

ILLUMINATIONS

The Physiology of Obesity

MestreChef nutritional game: an alternative method to promote nutrition facts label reading in obesity outreach activities

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Abstract

Reading nutrition facts labels is a competency for which training is given in several nutrition education programs, especially in obesity outreach workshops. The Top Trumps-style card game is commonly used in obesity prevention educational programs to engage participants in reading nutrition facts labels; however, the success of TV cooking shows among children and teenagers has not been explored for educational purposes. This paper is a descriptive study of developing a gamified activity as part of the one-time outreach workshop facilitated by the Obesity and Comorbidities Research Center (OCRC) in Brazil. By playing the MestreChef Nutritional (MCN) game, participants followed similar rules as the corresponding TV cooking show. They were challenged to decide to select food items, calculate dietary food intake, and prepare a recipe to visualize the proportion of macronutrients contained in daily diets. The analysis of the nutritional dietary table completed by participants revealed to be a rich source of information, and we identified in our cohort that selecting an adequate number of food items and making healthy food choices was not concerning. However, their lack of competency in performing mathematical reasoning, particularly in calculating serving sizes and converting grams of macronutrients into calories, was evident. Moreover, facilitators of the workshops agreed that the MCN game presents definitively more didactic effectiveness and playability than the Foods Top Trumps, a former game used in the outreach workshops. The MCN game nourishes the engagement of the participants in learning nutrition-related concepts and may be an efficient didactic resource to improve nutrition knowledge in outreach activities when an alternative method is required to stimulate reading nutrition facts labels.

NEW & NOTEWORTHY Reading nutrition facts labels is a typical activity promoted in obesity prevention educational programs. By playing the MestreChef Nutritional, participants can immerse in the context of a food TV show game to have the first contact with reading nutrition facts labels for a learning purpose. However, the game can reveal the participant's limitations in mathematical reasoning despite the didactic potential of the game in promoting obesity-related physiology concepts.

gamification; nutrition education; nutrition facts label; obesity; outreach

INTRODUCTION

The capacity to read the nutrition facts label is positively associated with choices that promote healthier diets (1), which ultimately could contribute to avoiding obesogenic behaviors. According to Moore et al. (2), there are two types of interventions aiming to educate people to read and interpret nutrition facts labels: 1) type 1 interventions, which are focused on nutrition label education facilitated during a one-time program or session, and 2) type 2 interventions, which are programs encompassing nutrition label education alongside other components of healthy diet consumption, such as healthy cooking, lifestyle, and metabolic status management. Additionally, using nutrition facts labels to learn basic nutrition knowledge should be integrated into the science curriculum, as recommended by the U.S. Food and Drug Administration and other

regulatory organizations worldwide (3). Reading nutrition facts labels is a typical activity promoted in obesity prevention educational programs, such as conceptualization of obesity, body composition measurements, and healthy food tasting. One common practice to engage participants in reading nutrition facts labels in those programs is to use the Top Trumps card game, which consists of confronting competitors in comparing the values of nutrients in nutrition labels (4). Despite its validity in promoting knowledge acquisition independently of behavioral changes, the Top Trumps card game is widely used as an educational resource for health sciences educational programs, obesity prevention interventions, and science curricula (5–7).

Using serious games to promote nutrition knowledge is a widespread strategy during educational interventions and school activities. In the 1970s, the first serious game created



to teach nutrition was reported, a game in which the players had to create a well-balanced meal using cards of food items (8). Currently, the gamification of lectures or scientific concepts is a didactic strategy to engage students in learning while having fun. Gamification transforms the experience of the participants into knowledge acquisition by adding game-based elements (story, challenge, feedback, rewards, etc.) to the content presented (9), either for formal education or noneducational purposes, such as TV shows. Additionally, the goal of gamification is not only to promote direct learning but to engage the players in an experience that targets a particular attitude/behavior, which fosters the learning process (10).

