evidence that high levels of mouse interaction (cluster 3)
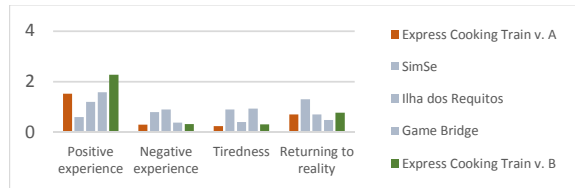
501

Fig. 8. GEQ Post-game module dimensions for versions A and B of "Express Cooking Train". Comparison with three serious games of the literature

indicate engagement with focus on game mechanics, while low levels (cluster 1) imply an immersive experience with focus on game content.

The relationship between intensity of mouse interaction and user experience will be verified for more participants and its relation to the educational outcome will be examined. Factors relating user engagement and serious game design will be further investigated through user reports and self-annotation of gameplay recordings, along with data collected from sitting position monitoring sensors, heart rate (HR), heart rate variability (HRV) and in-game interaction.

Further investigation will be conducted for the assessment of the serious game's educational value. A Randomized Controlled Trial (RCT) will be employed, with a larger number of participants. Participant baseline nutritional knowledge will be taken into account in the group randomization process, using a stratified randomization technique [26]. Additional tools associated with the assessment o NL and FL skills will be applied [7]. Future work also focuses on the evaluation of the serious game's capacity to promote sustainable effective dietary behavioral change.

VI. CONCLUSION

The present study summarized the initial results from the evaluation of educational value and user experience of "Express Cooking Train", a novel serious game that aims at enhancing Food and Nutrition Literacy skills. A preliminary investigation of the potential value of information collected from in-game user interaction with the serious game was also presented. Such preliminary evaluation results are essential for the improvement of "Express Cooking Train", in terms of design, game mechanics and content, towards a personalized experience.

REFERENCES

[1] K. Dalakleidi, K. Zarkogianni, A. Thanopoulou and K. S. Nikita, "Comparative assessment of statistical and machine learning techniques towars estimating the risk of developing type 2 diabetes and cardiovascular compicatios," *Expert Systems*, vol. 34, no. 6, Apr. 2017.J.

[2] "The nutrition challenge and food system solutions," World Health Organization, 07-Jan-2019. [online]. Available:
https://www.who.int/nutrition/publications/policies/nutrition-challenge-food-system-solution/en/ .[Accessed 20-Aug-2019].

[3] Colatruglio, Sarah & Slater, Joyce & Deer, F & Falkenberg, T & Mcmillan, B & Sims, L. Sustainable well-being: Concepts, issues, and educational practices, 2014, ch 3.

[4] K. Zarkogianni, E. Litsa., K. Mitsis, P. Wu, C. Kaddi, C. Cheng, M. Wang and K. S. Nikita, "Review for emerging technologies for the management of diabetes mellitus," *IEEE Transactions on Biomedical Engineering*, vol. 62, no. 12, pp. 2735-49, Dec. 2015.

[5] C. Krause, K. Sommerhalder, S. Beer-Borst and T. Abel, "Just a subtle difference? Findings from a systematic review on definitions of nutrition literacy and food literacy," *Health Promotion International*, vol. 33, no. 3, pp. 378-389, Jun. 2018.

[6] K. Silk, J. Sherry, B. Winn, N. Keesecker, M. Horodynski and A. Sayir, "Increasing Nutrition Literacy: Testing the Effectiveness of Print, Web site, and Game Modalities," *Journal of Nutrition Education and Behavior*, vol. 40, no. 1, pp. 3-10, Jan. 2008.

[7] E. Yuen, M. Thomson and H. Gardiner, "Measuring Nutrition and Food Literacy in Adults: A Systematic Review and Appraisal of Existing Measurement Tools," *HLRP: Health Literacy Research and Practice*, vol. 2, no. 3, pp. e134-e160, Aug. 2018.

[8] F. Bellotti, B. Kapralos, K. Lee, P. M. Ger, "Assessment in and of Serious Games: An Overview," *Advances in Human-Computer Interaction*, vol.2013, Jan. 2013.

