



# Robo-cook's Path: An online multiplayer board dietary game

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## ABSTRACT

Employing games in educational context have the potential to be a powerful means of learning or review previously taught material. The case presented in this paper is based on a multiplayer board game that was developed as an online browser game. Its gameplay is based on short dietary quizzes and minimalistic role-playing where students are acting as a team. Notably, the game's quiz content has been developed with the participation of catering school educators and targets student ages from 10 to 16 years old. Evaluation results, which were provided by educators after using the game in classroom environment, demonstrate the potential of using a dietary game in classroom context as complementary teaching/learning materials.

## CCS CONCEPTS

• Human-centered computing; • Computers in other domains;

## KEYWORDS

Educational Games, Dietary Games, Computers in education

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## 1 INTRODUCTION

Promoting the engagement of students with certain school subjects by employing videogames is an ongoing challenge that has been addressed with many possible approaches. In recent years there has been various research efforts to employ a wide range of game applications based on information technologies as a means of educational content related to dietary concepts [1]. The main target

of these game applications is to provide features and conveniences that make their educational content more vivid and attractive to the learner compared to traditional educational methods. By achieving that, games can be used as a supporting tool to complement traditional teaching methods to improve the learning experience of the learners. As previous research has demonstrated consistently, video games can impact positively on problem solving skills and knowledge acquisition while they have positive impact on student motivation and engagement [2].

Motivated by the aforementioned, in this paper we present a multiplayer online board-game of dietary content that challenges student to apply their relevant knowledge, using some critical thinking and teamwork to answer to short quizzes based on dietary classroom subject and thus progress the game. We then go on to assess the possibility of having such an application used by educators as a complementary part of a catering school's curriculum with the ultimate intention of making the learning process more interactive and fun.

More specifically, the main points of discussion in this work are:

- A detailed presentation of the game's gameplay, its design and technical development process.
- The presentation of the game's content and how it was developed
- The study of using the game experimentally gathered by 5 teachers who supervised the interaction of 96 students with the game. The results demonstrate the potential of using the presented game in the context of a classroom course.

The remainder of this document is organized as follows. Section 2 describes related work on digital educational games, while Section 3 focuses on the design and development of the presented game from both technical and non-technical perspectives. Finally, Section 4 presents the experimental evaluation of the presented game in a classroom setup, while Section 5 draws our conclusions from the presented case.

## 2 RELATED WORK

In general game-based learning describes a learning environment designed in way that game content and gameplay enhance knowledge and skills acquisition [3] where the game activities present challenges that provide potential learners with a sense of learning achievement. In this context, educational games is a term applied typically to games adapted to include curriculum content or other

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classroom material in order to be integrable into educational process.

Relevant work on classroom interventions that have targeted similar age groups have shown promising results in a variety of subjects. An early example regarding computer science teaching in high school have been presented in [4] where researcher worked with a computer browser game of quizzes and compared the students' performance when they took the equivalent non-game version of the quiz. Virtual learning environments have also been employed since early years with a prominent example being presented in [5] which presents a virtual game for geography teaching that was designed specifically to act as an educational web platform. Another example regarding the teaching of history in high-school is discussed in [8] which presents in detail the design, implementation and usage of a set of computer mini-games (word search, crossword, jigsaw puzzle, quizzes etc.) that were developed using an open-source tool and specifically adapted with content of history courses.

Interestingly, games have also been used in classroom context to teach and enhance other important skills and qualities or knowledge valuable for society [3] that are not explicitly part of typical school courses. A serious game on recycling that targets primary school students is presented in [6] where a social robot is part of game that educates students on the importance of recycling and thus, improve children's environmental sustainability attitude. A multiplayer game designed toward teaching and learning of social and emotional skills is presented in [8]. In-class experiments demonstrated that playing such a cooperative videogame collaboratively in classroom context can incentivize team work and make the participating students part of experiences that promote prosocial values and behavior.

