Nutrición Hospitalaria

Trabajo Original

Pediatría

Efficacy and acceptability of a web platform to teach nutrition education to children

Eficacia y aceptabilidad de una plataforma web para enseñar educación nutricional a niños

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Abstract

Introduction: Nutrition Education (NE) has been identified as a key factor to prevent children obesity. Teachers and dietitians are the professionals in charge of transmitting this knowledge to children; however, it has been identified that they do not possess either proper training, or the proper tools to perform this activity.

Objectives: to evaluate the acceptability and usability of a NE Internet platform and its two "Serious Games" (SGs) among a sample of elementary school teachers, dietitians, and education students. In addition, to evaluate the efficacy of this platform to teach NE in a sample of children aged 9 to 12 years.

Methods: a total of 66 NE professionals and 135 children participated. Usability and acceptability questionnaires of the platform and an instrument to measure the acceptability, immersion, and playability of the SGs were administered to the professionals. The children fulfilled a questionnaire on nutritional knowledge. Descriptive statistics analyzed the main responses of the professionals involved, and an ANOVA compared the differences observed. For the children´s data a t-test of repeated samples and a repeated-measures ANOVA were performed.

Results: dietitians and education students responded with a favorable opinion about the platform; however, the scores given by all professionals to the SGs ranged from low to moderate. Children increased their nutritional knowledge from pre to post evaluation ($p < 0.001$). This increase was observed in 10-year-old children and in children with 11 to 12 years of age, but not in 9-year-olds.

Conclusions: this platform proved to be an effective tool to increase children's nutritional knowledge. Professionals expressed a medium level in terms of acceptability and usability for this platform, but also effectiveness in providing NE to children.

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Resumen

Introducción: la educación nutricional (EN) se ha identificado como un factor clave para prevenir la obesidad infantil. Los profesionales encargados de transmitir este conocimiento a los niños son maestros y dietistas; sin embargo, se ha identificado que no cuentan ni con la capacitación, ni con las herramientas adecuadas para realizar esta actividad.

Objetivos: evaluar la aceptabilidad y la facilidad de uso de una plataforma de Internet de EN y sus dos "Juegos Favoritos" (JF) en una muestra de maestros de primaria, nutricionistas y estudiantes de educación. Además, evaluar la eficacia de esta plataforma para enseñar EN en una muestra de niños de 9 a 12 años.

Métodos: participaron un total de 66 profesionales de EN y 135 niños. Se administraron a los profesionales cuestionarios de usabilidad y aceptabilidad de la plataforma, y un instrumento para medir la aceptabilidad, la inmersión y la jugabilidad de los JF. Los niños completaron un cuestionario sobre conocimiento nutricional. Se analizaron con estadísticas descriptivas las principales respuestas de los profesionales y las diferencias se compararon con un ANOVA. Para los datos de los niños se realizaron una prueba "t" de muestras repetidas y un ANOVA de medidas repetidas.

Palabras clave:

Nutrición saludable. Ciencias de la nutrición infantil. Nutricionistas. Maestros de escuela primaria. Intervención basada en Internet.

Resultados: los nutricionistas y los estudiantes de educación dieron una opinión favorable sobre la plataforma; sin embargo, las puntuaciones de todos los profesionales acerca de los JF fueron de bajas a medias. Los niños aumentaron su conocimiento nutricional al comparar la evaluación antes y después de la plataforma ($p < 0.001$). El aumento se observó en los niños de 10 años y en los niños de 11 a 12 años, pero no en los niños de 9 años.

Conclusiones: esta plataforma demostró ser una herramienta efectiva para aumentar el conocimiento nutricional de los niños. Los profesionales expresaron un nivel medio en términos de aceptabilidad y usabilidad para esta plataforma, pero también efectividad para impartir EN a los niños.

INTRODUCTION

The World Health Organization (WHO) defines overweight and obesity as an abnormal or excessive fat accumulation that may endanger one's health (1). This problem is mainly caused by an increased intake of energy-rich foods with high-fat content, and a decrease in physical activity or a sedentary lifestyle (1). The most important source of childhood obesity is an imbalance between energy intake and expenditure (2), with excessive consumption of calories (3). According to the latest data of the WHO Childhood Obesity Surveillance Initiative (4), southern European countries (including Spain), have the highest rate of child obesity, with approximately 1 in 5 boys being obese (4). Data indicate that the prevention of obesity has to be directed to children younger than 11 years of age, given that persistent obesity has been identified as being established before that age (5).