Frequently, using nutrition facts labels without a game-based approach can be repetitive and not stimulating for the students. We present herein a gamified strategy based on a cooking TV show used to engage the participants in reasoning about nutrition facts labels and food choices as an alternative method for using Top Trumps-like games. This study describes the game instructions, as well as discusses the use of the activity worksheet as an instrument to assist educators in assessing the achieved outcomes (Table 1), and depicts the perceptions of facilitators regarding the advantages of MestreChef Nutritional over simplistic games similar to Top Trumps.

THE PURPOSE OF THE MestreChef NUTRITIONAL GAME

The MestreChef Nutritional (MCN) game was created as part of the outreach activities promoted by the Obesity and Comorbidities Research Center (OCRC), whose goals are to investigate the mechanisms underlying the pathogenesis of obesity and educate the population about understanding and preventing obesity and its associated diseases (diabetes, hypertension, cancer, etc). The MCN game is the introductory activity of the one-time workshop developed to target participants with a K-12 level of schooling and offered by the OCRC to the general public. The goals of the MCN as one activity of the workshop are to immerse the participant in reading nutrition facts label and to map the level of nutrition knowledge and nutrition facts label reading skills of the participants to facilitate educators in deciding the depth of approach for the subsequent activities, such as short lecture about healthy habits to prevent obesity or a hands-on activity to learn about the pathophysiology of obesity and comorbidities and degustation of a healthy meal. The MCN game was created to engage the participants in making food decisions by reading the nutrition facts of commercial products and help the participants visualize the proportion of macronutrients present in different diets. Originally, the outreach

activities included the Top Trumps card games as the “ice-breaking” strategy to immerse the student in nutrition facts label reading; however, its application in educational activities is widely overused, and novelty was required to connect the learning object to the contemporary needs of the new generation of students. Top Trumps is an old-fashioned game created in the late 1970s, despite its prevalent use by educators (11) and positive effects in promoting nutrition knowledge in both children and parents, such as the Top Grub that is used in UK nutrition education programs (6, 7). Studies have shown that games like Top Grub increase knowledge and, consequently, awareness of a healthy and balanced diet. Following the trend of 2010 yr, we developed the game “Super Trunfo dos Alimentos.” The game consists of a competition where the winner collects the highest number of cards after confronting competitors by making decisions based on the numerical information given in the cards (see Supplemental Fig. S1; all Supplemental material is available at <https://doi.org/10.6084/m9.figshare.24514342.v1>). The player picks the top card of his pile and announces the value of a given item, and it wins if it is the lowest value for items of the red category or the highest value for items of the green category. Nevertheless, the stakeholders of the OCRC considered the game boring, excessively used in the Brazilian educational system, and without perspectives of contributing as a game changer in the fight against obesity.

MestreChef NUTRITIONAL GAME RULES

Figure 1 illustrates the timeline of the game and overall information on goals, actions, timing, and learning objectives. Groups of five to eight participants were advised about each role they should play: the shoppers, represented by a maximum of two players in charge of food choice and shopping in the supermarket; the accountants, represented by a maximum of two players responsible for calculating the proportions of food and macronutrients to achieve the goal; the cooks, represented by a maximum of two players that measure the amount of each representative ingredient to prepare the recipe. Whenever there was a supernumerary amount of participants, they played, choosing the food for the recipe, guiding the shoppers, and/or making decisions about healthy elements of the selected food item. To start the game, each group had to randomly draw characteristics of the situation that the diet must be created for 1) a real-life situation that involves food choice, such as “having a picnic with your best friend” or “buying a snack for a friend at the cinema” or “preparing a breakfast and feeding your parent in the bed” or “buying a snack

Table 1. Outcomes of the groups according to the filling up the dietary nutritional worksheet

Outcome	Unsatisfactory, %	Satisfactory, %	P Value
Achievement of number of portion goal	28.49 ± 19.9	71.50 ± 19.9	0.0212
Achievement of calorie goal	55.04 ± 31.4	44.84 ± 31.6	0.8335
Macronutrient-calorie conversion	56.75 ± 23.9	43.25 ± 23.9	0.4633
Mathematical reasoning	55.52 ± 24.9	44.48 ± 24.9	0.5284
Food choices	30.06 ± 14.2	69.94 ± 14.2	0.0421

Data express the mean percentage of a total of 50 worksheets collected in 5 different workshop offers. Achieving the number of portion goals and choosing adequate food were significantly more satisfactory. Results are expressed as means ± SD, and the Mann-Whitney test was applied.