When it comes to nutritional and dietary education, research findings have shown that games can be effective as in-class interventions or as part of classroom courses according to the review presented in [1]. Physical and videogames like board game, memory games [13], card games [14] or advergimes [7] were found to be effective in promoting the increase of nutritional knowledge and healthier eating behavior in students but it was also observed that games have the potential to promote not beneficial behaviors such as increasing the consumption of processed and high-calorie snacks. Such a case was examined in [7] where researchers employed a modified version of Pac-Man and measured the effect that it had on the snack consumption of students under age 10. Children who played the healthy-food version that Pac-Man should collect healthy snacks tended to select significantly more such snacks after-game whereas the students who played the less healthy version tended to choose unhealthy snacks. Notably games have also been employed in long-term interventions targeting more specific nutritional knowledge as in the case of [15] where a nutritional education game was particularly designed to teach bone health information to students aged 9-11 years old. It was observed that children that participated in the nutritional program increased the consumption dairy products and vegetables that contribute to bone health according to the knowledge provided by the game.

The abovementioned works constitute an indicative sample of research examples on the potential and the effectiveness of game-based learning applications that have shown to be effective in enhancing the learning experience in various domains. In our work,

we focus on developing a simple, flexible yet engaging board game based on affordable and accessible open-source web technologies. This game is part of the game suite developed in the context of the PROTEIN project [11] which aims to develop an accessible application ecosystem with one of its main objectives being the provision of personalized nutrition and activity recommendations [12] that can assist users in achieving a healthier lifestyle

### 3 THE GAME

We have chosen the digital board games genre as a basis for our dietary game. Typical board games are based on a tile-board in which the players move inside its limits, visiting each tile has a different functionality according to its type. We chose this game genre taking into account that board-games are well-suited for a wide range of audience of student age that may be accustomed to play such games and can begin with them only with minimal instructions. A digital board game also serves as a flexible platform to include quiz mechanics and at the same time allows the developer and the educator to adapt the content according to difficulty level.

Importantly, one of our goals has been to develop an online game that can be accessed and played easily by an audience of students in a classroom at the same time. Adapting it as an online browser game comes with some advantages such as no need of extra installation of software on personal devices of students and the by-default full anonymization of the student-gamers.

#### 3.1 Gameplay

The *Robo-Cook's Path* is a cooperative board game where the players are part of a robotic cook team whose objective is to reveal the recipe steps of a dish by gathering in-game knowledge points. The points are collected when a player answers correctly to the short dietary quizzes that appear according to the board tile that is visited. Upon starting, each player is assigned a unique mini-role that indicates its part on the recipe execution.

To achieve this goal, the robot walks through a board consisting of quiz tiles. During each turn, the players roll a virtual dice which indicates how many nodes away from their current position they can move on the board. Each tile is assigned a thematic category of questions (e.g.: Locality & Seasonality, Food Hygiene, Nutritional Principles) and a multiple-choice question is randomly picked and presented to the robot according to the tile that was visited. If the robot (player) answers correctly, then it gains knowledge points for this category attributed to its team. When a multiple-choice question appears, a timer begins to run, and the players must answer before it stops. At the same time the other robots are prompted to help their teammate by providing a possible answer to the given question by showing them the question without the available multiple choices (bottom left corner of Figure 1). At each step of the recipe, the team should collect a balanced number of correct answers from each category in order to enable to the next step.

Apart from answering correctly to the dietary quizzes, the game progresses by requesting the players to complete the missing steps of a recipe (bottom right corner of Figure 1). This is the part of the game that each player's assigned character, namely Instructor, Shopper and Cook, plays a different role. The instructor's duty is to

**Table 1: Summarizing the specs of the game**

<b>Name:</b>	The Robo-Cook's Path
<b>Target group:</b>	10+ years old
<b>Platform:</b>	Targets desktop web browsers
<b>Learning goal:</b>	Game content that covers classroom dietary learning topics
<b>Genre:</b>	Multiplayer turn-based board game emulation with questions
<b>Link:</b>	URL in PROTEIN server: <a href="https://pms.protein-h2020.eu:8080/">https://pms.protein-h2020.eu:8080/</a>