One of the factors that predicts the inappropriate selection of food, or a poor diet, in children is lack of knowledge about nutritional aspects (6). Therefore, nutrition education (NE) plays an important role in tackling this pandemic. According to Contento (7), NE is defined as "any combination of educational strategies, accompanied by environmental supports, designed with the objective of facilitating the voluntary adoption of dietary choices and other behaviors related to nutrition and food that will lead the individual to an optimal state of health and well-being. NE must be transmitted through multiple pathways and activities led at individual, community, and political levels" (7). Among these pathways, the use of information and communication technologies (ICTs) has been increasing over the last decades (8).

Although NE is present in the school curriculum of European children, several studies have shown that NE level needs to be reinforced (9). Furthermore, the NE competences incorporated in the curriculum are mainly based on food components and nutrition and biological mechanisms, but do not include information about eating habits or behaviors, such as intake planning, developing strategies and competences to improve awareness during intake, learning self-control techniques, or making nutritional decisions

in specific situations (7). Also, nutrition clinics and hospitals are important for this matter since it is there that children receive treatment if they are already overweight or obese (10).

In addition, it seems clear the need to provide training and updated materials to the professionals in charge of teaching NE to children, such as teachers at elementary schools, dietitians, and student teachers. For example, the study performed by Kupolati et al. focused on a sample of 73 teachers, and identified that 30 % had no training in teaching nutrition, and 86 % of the teachers expressed that they would like to receive training in nutrition. This study also detected a need to provide up-to-date instructional materials for teaching nutrition (11). In another study it was observed that elementary school teachers had moderate scores regarding nutritional knowledge; specifically, more than 60 % of the teachers participating in this study did not know which are the components of a Mediterranean diet, nor the goals of the current scientific, evidence-based guidelines (12). A research conducted with 98 nutritionists from four European countries—Spain, Italy, Norway and Austria—identified that although nutritionists have a vast knowledge of NE, these professionals did not perceive themselves with enough pedagogical skills to share this knowledge with children; specifically, 32.7 % perceived they had "adequate" training, 30.6 % "did not have enough training", 24.5 % had a "little" amount of training, 9.2 % "did not have training at all", and just 3.1 % perceived they had "very good" training (13).

An Internet platform was designed to provide specific training for professionals who train, promote, and transmit competences related to healthy eating behaviors to children who are between 9 and 12 years old (14). It includes the following modules and their respective contents: Module 1 provides general information about food, nutritional groups according to the food pyramid, and how they interact inside the body. Module 2 teaches *how* to apply nutritional knowledge to develop and create healthier and better-balanced menus. Module 3 offers information to the child about certain eating behaviors, beliefs, and fears that are common between the ages 9 and 12 years. Information is provided about the mechanisms that

generate the desire to eat, and about intake styles (external, emotional, and restrictive eating). This module also includes contents related to neophobia (fear of new foods). Finally, Module 4 presents the characteristics and particularities of children's developmental stages. This section, called "Nutrition and Children", provides tools focused on helping teachers and dietitians give suggestions about more effective ways to address the sessions.

The Internet platform contains two "Serious Games" (SGs) (15). The objective of the first game is for the player to differentiate among a variety of food groups by selecting only indicated foods and avoiding non-indicated foods (e.g., selecting only foods with protein). In the second game, the player can create a menu for breakfast, lunch, or dinner, and at the end of the selection s/he receives feedback about her/his decision.

The aim of this study was to analyze the acceptability and usability of this NE Internet platform with professionals who teach NE, and to test its efficacy in teaching NE to children between 9 and 12 years old.

METHODS — PROFESSIONALS' ACCEPTABILITY AND USABILITY

PARTICIPANTS

Four elementary school principals from the Valencian Community in Spain were contacted and invited to participate in this study. The same was done with the Official College of Dietitians and Nutritionists of the Valencian Community and the University of Valencia. The total sample of professionals who accepted to volunteer to this study consisted of 66 participants (54 women and 12 men); of these, 15 were elementary school teachers, 12 were dietitians, and 39 were university students of bachelor's degrees in Education. Participants age ranged from 19 to 60 years (M = 25.35, SD = ± 10.83).

INSTRUMENTS

Course evaluation and evaluation of the platform questionnaire (CEEM)

This was an *ad-hoc* questionnaire developed to assess professionals' opinions about the system and its contents. It contains 10 items and is composed of two sections. The first section presents 3 statements that participants must respond to on a 5-point Likert scale (1: strongly disagree, 5: strongly agree). Example of one item in this section: "The Internet platform covers the need of professionals to teach nutritional knowledge" (1: strongly disagree, 2: in disagreement, 3: neither in disagreement nor in agreement, 4: in agreement, 5: strongly agree). The second section presents 7 adjectives (e.g., "easy to use", "intuitive") that participants must rate it using a 5-point Likert scale (1: not at all, 5: a lot). A high score on this questionnaire indicates a positive opinion about the platform, and the maximum possible value that can be obtained is 50.

