APPLICATION OF A SERIOUS GAME ABOUT NUTRITION FOR CHILDREN UNDER TWO YEARS OF AGE AS A FOOD EDUCATION TOOL: Development and Usability Study

Nícholas Meyer, Marianne Machado, Matheus da Trindade Viegas, Clandio Timm Marques, Camila Lehnhart Vargas, Fabrício Tonetto Londero, Franceliane Jobim Benedetti

Submitted to: JMIR Serious Games
on: March 01, 2024

Table of Contents

APPLICATION OF A SERIOUS GAME ABOUT NUTRITION FOR CHILDREN UNDER TWO YEARS OF AGE AS A FOOD EDUCATION TOOL: Development and Usability Study

Nícholas Meyer[1] Grad Dip; Marianne Machado[1] Grad Dip; Matheus da Trindade Viegas[1] Grad Dip; Clandio Timm Marques[1] PhD; Camila Lehnhart Vargas[1] PhD; Fabrício Tonetto Londero[1] MSc; Franceliane Jobim Benedetti[1] PhD

[1]Universidade Franciscana (UFN) Uruguaiana BR

Corresponding Author:
Nícholas Meyer Grad Dip
Universidade Franciscana (UFN)
Domingos de Almeida 2556
Uruguaiana
BR

Abstract

Background: Feeding children under two years of age is often inadequate, one of the main reasons being that parents and professionals possess a lacking knowledge of the subject. Digital games can be a good way to enhance this audience's awareness, presenting new information in a playful and immersive manner.

Objective: This work aims to describe the technical development of the game “Primeiras Refeições”, and to compare the knowledge of university students about feeding children under two years old before and after the application of the digital game.

Methods: It was necessary to provide a questionnaire with ten questions about complementary feeding and breastfeeding. The questionnaire had to be answered before and after the mobile game application with the students from undergraduate courses face-to-face, in four distinct areas of higher education at a university in Rio Grande do Sul- Brazil.

Results: The game was developed in Unity game engine, with original 2D art and commercially acquired sound effects. It is available on the Web and Android platforms. The focus of the game's mechanics was the promotion of breastfeeding, the appropriate consistency of foods for each age, encouraging the non-use of infant formula and ultra-processed foods. Data from 129 students were analyzed, where there was an increase in the average of correct answers from 4.67±2.01 to 5.26±1.89 ($p<0.01$) between Questionnaires 1 and 2.

Conclusions: The results show that the Intervention with “Primeiras Refeições” game led to a general increase in academics' knowledge of infant feeding.

(JMIR Preprints 01/03/2024:57971)
DOI: https://doi.org/10.2196/preprints.57971

Preprint Settings

1) Would you like to publish your submitted manuscript as preprint?

✓ **Please make my preprint PDF available to anyone at any time (recommended).**
Please make my preprint PDF available only to logged-in users; I understand that my title and abstract will remain visible to all users.
Only make the preprint title and abstract visible.
No, I do not wish to publish my submitted manuscript as a preprint.

2) If accepted for publication in a JMIR journal, would you like the PDF to be visible to the public?

✓ **Yes, please make my accepted manuscript PDF available to anyone at any time (Recommended).**
Yes, but please make my accepted manuscript PDF available only to logged-in users; I understand that the title and abstract will remain v
Yes, but only make the title and abstract visible (see Important note, above). I understand that if I later pay to participate in <a href="http

Original Manuscript

APPLICATION OF A SERIOUS GAME ABOUT NUTRITION FOR CHILDREN UNDER TWO YEARS OF AGE AS A FOOD EDUCATION TOOL

Abstract

Background: Feeding children under two years of age is often inadequate, one of the main reasons being that parents and professionals possess a lacking knowledge of the subject. Digital games can be a good way to enhance this audience's awareness, presenting new information in a playful and immersive manner.
Objective: This work aims to describe the technical development of the game “Primeiras Refeições”, and to compare the knowledge of university students about feeding children under two years old before and after the application of the digital game.
Methods: It was necessary to provide a questionnaire with ten questions about complementary feeding and breastfeeding. The questionnaire had to be answered before and after the mobile game application with the students from undergraduate courses face-to-face, in four distinct areas of higher education at a university in Rio Grande do Sul- Brazil.
Results: The game was developed in Unity game engine, with original 2D art and commercially acquired sound effects. It is available on the Web and Android platforms. The focus of the game's mechanics was the promotion of breastfeeding, the appropriate consistency of foods for each age, encouraging the non-use of infant formula and ultra-processed foods. Data from 129 students were analyzed, where there was an increase in the average of correct answers from 4.67±2.01 to 5.26±1.89 ($p<0.01$) between Questionnaires 1 and 2.
Conclusions: The results show that the Intervention with “Primeiras Refeições” game led to a general increase in academics' knowledge of infant feeding.