[9] T. Baranowski, R. Buday, T. I. Thompson and J. Barranowski, "Playing for real: video games and stories for health-related behavior change," *American journal of preventive medicine*, vol. 34, no. 1, pp. 74-82, Jan. 2008.

[10] L. Sardi, A. Idri and J. Fernández-Alemán, "A systematic review of gamification in e-Health," *Journal of Biomedical Informatics*, vol. 71, pp. 31-48, Jul. 2017.

[11] D. Drummond, A. Hadchouel, A. Tesniere, "Serious games for health: three steps forward," *Advances in Simulation*, vol.2, 2017.

[12] K. Alonso-Fernandez, A. R. Cano, A. Calvo-Morata, M. Freire, I. Martinez-Ortiz and B. Fernadez-Manjon, "Lessons learned applying learning analytics to assess serious games," *Computers in Human Behavior*, vol. 99, pp. 301-309, Oct. 2019.

[13] K. Mitsis, K. Zarkogianni, N. Bountouni, M. Athanasiou and K. S. Nikita, "An ontology-based serious game design for the development of nutrition and food literacy skills," *2019 41st Annual International Conference of the IEEE Engineering in Medicine and Biology Society* (EMBC), 2019.

[14] WHO.int. (2019). [online] Available at: https://www.who.int/ [Accessed 21 Aug. 2019].

[15] American Heart Association. (2019). [online]. Available at: https://www.heart.org/ [Accessed 21 Aug. 2019].

[16] G. Hookham and K. Nesbitt, "A Systematic Review of the Definition and Measurement of Engagement in Serious Games," *Proceedings of the Australasian Computer Science Week Multiconference on - ACSW 2019*, 2019.

[17] Alonso-Fernandez, Cristina & Calvo-Morata, Antonio & Freire, Manuel & Martinez-Ortiz, Ivan & Fernández-Manjón, Baltasar. "Applications of data science to game learning analytics data: a systematic literature review," *Computers & Education*, June 2019.

[18] N. Kliemann, J. Wardle, F. Johnson, and H. Croker, "Reliability and validity of a revised version of the General Nutrition Knowledge Questionnaire," *European Journal of Clinical Nutrition*, vol. 70, no. 10, pp. 1174–1180, Jan. 2016.

[19] T. Lazou, M. Georgiadis, K. Pentieva, A. Mckevitt, and E. Iossifidou, "Food safety knowledge and food-handling practices of Greek university students: A questionnaire-based survey," *Food Control*, vol. 28, no. 2, pp. 400–411, 2012.

[20] IJsselsteijn, W. A., de Kort, Y. A. W., & Poels, K. (2013). The Game Experience Questionnaire. Eindhoven: Technische Universiteit Eindhoven.

[21] A. DeSmet, et. al., "A meta-analysis of serious digital games for healthy lifestyle promotion," *Preventive Medicine*, vol. 69, pp. 95-107, Dec. 2014.

[22] D. J. Cargning, M. Cordeiro d' Ornellas, A. L. Cervi Prado, "A serious game for upper limb stroke rehabilitation using biofeedback and mirror-neurons based training," *Studies in Health Technologies and Informatics*, vol. 216, pp. 348-352, 2015.

[23] A. Fuchslocher, K. Gerling, M. Masuch, and N. Kramer, "Evaluating social games for kids and teenagers diagnosed with cancer," *2011 IEEE 1st International Conference on Serious Games and Applications for Health (SeGAH)*, 2011.

[24] L. Gustavo Rotoly de Lima, A. Salgado, and A. Freire, "Evaluation of the user experience and intrinsic motivation with educational and mainstream digital games," *CLIHC '15 Proceedings of the Latin American Conference on Human Computer Interaction*, 2015.

[25] K. Oksanen, and R. Hämäläinen, "Assessing Game Experiences Caused by Educational Collaborative Game," *5th European Conference on Games-Based Learning*, Oct. 2011.

[26] J. M. Kendall, "Designing a research project: randomized controlled trials and their principles," *Emergency Medicine Journal*, vol. 20, pp. 164-168, 2003.