Acceptability, immersion, and gameplay of the Serious Games in the Internet platform questionnaire (AIG)

This questionnaire was designed *ad-hoc* to evaluate the SGs included in the platform. It is composed of 20 items to be answered on a 5-point Likert scale (1: not at all, 5: a lot). Items cover 3 main aspects of the games: immersion (16), acceptability (17), and gameplay (18). Examples of the items include: for immersion, "Did the game have you hooked?"; for acceptability, "Do you think the game is useful to learn about nutrition and food?"; for gameplay, "Do you think the rate at which the game runs is correct?". The instrument is composed of 20 items, and the results of the most relevant 8 items will be presented. Of these 8 items, 7 are normal and 1 is reversed ("Did you find it difficult to learn how to play?") Therefore, the maximum possible score for all the 7 normal items is 35 and the minimum is 8, and in the reversed item the maximum possible is 5 and the minimum is 1.

Questionnaire based on the theory of diffusion of an innovation (QTDI)

This questionnaire was developed *ad-hoc* based on Rogers' theory (19), which asserts that the perception of innovation is more important than its content. According to this theory, the process of adopting an innovation is complex and includes 5 factors: relative advantage, compatibility, complexity, experimentation, and visibility. In this questionnaire, 2 of the 5 attributes were not taken into account. Complexity was not considered because a specific scale of system usability, which covered this attribute, was already used. The experimentation attribute is not relevant on this platform because the objective was to be able to use this system on any computer with Internet access. The questionnaire consists of 25 items, and the 8 most relevant items were selected. These items are responded using a Likert-type response format ranging from 1 (strongly disagree) to 7 (strongly agree). An example of one item corresponding to relative advantage is: "This internet platform is a much more effective method because it is based on information and communication technologies (ICTs), when compared to traditional methods such as manuals, brochures or teaching classes"; compatibility: "The Internet platform is congruent with the contents that I consider necessary to teach NE to children"; and visibility: "I would recommend using this internet platform to other education professionals". Higher scores reflect a greater relative advantage, compatibility, or visibility. These instruments were designed by the professionals involved in the development of the platform (20).

PROCEDURE

Elementary school teachers were invited to a meeting in their respective schools. Dietitians were invited to a meeting in a classroom at the University of Valencia, and education students

were invited to a meeting in a classroom at the Faculty of Education, University of Valencia. Access to the Internet platform was provided, and participants were asked to access said platform. Afterwards, each of the modules was presented, indicating how to navigate through the platform. This navigation included the modules 1 (Nutritional knowledge), 2 (Food care and nutrition), and 3 (Healthy eating habits). Subsequently, the SGs were explained to the participants. The first one was presented, and the participants were asked to play the game for 10 minutes. Then, the second one was presented, and the same procedure was performed. Finally, the user administration section was introduced, where they could see the score obtained by each of the children. They were explained how to generate a user, and were requested to try this function out as new users (access for children). At the end of the trial, they were asked to fill out the questionnaires.

DATA ANALYSIS

Descriptive statistics were analyzed for each group of professionals, and one-factor ANOVAS were performed to compare the scores of teachers, dietitians, and education students. When a significant interaction was found, post-hoc analyses using Bonferroni's adjustment were conducted. The analyses were performed using the Statistical Package for the Social Sciences (SPSS), version 20.0.

RESULTS—PROFESSIONALS' ACCEPTABILITY AND USABILITY

ACCEPTABILITY AND USABILITY OF THE INTERNET PLATFORM BY PROFESSIONALS

Regarding the evaluation of the platform with the CEEM questionnaire, descriptive statistics and ANOVA results are listed in table I. The best scores were obtained by education students and dietitians, whereas the group of teachers evaluated the platform contents with a lower score, the mean score indicating neither disagreement nor agreement with the statements regarding the platform. The results of the ANOVA showed statistically significant differences for almost all the items when comparing the 3 groups of professionals involved, except on the questions related to "Covers professional needs"—F = 2.19, $p = 0.121$, $\eta^2_p = 0.073$—and "Intuitive"—F = 2.57, $p = 0.085$, $\eta^2_p = 0.084$, where a majority of participants provided low scores. In all other items education students and dietitians scored higher.

As to the perception of innovation and usefulness, descriptive statistics and ANOVA results appear in table II. The results obtained for the QTDI scale showed high scores on most of the answers. ANOVA results revealed statistical differences between participants in almost all items except for the item "It is possible to imagine the children learning with the SGs"—$F = 1.86$, $p < 0.164$, $\eta^2_p = 0.056$—where a majority of participants provided high scores. In all other items education students and dietitians scored higher than teachers.