Keywords: Breastfeeding; Complementary feeding; Educational technology; Food and Nutrition Education; Infant;

Introduction

Feeding children younger than two years old is a extremely important process for the child’s development, since if it’s done correctly, is able to prevent nutritional deficiencies, child obesity and favors a good growth and physical, psychological and motor development [1].

Exclusive breastfeeding until six months of age is a necessity for a child and it brings many health benefits. However, from six months onwards, breast milk no longer can completely supply the baby’s necessities, which makes essential the complementary feeding. Still, if that is done before that time or incorrectly, it could turn the child susceptible to infections, diarrhea, malnutrition, short and long-term development impairment, increased risk of developing food and respiratory allergies, among others [2].

There’s the need to discuss the harms brought by the artificial dairy feeding and the early introduction of food in children, especially among health professionals, for them to guide and encourage exclusive breastfeeding up to six months of age and continued up to two years or more [3]. The use of innovative methodologies can start this discussion, in addition to being a good strategy so that beyond learning, it allows changes in behavior.

In that way, ludic activities such as board games, cards and electronic games display great effectiveness in teaching methodologies and dynamics in the health area [4]. Among these, digital games are a great recreational activity, able to make students more interested and take in content

more easily [5]. Therefore, games are a possible tool to be explored in teaching complementary feeding.

Given the importance of complementary feeding and the impact it has not only on the child's health and development, but also on public health, it is crucial to highlight the preparation of professionals to provide the correct instructions for their patients. However, this is not always the case, as there is a lack of knowledge among health professionals regarding food introduction [6], which can lead to unclear doubts and misunderstandings for pregnant and breastfeeding women. Furthermore, the general population has doubts regarding the appropriate consistency, preparation method, appearance of the food and get mistaken when weaning early due to misinformation [7].

A tool to assist learning in a playful and entertaining way are digital games, as they provide content, assist in the development of logical reasoning, and encourage interest in learning the proposed content. Additionally, digital games are integrated into people's lives, as they are present on nearly all types of platforms and environments [8].

Digital games such as serious games can also be useful in updating healthcare professionals through new technologies. This is because the application of serious games requires the qualification of these professionals so that they can use the necessary technological platform, thus enabling the exchange of knowledge with professionals from other areas, such as computing and game design, which will lead to an interprofessional exchange of knowledge [9].

Games are on the rise and are increasingly sought after by the public, having already become a common means of entertainment [10]. Currently, the games market is one of the most profitable sectors in the world and is rapidly growing, especially when it comes to entertainment, with Brazil being the third largest electronic games market, demonstrating that there is demand and players craving for new content [11].

Observing this possible dilemma in public health, it is necessary to better prepare students to become professionals with greater knowledge on the subject. Given the growth of the market and the learning aid capacity that can be brought by digital games, the application of a game about feeding children under two years of age for that target audience can be effective. Therefore, the objective of this work is to describe the technical development of the serious game “Primeiras Refeições”, and to compare the knowledge of university students about feeding children under two years of age before and after the application of the digital game.

Methods

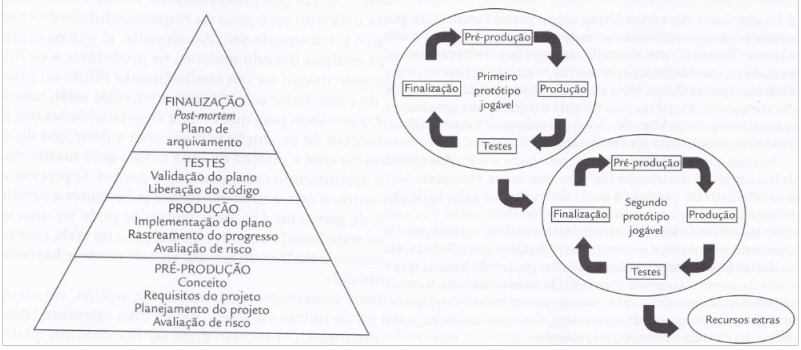
Game Development

The game called “Primeiras Refeições” was developed in the Technological Development and Innovation Initiation Scholarship Program - PIBITI CNPq with the project entitled "It looks like it but it isn’t, feeding children under two years of age" in the years 2021 and 2022.