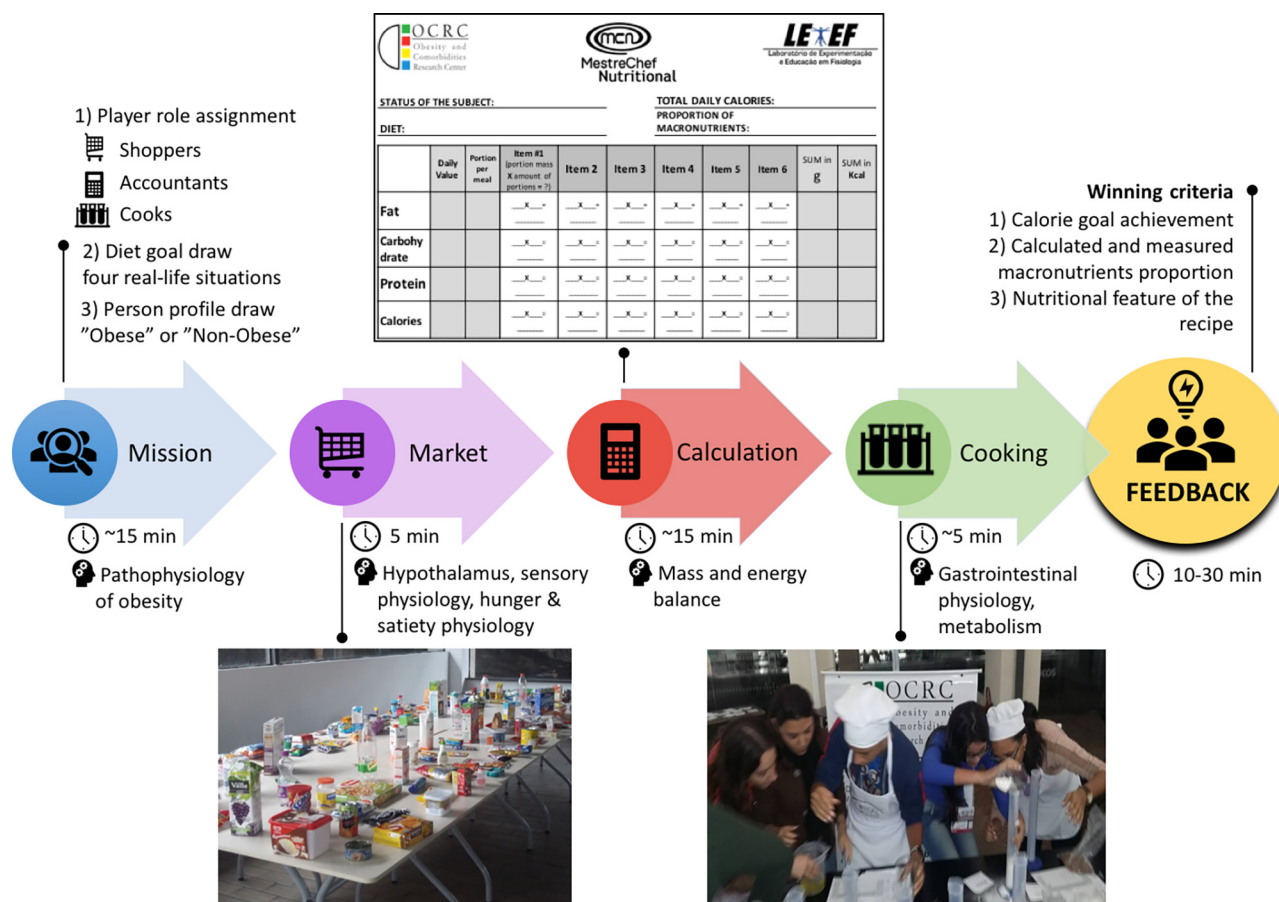


Figure 1. Timeline and MestreChef Nutritional (MCN) game setting. The 5 phases (Mission, Market, Calculation, Cooking, and Feedback) are presented, including information on duration and physiology concepts addressed. The mission and feedback phases determine the specific goals for each group and the winning criteria, respectively. *Top:* illustration of the nutritional dietary table given to the participants as the activity worksheet. *Bottom left:* illustration of the market, where the shoppers could select cooking items from 152 foods or 38 beverages' actual packaging. *Bottom right:* illustration of participants cooking their dietary recipes.

for your best friend at the cafeteria," and 2) a weight status of the person you are feeding, such as "non-obese" or "obese." Each group received a worksheet (nutritional dietary table) to complete with the following information: daily value, portion per meal, portion mass multiplied by the amount of portion for each item, sum in grams, the sum in kilocalories for each macronutrient (fats, carbohydrates, and proteins; Fig. 1, top). Besides, each group received a nutritional dietary reference table describing the proportion of macronutrients in a standard diet (2,200 kcal of daily calories, 73 g/30% of lipids, 330 g/60% of carbohydrates, and 82 g/15% of proteins) or a balanced diet for weight loss (1,450 kcal of daily calories, 40 g/25% of lipids, 163 g/45% of carbohydrates, 90 g/25% of proteins) according to the Brazilian Ministry of Health (12) and dietary reference intakes for obesity treatment (13, 14). Participants were instructed to use the classical system to convert mass to calories for lipids (1 g = 9 kcal), carbohydrates (1 g = 4 kcal), and proteins (1 g = 4 kcal). The groups have to complete three phases.

Phase I: Market Shopping

With the aid and screaming of all group members, the shoppers go to the supermarket to choose 6 items out of 152

