

**Development and application of a manual and virtual game for food education for
children with Down Syndrome**

**Desenvolvimento e aplicação de um jogo manual e virtual para educação alimentar de
crianças com Síndrome de Down**

**Desarrollo y aplicación de un juego virtual y manual para la educación alimentaria de
niños con Síndrome de Down**

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Abstract

Games provide fun and can serve as a tool for learning and behavior change. Thus, the objective was to develop and apply a manual and virtual game to work on food education for children with Down Syndrome, with or without food allergy, seeking to instruct and compare the efficiency of the methodologies used through play. For the development of the virtual game software, the construction platform Delphi 10.1 Berlin Starter Edition was used, simulating a supermarket for the purchase of food. For the development of the manual game, cards that simulated the same situation were used. After making and approving the ethics committee (n° 2,094,016), the games were applied to 60 children from a social organization in Fortaleza-CE in the age group from 5 to 11 years old, 22 of whom were allergic children. Allergic children were taught through games to avoid consuming allergenic food. Children without allergies have been taught to avoid the consumption of foods that are bad for their health. The children were divided into two groups of 30 and questions were asked to assess

their learning. It was observed that 48.32% of the children responded correctly with the virtual game, 43.33% responded correctly with the manual game and 8.35% were wrong, with 1.67% errors with the virtual game and 6.68% errors with the manual game. It was observed that it was easier to learn with the virtual game. Therefore, the use of games to carry out children's food education proved to be a good teaching/learning strategy.

Keywords: Games; Nutrition education; Down's syndrome.

Resumo

Os jogos proporcionam diversão e podem servir como uma ferramenta de aprendizagem e mudança de comportamento. Assim, o objetivo foi desenvolver e aplicar um jogo manual e virtual para trabalhar a educação alimentar de crianças com Síndrome de Down, com ou sem alergia alimentar, buscando por meio lúdico instruir e comparar a eficiência das metodologias utilizadas. Para o desenvolvimento do software do jogo virtual, foi empregado a plataforma de construção *Delphi 10.1 Berlin Starter Edition*, simulando um supermercado para compra de alimentos. Para o desenvolvimento do jogo manual, utilizaram-se cartas que simulavam a mesma situação. Após a confecção e aprovação do comitê de ética (nº 2.094.016), os jogos foram aplicados com 60 crianças de uma organização social de Fortaleza-CE na faixa etária de 05 à 11 anos, sendo 22 crianças alérgicas. As crianças alérgicas foram ensinadas através dos jogos a evitarem o consumo do alimento alergênico. Já as crianças sem alergias foram ensinadas a evitar o consumo de alimentos que fazem mal a saúde. As crianças foram divididas em dois grupos de 30 e realizaram-se perguntas para avaliar sua aprendizagem. Observou-se que 48.32% das crianças responderam certo com o jogo virtual, 43.33% responderam certo com o jogo manual e 8.35% erraram, sendo 1.67% de erros com o jogo virtual e 6.68% de erros com o jogo manual. Observou-se que houve maior facilidade de aprendizado com o jogo de virtual. Portanto, o uso dos jogos para realizar a educação alimentar das crianças mostrou-se ser uma boa estratégia de ensino/aprendizagem.

Palavras-chave: Jogos; Educação nutricional; Síndrome de down.

Resumen

Los juegos brindan diversión y pueden servir como una herramienta para el aprendizaje y el cambio de comportamiento. Así, el objetivo fue desarrollar y aplicar un juego manual y virtual para trabajar la educación alimentaria de niños con Síndrome de Down, con o sin alergia alimentaria, buscando instruir y comparar la eficiencia de las metodologías utilizadas a través del juego. Para el desarrollo del software del juego virtual se utilizó la plataforma de