To create the game, it was necessary to organize a multidisciplinary team composed of a game and lead designer who is a Nutrition student, a programmer specialized in the C# language, a digital illustrator with experience in game production and a nutritionist specialized in Maternal and Child Nutrition.

The methodology used during product development was that of Chandler [12], which consists of four cyclical pyramid shaped cyclical steps focused on planning, development, and validation tests (Figure 1).

Figure 1 – Pyramid-shaped cyclical methodology



Source: Chandler (2009).

Game Application and Quiz

To execute this work, it was necessary to provide a quiz before and after the application of the mobile game Primeiras Refeições to students attending in-person undergraduate courses, from the four areas of knowledge of higher education at a university in Rio Grande do Sul - Brazil. For the calculation sample was used the total number of students (3152) from the Higher Education Institution, which resulted in 229 answers, using the variables of 5% sampling error and 95% confidence level, with a maximum percentage of 80%. The result of required students by area is attached in Table 1. In there were included students enrolled in undergraduate courses and were excluded those who were not there on the day of application along with students with special needs who are unable to play the game, such as blind people.

Table 1 – Sample of students by area.

	Total number of students	% students per area	Students required for sampling
Social Sciences	736	23%	52
Technological Sciences	538	18%	41
Health Sciences	1778	56%	129
Human Sciences	100	3%	7
TOTAL	3152	100%	229

Source: author's elaboration.

The sampling of courses and classes was simple random, in which a proportional draw was used, that is, using more courses from areas with the largest number of students, with the result being Journalism and Advertising courses in the Science area. Social, Design, Digital Games and Computer Sciences in Technological Sciences area, Nutrition, Medicine, Psychology and Pharmacy in Health Sciences area and History in Human Sciences area.

After being authorized by the coordinators of each course, the researchers went to the classroom and were asked to carry out the assignment for 20 minutes. To participate in the research, university students accepted the Free and Informed Consent Form, and responded to a questionnaire that was created on Google Forms, made available the classroom in the form of a QR Code, which then directed the student to the researcher's Linktree, where Questionnaire 1, the game and Questionnaire 2 were attached. In both questionnaires were the same ten closed questions, generated to address specific knowledge related to breastfeeding and complementary feeding and referencing

the Food Guide for Brazilian children under two years [1]. To make a before-after comparison, personal data such as name, gender, course, semester, and email were included in the questionnaire.

The presented research was prepared in accordance with National Health Council resolution Nº 466/2012, which deals with human research, forwarded and approved by the Ethics and Research Committee with approval number 5.843.784 in January 2023. The classes were invited to participate in the research and signed an authorization to fulfill the research. Before participating in it, students accepted the Free and Informed Consent Form, that could be accessed through a link in the questionnaire.

Statistical Analysis

The information collected was stored in a Excel spreadsheet and subjected to statistical processing in the Statistical Package for the Social Sciences, version 23.0 software. To evaluate the distribution of variables, the Kolmogorov-Smirnov test was applied and, to describe the nominal and ordinal qualitative variables, absolute and relative frequencies and continuous quantitative frequencies, the mean and standard deviation were used. The difference between the average scores before and after the game and the average difference between courses in the health area and other areas were both confirmed by the t-test. It was considered a significance level of 5% ($p<0.05$).

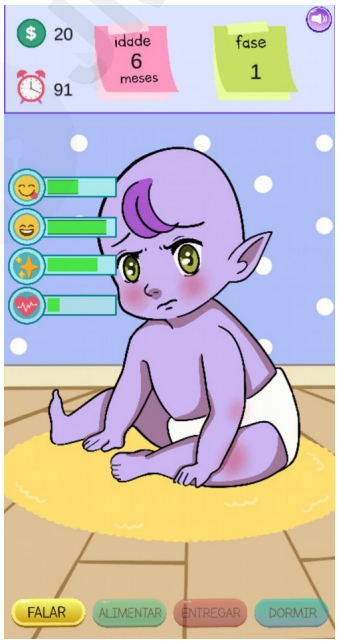
Results

Game Development Results

Following the methodology [12], in the first stage, pre-production, the theme of breastfeeding and complementary feeding was defined. The chosen platforms were Web and Android. Unity was decided as the game engine to be used. The artistic style, scope, costs involved, and project time were also defined at this stage. Also, the game language would be settled as Portuguese, and its genre would be simulation and resource management, inspired by the classic game Tamagotchi (1996).

