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goussiou@aegean.gr, m.kordaki@aegean.gr
Department of Cultural Technology and Communications, University of the Aegean

Abstract

This paper presents the design, the features and a pilot formative evaluation of a 10 content-level Educational Digital Card Game (EDCG) for the learning of essential food safety and nutrition concepts by pre-primary, primary and secondary level education students. The design of the aforementioned game is based on the "7-step modeling methodology" for constructivist computer card games. A brief description of the features of the EDCG is also presented accompanied by the presentation of results coming from a preliminary evaluation of the game –used as a diagnostic tool of students' prior knowledge - with 100 students. The analysis of these data show that, students were interested and engaged in the game, while they were triggered to study a number of topics about nutrition and food safety in order to win.

Keywords: card game based learning, food safety, nutrition, education, constructivism

Introduction

Computer games motivate young people in ways that formal education doesn't (Facer, 2003; Prensky, 2005), thus, they have been acknowledged as effective tools for teaching hard and complex concepts (Kebritchi & Hirumi, 2008). Essential elements of computer games that could enhance people's motivation and engagement are challenge, curiosity, fantasy (Malone, 1981), control, and feedback (Malone & Lepper, 1987) that yield to the "flow experience"; a state of players' complete immersion in the game-play that nothing else seems to matter and players feel happiness and satisfaction (Csikszentmihalyi, 1990). In fact, computer games constitute appropriate learning environments where knowledge construction could be promoted within constructive, collaborative, conversational, reflective, contextualized, complex, intentional and active contexts (Jonassen, 1994). Such contexts are perfectly aligned with the social and constructivist views of learning (Charsky, 2010; Jonassen, 1994; Vygotsky, 1980).

Among the plethora of genres of computer games that have been around, digital card games are one of them. In fact, they are the digital mode of physical card games (CGs). Concerning their learning perspectives, it has been reported that they could improve players' communicative skills and promote active learning through the interaction with other peers (Bochennek et al., 2007). It has also been acknowledged that through card game-play the enforcement of matching, number manipulation and pattern recognition skills are being promoted (Van Eck, 2006), while players' logico-mathematical and interpersonal intelligence are also encouraged (Berger & Pollman, 1996). To this end, physical and digital educational CGs have been designed to supplement the learning of various subjects, such as: Computer Science, Physics, Mathematics, Language, Business, Health and Food education, (Kordaki, 2011; Kordaki & Gousiou, 2014).

Taking the aforementioned issues into account, this paper describes a game-based approach on "Food Safety and Nutrition Education". This study is realized within the context of the "EduForHealth" European Project. In the context of this project, a 10 content-level EDCG entitled 'Health Goal' had been constructed. The design, the features and the pilot evaluation of this EDCG will be described in this paper. The paper is organized as follows: first, the importance of nutrition and health education is discussed. Next, the design framework of the suggested EDCG is described, followed by a brief presentation of the game and, subsequently, the findings of a pilot evaluation of the EDCG by secondary school students. Finally, the implications of the results are discussed and the study's limitations and future research directions are explored.

Nutrition and health education and the "EduForHealth" project

Nowadays, one of the most severe health conditions is childhood obesity; during the last decade, approximately 20% of youth aged 6 to 17 are considered obese (Federal Interagency Forum on Child & Family Statistics, 2009). Research has also shown that obese children have an increased risk for health problems and are more likely to become obese adults (Centers for Disease Control, 2010). However, despite the efforts made by policy makers across the axis health-food, numerous scientific papers related to school children education draw a warning to the fact that a significant proportion of teens and adults have never learned the basic principles of food safety, and as a consequence they might be unable to protect themselves and their future families. Hence, an effective educational intervention starting even at the pre-primary level combined with the reinforcement of parent education could be necessary so as this risk to be diminished. The "EduForHealth" project attempts to approach Health education from the scientific, pedagogical and legislative perspective, considering the age of children, the classroom level, and the psychosomatic development of students along with their national and local particularities. To this end, specific learning materials were designed incorporating the following ten Essential Topics (ETs) of Food Safety and Nutrition as appropriate for pupils' and students' healthy nutrition education at the pre-primary, primary and secondary educational level:

- The Food Pyramid and the basic composition of foods (carbohydrates, fats, proteins, vitamins, minerals, biological active compounds).
- The role of nutrients in the human body function and health status.
- The biologically active compounds of foods and their implication in health wellness and preservation.
- The risk of chemical substances in food consumption (e.g. heavy metals, pesticides, self-born toxins, industrial born poison, etc.) and their implication in health.
- The biological health risks in food consumption.
- Chemical and biological risks and their prevention.
- The nutritional food labeling.
- The concept of RDA (Recommended Daily Allowance) and consumption security.
- Health logos.
- Food Hygiene.