Table I. Mean scores, one-way ANOVA results, and post-hoc comparisons of the *Course Evaluation and Evaluation of the internet Platform Questionnaire (CEEM)* (n = 66). Possible minimum score 1 (strongly disagree), possible maximum score 5 (completely agree)

	T	D	ES				
Item	**M (SD)**	**M (SD)**	**M (SD)**	***F***	***P***	η^2_p	***Post hoc***
Adequate contents	3.53 (± 0.915)	4.00 (± 1.12)	4.28 (± 0.510)	5.417	0.007	0.147	(ES = N) > T
Basic principles of NE	3.13 (± 1.24)	4.25 (±.622)	4.28 (± 0.647)	11.360	< 0.001	0.265	(ES = N) > T
Clear structure	3.47 (± 1.06)	3.75 (± 1.13)	4.26 (± 0.751)	4.635	0.013	0.128	(N = T) < ST
Covers objectives of NE programs	3.20 (± 1.32)	4.17 (± 1.11)	4.23 (± 0.902)	5.477	0.006	0.148	(ES = N) > T
Facilitates transfer of NE	3.77 (± 0.832)	4,43 (± 0.535)	4,36 (± 0.486)	5.427	0.007	0.162	(ES = N) > T
Helps in pedagogical process	3.54 (± 0.660)	4.29 (± 0.488)	4.28 (± 0.510)	9.492	< 0.001	0.253	(ES = N) > T
Covers professional needs	3.62 (± 0.870)	3.86 (± 0.690)	4.13 (± 0.767)	2.196	0.121	0.073	ES = N = T
Useful to teach NE	3.46 (± 0.660)	4.14 (± 0.378)	4.13 (± 0.615)	6.212	0.004	0.182	(ES = N) > T
Fast	3.23 (± 1.16)	3.57 (± 0.535)	4.00 (± 0.688)	4.752	0.012	0.145	(N = T) < ST
Comfortable	3.31 (± 1.25)	4.14 (± 0.378)	4.23 (± 0.742)	5.824	0.005	0.172	(ES = N) > T
Easy to use	3.23 (± 1.30)	4.14 (± 0.378)	4.56 (± 0.598)	14.003	< 0.001	0.333	(ES = N) > T
Safe	3.31 (± 1.37)	4.00 (± 1.00)	4.41 (± 0.595)	7.937	0.001	0.221	(ES = N) > T
Intuitive	3.15 (±1.14)	3.71 (± 0.756)	3.72 (± 0.647)	2.574	0.085	0.084	ES = N = T
Easy to learn to use	3.3 (± 1.32)	4.43 (± 0.535)	4.67 (± 0.478)	14.301	< 0.001	0.338	(ES = N) > T

T: teachers; D: dietitians; ES: education students; M: mean; SD: standard deviation.

Table II. Mean scores, one-way ANOVA results and post-hoc comparisons obtained based on the responses of the groups of professionals about the questionnaire based on the diffusion theory of an innovation (n = 66). Possible minimum score 1 (strongly disagree), possible maximum score 7 (completely agree)

	T	D	ES				
Item	**M (SD)**	**M (SD)**	**M (SD)**	**F**	**p**	η^2_p	**Post hoc**
Makes it possible to learn NE	4.80 (± 1.89)	5.50 (± 1.24)	5.92 (± 0.623)	5.29	0.008	0.144	(ES = N) > T
More effective method based on ICTs	4.73 (± 1.75)	5.25 (± 1.81)	5.90 (± 1.04)	4.10	0.021	0.115	(ES = N) > T
Facilitates transmission of NE	4.53 (± 1.84)	6.00 (± 0.739)	5.85 (± 0.670)	9.48	< 0.001	0.231	(ES = N) > T
Stimulating way to learn	4.60 (± 1.88)	6.00 (± 0.739)	5.92 (± 0.774)	8.40	0.001	0.211	(ES = N) > T
Congruent with necessary contents of NE	4.47 (± 2.35)	5.50 (± 1.50)	5.74 (± 0.677)	4.66	0.013	0.129	(ES = N) > T
It is possible to imagine children learning with the SGs	4.87 (± 1.84)	5.17 (± 1.99)	5.67 (± 1.00)	1.86	0.164	0.056	ES = N = T
I would recommend MEAL to other professionals	4.47 (± 2.10)	6.08 (± 1.08)	6.08 (± 0.839)	9.35	< 0.001	0.229	(ES = N) > T
Clear advantages of the platform	4.73 (± 1.83)	5.75 (± 1.81)	5.79 (± 0.656)	4.05	0.022	0.114	(ES = N) > T

T: teachers; D: dietitians; ES: education students; M: mean; SD: standard deviation.

