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PARTICIPATORY DESIGN AND FOOD LITERACY, PROMOTING HEALTH AND WELL-BEING AS INTEGRAL COMPONENTS OF A POST-GROWTH ECONOMY

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In a post-growth economy, it is important to consider the qualitative characterisation of people's well-being, considering food as a basic need. Inadequate eating habits can have negative health consequences. The presented study aims to demonstrate how participatory design based on gamification, can transfer knowledge about food literacy in children. The methods used are based on the mapping of interdisciplinary knowledge (design and nutrition); in the construction of a physical model with gamified activities; and in the application of methods inherent to the participatory design methodology. Namely, participant observation during testing of the physical model and the application of a questionnaire, with non-probabilistic convenience sampling, which generated qualitative and quantitative data, which were analysed in a descriptive way. The effective contribution of this study lies in demonstrating how participatory design can maximise children's involvement while increasing their interest in food literacy, as well as deepening reflection on the requirements inherent to the development of educational games. The expected results focus on the need to carry out more applied research that relates to design and nutrition, in order to promote healthy and sustainable eating.

Keywords: Participatory Design, Food Literacy, Gamification, Analogue Game, Children.

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1. Introduction

Healthy eating habits in children are essential for the development of their future eating patterns, with a direct impact on their health (Haines et al., 2019; Kupka et al., 2020; Sandell et al., 2016). Advances in food technology and increasing rates of globalisation and urbanisation have resulted in an increase in the availability of foods with high energy density and low nutrient content. At the same time, there was an increase in sedentary lifestyles in children and a loss of knowledge and skills to prepare or purchase healthy meals (Haines et al., 2019). As a result, there was a significant increase in overweight and obese children. These are health problems that contribute to the onset or worsening of other diseases and can generate numerous psychological effects (e.g. low self-esteem) (Huffman et al., 2010).

Post-growth consists of developing a regenerative economy that prioritises well-being. This is a challenging process, centred on humans and the environment, which requires cooperative involvement, with more inclusive, equitable and creative practices (Fioramonti et al., 2022). This study proposes that Design is a highly qualified field to intervene in the problem of inadequate nutrition, as it is capable of helping to promote food literacy in a playful way (Celi & Rudkin, 2016). In particular, participatory design emerges as an approach, but above all as a methodology, that focuses on the active involvement of potential users throughout the design process. Designer-researchers act as facilitators so that participants have the autonomy to make decisions, with the help of tools, designed to be used in the context studied (Oosterbroek et al., 2024; Spinuzzi, 2005).

Playfulness must be present in the environments where participants are observed in their participatory experiences, especially when they are children, who need to play and have fun so that they feel welcome and can immerse themselves during the participatory sessions. The application of playful activities can be planned and implemented based on gamification, which consists of applying elements such as game mechanics and dynamics to engage children so that they can improve learning, solve problems and feel motivated to change behaviours, reflected in everyday life (Kapp et al., 2014).

On the other hand, it is also possible to consider the results of gamification approaches to create meaningful solutions, such as analogue games for educational purposes, which have the potential to satisfy the needs of playing and learning, and which are inherent to children's well-being. This type of game, in addition to helping guide children in solving problems, strengthens their senses, which are the main instruments for exploring the environments in which they live (Rice & Lueder, 2008).

Participatory design, gamification and food literacy can be interconnected to enable children to actively participate in shaping their environments, develop the knowledge and skills necessary to make sustainable choices, lead a healthy, rewarding life and minimise possible negative effects on the planet. All of this can become achievable with the crossing of interdisciplinary knowledge (Félix & Duarte, 2018; Miller, 2018; Spinuzzi, 2005). Therefore, this study is based on mapping elements that characterise participatory design and factors inherent to food literacy. Cross-referencing this information resulted in the design of a physical model, consisting of six gamified activities that were adapted to children of different age groups, and whose activities aimed to examine children's knowledge and promote healthy eating.