foods or 38 beverage items (Fig. 1, bottom left). While shopping, the player can discuss with the team to decide on the best items to buy, but only shoppers can enter the supermarket zone and touch the products. The participants use baskets to collect items during 5 min of shopping.

Phase II: Recipe Calculation

Participants have to select at least three out of six items bought at the supermarket and include at least one item with a "plus," which is a nutritional feature that the group considers healthier than the properties of the macronutrients. All the students must participate in the recipe decision and item selection to reach the best proportion according to their goal; however, only the accountants are allowed to fill up the nutritional chart (activity worksheet). At this moment, it is essential to include the participation of undergraduate or graduate students as instructional assistants to guide the students with basic orientations: 1) the amount of calories to be eaten in the selected situation must be proportional to the metabolic status of the subject picked as a goal; 2) the amount of calories shown in the reference table is equivalent to the total daily consumption; and 3) the diet recipe should consider the consumption of three meals per day.

Phase III: Cooking the Dietary Recipe

At this phase, the students should have their calculations done, and the cooks have to start preparing the recipe. Students have to measure the volume of each macronutrient using a graduated cylinder. They have to fill the graduated cylinder with cooking oil, sugar, and soy meat, representing the calculated mass of lipids, carbohydrates, and proteins, respectively. They are oriented to use 1 mL of oil as equivalent to 1 g of oil. The cooking outcomes are critical to helping the participants visualize the amount and proportion of each macronutrient in their prepared recipe (Fig. 1, bottom right). The primary instructor, who plays the role of the presenter, starts a 20-min countdown at the beginning of phase II, and the anxiogenic effect of the timer is desired to create an ambiance similar to the TV show.

