

The Power of Gamification to Learn and Promote Healthy Habits among Children

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ABSTRACT

Childhood obesity is one of the biggest paediatric public health concern, affecting more than one in three school-aged children in countries like Spain, Brazil and Greece. This paper describes the gamification approach used in the OCARIoT project in order to promote a long-term behavioral change towards healthy habits in children between 9 and 12 years old. This gamification approach has been designed and validated following a user centric-approach, with a gender-balanced population of around 100 children aged 9 to 12, in four schools in Spain, Greece and Brazil.

Author Keywords

Childhood obesity; Gamification; Healthy habits; IoT; Playful learning.

ACM Classification Keywords

H.5.m. Information interfaces and presentation: User-centered design; Prototyping; GUI.

INTRODUCTION

Bad long-term habits in eating and lack of physical activity causes an energy imbalance between consumed and expended calories. This is the primary cause of obesity. Therefore, obesity is largely preventable by making healthier eating choices and exercising regularly¹. In the case of children, childhood obesity is one of the biggest health problems worldwide and the major paediatric public health concern, affecting around 224 million school-age children in the world². Its prevalence has shot up since 1980 even tripling in many European countries. Childhood obesity already affects more than one in three school-aged

children in countries like Spain, Brazil and Greece³.

Behavioural treatment helps individuals to develop a set of skills to achieve a healthier lifestyle. It is more than helping people to decide what to change; it is helping them identify how to change [1]. And the most effective prevention strategy to grow in good health is to promote a healthy lifestyle, with adequate nutrition and active physical activity condition from early age. Proving that point, training of children up to 12 years of age to eat and move in a non-pathological way has been demonstrated effective against obesity and changing behaviours in randomized control trials [2, 3]. So, childhood is an important period for forming healthy behaviours in order to reduce obesity inequities. Besides, schools and families provide good opportunities to ensure that children understand the importance of good nutrition and physical activity habits, and how they can benefit both children and families.

To promote the adoption of healthy habits as well as to prevent obesity of children in ages from 9 to 12 years, the OCARIoT project takes advantage of the Internet of Things (IoT) in order to provide a digital health coaching platform to empower children (and also both families and educational staff) in taking control of their lifestyle. For doing so, OCARIoT is developing a gamified [4] app specifically for children, to drive their engagement and behavioural change while having a clear focus on treating obesity. The gamified app integrates data from several IoT devices related to healthy parameters (such as a wristband to measure physical and sleep patterns or a weighstcale) in order to provide a close follow-up of child's activities while adapting the coaching plan based on the progress.

This paper provides a detailed description on how we have designed and validated the gamified app following a user centric-approach and based on a gamification strategy developed ad-hoc to the OCARIoT's target group to motivate and engage them while they acquire healthy habits.

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¹ <http://www.who.int/mediacentre/factsheets/fs311/en/>

² <https://www.worldobesity.org/what-we-do/aboutobesity/>

³ www.oecd-ilibrary.org/docserver/health_glance-2015-en.pdf

The final implementation is still ongoing and will be validated to support a clinical study that will be performed in three pilot sites in Europe and Brazil following standard methodologies already adopted in similar studies [5, 6].

THE CONTEXT OF THE PROJECT

In order to be able to define a suitable gamification strategy, it is important to understand the context related to healthy habits in children according to what the experts say, especially which type of activities we should promote in the gamified app. There are some simple recommendations for families to lead a healthy lifestyle and get back on track^{4 5}:

- **Distribute meals along the day:** eat small amounts several times a day;
- **Lots of fruit and vegetables;**
- **Water as a drink to quench the thirst,** avoiding sugary and industrial drinks;
- **Get active each day:** at least 1 hour of physical activity every day;
- **Limit screen time:** sedentary time is associated with an increased risk of becoming overweight;
- **Sleep quality:** associations between short sleep duration in early childhood and obesity are consistently encountered.

Using as basis these recommendations and with the support of health professionals, we have also defined a set of KPIs to validate scientifically the outcomes of the project. These KPIs will be measured with the final version of the gamified app ready for the last piloting phase:

- Reduction rate of obesity childhood $\geq 50\%$;
- Improvement of adherence to suggested healthy activities $\geq 60\%$;
- Increment of physical activity for end-users $\geq 50\%$
- Satisfaction from end-users $\geq 95\%$

USER-CENTRIC DESIGN

The aim of OCARIOt is to educate and empower children to become the protagonists of changes in the family environment. That is why we have applied a user-centric approach, involving children from the beginning in the definition of the gamification strategy and gamified app design.