In 2019, the physical model was tested on 38 children, according to the participatory design methodology, which included the participant observation method and a questionnaire to obtain qualitative and quantitative data, which were described. The results pointed to the effectiveness in applying participatory design, in accordance with gamification principles, but also suggested that it is pertinent to consider the factors of competition and cooperation. On the other hand, it was understood that through repetition of activities, children re-learned about issues relating to food literacy.

This study has a twofold objective. Firstly, we intend to describe the results of the participatory design experiment, demonstrating the potential of this methodology — according to the use of gamification principles. Then, based on the data obtained, a reflection is suggested on the requirements that must be present in the development of educational games that promote food literacy. We hope to collaborate in the discussion about the relevance of applied research in the field of design, which can encourage healthy eating lifestyles, and inspire other researchers in the fields of design and nutrition to deepen the integration of different disciplines.

2. Materials and Methods

The research design used in this study was based on mixed methods, mostly qualitative. This section is divided into three stages: (1) mapping of interdisciplinary information, which crosses knowledge of participatory design and food literacy, whose research is theoretical and qualitatively based; (2) construction of a physical model with gamified activities about foods, this being the first part of the applied research, with a qualitative basis; and (3) participatory project experience, which consisted of observing children while carrying out gamified activities and completing a questionnaire. This last stage was the second part of the applied research and aimed to collect qualitative and quantitative data. Next, each step will be presented in more specific terms.

2.1. Step 1 — Interdisciplinary information mapping

At this stage, we began by examining written documentary sources, namely scientific articles and books. The information was collected and analysed, to interconnect the different theoretical subjects that were intended to be used later in applied research. This task was supported by the discussion of ideas from the authors of this study, considering their specialities (three designers and a nutritionist). To combine interdisciplinary knowledge, relevant to this study, the characteristics and objectives of participatory design and various issues related to food literacy were mapped (**Fig. 1**). Subsequently, the analysed contents were reinforced, discussing them, in order to categorise the information and deepen the possibilities on how to apply the content in practice, so that it was attractive to children, but we could also touch on different topics, such as cultivation, distinguishing foods by smell, seasonality, food portions, distinguishing foods by taste and composting.

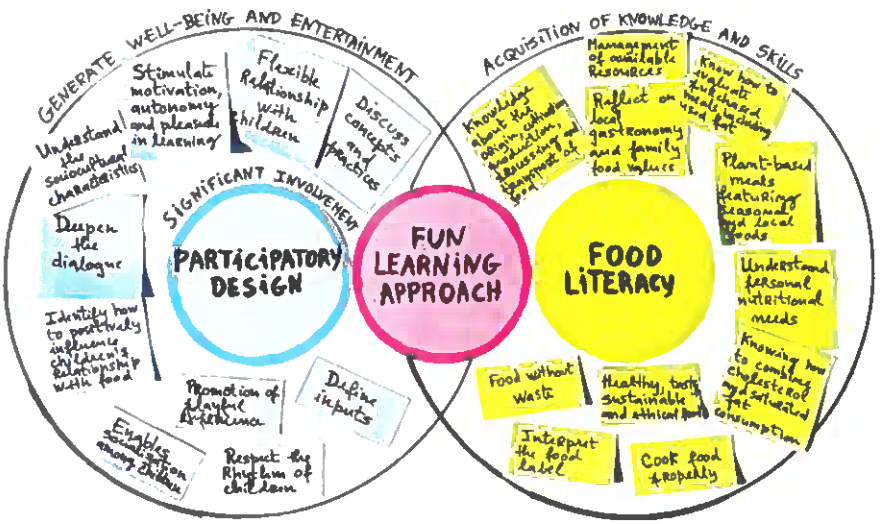

Fig. 1. Mapping topics inherent to participatory design and food literacy.
Source: Elaborated by the Author.

Participatory design is a flexible action research methodology, with practical applications, which involves the articulation of techniques and methods of observation and analysis, which follow one another continuously or repeatedly. Hence, interactions arise between people and objects or practices, which generate knowledge. The results are co-interpreted, because in addition to being analysed by the designer-researchers, they take into account the opinions of the participants. Furthermore, they are generally accompanied by the development of new perspectives or the design of artefacts, tools, environments or workflows, which have the purpose of achieving best practices or policies that contribute to the well-being of participants (Bosch et al., 2022; Spinuzzi, 2005).