THE FEEDBACK PHASE

This phase is critical to the learning process of the MCN because it is the moment to teach basic concepts that help participants understand the impacts of obesity on the human body. Because the MCN was created by a physiologist, assisted by undergraduate and graduate facilitators from a physiology background, and originated in a research center dedicated to the studies in the physiology of obesity, the concepts addressed during the feedback phase were oriented toward the physiological foundations of obesity. To determine the winner, the nutritional dietary table of each group has to be analyzed, and the proportion of the macronutrients has to be verified. The facilitators perform this task while the presenter provides feedback and dialogued reasoning about each phase. Three criteria decide the winner of the game: 1) if the calculations did not pass 50 kcal for more or less of the calorie goal; 2) if the comparison between the calculated amount of macronutrients and the actual amount measured in the graduated cylinder was equivalent; and 3) if the choice for the “plus” was well justified. Although the discussion could be adjusted for different audiences and available time, throughout our experiences, we developed the strategy to associate each phase with specific concepts. The presenter reviews each phase and connects it to some scientific concepts before announcing the winner. Briefly, the concepts addressed in each phase are as follows: 1) the mission; because the obese and nonobese body profiles are introduced, we discuss the pathophysiology of obesity in terms of adipose tissue accumulation, weight gain, and body mass index; 2) the market; because there is a visual appeal to market products and decision making about food, we introduce the role of the hypothalamus in the physiology of hunger and satiety, and the visual contribution to trigger autonomic responses; 3) the calculation, because students are engaged in mathematical reason, this phase is suitable to discuss the core concept of mass balance and the biochemistry of energy balance; and 4) the cooking, because visualization the proportions of macronutrients is the goal of this phase, we discuss gastrointestinal physiology, metabolism and the role of hormones (ghrelin, leptin, and insulin) in the pathogenesis of the obesity. It is worth mentioning that the deepness of the discussion is an immediate decision skill

developed by the presenter to accommodate diverse groups of learners.

WHICH EDUCATIONAL INFORMATION DOES THE *MestreChef* NUTRITIONAL GAME REVEAL?

As previously mentioned, the MCN game was strategically created to deliver a more engaging activity for using nutrition facts labels in our obesity prevention program and served to assist our workshop facilitators in identifying the level of nutrition knowledge of the participants and adjusting the complexity of subsequent activities.

All nutritional tables (worksheets) filled by the participants were classified as satisfactory or unsatisfactory achievement. Data are expressed as mean percentage $\pm$ standard deviation of a total of 50 worksheets collected in 5 different offers of workshops, and the Mann-Whitney test was applied because the majority of data did not pass the Kolmogorov-Smirnov normality test. This study was approved by the Unifesp Institutional Review Board and registered under the registration number CAAE:86694918.3.0000.5505, and participants provided informed consent and authorized the use of their collected individual data. A total of 217 attendees of the workshops, divided into 50 groups, were included in this study. Attendees were 52% enrolled in high school, 39% percent in middle school, and 9% in adult education programs. The female-to-male ratio was 54/26, and the age range was 13 to 42 years old.

Regarding the number of portions, groups were classified as satisfactory (SAT) when able to establish 2 or more portions per item of the recipe. The percentage of SAT groups was significantly higher compared to unsatisfactory (UNSAT) groups (71.50 ± 19.9 vs. 28.49 ± 19.9 , $P = 0.0212$). The groups in which the sum of calories was overestimated or underestimated by a maximum of 50 kcal were considered SAT. More than half of the groups were unable to reach this status of calorie goal (SAT 44.84 ± 31.6 vs. UNSAT 55.04 ± 31.4 , $P = 0.8335$). The participants struggled to accommodate the chosen items because they contained unforeseen disproportional amounts of macronutrients. The overall population mismatches food choices and calorie ingestion due to the lack of knowledge of the recommended daily calorie intake (15). Therefore, nutrition education and policy initiatives may help to overcome this issue. The data revealed that mathematical reasoning is not mastered by the majority of the players, despite their knowledge of making satisfactory food choices. Regarding grams-to-calorie conversion, groups were classified as SAT when making correct calculations to sum the total amount of grams and multiply it by the proper factor to convert into calories. Over half of the groups were considered UNSAT (SAT 43.25 ± 23.9 vs. UNSAT 56.75 ± 23.9 , $P = 0.4633$). Consequently, groups were classified as UNSAT regarding mathematical reasoning when making calculations with mathematical errors. The MCN game revealed a weak mathematical reasoning competency of the participants (SAT 44.48 ± 24.9 vs. UNSAT 55.52 ± 23.9 , $P = 0.5284$). The most frequent mistake was in sum or subtraction operations, which are supposed to be elementary competencies for the age level of the participants. This observation

reinforces the importance of biology and mathematics integration in elementary and secondary schools to consolidate learning and develop skills for daily decisions, such as food choices in a supermarket. When interpreting this data, we cannot ignore the pressure caused by the time counting or the inadequate setting to make calculations (16).