EVALUATION OF THE PLATFORM'S SERIOUS GAMES BY PROFESSIONALS

Regarding the evaluation of the SGs, descriptive statistics and ANOVA results are listed in table III. The results of the AIG questionnaire indicated differences on most of the items, revealing that education students and dietitians evaluated the first game more positively than teachers. A similar pattern was identified in the second game. However, the general scores for both SGs by all participants ranged from low to middle.

METHODS — EFFICACY OF THE PLATFORM IN INCREASING NUTRITIONAL KNOWLEDGE

PARTICIPANTS

The initial sample was composed of 135 children between the ages of 9 and 12 years (M = 10.15, SD = ± 0.806). However, 23 participants were removed from the analysis due to lack of post-tests, leaving a final sample of 112 children (51 girls and 61 boys). The average age of the participants who completed the pre and post assessments was 10.20 years (SD = ± 0.804). The sample was obtained from 4 elementary schools in the Valencian Community. The inclusion criteria were that children had to be in the age range of 9 to 12 years and be regular students. No exclusion criteria were indicated. This study was approved by the Ethics Committee of the University of Valencia, and the parents gave their written consent allowing their children to participate in the study.

INSTRUMENTS

The Nutritional Knowledge Questionnaire (NKQ) is an *ad-hoc* questionnaire based on the questionnaire developed by Parmenter and Wardle (21), which measures nutritional knowledge acquisition in adults, and has shown good psychometric properties, with a Cronbach's alpha level in the range of 0.70 +/- 0.97, and a test-retest reliability of 0.716. The instrument developed by Baños et al. (22) was considered for the development of this questionnaire to measure the level of nutritional knowledge acquired by a child population after an NE intervention and physical activity. The Cronbach's alpha of this instrument was also calculated with a result of 0.657. This instrument is composed of 29 items, and most of the questions have the same format: a question with 3 possible answers, only one being the correct one. A score of 29 represents the maximum score.

PROCEDURE

Four elementary schools were contacted. The interested schools provided their consent. The contents of the Internet platform were taught to the children in 3 sessions of 1 hour each, and in the last session access to the SGs was granted to them. The NKQ was administered to measure the changes in nutritional knowledge observed after the 3 sessions as compared to baseline.

DATA ANALYSIS

A t-test of repeated samples was performed to analyze if there were significant changes in the pre and post time periods. Afterwards, an ANOVA of repeated measures was carried out to analyze if there were differences in the level of nutritional knowledge between the pre and post periods by age groups (group 1: 9-year-old children, group 2: 10-year-old children, and group 3: 10- to 11-year-old children). Also, the effect size was calculated. The analyses were performed using the Statistical Package for the Social Sciences (SPSS), version 20.0.

Table III. Comparison of the evaluations made of the Acceptability, Immersion, and Gameplay of the Serious Games Platform questionnaire (AIG) by professionals (n = 66). Possible minimum score 1 (nothing at all), possible maximum score 7 (very much)

	First SG							Second SG						
	T M (SD)	D M (SD)	ES M (SD)	F	P	η^2_p	Post hoc	T M (SD)	D M (SD)	ES M (SD)	F	P	η^2_p	Post hoc
Playability														
Did you like the game?	2.40 (± 0.828)	3.08 (± 1.08)	3.47 (± 1.13)	5.524	0.006	0.151	(ES = N) > T	2.13 (± 1.60)	2.58 (± 0.996)	3.10 (± 0.821)	6.507	0.003	0.171	(ES = N) > T
Was it entertaining?	2.53 (± 0.915)	3.00 (± 0.953)	3.63 (± 0.998)	7.398	0.001	0.193	(ES = N) > T	2.13 (± 9.90)	2.50 (± 0.905)	3.21 (± 1.03)	7.027	0.002	0.182	(ES = N) > T
Did you find it was fun?	2.40 (± 0.910)	3.08 (± 1.16)	3.66 (± 0.994)	8.594	< 0.001	0.217	(ES = N) > T	1.80 (± 0.941)	2.67 (± 0.888)	2.82 (± 0.942)	6.579	0.003	0.173	(ES = N) > T
Immersion														
Did the game have you hooked?	1.67 (± 0.900)	2.33 (± 0.985)	3.41 (± 1.18)	5.192	< 0.001	0.325	(T = N) < ES	1.87 (± 1.06)	2.00 (± 0.853)	2.27 (± 1.12)	1.132	0.424	0.028	ES = N = T
Acceptability														
Do you think the game is useful to learn about nutrition and food?	3.00 (± 1.19)	3.75 (± 1.13)	3.23 (± 1.22)	1.354	0.266	0.041	T = N = ES	2.80 (± 1.42)	3.50 (± 1.16)	4.03 (± 0.833)	7.299	< 0.001	0.193	(ES = N) > T
Have you learned about nutrition and food by playing with it?	2.40 (± 1.54)	3.00 (± 1.47)	3.18 (± 1.14)	1.936	0.153	0.058	T = N = ES	2.87 (± 1.55)	2.67 (± 1.72)	3.81 (± 0.701)	6.140	0.004	0.168	(T = N) < ES
Do you think that playing the game can be useful in changing our eating habits?	2.40 (± 1.54)	3.67 (± 1.15)	3.15 (± 1.08)	3.806	0.028	0.108	(ES = N) > T	2.73 (± 1.38)	3.58 (± 1.24)	3.86 (± 0.855)	5.948	0.004	0.163	(ES = N) > T
Did you find it difficult to learn how to play?	2.20 (± 1.65)	1.67 (± 0.778)	3.18 (± 4.89)	0.840	0.437	0.026	(T = N) < ES	2.40 (± 1.45)	1.58 (± 0.669)	1.97 (± 1.44)	1.256	0.292	0.040	ES = N = T