The production of knowledge generated by this methodology can result from interdisciplinarity and promotes design as a self-reflexive discipline. Interactivity arises from the different points of view of stakeholders, which allow the activity to be shaped and occur within ethical principles. This approach reflects a paradigm shift that influences design practice, design discourse and design education. In terms of practical limitations, participatory design requires a lot of time, resources and commitment to be implemented (Miller, 2018; Oosterbroek et al., 2024; Spinuzzi, 2005).

The participatory project can be designed to involve children, listening to and observing them, regarding relevant topics in society, such as healthy eating. Food literacy is essential to cover all the knowledge necessary to make choices and create healthy and sustainable eating habits. This is a very comprehensive concept as it relates to the acquisition of skills, abilities and knowledge related to planning, selecting, preparing and consuming healthy meals, which meet nutritional needs at different stages of life. Moreover, food literacy encompasses food culture, food systems and the management of resources available to choose and prepare meals, namely time, equipment and money (Vidgen & Gallegos, 2014; Wijayaratne et al., 2018).

2.2. Step 2 – Design of a physical model with gamified activities

Following the information mapping, the idea of designing a physical model resulted, where gamification was used, applying analogue game mechanics and rules in practical activities that included constructed parts and foods. In this way, a more playful character was provided for the activities. The objective of including gamification was to provide an experience that aroused motivation and interest in participating in the activities, which were explained to the children as being challenges, since a gamified activity aims to challenge participants, especially in pedagogical applications (Hitchens & Tulloch, 2018). The tasks for each activity were planned and organised in a synthesised way so that the activities were carried out in sequential order, as if they were game levels. In addition, what allowed the activities to be gamified was the execution of challenges that involved mapping parts, associating elements and trying to guess the foods by their smell or flavour.

In total, six gamified activities were designed. Because it was not known which ages would be most suitable for children to learn about concepts related to food literacy, the physical model was adapted to be used by children of two age groups: from 3 to 5 years old (with activities that were easier to carry out) and from 6 to 10 years old (with activities that had a slightly greater degree of difficulty). This age division also aimed to make the analysis and understanding of the data as clear as possible. The base of the physical model was made from MDF (Medium-Density Fibreboard) and served to guide children on the order in which each activity should be carried out. Each piece of the model's base had a flower petal shape and had maximum dimensions of 295 x 155 x 3mm (length x width x height). The piece that was in the centre of the model, connecting all the other pieces had dimensions of 156 x 150 x 3mm (maximum length x minimum length x height) (**Fig. 2**).

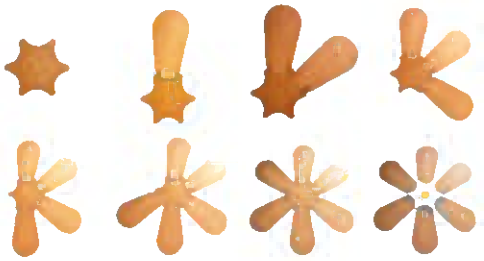

Fig. 2. Physical model basis.
Source: Elaborated by the Author.

The remaining pieces were for children to handle or make associations during the experiment and were constructed or adapted from existing objects. Each piece was designed to be interpreted and used as easily as possible. To this end, affordances were considered. The affordance associated with a product can be defined as an inherent quality, which is usually a characteristic in appearance, that enables the user to intuitively understand an object in terms of its functions, including how it can be picked up, used and manipulated (Norman, 1999). Tables 1 and 2 show what the activities consisted of for each age group, with **Table 1** referring to the first group (children aged 3 to 5) and **Table 2** referring to the second group (children aged 6 to 10).

Table 1: Activities planned for the first group.
Source: Elaborated by the Author.