Based on the above, an EDCG containing and handling these ETs was designed. In the next section, the design framework of the suggested EDCG will be discussed.

The design framework of Health Goal: a 10 content-level EDCG

An interactive multi-language digital card game was designed in an attempt to aid students to learn basic aspects of nutrition, health and food safety in a pleasurable environment. The design of this game was based on social and constructivist learning perspectives combined with essential educational digital game design principles. Specifically, it was based on the 7-step model methodology for EDCGs (Kordaki, 2016) and will be presented below.

Step 1 - Definition of the subject matter model and of the student model:

Definition of the subject matter model: Each content-level of the EDCG is related to one of the aforementioned ETs (See section 2) and contains certain aspects that are considered by food and nutrition experts as necessary to be learned by the students. These topics are illustrated in the games' interface (see Fig. 1).
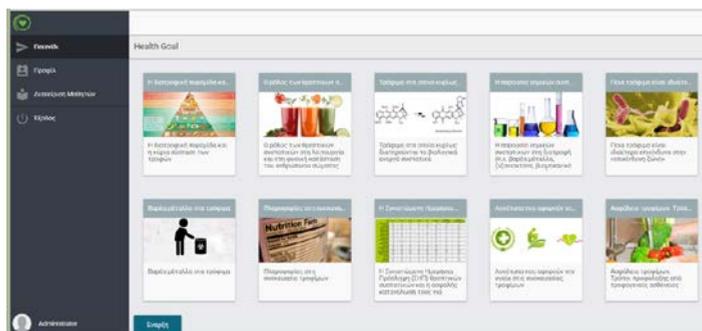

Figure 1. The Health Goal interface

Definition of the student model: For each ET the difficulties that students of pre-primary, primary and secondary education usually face have been analyzed. All these difficulties have been taken into account in order to be surpassed through card game-play.

Step 2 - Definition of the aims of the CG-play: Considering the data emerged from the previous step, Health Goal was created to support students to: (a) learn the basic aspects of each ET, (b) be able to adopt the right behavior related to each ET, (c) be aware of and also correct the misunderstandings they have had about these ETs, and (d) identify healthy, nutritious habits and perceptions as opposed to unhealthy ones so as to be able to develop healthy choices.

Step 3 - Definition of appropriate card game-play learning activities: The objective of the Health Goal EDCG is to encourage players to collect all the appropriate cards and also to answer multiple choice questions related to each ET; thus, classification (Marzano et al., 1988) combined with multiple choice questions have been employed as learning activities to facilitate students' critical thinking and overcome their difficulties about the concepts in focus. Students' misconceptions about each ET were taken into account in the design of cards and of multiple choice questions. In fact, students' misconceptions were reflected in the figurative cards and have been also included as choices in the multiple choice questions. These learning activities were designed to support students to grasp the learning concepts in question by: (a) focusing on the basic aspects related to each ET, (b) thinking critically about each ET in order to make the correct choices during CG-play, and (c) drawing appropriate conclusions based on the feedback provided in the game. Specifically, 4 Figurative Cards (Total: 40; 4 cards for 10 ETs) accompanied with 10 Multiple Choice Questions Cards (Total: 100; 10 cards for 10 ETs) were designed for each ET and were involved in the card-game

play. An example of (a) a set of cards needed for the realization of a valid grouping of the 1st ET, and (b) a Multiple Choice Question card, are illustrated in Fig. 2(a) and Fig. 2(b) respectively. It is worth mentioning that the EDCG offers 3 play-modes, one for each of the 3 educational levels. Specifically, (a) pre-primary level: containing only figurative cards, (b) primary level: containing also a set of 5 multiple choice question cards, and (c) secondary mode: containing also another set of 5 multiple choice question cards.

Figure 2. Health Goal cards

Step 4 - Definition of specific CG-play activities to help students overcome their difficulties: Students had to reject those cards as irrelevant to the certain ET they were playing for (8 cards for each ET: these are figurative cards randomly selected from two other ETs and play the role of "Challenging cards" for the ET at hand).

Step 5 - Definition of the kind of motivation that should be provided for students during CG-play: In order students to be engaged in the game-play, Joker cards were created. Specifically, ten (10) "Joker cards" were designed, reporting significant suggestions about healthy choices (e.g. the importance of physical exercise, having a healthy and balanced diet) which could contribute to the creation of valid groups for all ETs during the CG-play. "Joker cards" are presented randomly to the player and only one can be used in each group of cards. An example of this kind of cards is illustrated in Fig. 2 (c).