construcción Delphi 10.1 Berlin Starter Edition, simulando un supermercado para la compra de alimentos. Para el desarrollo del juego manual se utilizaron cartas que simulaban la misma situación. Después de realizar y aprobar el comité de ética (n° 2.094.016), los juegos se aplicaron a 60 niños de una organización social en Fortaleza-CE en el grupo de edad de 5 a 11 años, de los cuales 22 eran niños alérgicos. A los niños alérgicos se les enseñó mediante juegos a evitar consumir alimentos alergénicos. A los niños sin alergias se les ha enseñado a evitar el consumo de alimentos nocivos para su salud. Los niños se dividieron en dos grupos de 30 y se les hicieron preguntas para evaluar su aprendizaje. Se observó que el 48,32% de los niños respondió correctamente con el juego virtual, el 43,33% respondió correctamente con el juego manual y el 8,35% se equivocó, con 1,67% de errores con el juego virtual y 6,68% de errores con el juego manual. Se observó que era más fácil aprender con el juego virtual. Por lo tanto, el uso de juegos para llevar a cabo la educación alimentaria de los niños resultó ser una buena estrategia de enseñanza/aprendizaje.

Palabras clave: Juegos; Educación alimentaria; Síndrome de down.

1. Introduction

Children with chromosome 21 trisomy, better known as Down's syndrome (DS), have mental and motor difficulties, to varying degrees, including learning and memory, congenital heart disease, Alzheimer's, leukemia, cancer and Hirschprung's disease (Farias et al., 2020). According to the Brazilian Federation of Down Syndrome Associations to FBASD, DS is characterized as one of the most common genetic diseases globally; the estimated incidence is 1 in 1,000 live births. Each year, about 3 to 5,000 children are born with Down Syndrome (Fbasd, 2020).

Such immunological changes and being related to the development of autoimmune diseases are also associated with food allergies (Pontes and Alcântara 2017). Thus, children with DS have a high probability of being allergic to dietary antigens. The need to encourage healthy foods such as vegetables, fruits and legumes, sources of vitamins, minerals and fibers, making clear the importance of adhering to a healthy diet and thus prevent disease progression (AbdAllah et al., 2013).

It is known that children with DS, when properly attended and stimulated, have the potential for a healthy life and full social inclusion. Researches that use nutritional education as one of the intervention strategies reported improved nutritional knowledge, attitudes, and

eating behavior, influencing the family's eating habits. Healthy behavior should be stimulated and motivated to change lifestyle (Pucci et al., 2016)

Playful processes to build learning in food and nutrition are more effective and with better results than other activities. This form of learning captures children's attention and arouses their curiosity in the search for new experiences and experiences (Salvi and Ceni, 2009). In recent years, spaces for debate on the use of new technologies as a tool have increased considerably useful in the teaching-learning process.

Informatics applied to education has many benefits, such as making information more attractive, improving teaching and arousing curiosity. Informatics has assumed a primary role in education. One way to use information technology in education concerns computer games, as they enable the development of skills such as perseverance, involvement, organization and autonomy (Martins, 2019).

Games are instruments that, in addition to providing fun, are also a technology capable of facilitating and accelerating learning and behavior change (Panosso et al., 2015). Digital games are becoming exquisite pedagogical tools, as they offer stimulating, pleasant and efficient teaching functions. In contemporary society, it is visible the constant growth of technology, thus opening up new possibilities for using this resource for education. By applying educational digital games, it is possible to create a connection between playful work and the organization of thought, a valuable resource for working with special children (Moreira et al., 2017). However, there is a lack of games, both manuals as computational geared towards special children's food education.

Thus, this study aimed to develop a manual and virtual game to work on food education for children with Down Syndrome, with or without food allergy, from the Association of Parents and Friends of the Exceptional (APAE) of Fortaleza-Ce. Also, compare the ease of learning with each game. In this way, in a playful manner and using manual, visual, sound and virtual resources, instruct children about allergenic foods and teach the importance of healthy eating for health promotion.

2. Metodology

The article presents a case study aligned to the quantitative analysis and cross-sectional design, based on the methodology proposed by Lima et al. (2015) and Fagundes et al. (2016), with adaptations. For the realization, a manual card game and a virtual game were

developed, aimed at the food education of children with Down syndrome with or without food allergy. The games were developed from October 2016 to March 2017.

In developing the virtual game software, the construction platform *Delphi 10.1 Berlin Starter Edition* (FREE) was used. The AGILE/SCRUM methodology was used. APAE teachers who already work with children with Down Syndrome were consulted to survey the requirements. The executable module was made available for Windows/Desktop XP/Vista/7/8/ 8.1/10 environment.