Surprisingly, the percentage of SAT food choices (combined the selected items to create a recipe containing food and beverage and prioritize healthier food items) was significantly higher than UNSAT (SAT 69.94 ± 14.2 vs. UNSAT 30.06 ± 14.2 , $P = 0.0421$). However, when we analyzed the most popular items chosen in all offered workshops, we observed that some wrong decisions were made. The three most popular items selected were white bread, bottled juices, and low-fat yogurt, respectively (data not shown). The cooking phase is essential to help participants visualize the amount of macronutrients consumed in a meal, especially sugar and fat because visualizing is more didactic and impressive than reading numbers on a table. Indeed, humans are more innately designed to discriminate magnitudes, such as proportions, than to perceive numerosity in large numbers and quantities precisely (17). During the feedback phase, it was explained that the food used for cooking was just representative items, and the equivalency of grams to milliliters and vice versa was clarified to avoid creating misconceptions about mass-volume conversion.

THE ADVANTAGES OF MCN ACCORDING TO THE PERCEPTIONS OF THE FACILITATORS

Finally, the facilitators of the workshops, who were undergraduate and graduate students and had previous contact with the Top Trumps for nutrition education, compared and evaluated the two gamified methodologies. A total of 11 facilitators (72% female; age range 27 to 59 years old; 63% with a major in biology education) responded to a survey. The survey asked the facilitators to express their perception about the didactic effectiveness and playability of the two games on a scale varying from “definitively more in MestreChef” to “definitively more in Top Trumps.” The characteristics analyzed by the survey were as follows: “having fun while learning,” “learning to read nutrition facts labels,” “learning nutrition and energetic metabolism concepts,” “learning mass-calorie conversion,” “understanding the nutrition properties of foods,” “making healthy decisions,” “Misunderstanding game

rules,” “feeling stressed while playing,” “interacting with players,” “understanding the importance of nutrition facts reading for nutrition management of obese people,” “improving mathematical reasoning,” and “promoting active learning.” Figure 2 depicts the advantages of MCN over Top Trumps for all characteristics analyzed, except for “learning to read nutrition facts labels,” which was considered to be achievable by both games. Indeed, “reading” can merely represent the capability of reading words and numbers not interpreting the meaning of the information or establishing more complex reflections. Although any statistical difference was not observed by applying the Kruskal-Wallis test, the analysis of the mean $\pm$ SD and confidence interval revealed the benefits of MCN on promoting fun while learning [1.00 ± 1.00 ; confidence interval (CI): 0.23–1.76], healthy decision-making (0.66 ± 0.86 ; CI: 0.00–1.33), group interaction (1.00 ± 1.25 ; CI: 0.05–1.94), the comprehension of the importance of nutrition facts reading for nutrition management of obese people (1.00 ± 1.18 ; CI: 0.14–1.85), and active learning (1.00 ± 1.00 ; CI: 0.23–1.76).