**Figure 1: Gameplay instances of the Robo-cook's Path game. Clockwise from upper left: 1- Player with role “shopper has rolled the dice and is about to move. 2 - Player with role “cook” is prompted to answer a dietary quiz.**

reveal a recipe's next step by visiting the correct tile, the Shopper decides about the missing parts regarding the missing ingredients or the necessary kitchen tools and the Cook should select the correct cooking action (as a cooking verb) for each step of the recipe

### 3.2 Game's content

The game's quiz content is grouped in three difficulty levels and subsequently each level's quizzes are grouped into three thematic topics. In order to develop each set of questions according to difficulty level and sufficiently cover the targeted dietary subjects, it was necessary to follow a collaborative approach that involved the participation of the project's piloting partners and catering school educators. Their participation was not only limited in the development of the quizzes' content but also they went on to review and provide their feedback about the presentation style and the pictures chosen to accompany the quizzes. We provide examples of the game's question sets in tables Table 2, Table 3 and Table 4 (correct answers are in bold font).

During content development, the main goal was to generate questions into three thematic categories, related to dietary concepts taught in classrooms according to the age of the students. A desired quality feature regarding the included quizzes was to convey important dietary information to the players and to be playful at the same time.

### 3.3 Technical development background

Being a multiplayer browser game, the creation of this game involved both frontend and backend development. Development for the frontend part was focused on creating the game's assets that are delivered through the players' browser. The Phaser.js game development framework was used to create the game's frontend code that realizes the turn-based board-game logic and to glue it with the game's graphical assets and quizzes' text content. The Socker.IO client JavaScript library was intertwined in the game's client code to handle the multiplayer connection of the game. The server-side part of the game was also based on popular open-source web technologies. Node.js (JavaScript) along with Socket.IO's server

**Table 2: Example of game quizzes and their answer options of easy difficulty level**

Category	Question’s text	Option1	Option2	Option3
Nutritional Principles/ Foods	Which food does not contain carbohydrates or sugars?	Pasta	Beans	Olive oil
Seasonality/ Locality	Zucchini are a typical vegetable in:	In winter	In spring	In summer
Healthy Nutrition	The fried food is very tasty! Let’s eat it:	Twice a week	Only on Sundays	Rarely because it is not very good for our liver’s health.

**Table 3: Example of game quizzes and their answer options of intermediate difficulty level**

Category	Question’s text	Option1	Option2	Option3
Healthy Nutrition	How many calories should an average snack provide?	3%	10%	20%
Hygiene/ Storage	Food contaminants are defined as:	All substances not intentionally added to food	Substances added intentionally to food	Additives
Nutritional Principles/ Foods	Table sugar (sucrose) is composed of....	Fructose and galactose	Ribose and glucose	Glucose and fructose

**Table 4: Example of game quizzes and their answer options of advanced difficulty level**

Category	Questions’ text	Option1	Option2	Option3
Feeding and Nutrition	A BMI of 15 corresponds to a situation of:	Underweight	Severe thinness	Normal weight
Hygiene/ Storage	Food must be sold packaged when:	Frozen	Deep Frozen	Both of the previous answers are wrong
Nutritional Principles/ Foods	The category of "fresh" food includes:	Bread	Beer	Meat

JavaScript implementation were used for handling the backend of the multiplayer logic. MongoDB database was chosen as a document database because of its flexibility. The database was initialized with the game’s quiz dataset and during each game session the database was used to save temporary data such as each team’s player-ids and its progress and at the end of the session certain statistics are saved permanently for future reference. Moreover, inside the project’s code, several other open-source plugins were used to develop the game’s user interface, for example a major UI component of the game is the sweetalert library to implement the quiz elements of the game.

### 3.4 Technical development background

During the development stages of the game, we had to ensure that the functionality and robustness of game’s server logic (orchestrating the multiplayer logic and progress tracking) and its interface, consisted of the score and progress UI, the playing board, and the quiz UI elements. To this end, along with the development process, the internal team performed testing and verification iterations on all aspects of the game’s components. This process began as soon

as the game had reached an alpha version of development in order to apply bug-fixes and functionality upgrades.