In the second stage, production, the game began to develop its technical aspects, such as game design, programming, illustration of the animation and other elements such as graphical interface and scenarios entirely in 2D (Figure 2), the purchase and inclusion of sound effects with acquired rights and other elements present within the game.

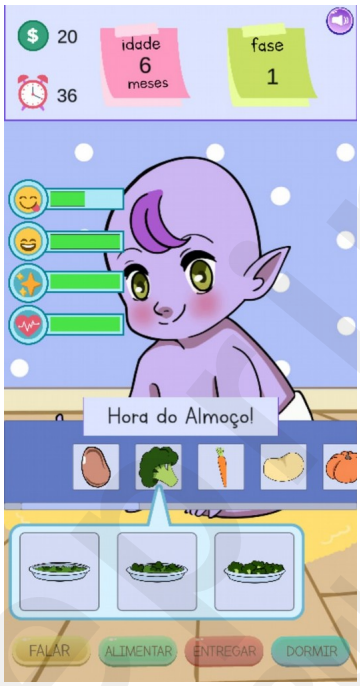
Figure 2 – Image of the character (baby) with character status



Source: author's elaboration

The focus of the game mechanics was the promotion of breastfeeding and how important this process is for the baby, the appropriate consistency of food for each age (Figure 3), encouraging the disuse of infant formula and ultra-processed foods rich in sugar and fats and promoting habits that improve the child's behavior, such as playing and communicating with them during meals. All game content was based on the Food Guide for Brazilian children under two years of age [1].

Figure 3 – Image of the character (baby) with food options and consistencies.



Source:author's elaboration.

At the beginning of the tests, in the third stage, the process was validated, and it was verified if it was being executed and in accordance with the project scope planning. Furthermore, the presence of errors in the project (bugs) that interfere with the operation of the program and the user experience was checked.

Upon completing this stage, the operation went back to the pre-production stage. In the end, the conclusion stage (fourth stage), which is summarized in the postmortem, where the positive and negative points of the project as a whole were raised, so that these errors could be avoided and the successes repeated in the future. The game was made available for the Web and Android platforms on the Itch.io platform, and can be downloaded and played directly on the device, or played in any browser.

The computer program entitled “Primeira Refeições” was registered with the National Institute of Industrial Property under number BR512022001799-7.

Results On Knowledge

A total of 234 responses were collected from students in the first questionnaire and 146 in the second, totaling 380 responses from 261 academics. However, some students only answered the first or second questionnaire, meaning that 115 responses from Questionnaire 1 and 27 from Questionnaire 2 were excluded, leaving data from 119 students for statistical analysis.

Among these 119 students, 51 students were enrolled in health care classes, including 19 (16%) in Nutrition, 13 (10.9%) in Medicine, 11 (9.2%) in Psychology and 8 (6.7%) in Pharmacy. In the other areas, 68 academics were counted, 18 (15.1%) from Design, 15 (12.6%) from Journalism, 13 (10.9%) from Computer Science, and 11 (9.2%) Advertising, 9 (7.6%) Digital Games, 2 (1.7%) History.

In total, 63 (52.9%) students were identified as female, 54 (45.4%) as male and 2 (1.7%) did not want to declare. The students were studying the 3rd (P25-1st- P75-5th) semester.

When asked whether they had prior knowledge about feeding children under two years of age, 20 (16.8%) responded yes and 58 (48.7%) responded partially. Among the sources from which they obtained this knowledge, the options that appeared most were "From personal experience" 23 (26.1%) and "Discipline in the course" 21 (23.9%).

The quizzes included 10 questions and the average number of correct answers in the first one was 4.65 (46%), with a total of 556 correct answers, accounting for 299 from academics in the health area and 257 from other areas. In the second questionnaire, the average increased to 5.2 (52%), with a total of 626 correct answers, 313 in the health area and 313 in other areas (Table 2).

Table 2: Frequency of correct answers before and after playing Primeiras Refeições.