Activities for children aged 3 to 5	
Activity 1: understand and associate the parts that make up a plant with the help of pieces that represent a carrot and a radish (roots), celery and turnip greens (stems), cabbage and rocket (leaves), tomato and cucumber (fruits), and a pansy and a marigold (edible flowers).	
Activity 2: distinguish by smell whilst blindfolded, foods cut into pieces and placed in glass containers. Next to each container was a figure that represented the food that was inside the container, so that when removing the blindfold, the children would have no doubts.	
Activity 3: associate foods with the respective season. There was a figure of a tree, divided into four parts, each representing a season of the year. In addition, the children had pictures that represented foods to help them make choices with real foods.	
Activity 4: separate healthy foods from unhealthy foods, considering the food portions presented. There were two figures to help with choices, one representing a character that suffered from obesity and was sad (used to place unhealthy foods) and another figure represented a character without illness and was happy (used to place healthy foods).	
Activity 5: perceive foods by their taste whilst blindfolded (it was not necessary to swallow them). The foods were cut into pieces and placed in glass containers.	
Activity 6: relating to composting. The children had to place the waste in the appropriate part of the compost bin, according to the colour associated with the waste. For example, brown waste should be associated with dry leaves, potato peelings and oilseed waste. Green waste should be associated with green leaves, crushed eggshells and vegetable and fruit waste.	

Table 2: Activities planned for the second group.
Source: Elaborated by the Author.

Activities for children aged 6 to 10	
Activity 1: distinguish the parts that make up a plant, placing real elements (fruit, flower, leaf, stem, root, tuber, bulb and seed) next to their name, which was written in Portuguese, because the children who participated in the experiment were of Portuguese nationality.	
Activity 2: perceive by smell and whilst blindfolded, the food essences that were present in pieces of cotton, considering the following foods: garlic, orange, mint, cinnamon, onion and lemon.	
Activity 3: associate foods with the respective season. The children only had access to foods and four figures that represented each season of the year.	
Activity 4: a wheat bran biodegradable plate was used for this activity. The plate was divided into four parts with white paint. The aim was to place each healthy food group in its respective part of the plate, so that there would be 50% vegetables, 25% carbohydrates (e.g. rice), 12.5% vegetable protein (e.g. beans) and 12.5% animal protein (meat).	
Activity 5: understand by taste whilst blindfolded, the ingredients that made up purees (it was not necessary to swallow). The foods were cut into pieces, crushed, mixed and placed in glass containers.	
Activity 6: relating to composting. The children had to mix the waste inside the container, in a structured way, following instructions from the researcher.	

After each child performed an activity, the researcher placed a circular-shaped piece on top of the MDF base, depending on the success or failure in carrying out the activity. If the child got it right, the piece would be green, with the aim of triggering feelings of competence and progression, as a form of reward. However, if the child made mistakes, the piece delivered would be red and the child would have the opportunity to repeat the activity. Leader boards were not used as a reward for each successful activity, because the score, in itself, does not generate interaction and can provoke feelings of loss of autonomy in children (Hitchens & Tulloch, 2018). Therefore, it was decided that the learning process would take place through trial and error, in order to generate better results with repetition. This decision also meets one of the principles of participatory design, which argues that participants must be involved repeatedly (Spinuzzi, 2005).

2.3. Step 3 — Participatory project experience

Participant observation was the method chosen to qualitatively evaluate children while carrying out gamified activities. This method involved partial participation by the researcher, to explain doubts and assign parts at the end of each activity, in order to demonstrate whether the activity had been carried out well or poorly. After each child finished all the gamified activities, a questionnaire was carried out that focused on collecting qualitative and quantitative data. The aim was to increase the rigour of the analysis and interpretation of findings relating to children's performance, the inherent usability of the physical model and children's knowledge of food literacy. Non-probabilistic convenience sampling was used.