A less technical but more content-focused phase of testing and verification was performed in collaboration with the piloting partners as soon as the game had reached at a beta version of development. The purpose of this phase was to perform a preliminary session of limited testing with them (teachers and students) and gather feedback and opinions from the evaluating users themselves. The first evaluation of this early version was made informally with 2 participating educators and selected number of their students. The results of this preliminary evaluation came mainly from the usability and educational perspective and were used as starting point to refine the game and improve its user experience.

## 4 EXPERIMENTAL RESULTS

### 4.1 The experiments in classroom

The multiplayer browser game “Robo-cook path” was used in the school pilots organized and run by ICDB network of schools. Due to Covid-19 measures the pilots took place exclusively in an online environment. The participating teachers were initially provided

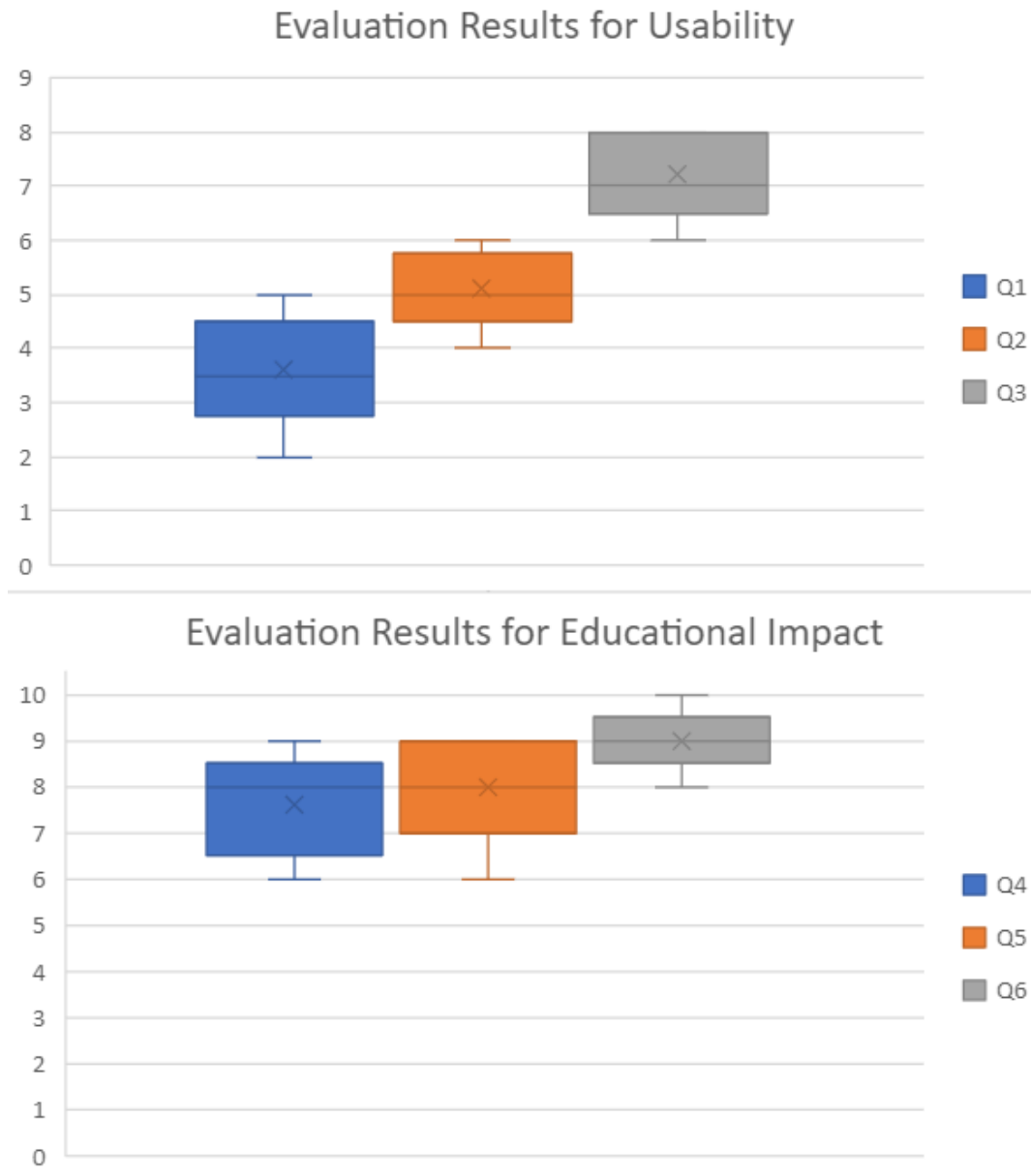


Figure 2: Box plots of evaluation results

with guidelines by the piloting partner and for the participating students the game itself contains gameplay instructions presented in its introductory screen according to the selected language.

Participating teachers register in the Robo-cook path's registration page by providing the requested information. Upon submission the game server creates the appropriate number of passcodes for the requested students which are meant to be used by the classroom to ensure that students from a class will be matched only with other students from their own class.

According to the logs of game's server a total of 18 teachers from different schools registered passcodes in the game for a total of 390 students. These students began 120 new game sessions in total. According to game progress logs, a certain number of these sessions indicate that substantial progress was done playing the game and completing its quizzes.

#### 4.2 Questionnaire results

In Table 5 we quote the questionnaire that was answered by 5 educators that oversaw playing and evaluation of the game in 5

**Table 5: The questionnaire of the evaluation experiments.**

Usability Questions	
Q1	The gameplay is fluid, without major technical errors
Q2	The game is graphically attractive and engaging for the children
Q3	The game was friendly to use
Educational impact Questions	
Q4	The game can be functional to the pedagogical aims of a teacher in
Q5	The game can be integrated with the school curriculum and the lesson plans
Q6	The values taught by the game are important for our society

different schools where a total 92 students participated under their supervision. The questionnaire is split in two group which each one address a different aspect of the game, namely the usability of the game and the effectiveness from a pedagogical perspective. The evaluation form was completed by the educators after their classrooms played the game during the first piloting phase (questions have been translated from original content in Italian).