	Correct Answers		
Questions	Questionnaire 1 (n%)	Questionnaire 2 (n%)	% of improvement
In general, at how many months of a child's life should complementary feeding start?	73 (61,3)	96 (80,7)	31,5
At how many months should meat start to be offered to the child?	34 (28,6)	43 (36,1)	26,5
For an 8-month-old child, what is the appropriate consistency for the dish?	72 (60,5)	79 (66,4)	9,7
Which of the options below provides the best development for the child?	66 (55,5)	67 (56,3)	1,5
Which of these activities are the most suitable for supporting a healthy child development?	63 (52,9)	73 (61,3)	11,1

If possible, how long can the baby be breastfed?	32 (26,9)	31 (26,1)	-3,22
Which of these are NOT benefits of exclusive breastfeeding up to six months?	17 (14,3)	19 (16)	11,7
Once the child starts eating, at least how many types of food are recommended to have on the plate?	57 (47,9)	62 (52,1)	8,7
Select the best foods for your child from 6 months onwards.	59 (49,6)	78 (65,5)	32,2
How many times should breastfeeding be offered during the day?	83 (69,7)	78 (65,5)	-7

The values are presented in number (%) and % of improvement between the correct answers in questionnaires 1 and 2.

In Table 3, it can be seen that the average number of correct answers was higher after university students, regardless of their area, played Primeiras Refeições ($p<0.05$).

Table 3: average of correct answers before and after playing Primeiras Refeições

	Average 1	Average 2	p
Total matches*	4,67±2,01	5,26±1,89	<0,01#
Healthcare are matches**	5,86±1,84	6,14±1,83	<0,01#
Other areas matches**	3,78±1,65	4,60±1,67	<0,01#

Values presented as mean±standard deviation. *T-test for paired samples. **T-test for independent samples. #$p<0.05$.

Discussion

Principal Results

The game and level design of the game was developed thinking about the player experience,

as they lose games and played again, they would learn to identify harmful and beneficial actions for the baby, in addition to noticing elements of the interface that interfere with these issues. Foods such as flavored yogurts, baby formula bottles and processed juices are examples of foods that are unsuitable for children under two years of age, causing the player to lose status points. Fresh foods such as broccoli, meat and beans are foods that increase this score if offered in the appropriate consistency for the age. These score-lowering foods are unsuitable and score-increasing foods are suitable for children in real life. This interaction with the serious game leads to players learning passively due to the immersion caused by the game [13].

According to the methodology, a game session was applied within the maximum given time. However, depending on the class and the space given by the teacher, some students played longer than others. With the game “Feed the Alien!” [14], the authors demonstrated that by applying a digital game in two brief sessions, the short-term knowledge is increased. However, nutritional knowledge and behavior was not affected in the long term, demonstrating that more interventions would be necessary.

Regarding the students' prior knowledge, only 20 (16.8%) stated that they had extensive knowledge about nutrition for children under two years of age. The most common sources of knowledge mentioned were "Discipline in the course", and "From own experience". Although students who have already had a subject in their classes and individuals with experience in raising a child should already have some knowledge about breastfeeding and complementary feeding, this wasn’t contemplated in the research. However, students in the health area had a higher average number of correct answers in both Questionnaire 1 (5.86±1.84) and Questionnaire 2 (6.14±1.83) compared to other areas. Other studies also show an improvement in students' short-term knowledge of nutritional awareness after playing a game. However, the target audience for these studies were elementary school children [4, 14-15]. These results indicate the importance of consolidating a basic knowledge on infant nutrition during academic training and encouraging the search for updated information based on scientific evidence, participation in education and professional development programs as a form of continuing education. Based on the education of these professionals, nutrition education must be promoted for parents and guardians so that the child can grow and develop healthily [1].

When it comes the student’s knowledge, in Questionnaire 1 the average number of correct answers was 4.65, while in Questionnaire 2 it was 5.2. The average number of correct answers for students from healthcare was higher in both questionnaires, but the increase in the average number of correct answers was greater for students from other areas, resulting in one more question being answered correctly. This result indicates a possible improvement in academics' knowledge after playing the serious game "Primeiras Refeições", especially with students with low academic knowledge on the subject. A study with children [5] brought an interesting result by showing that the number of correct answers tripled. However, the methodology required participants to be involved in the production of mechanics, not just as players, making it a longer and more constant intervention. Furthermore, the study was carried out with children and with a theme that was easier to understand.

The questions with the greatest increase in correct answers were: "In general, at how many months of the child's life should complementary feeding be started?" "At how many months should meat start to be offered to the child?" and "Select the best foods for your child from 6 months onwards." With an improvement of 32.2% in correct answers, these results were significant. These three inquiries are discussed a lot in the game, since during the gameplay, the player starts feeding a child from the age of six months and meat can be offered from that age as something healthy. Furthermore, the appropriate and inappropriate food options represented in the game could be defined in a positive or negative way, depending on the context. This shows that even if played for a short amount of time, the game managed to bring insight through the association between the game and real life.