Authorisation was obtained from guardians, who were duly informed about the objectives and procedures of the study, signed the informed consent form and kept a copy of the same document. On the other hand, the children's participation was voluntary. They were asked if they would accept participating in activities similar to games, telling them that they would have fun. Some of the test results were photographed, without exposing the children in the photographs, in order to protect their

identity. The children's selection criteria focused on the inclusion of both genders, aged 3 to 10 years, with apparent demonstration of motor skills, necessary to manipulate the physical model and with the ability to listen and follow instructions.

Before implementing the participatory project, a pre-test was carried out on 8 children of both genders, aged between 3 and 10 years old. The main objective of the pre-test was to test the clarity and understanding of the physical model and the questions in the questionnaire. It was found that it would be necessary to exclude some questions, in order to reduce the time it took to complete the questionnaire, as well as reformulating some questions to be easier to understand. This study took place in 2019. Thirty-eight children of both genders participated (19 children aged 3 to 5, including 11 girls and 8 boys, and 19 children aged 6 to 10, including 9 girls and 10 boys) and residents in different rural and urban locations, belonging to the district of Aveiro. The study was carried out in person, in indoor (housing) and outdoor spaces, depending on what the children suggested. Each activity lasted between 2 and 3 minutes. Parents watched the activities without interfering in them.

With regard to the questionnaire, in order to characterise the profile, only the gender and age of each child were recorded, without the associated name. The researcher filled out the questionnaire as the children responded. There were no null responses and, therefore, all responses were considered for analysis. Regarding its structure, the questionnaire consisted of seven questions and two sub-questions, of which three questions on a Likert scale (Q3, Q5 and Q6), two questions and two closed sub-questions (Q1, Q1.1, Q1.2, Q2) and three open questions (Q4 and Q7). Completing the questionnaire was anonymous and voluntary. All children who participated in the experiment agreed to answer the questionnaire.

The questions included in the questionnaire were: Which challenges did you need to repeat (none, one, two, three, four, five, six)? (Q1); Justify the reasons for the difficulties (difficulty in understanding the task requested, lack of knowledge about the subject of the challenge, unergonomic parts that allowed poor handling, size of the parts, number of parts that made up the model, weight of the parts, lack of autonomy, depreciation due to the use of foods in activities)? (Q1.1); After the repetitions, did you complete the challenges successfully (yes or no), and if not, which challenges were you unable to complete (one, two, three, four, five, six)? (Q1.2); Do you consider the dimensions of the physical model to be adequate (yes or no), and if not, what do you consider inappropriate in the model (height [is there more or less], length [is there more or less], volume [is there more or less], thickness [is there more or less])? (Q2); How often did you have fun doing the challenges (never, rarely, occasionally, frequently, very frequently)? (Q3); What did you like most and least about the challenges and do you consider them to be similar to games? (Q4); How much do you agree with the following statement? Healthy eating is important for your health and well-being (strongly disagree, disagree, neutral, agree, strongly agree), (Q5); How important is it for you? (not at all important, slightly important, moderately important, very important, extremely important)? (Q6); What did you learn about food from the challenges? (Q7).

The children received instructions on the tasks of the gamified activities, which were carried out individually to analyse the performance and knowledge of each child. The same researcher, to ensure the consistency of the research, conducted all sessions in this study. During each activity, the children were not interrupted; however, the researcher intervened whenever requested to clarify the children when they asked questions. The data obtained was coded in an Excel spreadsheet and statistics were performed using version 14.3.0 for Mac. Considering that most of the variables are qualitative in nature, descriptive statistical analysis was used.

3. Results and Discussion

The mapping of interdisciplinary knowledge was useful to structure the researchers' ideas and, in this sense, determine the types of gamified activities that were inserted into the physical model. Participatory design, through the application of gamification principles, contributed significantly to children's well-being in the context of the study. It was observed that in general, the children immersed

themselves in the gamified activities. In addition, gamified activities provided motivation, which, in turn, facilitated the children's learning process about the various subjects inherent to food literacy.