T: teachers; D: dietitians; ES: education students; M: mean; SD: standard deviation.

RESULTS — EFFICACY OF THE PLATFORM IN INCREASING NUTRITIONAL KNOWLEDGE

Significant differences between the pre and post assessments were found in the results of the NKQ [$t(111) = -3,289$ $p < 0.001$, $d = 0.62$], thus indicating an increase in the knowledge of most of the children from the pre to the post evaluation. This increase was observed in the 10-year-old children group (pre-score $M = 20.06$ to post-score $M = 21.27$) and the 11- to 12-year-old group (pre-score $M = 21.27$ to post-score $M = 22.56$), but not in 9-year-olds (pre-score $M = 21.25$ to post-score $M = 21.21$).

The ANOVA results indicated that for all age groups (9, 10 and 11-12 years), there was a main effect of time on the level of nutritional knowledge—$F(1, 109) = 7.14$, $p = 0.009$, $\eta^2_p = 0.061$—in which the level of knowledge after the intervention ($M = 21.91$, $SD = 3.09$) was higher than before the intervention ($M = 20.78$, $SD = 3.62$). However, no effect was found on the interaction between age group and time period—$F(2, 109) = 1.69$, $p = 0.189$, $\eta^2_p = 0.030$—indicating that the changes from the period before the intervention were not different depending on age group. Regarding sex, a main effect of time was found on the level of nutritional knowledge—$F(1, 110) = 11.14$, $p < 0.001$, $\eta^2_p = 0.092$, in which the level of knowledge after the intervention ($M = 21.91$, $SD = 3.09$) was higher than before the intervention ($M = 20.78$, $SD = 3.62$). However, no effect of the interaction between gender and time period was found—$F(1, 110) = 0.586$, $p = 0.446$, $\eta^2_p = 0.005$—indicating that changes from the period before and after the intervention were not different depending on gender.

DISCUSSION

The tool presented in this study is an innovative technological platform focused on providing training in, promoting, and transmitting contents related to healthy eating behaviors to professionals such as elementary school teachers, dietitians, and education students with the purpose of teaching this knowledge to 9- to 12-year-old children. The aim of this study is to present data about the acceptability and efficacy of this internet platform, both for the professionals who teach NE (teachers of primary schools, dietitians, and student teachers), and for 9- to 12-year-old children.

Overall, most of the professionals had a positive opinion about the system and the content of this Internet platform. In addition, they scored high on questions related to relative advantage, compatibility, and usability of the platform. The professionals considered that this tool was an effective method for teaching NE contents. In addition, they reported that this platform and the games it includes facilitated the transmission of information to children, encouraging them to learn more. Similarly, they recommended the use of this type of platform to other professionals, recognizing all the advantages that this would have. The highest scores were obtained by dietitians and education students. However, the results obtained in the group of teachers indicated a need to improve some aspects of the platform and the contents, especially its usability. Specifically, most teachers did not evaluate the contents so positively, indicating that they neither disagreed nor agreed with the proposed items, and showing significant differences with nutritionists and education students, given that these professionals did evaluate the contents positively.

SGs acceptability, immersion, and gameplay indicated that they were not perceived by the professionals as sufficiently entertaining, and the scores were specially low regarding immersion ("Did the game have you hooked?"), indicating that the game was not well developed in order to pique interest in playing it again soon in the future. Also, in general, the participants indicated that they did not find it was fun, which indicates that the SGs will need to be improved in several aspects in order to implement them for a broader population. Despite these results, it is worth mentioning that these professionals found the SGs useful for teaching nutritional knowledge and cognitive skills to children. These results are consistent with those provided by other studies, such as the ETIOBE Mates (22), where children exhibited a high acceptability of NE interventions using computer games. Finally, similarly to a tendency previously observed, teachers evaluated these games less positively than dietitians and education students. According to the literature, the evaluation of the platform in this sense could be related to certain aspects and beliefs regarding the use of computers in the classroom. Hermans et al. (23) found that elementary school teachers with constructivist beliefs were a strong predictor of computer use in the classroom, and traditional teacher's beliefs had a negative impact on integrated classroom computer use.