On the other hand, some issues that were also addressed within the game, such as

breastfeeding and the minimum number of foods on the child's plate, had a less significant improvement or even a 7% decrease in proportion of correct answers. The question "For an 8-month-old child, what is the appropriate consistency of the dish?" had an improvement of 9.7% correct answers, which is a less significant result than other issues. The consistency of the dish brought up on throughout the game, however, most university students were unable to reach the child's eighth month due to the time allowed for the exercise having run out and/or not being able to reach this stage due to game overs and having to answer Questionnaire 2. Therefore, there was no time to convey the knowledge on this topic for it to be truly effective. These results may indicate that the game time was unable to transmit certain learnings or that the explanation of these items was not clear enough within the game. It shows that the game may have probably been more effective in some aspects of education about children's nutrition than in others.

Limitations

Few educational games focus on complementary foods and only "Primeiras Refeições" worked on appropriate consistency for each age group during the period of food introduction. Furthermore, there is a short number of serious games that are aimed at food education and focused on adults, with the majority of them being developed for children and young people. These points make this work distinguished from other serious games in the area and unique in its proposal. Nonethelesss, the application of the game had limitations such as low student adherence to the second questionnaire, available classes in some health courses and the given time by teachers in each classroom.

Conclusions

In conclusion, the results show that the intervention with the game “Primeiras Refeições" led to a general increase in academics' awareness about infant nutrition. Even with limitations, there was a satisfactory and significant result. These findings highlight the importance of adequately addressing the topic of infant nutrition in training. However, it is believed that with more playing time and working with other audiences, the game will be able to contribute to proper nutrition knowledge for children under two years of age.

Acknowledgements

The innovation agency of the Universidade Franciscana (UFN) for registering the software.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

References

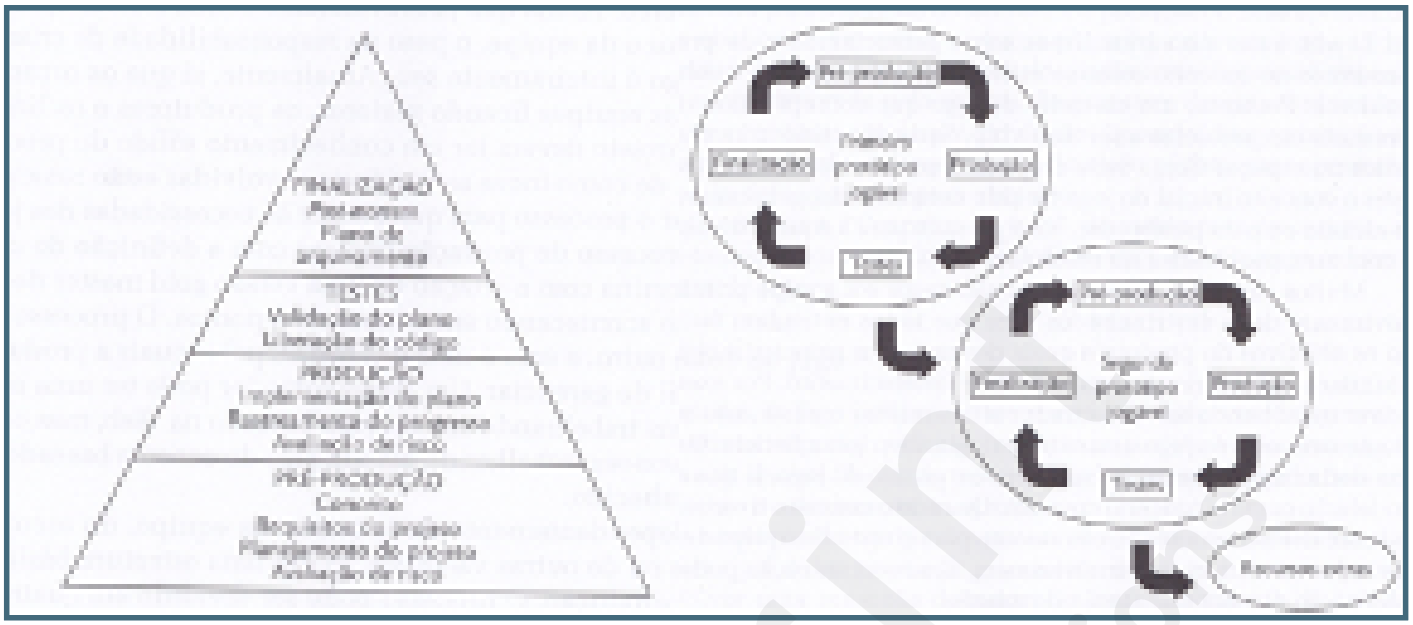
1. Ministério da Saúde (BR). Guia alimentar para crianças menores de dois anos. Brasília: Ministério da Saúde; 2019. [FREE full text]
2. Machado, D., Sines, G., Bizerra, A. Consequências do desmame e da introdução alimentar precoce em lactentes**.** Revista Científica Multidisciplinar Núcleo do Conhecimento; 2021; Ano 06, Ed. 04, Vol. 10, pp. 140-167. [FREE full text]
3. Dias, M. C. A. P., Freire, L. M. S., & Franceschini, S. D. C. C. Recomendações para alimentação complementar de crianças menores de dois anos. Revista de Nutrição; 2010; 23,