In Figure 2 the presented box plot diagrams summarize the statistics of the evaluation results on the two group of questions. Regarding the average scores about game’s fluidity and friendliness to use, it is plausible to assume that students accessing a multiplayer board game for the first time may require considerable startup time to familiarize themselves with its gameplay and its technical details. At the same time, they depend on each other of their teammate’s progress on that matter. It should be especially noted that the game was not tested extensively beforehand in a multiplayer remote environment.

There are cases that its performance can be affected either by the players’ connections or the device they access it through. For example in one occasion that author are aware of, a classroom made use of Android tablets to access the game. These particular tablets’ browser affected unexpectedly the scaling of the game HTML canvas and caused some graphical elements to not be properly rendered, degrading their accessibility and game’s overall performance. Towards fixing and preventing similar issues the authors plan to extend testing and debugging on more devices.

Apart from the abovementioned numerical scores, the evaluation produced qualitative comments that were a strong indication that the game became interesting and fun to play as soon as the students familiarized themselves. Most importantly, the comments indicate that the game’s concept is perceived as promising and may be suitable to be used as a complementary tool in related classroom subjects.

## 5 CONCLUSIONS

This paper has presented in detail the board-game “Robo-cook’s Path” which was developed as a browser game targeting to be used in classroom context by students in multiple classrooms at the same time. Based on the experiments run in school environment, we can conclude that complementing dietary classroom courses with an

online web games has potential to be an engaging way to convey dietary content to a classroom. In such a context students can become more eager to participate in classroom and make participation in a course feel like a more meaningful and rewarding activity.

It should be noted that the presented experiment has certain limitations. It was conducted as a short-term intervention and the classroom content included a selected sub-set of the nutritional concepts that are part of school curriculum. While the data the survey provides are specific to 5 classrooms, they are suggestive of a broader picture of game-based learning their way into schools. A future target on this directions is to get more insight into our hypothesis by conducting an extended version of the experiment with bigger duration, more difficulty levels and the inclusion of classroom content would have provided more insights.

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