Step 6 - Definition of the kind of scaffolding used during CG-play: Ten (10) "Scaffolding Cards" were designed, one for each ET. These cards contain text that refers to essential points related to each ET and appear upon player's demand - when she/he is unable to do the right matching or answer the multiple choice questions. An example of this kind of card is illustrated in Fig. 2 (d).

Step 7 - Definition of the rules of CG-play: One (1) card illustrating the rules of the game was finally designed and appears upon each player's demand. The total number of cards included in this game is 161.

Health Goal game-play

In the beginning of the game the player has to provide some personal information (username and password) since the system keeps log files containing students' playing activity. Then, the player has to select the ET(s) she/he wants to play with (up to three

topics) and the game starts. She/he has also the opportunity to press the button "Game Rules" in order to view them. During game play, the system provides the player with all the available: (a) Multiple Choice cards which should be correctly answered, (b) Figurative cards that should be classified in the appropriate ET or rejected if the player thinks that it does not fit to any of the selected ETs, and (c) Joker cards that pop up randomly and should be selected by the player since they gain points. Scaffolding cards appear upon each player's demand but then she/he loses 5 points. The player has to deal with each card for 50 seconds except for the scaffolding card, which remains on screen as long as the player needs it. The game ends when the cards are all used or when the player has formed the valid groups of cards for the ETs she/he has been playing for. Then, the system informs her/him about the score and her/his wrong answers, along with the correct answer for each question. Students have the opportunity to reflect on this information that could support them, thus, to become aware of their misunderstandings about the learning subject in question and try to correct them. Moreover, the teachers also have access to the log files of their students in order to draw conclusions about their knowledge and about the effectiveness of the game.

The game was implemented using HTML5 and PHP and it can be accessed at: http://eduforhealth.ssai.valahia.ro/game

Preliminary evaluation study

Health Goal was piloted in classrooms -located in Athens Greece- where one hundred students (48 boys and 52 girls), aged 13-14, participated voluntary in a pilot formative evaluation of the said EDCG in order to investigate its perceived utility, appeal and learning effectiveness when it is used as a tool for the diagnosis of students' prior knowledge. Students' participation was not graded. In terms of methodology, this formative evaluation study could be characterized as a quantitative study (Cohen et al., 2007). The data were collected through a questionnaire consisting of 11 close-type questions. Interviews were also conducted to clarify the results. The students interacted with the EDCG in Greek language at a school computer-lab during one 45 min. session. Each student used one computer. Before the game-play started, students weren't taught anything about the ETs supported by the EDCG at hand. Thus, in each session the EDCG was used as a diagnostic tool for students' prior knowledge. The structure of each session is described below:

- Phase 1: Introduction - Students were given a short introduction about the goals and the mechanics of the EDCG while they were also provided with their personal username and password (5 minutes).
- Phase 2: Game-play – Students played the game for 30 minutes. Most of the students played with 4 to 5 ETs.
- Phase 3: Feedback – After finishing the game, students had to fill (in 10 minutes) a questionnaire containing 11 close-type questions (5-point Likert type). Possible answers to the close-type questions ranged from 1 (strongly disagree) to 5 (strongly agree). The formation of the aforementioned questionnaire was based on previous conducted studies (e.g. Kordaki et al., 2016). Descriptive statistics of students' answers to these questions are illustrated in Table 1.

As deduced from Table 1, students' responses to the EDCG were positive overall. The students found the EDCG very user-friendly and very interesting. They also considered that they were supported by the EDCG to comprehend and learn more about nutrition and food-safety concepts; they regarded that they were also contributed by the provided feedback to reflect on their knowledge and their answers in order to correct their wrong perceptions

about nutrition and food-safety matters while they also thought that the help provided by the EDCG was very helpful, too. It is also worth noting that students after playing the game mentioned that they were motivated to study more about the learning subjects in question. They were also positive in the adoption of similar EDCGs in other school courses as well. The means of the answers to the relevant questions (1, 2, 3, 4, 8, 9, 10, and 11) were all about or greater than 4. However, as derived from the answers to the questions 5, 6, and 7, which were lower, the students found the EDCG's questions difficult while they didn't seem appealing and fun enough for them. This points out that, they need extra knowledge about nutrition and food safety. It also seems that, several improvements in the EDCG should be conducted in order to become even more appealing, fun, and useful for students.