For the development of the manual game, the presentation was used in the form of letters containing the food's image and its respective name. The game consists of 60 cards, 29 cards with the image of different foods and the border in green and 29 more cards with the same foods with the wall in red, in addition to these, two more cards with the image of cart supermarket, one with a green border and the other with a red border.

The two games developed were created in a way that it is possible to use them for food education both for children with food allergies/intolerance and to educate about healthy eating. The games feature the following food groups: fruits and vegetables; cereals and oilseeds; proteins and seafood; sweet and industrialized.

The two games feature a supermarket shopping scenario, with images of food and a shopping cart. In the virtual game, the child needs to drag the food to the cart using the mouse, and in the manual card game, the child needs to place the card with the image of the food in a box with the image of the shopping cart. Both the manual game and the computer game can be configured, considering whether the child has food allergies/intolerance, enabling individualized nutritional education.

After submission and approval by the ethics committee for research with human beings at the Centro Universitário Estácio do Ceará (under protocol number 2.094.016), the games were applied at APAE in Fortaleza-CE, with the children who attend this Association, from April to June 2017. The study comprised children enrolled in the age group between 5 to 11 years old during the research period, and children under 5 years of age were excluded from the study because they did not yet attend the computer room of the Association.

The study's initial objective was to carry out the application of games only with children with food allergies/intolerance. However, as the number of children in this situation showed little about the total number of children with Down Syndrome enrolled in the range mentioned above, they were children without food allergies/intolerance are also included.

For the games' application, the children who participated in the study were divided equally into two groups. Initially, the computer game was performed with one group, and then

the manual card game with the other group was applied. When the child had food allergy/intolerance, a fact reported in advance by the parents or guardians, the game was then configured according to the type of allergenic food the child had allergy/intolerance to carry out the specific food education. For this, in the virtual game, the food allergenic or that the child had intolerance or for those without allergies/intolerance the unhealthy food was “blocked,” and the child was unable to drag it to the shopping cart. The same was done with the manual game of 60 cards, 29 cards with a green border with the image of food according to the food groups already mentioned, and to represent the foods not allowed because they are allergenic or unhealthy, 29 cards with the border red, making it possible also to configure it for each child.

At the end of each game's application, questions were asked to assess the children's level of learning. With the data obtained, it was possible to analyze which of the two educational tools the children learned most easily.

After analysis, the results were presented in graphs. The research project was submitted to the Research Ethics Committee of the Estácio do Ceará University Center-Via Corvvs and followed Resolution No. 510 of April of 2016 of the National Health Council, in which they address guidelines and regulatory standards for research involving human beings. It considers respect for human dignity and special protection due to participants in scientific research and that any progress must respect the autonomy and freedom of human beings. Parents or guardians were invited to sign the Free and Informed Consent Term, containing all the necessary information in a clear, objective, and easy-to-understand language prepared following the current Resolution.

3. Results

All 60 children with Down Syndrome enrolled in APAE in the age group of 05 to 11 years old participated in the study; of these, 22 with allergies/food intolerance and 38 without food allergies/intolerance. Children with food allergies were taught through games to avoid allergenic food consumption because it is bad for their health, and they also learned about healthy foods. Children without food allergies/intolerance were taught to avoid frequent consumption of processed foods rich in sodium, sugar and saturated fats, their danger to health, and about healthy foods.

Figure 1 contains the game rules, explains how it works and how to program according to the allergenic profile of each child. It can also be configured for food education

for children without allergies. Before starting the game with children who had food allergies, this part of the game was configured according to each child's allergenic profile. Allergenic foods were marked in that part of the game that contains the food groups, as shown in figure 1 above. After selecting allergenic foods or if the child does not have any food allergies, unhealthy foods rich in sugar, sodium, fats or nutritionally deficient were selected to work on nutritional education.

Figure 1. Game Rules.



Source: Authors.

Figure 2 shows the interface for choosing food groups: proteins, fruits, vegetables, seafood, processed foods, sweets. Besides, this part of the game features alerts with the expression “watch out!” and mentioning the food group that will be purchased by the child who will be playing, completes the warning for the child not to buy what he will not be able to eat because of the allergic problem. That part always appears before the food group shopping game starts. In this part of the game, the child was also explained only about the food group and warning not to buy what he could not eat.