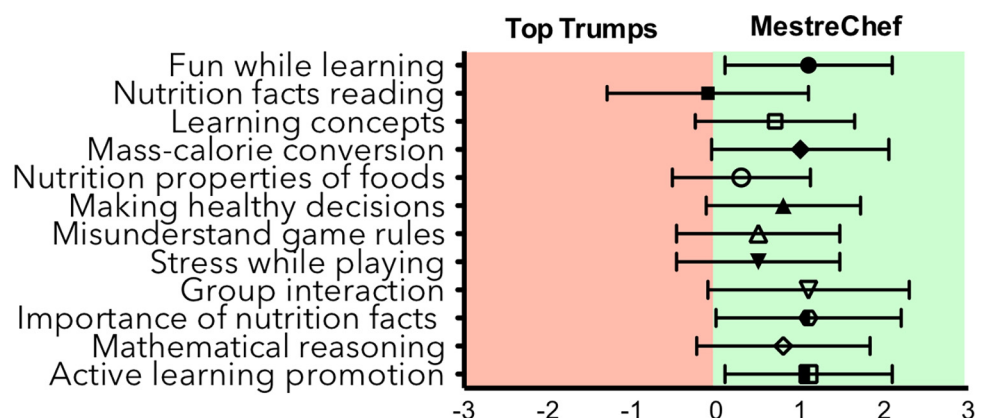
LIMITATIONS

Among the limitations of the study is that the lack of quantitative data collected from the participants generates uncertainty about the contribution of the MCN game to improving mathematical reasoning, converting mass to calories, and achieving calorie goals. Despite not having explored the impact of the MCN on promoting learning of the specific physiology content discussed during the feedback phase, this study described an alternative method to integrate physiology concepts in a nutrition education activity, which can be more effective, at least more fun, than the traditional method of using nutrition facts to dispute a Top Trumps game.

CONCLUSIONS

By gamifying the reading of nutrition facts labels through the rules of a TV show competition, we were able to engage the participants in a series of tasks that can contribute to understanding the correlation between food choices and calorie consumption. Television cooking shows may affect children’s food choices by providing portion-size cues (18),

Figure 2. Perception of the facilitators regarding the educational effectiveness and playability of MestreChef Nutritional (MCN) game. Undergraduate and graduate students, who served as facilitators in some workshops offering the MCN game activity, elaborated a comparison between the MCN game and Foods Top Trumps. The scale varying from “definitively more in MestreChef” to “definitively more in Top Trumps” was numerically converted to 2 and -2 , respectively. Data are expressed mean $\pm$ SD ($n = 11$) and the Kruskal-Wallis test was applied.



encouraging reflections on managing weight status (19), and stimulating the consumption of healthy food (20).

Thus the MestreChef Nutritional game is a didactic resource suitable for activities of scientific outreach and nutrition education programs. To the best of our knowledge, this is the first study transferring the dynamics of a cooking TV show into a strictly educational activity. The structure and rules of the game are easy to implement because most of the young generation are familiar with reality TV shows, contributing to the engagement we observed. The MCN game is fun and can reveal valuable information about the nutrition facts reading skills of the participants, which further assist facilitators during interventions. Additionally, it can exteriorize the paradoxical behavior of knowing how to select healthy food without knowing how to determine portions or interpret caloric values. Overall, it is a good resource to help students visualize the amount of sugar and fat present in our daily meals. Moreover, involving undergraduate and graduate facilitators in a community outreach activity, such as the MestreChef Nutritional Game, builds their skills as aspiring healthcare professionals.

DATA AVAILABILITY

Data will be made available upon reasonable request.

SUPPLEMENTAL INFORMATION

Supplemental Fig. S1: <https://doi.org/10.6084/m9.figshare.24514342.v1>.

ACKNOWLEDGMENTS

We thank all the undergraduate and graduate students of the Federal University of São Paulo and State University of Campinas that assisted the participants of the workshops as facilitators.

GRANTS

The outreach workshops were offered due to the support of São Paulo Research Foundation (FAPESP No. 2013/07607-8).

DISCLOSURES

C. Lellis-Santos is an editor of *Advances in Physiology Education* and was not involved and did not have access to information regarding the peer-review process or final disposition of this article. An alternate editor oversaw the peer-review and decision-making process for this article.

No conflicts of interest, financial or otherwise, are declared by the authors.

AUTHOR CONTRIBUTIONS

P.M.I. and C.L-S. performed experiments; P.M.I. and C.L-S. analyzed data; P.M.I. and C.L-S. interpreted results of experiments; C.L-S. prepared figures; P.M.I. and C.L-S. edited and revised manuscript; P.M.I. and C.L-S. approved final version of manuscript.

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