Regarding children, this study shows that this Internet tool is effective in increasing the children's nutritional knowledge. Other similar platforms have focused on teaching NE, such as FATaintPHAT by Ezendam (24), where a web platform with 8 modules obtained an increase in the consumption of fruits and vegetables, and a decrease in the intention to consume sugary drinks and unhealthy food. Similarly, in the study that included the serious game Squires Quest! II (25), the participating children increased their consumption of vegetables at dinner and their fruit intake at breakfast. Continuing with the use of technologies to teach NE, Rosi et al. (26) conducted an intervention with 112 8- to 10-year-old children in order to teach NE to students in elementary schools. They used computer games and also found that the knowledge of the students increased significantly from pre- to post-intervention measures. Finally, it is important to point out that in this study 9-year-old children were the ones who benefited the least from the platform. Some aspects of this Internet platform may need to be readapted to younger children. This should be taken into account in future studies.

LIMITATIONS

Some limitations of the current study should be pointed out. First, the study sample was small, and there was no control group to compare the children who received NE classes from our internet NE platform to children in standard NE classes at elementary schools. Due to the limited time of the study it was not

possible to measure if participants modified their eating habits, therefore it was not measured if the Internet platform contents were efficient in providing support for these children to facilitate the voluntary adoption of dietary choices. Also, the acceptability and usability of the MEAL platform and their SGs was not evaluated by the primary school teachers of the children who received the MEAL contents. This perspective would have given a broader view of the platform and how it would be evaluated in a more realistic context and less controlled environment such as just prototyping. These are tasks that should be considered and analyzed in the future.

CONCLUSIONS

In general, the Internet platform "MEAL" has been shown to be effective in transferring NE to children, and primary schools teachers, dietitians, and education students have all found it useful for learning how to teach NE. It may be adapted to any elementary school or nutrition clinic, and in this way professionals can quickly and effectively obtain the necessary tools to teach NE to children. It should be noted that the efficacy of this platform is achieved with a relatively short program that includes only three sessions and the possibility of being implemented through the Internet. Internet platforms have significant potential to impact NE for children across the world, particularly in areas where trained nutrition educators are lacking. These platforms can be used on any computer in any school with Internet access. The benefits of implementing this program could be reflected in an improvement in children's quality of life, and a decrease in health costs to public health systems. The use of these platforms may be very cost-effective, although cultural adaptations will always be necessary, depending on the most common diets and food patterns of each culture.

To our knowledge, this is the only NE platform that has been developed, implemented, and had its efficacy analyzed with dietitians, primary school teachers, education students, and 9- to 12-year-old children.

NUTRITIONAL KNOWLEDGE QUESTIONNAIRE – MEAL

Name:
Age:
School:

1. The digestive system is responsible for:
   A. The correct functioning of the bone system.
   B. The transformation of food into nutrients.
   C. Aspects related to the visual system.

2. Indicate the time that you think our body needs to digest these foods:

	Less tan 2 hours	2 to 4 hours	More tan 4 hours
Liquid foods like juices and smoothies			
Carbohydrates like bread, cereals and rice			
Proteins like meat, fish, legumes and eggs			
Fats like pastries, french fries or fast food			

3. It is important to know when our body is really hungry because (choose the correct answer):
   A. It is a way to give it as much food as possible and avoid frequent hunger.
   B. To control not eating and thus stay healthy and slim.
   C. To adjust to these regular periods and to maintain the natural and healthy functioning of our body by giving it what it needs when it really needs it.

4. What are the functions that fiber plays in our body? (Choose the correct answer):
   A. Increases cholesterol levels.
   B. Builds and repairs muscle tissues.
   C. Helps regulate intestinal transit, is a detoxifier, and has a satiating effect.

5. The Food Pyramid represents:
   A. The types of food that used to be consumed in ancient Egypt.
   B. The different foods and the frequencies to eat them and achieve a healthy and balanced diet.
   C. What food should be eaten and what should not.

6. Indicate how often the following foods should be consumed to achieve a healthy and balanced diet. Put a cross on the box that you think is correct:

	Daily	**One to three times a week**	**Sporadically (once a month or less)**
Cereals, bread, pasta, potatos			
Red meat, butter, sweets, fries			
Meat, fish, eggs, legumes			
Dairy products, legumes, fish			
Cereal, legumes			
Water			

7. The recommended number of daily meals is:
   A. 7
   B. 5
   C. 3

8. Being physically active helps us to:
   A. Play video games in a much better way, quiet at home and without getting tired, hot or cold on the street.
   B. Improve our overall health, get healthy as well as meet other children and sleep better.
   C. Have fun when we are bored.