The majority of children in the first group and a significant percentage of children in the second group needed to repeat some activities once or twice. In the first group, 58% of children repeated activities 2, 3, 4, 5 and 6. Of these activities, number 2 (related to the identification of food smells) was the most repeated, followed by activity 3 (related to the association of foods with the respective season). In the second group, 42% of children repeated activities 2, 3, 4 and 5 — of which number 3 was the most repeated (Q1).

Prior knowledge about the subject of the challenge was the main reason that justified the failure to complete the tasks, being mentioned by 71% of the children in the first group and by 94% of the children in the second group (Q1.1). The observation method helped to clarify that at 3 years of age, children already have pre-formulated ideas and make their own interpretations about foods. Therefore, at this age, to demonstrate to children a new paradigm of food, it is already necessary to re-educate them.

Repetition increased the degree of success in carrying out the activities. In general, as children repeated an activity, they were faster at executing it. After repetition, some children still failed, but the majority managed to carry out the gamified activities successfully. In the first group, 63% of the children repeated the activities successfully, in contrast to 37% of the children who always showed difficulties, which were distributed equally between identifying the smells of foods (activity 2), distinguishing healthy foods from unhealthy foods (activity 4), identifying foods only by taste (activity 5) and carrying out composting correctly (activity 6).

In the second group, 74% of the children repeated the activities successfully; however, after repetition it was also possible to observe difficulties that led to the failure of some tasks, as 26% were unable to achieve the desired objective in certain activities, distributed by associating foods with their respective seasons (activity 3), identifying the smells of mint and garlic (activity 2) and distinguishing the different food groups, such as vegetables and legumes (activity 4), (Q1.2). The participatory project, with the inclusion of the physical model with gamified activities, resulted in, and made it possible to increase children's knowledge about food literacy. According to the rhythm of each child that upon discovering the error, went back to doing the activity and managed to execute it with more success. Therefore, by repeating, the child re-learns.

On the other hand, 98% of children in the first group and 66% of children in the second group reported that the physical model had adequate dimensions. The remaining children from both groups, with opposing opinions, were similarly divided on the suggestions that the pieces could have more or less height, length, volume or thickness (Q2). As for how often children had fun completing the challenges — in the first group, 3% reported occasionally, 23% frequently and 74% indicated that they had fun very frequently. In the second group, 11% said they had fun occasionally, 52% frequently and 37% said they had fun very frequently (Q3). Furthermore, it was noticed that the more fun they had while carrying out the activities, the more interest they showed. Children were more intuitive and quicker to make choices when they used pieces with images of foods to make associations. In the same way, they were more explorative, but, at times, they were also apprehensive when using real foods. In this sense, the pieces of the physical model that were used for handling and associations were seen as teaching materials, because they motivated children and facilitated the transmission of knowledge about food literacy.

Regarding what they liked most and least during the activities, 11% of the first group and 19% of the second group mentioned aspects they liked least — indicating mainly activities 2 and 4. The remaining children said they did not know what they liked the least or indicated that they liked everything. The responses were quite consistent between children in both groups. They mostly mentioned the association of foods with the respective seasons (activity 3), discovering foods or ingredients just by taste and blindfolded (activity 5) and the composting process (activity 6).

Not all children considered the activities identical to games, especially in the first group. Above all, they pointed out the lack of interaction with other children to make them feel like they were participating in a game. Considering that the gamified learning experience took place individually, the children did not

demonstrate feelings derived from tension, competition or cooperation and therefore, even if they felt integrated within a playful context, they might not feel like they were participating in a game. Even so, 69% of children in the first group and 82% of children in the second group identified some aspects that they associated with games.

The responses were divided between the opinions that the challenges were funny; they had several objects to use; the degree of difficulty changed as challenges were overcome; and the challenges made the children feel as if they had been transported to the game's setting and were the characters themselves who had to use their senses efficiently to be successful. In the second group, some children also mentioned that the challenges were identical to educational games, because they learned about foods, while overcoming challenges that were fun (Q4).