Figure 2. Food groups.



Source: Authors.

In Figure 3, there is a simulation where the child, through the game, was invited to buy the food arranged in the stalls. At this point in the game, the child would choose the food and take it to the shopping cart. If the choice were for allergenic food, then the noise would sound, and the child could not take the chosen food to the cart. It was then that he explained why and carried out nutritional education. When shopping was finished, the cart would run off to the sound of a career noise and pass to the next food group.

Figure 3. Shopping cart.



Source: Authors.

In Figure 4, there is a manual physical game, where the child was instructed to choose the food and put it in the shopping cart. For this manual game, it was used as a marker to differentiate and indicate allergenic and non-allergenic foods, and unhealthy and healthy foods, the colors green and red at the edges of the cards. The green color at the cards' edges indicated that those foods could be bought and consumed by the child. The red color on the edges of the cards, on the other hand, suggested that those foods could not be bought and consumed by the child. The same foods used in the virtual game were the same used in the manual game. Two boxes were also used, one containing the figure of the shopping cart with the green border and the other box with the figure of the shopping cart with the red wall's color. Before starting the game and knowing whether or not that child was allergic to any

food, he explained how the game worked and invited the child to choose the food he wanted to buy using the green border cards initially. If the choice was for an allergenic food, the child explained that the letter should be replaced by the letter with a red border indicating that the food could not be consumed and that it should be kept in the box with the figure with the red border and then explained the reason carrying out nutritional education. If the choice was for non-allergenic or healthy foods, I could put it in the box with the cart's figure with the green border and carry out nutritional education.

Figure 4. Manual gam.



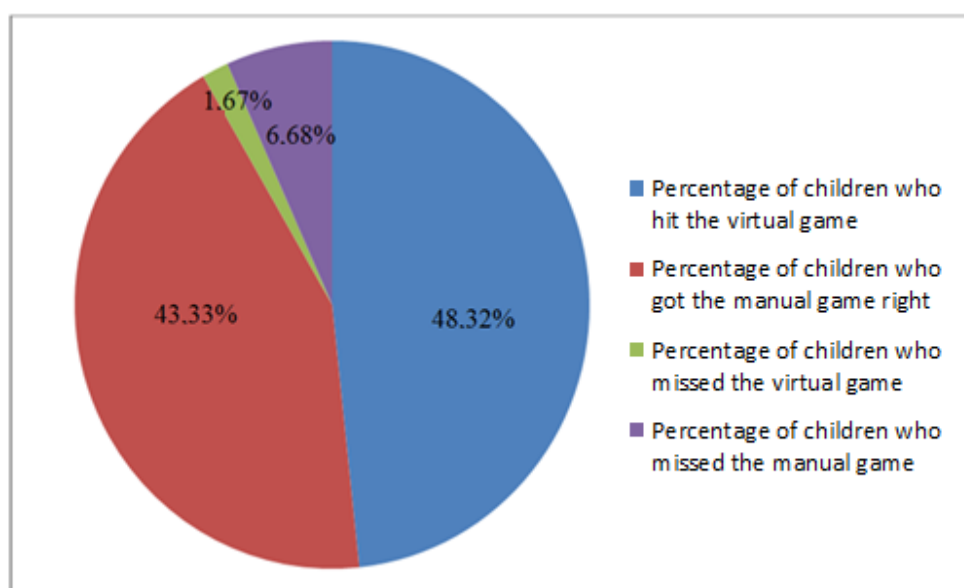
Source: Authors.

The children were divided into two groups of 30. The first group of 30 children participated in the virtual game. The game was applied on different days, as the children attended the APAE on alternate days. At the end of the game, 29 children correctly answered the questions asked to assess their understanding and showed that they learned. Besides, great interest and enthusiasm for the game were observed, possibly due to the virtual game's striking characteristics, such as images with movements and sounds.

The second group of 30 children participated in the manual game also on different days. At the end of the game, 26 children correctly answered the questions showing that they learned. There was also enthusiasm for the manual game.

And when comparing the games, it was observed that there was greater ease of learning with the use of the virtual game. There were 91.66% of children who answered the games' questions, 48.32% in the virtual game and 43.33% in the manual game. The children who made mistakes were 8.35%, with more errors in the manual (6.68%) than in the virtual game (1.67%), as shown in Graph 1.