475-486. DOI:10.1590/S1415-52732010000300015 [FREE full text]
4. Coscrato, G., Pina, J. C., & Mello, D. F. D. Utilização de atividades lúdicas na educação em saúde: uma revisão integrativa da literatura. Acta Paulista de Enfermagem; 2010; 23, 257-263. DOI: 10.1590/S0103-21002010000200017 [FREE full text]
5. Haruna, H., Okoye, K., Zainuddin, Z., Hu, X., Chu, S., & Hosseini, S. Gamifying sexual education for adolescents in a low-tech setting: quasi-experimental design study. JMIR serious games, 9(4), e19614; 2021. PMID: 34636739 [FREE full text]
6. Ramos, A. E., Ramos, C. V., Santos, M. M. D., Almeida, C. A. P. L., Martins, M. D. C. D. C. Conhecimento sobre aleitamento materno e alimentação complementar dos profissionais de saúde. Revista Brasileira de Enfermagem. 2018; 71, 2953-2960. DOI: 10.159/0034-7167-2017-0494 [FREE full text]
7. Santos, A. T., Uchoa, F., Lima, M., & Lustosa, R. Conhecimentos e práticas maternas em relação à alimentação complementar. EFDeportes.com, Revista Digital. Buenos Aires; 2016; 20(213). [FREE full text]
8. Santos, L et al. Desenvolvimento de jogos educativos na conscientização da prevenção do câncer de mama. A plurivalência da engenharia da computação e seu amplo campo de aplicação. Atena Editora; 2021; p. 92-109. DOI: 10.22533/at.ed.0142103058 [FREE full text]
9. Moraes, V. C. D., Ferraz, L. (2021). Educational technology on expressing breast milk: development and validation of a Serious Game. Revista Brasileira de Saúde Materno Infantil; 2021; 21, 845-855. DOI: 10.1590/1806-93042021000300007. [FREE full text]
10. Venturelli, S., & Ferraz, D. P. D. A. A visão do professor sobre jogos digitais no ensino da matemática para alunos com deficiência intelectual: estado da arte. Educação Matemática Pesquisa; 2019; 21(1), 180-196. DOI: 10.23925/1983-3156.2019v21i1p180-196 [FREE full text]
11. Souza, L., Freitas, A. A., Heineck, L. F., & Wattes, J. L. Os grupos de gamers: segmentação de mercado dos jogadores de jogos eletrônicos. BBR. Brazilian Business Review; 2021; 18, 177-195. DOI: 10.15728/bbr.2021.18.2.4 [FREE full text]
12. Chandler, H. Manual de produção de jogos digitais. Bookman Editora; 2009. IBSN: 8540701839
13. Haoran, G., Bazakidi, E., & Zary, N. Serious games in health professions education: review of trends and learning efficacy. Yearbook of medical informatics; 2019; 28(01), 240-248. PMID: 31022747 [PubMed]
14. Hermans, R. C., Van Den Broek, N., Nederkoorn, C., Otten, R., Ruiter, E. L., & Johnson-Glenberg, M. C. Feed the alien! The effects of a nutrition instruction game on children's nutritional knowledge and food intake. Games for health journal; 2018; 7(3), 164-174. PMID: 29634366 [PubMed] [FREE full text]
15. Espinosa-Curiel, I. E., Pozas-Bogarin, E. E., Martínez-Miranda, J., & Pérez-Espinosa, H. Relationship between children's enjoyment, user experience satisfaction, and learning in a serious video game for nutrition education: empirical pilot study. JMIR Serious Games; 2020; 8(3), e21813. PMCID: PMC7530690 [PubMed] [FREE full text]