In observational terms, the inclusion of foods in the challenges and the interactions between the different senses were found to be relevant to the dynamics of the activities, because they provided diversity in the type of tasks, causing children's emotions to vary quickly according to the sensory differences that they perceived. In particular, the sense of smell was useful in working together with taste in the activity in which children had to identify foods and ingredients by their flavours. On the other hand, it was found that in indoor environments, children were more focused on carrying out activities, and in outdoor environments, they had more fun.

All children in the second group strongly agreed that healthy eating is essential for their health and well-being. In the first group, 21% of the children reported neither disagreeing nor agreeing with this statement and the remaining children recognised the relevance of healthy eating, agreeing in part (3%) or strongly (76%) (Q5). Regarding the importance attributed to what they learned, in the first group, 7% considered it slightly important, 6% moderately important, 22% very important and 65% extremely important. In the second group, 4% indicated it was moderately important, 17% very important and 79% extremely important (Q6).

When asked what they learned from the challenges, both groups mentioned above all — the seasonality of foods and the composting process. In the second group, they also significantly mentioned the distribution of food portions on the plate as learning content (Q7). It is important to mention that in the second group, children aged seven and over demonstrated that they assimilated the concepts they learned better than younger children. This aspect was perceived in the responses where they addressed explanations relating to different food groups and when explaining the composting process themselves. Therefore, it is considered that children aged six could have been included in the first group.

Through the results obtained in the participatory project (**Fig. 3**), it is confirmed that design can meet post-growth, prioritising factors centred on approaches that facilitate children's interest in healthy eating; however, it should be borne in mind that the number of children who participated in the study is small. Therefore, it is recommended that more additional research be carried out, with a greater number of participants involved and materialising interdisciplinary methodologies that cross design, food and nutrition.

The applicability of this study can and should be enhanced. All the aspects analysed, from how to approach the different issues inherent to food literacy to designing challenges that truly stimulate children, deserve deeper reflection on the relationship they can establish with the development of educational games. Given that these are products that offer the opportunity for design and industry to assert themselves as integral parts of society. They are capable of adding the playfulness factor to the teaching and learning process, to expand games in this category to families, schools and other institutions — where the role of food in human health and the planet is recognised.

Fig. 3. Some of the foods used and results generated by children of both age groups.
Source: Photographed by the Author.

3.1. Benefits and implications for the development of educational games on food literacy

Games are interactive, have objectives, challenges and rules. Each game must evolve throughout its development cycle. When a game involves solving a problem that concerns the player, it is a way of generating engagement, as the player will be focused on finding the solution. If a game is designed for educational purposes, it must teach about the intended subject (Fullerton, 2019; Schell, 2020). In this sense, it is important to focus on the aspects necessary to teach the subject and the possibilities of making learning motivating, while keeping the game enjoyable.

Based on the results mentioned above, in this section, some reflections are presented, which should be considered during the development of analogue games that promote food literacy. Firstly, it is important to remember that it becomes more challenging and favourable to playful learning when a game allows competition between opposing players. Furthermore, if competition occurs between teams, the game also develops cooperation and empathy skills, in addition to encouraging socialisation. The game allows its use to be repeated countless times, always providing different experiences. The existence of different mechanics in the same game increases the possibility of alternatives to the direction of the game.

As children repeat the educational game, they absorb the content on the topic and associate elements that contribute to developing their knowledge; however, it should be noted that the results showed that from the age of seven onwards, children assimilated the concepts better. In this sense, children of younger ages should have games with simpler concepts and learned based on associations, analogies or examples. For children over the age of seven, games that aim to encourage healthy eating cannot be restricted to distinctions between healthy and unhealthy foods. Learning about healthy eating must focus on combining healthy, balanced and varied food choices.

As food literacy is a comprehensive concept, it is suggested that subjects be selected and explored within each theme, depending on the context and culture where the game will be inserted; additionally, each game must follow principles of universal design or inclusive design. Some of the learning content that can be covered are: foods flavours, seasonality, resource management to purchase and prepare meals, food portions, combining foods to make a healthy and balanced meal and the composting process. Moreover, analogue games can include practical challenges (e.g. preparing simple recipes), as long as they provide tools that make tasks easier or the elements necessary for their execution are easily accessible. Challenges based on physical activities may also be included, as a complement to healthy eating (e.g. jumping, dancing and somersaults).