In order to clarify the results presented on Table 1, we conducted interviews with 15 students aiming at investigating what the students liked most/least about the EDCG and whether they were motivated to learn more about nutrition and food safety maters. As derived from the students' answers; they enjoyed the fact that they had the opportunity to use an educational computer game in school. More specifically, it emerged that the game-based approach enhances teaching and makes it more interesting and entertaining for them. Moreover, students mentioned that they were keen on studying various subjects with the use of computers apart from computer science and this is a fact that rarely happens in school. As regards the EDCG, they mostly liked the graphics and the user friendly environment that combines figures and text. They also mentioned that they enjoyed the fact that they had to deal with multiple choice questions and they found the final analysis of their score with the correct answers really helpful. Overall, they considered the whole experience really interesting and they would prefer spending more time on the game.

Table 1. Students' answers to the questions of the evaluation questionnaire (N=100)

#	Question	Mean	Standard deviation
1	The game helped me acquire knowledge about nutrition and food safety	4,09	0,84
2	The game helped me better understand nutrition and food-safety related concepts	4,16	0,87
3	I would like such digital games to be used in other school courses as well	4,24	1,01
4	The game is interesting	4,17	0,90
5	The game is appealing	3,85	1,07
6	The game is fun	3,81	0,99
7	The game is easy (its questions is easy to answer)	2,64	1,16
8	The game is user-friend (it is easy to use)	4,25	1,12
9	The feedback provided by the game helped me comprehend and overcome my wrong perceptions about nutrition and food safety	4,08	0,97
10	The help provided by the game was useful	4,30	0,71
11	After playing the game I am motivated to learn more about nutrition and food safety	4,05	1,27

However, according to their answers for what they liked least, it emerged that the multiple choice questions were in several cases difficult for them because they had never heard of specific concepts and words, such as: heavy metals, food adulteration, pesticides, PAH (Polycyclic Aromatic Hydrocarbons), 'big 4' and 'big 8', DRV (Dietary Reference Values), Nordic Keyhole, and UK Heart. As a result, they couldn't answer the questions and they felt

disappointed by that fact; however, they stated that they wanted to keep on playing the game and they had the confidence that in a second try they would be able to improve their score as they were going to be more prepared for the learning subject. Moreover, the students wanted to know their score during the game play; as they mentioned they preferred to know whether their answer was right or wrong while playing, since when they were concentrating in the specific question it would be easier for them to comprehend the right answer and clarify their misunderstandings. They also mentioned that they would enjoy having more Joker cards in the EDCG play. Finally, according to the students' answers about whether they were motivated to learn more, it emerged that students were motivated and they intend to study further about the learning subjects in question, especially those ones they didn't know and the ones that they wanted to learn more about, such as: essential nutrients, vitamins and minerals, soluble and insoluble fibers, food borne illnesses, and food allergy.

Implications of the study for educators and researchers

The Health Goal EDCG could support students to learn basic aspects of Nutrition and Food-safety matters in a card game-based approach. In this way, the awareness of students as related to their misunderstandings, errors and wrong perceptions might be highly raised while the feedback and consolidation practices provided by the EDCG would enhance the students' active learning. The designed EDCG could be used by educators of all educational levels in Health education courses in various instructional modes, such as: (a) a diagnostic tool of students' prior knowledge before the course is taught, (b) an evaluation tool after an instructional intervention and (c) a learning tool that could go hand-in-hand along with the learning process.

Limitations of the study and future research directions

This study was conducted in a secondary school within a short session and only as a diagnostic tool for students' misconceptions. Hence, students didn't have the opportunity to play with all the available ETs and have an overall and comprehensive view of the whole EDCG. This happened due to the fact that the evaluation took place on schooldays and the available time for the study was only 45 minutes for each class. The emerged drawbacks - related to the difficulty of the questions, the scoring information, as well as the factors of fun and attractiveness involved - from this current study need to be addressed. A new version of the EDCG is in our immediate plans in order the game to become more entertaining, so as the learning experience to become more engaging for the students. Moreover, the next step of our research is to conduct evaluation studies with more than one school students, allowing them to have more time to interact with the game in order to acquire a more extensive view for the game and reflect on its learning contents and the feedback provided. The learning effectiveness of this EDCG could be also examined not only as a tool for the diagnosis of students' prior knowledge but as a motivation tool during a teaching intervention and also as an evaluation tool of students' knowledge after a learning process. All in all, it seems that the field of nutrition and food safety is a learning subject that is in the scope of students' interests and it seems that the card game-based approach could potentially motivate students to learn and overcome their conceptual difficulties about the learning concepts in question. Thus, teachers could adopt this game-based approach and use this game in order to engage, motivate and support students' effective learning about nutrition and food safety.

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