Graph 1. Distribution of the percentage of learning per game.



Source: Authors.

4. Discussion

The game is not something without purpose; it is through games that the child's logical and motor reasoning is monitored. In playing that the child's learning takes place, it is through playing that they can expand their capacity and development conditions in the experiences through the exchange with another child or with the teachers or their family. In the case of the game, parents and/or responsible (Lambem and Jesus, 2018). Games allow students to get involved from start to finish in the learning process, creating a positive long-term effect on motivation, commitment and learning behaviors (Contreras, 2020).

Studies carried out intending to evaluate the effectiveness of playful interventions as mediators in health education, covering aspects such as eating habits, concluded strong evidence to determine the efficacy of computational and dynamic games in health education for children and adolescents. For example, there was a change in the children's eating behavior involved in the research, which started to increase the consumption of fruits, juices, and vegetables (Coscrato et al., 2010). The present study had a similar result. There was better learning with the use of games, especially with the virtual game. After the games' intervention, some parents reported a change in children's eating behavior, consuming more fruits, natural juices, and accepting vegetables in their diet. This shows that games are valuable teaching strategies for learning that can influence children's behavior.

Besides, the use of the board game as a strategy in early childhood education proved suitable for acquiring content related to health habits. As playful artifacts, games can involve students in learning activities (Santos et al., 2020). Another study used several manual resources to teach about healthy eating. It was found that of the strategies used for food and nutrition education, games were the most successful among children, and they helped assimilate the content presented (Prado et al., 2016). Another search conducted with children to offer their experience with the application of playful-pedagogical procedures in food and nutrition education showed that the children's favorite activities were games, and they commented enthusiastically on what they had learned (Da Silva et al., 2016). These results are similar to the present study, which demonstrated that both manual and virtual games were very well accepted by children and effectively helped assimilate the content presented, leading to a change in behavior.

The technological and playful resources, combined with education for the public of special children, are a medium that needs to be used more. Studies show that its use in education has positive results. A survey conducted in 2015 that assessed the potential of a serious game developed for the education of children with a history of obesity and disease prevention received a positive evaluation from experts. They considered the game to be appropriate as an educational instrument and a differentiated strategy to motivate the child, assist the health professional and contribute to coping with childhood obesity (Dias et al., 2016).

Children with Down Syndrome, in addition to having a higher risk of suffering from food allergies due to their compromised immune system, also have a higher prevalence of obesity than the general population. These are worrying factors that can lead to the development of diseases and therefore need to be addressed. Thus, the development of games

for the education of these special children can contribute to correct and prevent health problems and improve their quality of life; digital or physical games, in themselves, are an attraction for children, in the process of intellectual development, the experience of the individual in the environment in which he is inserted is fundamental. He changes, as does the child, throughout his existence (Alves and Hostins, 2019).

Lamblem and Jesus (2018) report of games has greatly influenced the educational environment since 2003, where it began to observe how much the child develops. When involved in games and play, he manages to develop cognitive, social and intellectual reasoning.

5. Conclusion

Through the two games developed and their application with children with Down Syndrome with allergies/food intolerance and without allergies/food intolerance, a positive result was observed, as the children learned about foods that can harm their health and that this should be avoided, as well as about the importance of consuming healthy foods. It was found that teaching using games, especially computer games, aroused great interest in children, proving to be a valuable tool for use in food education. However, for effective results to be achieved, it is essential to promote parallel and continued actions with children and parents.

The use of educational games aimed at food and nutrition education, especially for children with food allergies/intolerance, has a potential still little explored. This study is expected to motivate researchers to carry out works with this theme to advance the creation of new tools in special education aimed mainly at the food and nutrition education of special children.

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Wesley Moreira Alencar de Lima – 8,5 %
Carla Láine Silva Lima – 8,5 %
Ogredson Luz Amaral de Lavor – 8,5 %
Lygia Claudia Oliveira Loiola – 8,5 %
Erika Freitas Mota – 8,5 %
Maria Izabel Florindo Guedes – 8,5 %
Luiz Francisco Wemmenson Gonçalves Moura – 10 %
Ana Claudia Marinho da Silva – 11 %