Games should provide feedback to children, especially when they fail in challenges involving food-related knowledge. The aim is for them to realise the error and after repeating the challenge, get it right, in order to strengthen their learning. To achieve this, the game must have affordances that are perceptible to players. Analogue games can present themselves in countless ways. The fact that they

are analogue does not limit them in appearance, nor in the different possibilities of how they can be manipulated (**Fig. 4**).

Fig. 5. Drawings of analogue games, designed to promote food literacy.
Source: Elaborated by the Author.

Testing of the game's physical models must take place throughout its development, in accordance with an evolutionary process — both from the point of view of the combination of mechanics, history, aesthetics and technology, as well as usability and ergonomics. The choice of materials is based on well-being during use (e.g. light, comfortable, with pleasant textures and non-toxic paints) and on the principle of serving as facilitators for learning the content. In addition, the characteristics of the materials (e.g. strength) and how they are interconnected (e.g. fitting or gluing) must be evaluated to understand what could happen to the game if a piece breaks or the game itself is discarded (understanding whether it can be recycled or reused).

Game testing is an added value to obtain concrete data on children's satisfaction and performance during gameplay. These tests will also help to perceive other factors of a more intangible nature, such as knowing whether the regulation of the game's difficulty level oscillates between easy and difficult, whether it contributes to the immersion of children and whether the mechanics present explore the strategic potential within the ages for which the game is intended. On the other hand, it is important to assess whether factors such as age and gender influence expressed preferences regarding the game's visual style. After analysing the usability tests, improvements must be made to the prototype, in accordance with the manufacturing process and finishes that guarantee the integrity, safety and functionality of the games. These considerations may lead to a perceived reduction in predictable and potential problems that may arise, as well as increasing the likelihood of game development being effective.

4. Conclusions

Applying gamification in participatory design methodology and approach is useful for promoting food literacy. Although the children's prior knowledge affected their perceptions and interactions, the majority liked and immersed themselves in the gamified activities, realised that there are motivating ways to learn about food, and learned about the benefits related to food portions, healthy foods and reuse of food waste for the composting process. Furthermore, children were almost always able to verbalise their opinions, as well as display their individual achievements and failures.

This research has limitations. Non-probabilistic convenience sampling was used, consisting of a small number of participants. In this sense, it is pertinent that additional research be carried out to complement this study. Still, the results obtained offer many clues for practical applications. Testing the physical model developed for the participatory project contributed to a critical reflection on important aspects to consider for the development of analogue games. Within a realistic framework, which consists of the production of games that aim to promote food literacy — it is essential to evaluate the factors that can increase the chances of games being effective and prevent possible and predictable failures.

It is important to keep in mind that gamification-based learning may not have positive effects for all children. Each child has their own pace of development, meaning they have their own ways of learning and having fun. The results showed that children aged 7 and over assimilate concepts better and, therefore, must face challenges with a higher level of difficulty than younger children. Repetition of the activities caused most children to increase their success in carrying out the tasks and learn more about the topics covered. The satisfaction of successfully carrying out an activity serves as a strong intrinsic reward, making children feel more competent and autonomous. It is also important to note that a significant minority of children did not consider gamified activities identical to games. It is pertinent that there is a joint participation of children in the participatory project based on gamification — in order to provide them with feelings of competition or cooperation. Therefore, it is understood that gamification can be enhanced if it allows actions between opposing teams.

This study establishes relevant directions, which cross different disciplines, pointing to participatory design and the use of games as inseparable factors of well-being and with the potential to help promote health; however, more applied research of an interdisciplinary nature is also needed to deepen the scope of the study. Designers are experts in creative methods and based on the knowledge provided by nutrition professionals, they have the skills to generate approaches that motivate children to learn about food. This is in accordance with behaviours that maximise their participation at the same time as encouraging them to develop sustainable habits that can continue into their adult lives.

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