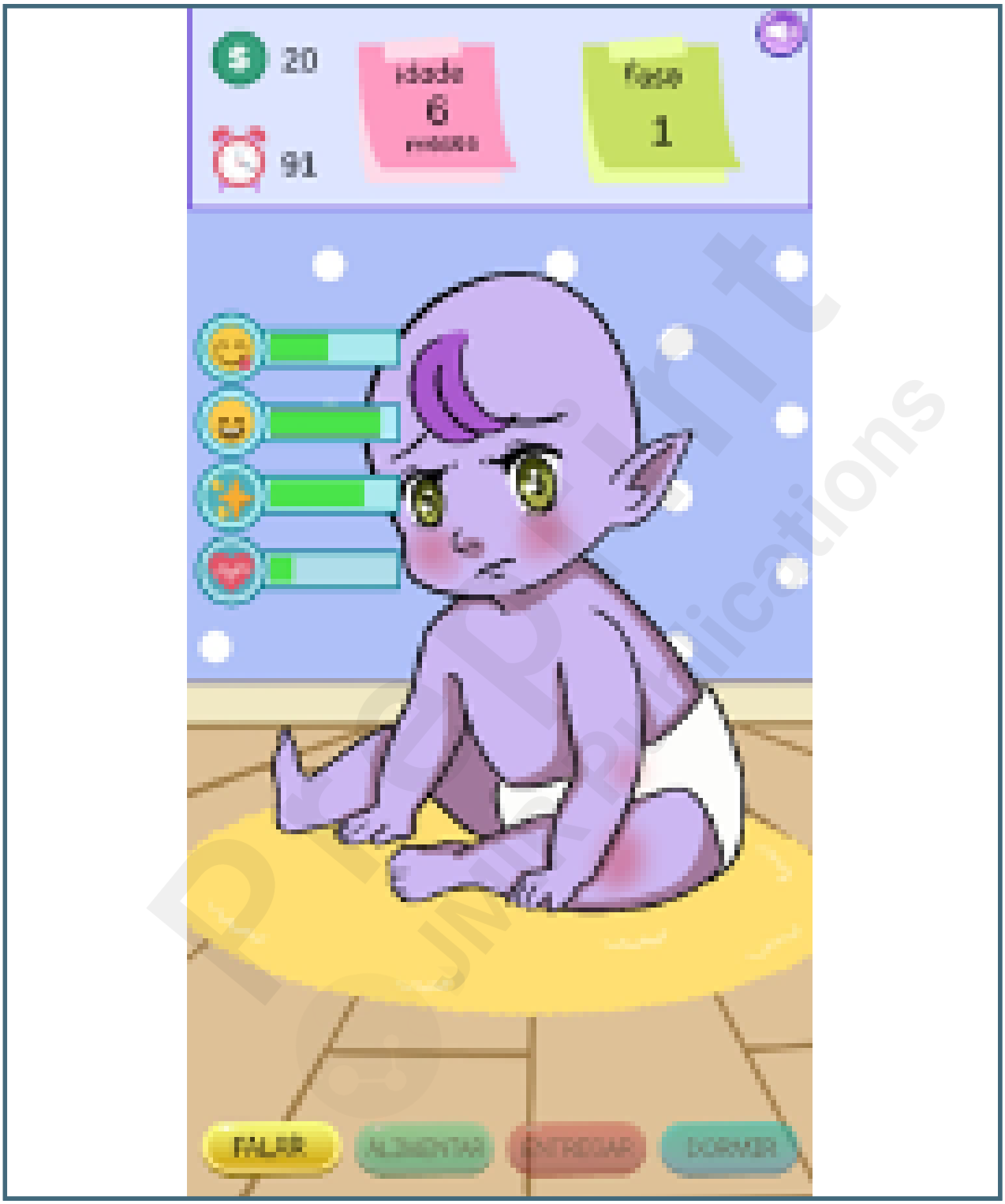
Supplementary Files

Figures

Source: Chandler (2009).



Source: Author's elaboration.



Source:author's elaboration.