The validation and assessment approach during the design stage of the gamified app has focused on the technical usability, engagement and acceptance from the User Experience (UX) and User Interface (UI) perspectives. A set of validation workshops with children have been done with the two releases of the gamified app design. The next

sections provide details about the different steps and results during the design process of the gamified app.

All the procedures followed in the project were in accordance with the ethical standards of the OCARIOt Ethics Board (national and international) and with the Helsinki Declaration of 1995, as revised in 2008. The parents and/or legal representatives of children has signed a consent form for participating in the project.

INITIAL DESIGN OF THE OCARIOt EXPERIENCE

The goal of the gamification strategy is to promote children between 9 and 12 years old to acquire healthy habits in the nutritional and physical activity areas while engaging them using fun and easy mechanisms. The expected results aimed to be achieved are:

- Children **embracing healthy habits.**
- Children acquire **knowledge** about healthy habits and understand how to apply them in their **daily life.**
- Make the learning process about healthy habits **as memorable as possible while using the app.**

Although the target audience are children between 9 and 12 years old, families, educators and health professionals also play a very important role, promoting the use of the application among children, participating in some activities and setting example in feeding, physical activity and healthy lifestyle. This will clearly reinforce each of the activities proposed by the app while achieving the proposed goal.

During this gamification strategy design and according to the motivators of the target group, we identified four core elements to be integrated in the OCARIOt gamified experience:

- **The storytelling and the world** where the experience takes place. Considering the requirements previously collected from the pilot sites and the differences between age ranges (mainly between children aged 9-10 years and 11-12 years) about their preferences and what they like, we designed 5 potential worlds and storytelling (story 1: ninja warriors; story 2: classical mythology; story 3: secret agents; story 4: sci-fi; story 5: superheroes).
- **The coach avatar** represents the mentor who challenges children with healthy activities while providing guidance during the whole experience. We designed 19 potential models covering humanoid, pet or monster appearance and combining cartoon and realistic art styles.
- **The items for personalization** will be used by children to personalize their mentor. Different types of potential predefined candidates were developed (e.g. clothes, glasses, accessories).
- **The type of educational games** will especially focus on promoting the acquisition of knowledge by children.

⁴ <https://www.who.int/behealthy>

⁵ <https://kidshealth.org/en/parents/overweight-obesity.html>

The following types of educational games were identified: Questions-Answer quizzes (e.g. wheel of fortune, Trivia) and Matching/memory games.

Based on this initial design, we organised the first workshops with the objective of collecting the children preferences and feedback about those four gamification elements. Five workshops were organized in four schools (Spain, Greece and Brazil). A total of 56 children between 9 and 12 years old were involved organized by groups of 3, 4 5 children (depending on the total children per workshop) with 29 girls and 27 boys to balance gender aspects. The number of votes for the five different stories provided to children is shown in Table 1 (children had to select two stories, their favorite one as option 1 and the second as option 2). Each vote weights 1 and the votes as Option 1 apply an extra 5% weight to the selected story. The selected storytelling and world were the secret agent with a total weighted score of 9,3.

	Story 1	Story 2	Story 3	Story 4	Story 5
Votes	5	2	9	5	3
As Option 1	5	0	6	1	0
As Option 2	0	2	3	4	3
Weighted Score	5.25	2	9.3	5.05	3

Table 1. Votes for every story

The number of votes for the three different type of mentors provided to children is shown in Table 2 (children had to select two types of mentors, their favorite one as option 1 and the second as option 2). The score calculation is the same as the one used with the story. The Human-type mentor was selected with a total score of 15,4.

	Animal	Monster	Human
Votes	7	1	15
As Option 1	3	1	8
As Option 2	4	0	7
Weighted Score	7.15	1.05	15.4

Table 2. Votes for every type of mentor

And the human-type mentor most voted was the hologram man which is the final design implemented in the gamified app.

Regarding the items for personalizing the mentor, all types of the items were welcome; and finally, the proposed types of educational games were well-accepted.

FINAL DESIGN OF THE OCARIOT EXPERIENCE

Based on the feedback from the first validation workshops, the design of the OCARIoT experience was refined around the storytelling of becoming a secret agent (see Figure 1),


where the children have to develop three abilities related with the healthy habits.


The look & feel of the app has followed the **aesthetics** of this agent secret storytelling, challenging children with a set of missions to be completed in the real-world about healthy habits (e.g. physical activity, food intaking).


Scientifics from around the world have identified a major health hazard for the entire population, which has been causing serious illness and even death. If not treated, in a not so distant future, this evil can be the end of the humanity. To address this problem, the scientists have formed an international organization to promote healthy habits. Alone, though, they are not match. So they started a program to recruit, select and train young field agents around the world. To lead this initiative, they have created a very powerful artificial intelligence technology as an agent trainer.