9. The nutrients provided by cereals are (mark the correct answer):
   A. Carbohydrates, proteins, and minerals.
   B. Calcium, iron, and aluminum.
   C. Magnesium, freon, and gold.

10.- Legumes (lentils, chickpeas, beans, etc.) have a high content of (check the correct answer):
   A. Fiber.
   B. Animal protein.
   C. Fats.

11.- The frequency with which it is recommended to eat red meat is:
   A. 2 to 3 times a month.
   B. 2 to 3 times a week.
   C. 2 to 3 times a day.

12.- Food composition tables show:
   A. Historical information about how food was prepared in the Middle Ages.
   B. A practical tool to obtain food information in a simple way.
   C. How many harmful elements do foods contain.

13. For our body to acquire all the nutrients that food provides us with, they must be prepared with hygiene, otherwise:
   A. The number of calories in food may increase.
   B. We could be eating contaminated food, with microbes, bacteria, and other elements harmful to the body.
   C. Nothing happens if the food is not washed, it is optional to clean it.

14. Breakfast is the main meal of the day, why?
    A. It is the first meal of the day and on it depend our body and mind having the energy and nutrients necessary to do all the activities that we have scheduled.
    B. It is the moment in which we can enjoy pastries, cookies, sweets, etc. The richest of all foods in the Food Guide Pyramid.
    C. Because when I go to school my parents let me go into the bakery and choose what I want for breakfast.

15. If you are hungry when you are nervous or sad, what do you think you should do?
    A. Eat sweets and chocolates to feel better.
    B. Try to realize why I feel that way.
    C. Watch a movie and eat fried food to clear myself and be happy.

16. Pablo had a difficult day at school because the teacher scolded him for speaking in class and then argued at recess with his best friend. Pablo comes home sad and tired, and decides to snack on two donuts because he wants to eat something sweet; an hour later, he's still feeling bad and decides to have a package of chips and a sugary drink. Evaluate Pablo's behavior considering what we have learned about healthy eating.
    A. I think that Pablo does the right thing, since he is tired and sad, and eating what he likes the most at that moment will help him feel better.
    B. I think that Pablo does not follow a healthy diet since he is using food to try to feel better.
    C. I think that Pablo does the right thing because when you are growing you can eat everything you want and when you want.

17. Following the principles learned about a healthy and balanced diet, check the option that you consider correct in the following situation: you are with some friends and go by a pastry shop that smells great and has amazing buns displayed on its windows. Both you and all of your friends have just had a snack, but…
    A. You join two friends to buy yourself the biggest chocolate bun because, although you are not hungry, you have craved it.
    B. Instead of buying that bigger bun you decide to buy yourself some donuts and a sugary drink because you think it is healthier.
    C. You decide to stay with two other friends outside the bakery and wait for the next main meal because you are really not hungry.

18. Isabel is a girl who feels that she has a few extra kilos as compared to her peers, and she wants to lose weight. What would you recommend Isabel to do to control her excess weight?
    A. Eat as little as possible, the less you eat the better and faster you will lose weight.
    B. Eat very little and only vegetables.
    C. Talk to your teachers and parents about how you feel and how you can have a balanced diet.

19. Carlos's friends told him that they do not like broccoli at all because of its appearance and the "strange" flavor they say it has; what should Carlos do?
    A. Don't try this food because you know beforehand that it does not taste good.
    B. Disregard the opinion of your friends and still try the food to discover for yourself what its texture and taste are like.
    C. Follow your friends' opinion and tell people that broccoli is bad and does not taste good.

20. You are given the chance to try a food that you have never tried before but you know is healthy; what do you do?
    A. You try it even though at first glance it may have a "rare" appearance or a taste not as sweet as you imagined.
    B. Even though you have never tried that food, you do not try it now because you know you won't like it.
    C. Although you have not tried it yet, you will not say that you don't like it so that your parents or other people will not overwhelm you when it comes to eating it.

21. Here are some myths or lies regarding food, please identify them:
    A. Fruits and vegetables should be eaten every day.
    B. If I eat fruit, I can eat as much junk food as I want.
    C. Breakfast is the most important meal of the day so it should not be avoided.

Answers

1.B	5.B	7.B	14.A	21.B
2.1.A	6.1.A	8.B	15.B	
2.2.A	6.2.C	9.A	16.A	
2.3.B	6.3.B	10.A	17.C	
2.4.C	6.4.A	11.B	18.C	
3.C	6.5.A	12.B	19.B	
4.C	6.6.A	13.B	20.A	

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