You have been preselected to be an agent in this organization

But first, you must submit to a training based on a set of tests and missions and prove yourself fit to help save the world. During your training you'll have to develop the following abilities:

 **Dexterity:** agility, power, endurance, resistance to overcome the tests.

 **Intelligence:** knowledge about subjects concerning the danger at hand.

 **Discipline:** awareness and self-control over your impulses and actions.

Many others have been called to this challenge. You have the chance to become **AGENT #1**.

Figure 1. Secret agent storytelling

The **missions** can be individual, if they are performed by the child alone, or social, if they are performed together with family or at school. And each mission is associated at least with one of the abilities to be developed:

- **Dexterity:** It is related to physical activity.
- **Intelligence:** It is used to teach children all the knowledge related to healthy habits in nutrition and physical activity mainly.
- **Discipline:** It is used for providing children awareness and self-control over the impulses for eating and actions related to sleep, especially to promote better choices with daily food and on weekends.

In order to provide personalized **missions** to each child, it is important to establish a baseline to know the current status of the child. To do so, we use the baseline data collected through questionnaires (such as Physical Activity Questionnaire for Children - PAQ-C [7] or Child Eating Behaviour Questionnaire – CEBQ [8]), IoT devices (e.g. a wearable for physical activity) and specific info collected directly in the app about food and physical activity habits.

To involve families in the OCARIOt experience, families have access to a dashboard, where children evolution and recommendations related to the missions are shown so they can help children to fulfil them (e.g. a mission can be not to eat industrial bakery for one week; and a recommendation could be to send families a homemade cake recipe). These recommendations will also serve as knowledge information to teach families about healthy habits.

To collect relevant data from children in an easy way about their daily activity and food consumption, we have defined the “**secret agent report**” feature. The child has to submit an agent report weekly answering some specific questions related to the missions achieved during that period.

The **mentor** design also evolved based on the feedback received from children by providing a more cartoonish design. As explained before, the mentor will be the virtual character that represents the agent trainer who will guide the child during the experience. It provides not only support about how to use the app through a tutorial, but also tips, recommendations and reminders about missions. The child would **personalise** the mentor with a set of different items, such as accessories, hair and colors (see Figure 2). The personalization items can be bought using coins earned achieving missions and playing the educational games.



Figure 2. Mentor and personalization items

The mentor supports children on how to use the app through a **tutorial**, which explains, the rules, the objective, the rewards and all the things the child should know to go inside the experience and back again.

The **educational games** give the child the ability (knowledge) to overcome a mission (actions to carry out in real life). The four types of educational games will be integrated in the app: “Trivia”, “True or False”, “Matching pairs” and “Find them all”. By playing these educational games, the child will also win points that can be used to buy the personalization items.

The **progress** is based on the abilities achieved with each mission, the earned coins and the badges achievement in

order to show the advancement and current state of child every moment.

Based on this final design, we arranged the second validation workshops to evaluate how the children interact with the app, if the graphical interface was easy to use and understand and if they could perform the proposed activities autonomously. Three workshops were organized in the same four schools (in Spain, Greece and Brazil). A total of 75 children between 8 and 13 years old were involved; 34 girls and 41 boys.

In order to collect their feedback, we used a Software Usability Scale (SUS)-questionnaire adapted for children, where each question was rated using a scale of 1-5, 1 being the lowest (no/nothing), 5 being the highest (yes/great):

- Q1: I liked the game.
- Q2: The instructions of the mentor were easy to understand.
- Q3: It was easy to complete the missions.
- Q4: I had some problems to complete the missions.
- Q5: The navigation through the game was easy and I found what I was looking for.
- Q6: I found the game complex.
- Q7: The game was easy to use.
- Q8: I will need the support of an adult to play the game.

The received feedback was very positive. The main conclusions about the app were that is easy to use, the role of the mentor is well integrated, and the tutorial will be relevant to introduce the app and also to explain its features. The next table shows a summary of the media results per question and pilot site.

Questions	Spain	Brazil	Greece
Q1	4,18	4,06	3,23
Q2	3,85	3,8	3,96
Q3	4,27	3,86	4,00
Q4	3,09	1,87	2,8
Q5	4,09	4,12	3,62
Q6	2,69	1,5	2,85
Q7	4,27	4,37	4,19
Q8	2,76	2,46	2,44

Table 3. Results of the SUS questionnaire from second validation workshops.

CONCLUSION AND FUTURE WORK

Although gamification and game design are showing a great potential for health applications, little is known whether and how effectively it can drive healthy improvement and wellbeing outcomes; specially in childhood obesity domain. This is why we started OCARIOt, aiming to combine

personalised health interventions with a gamification strategy addressing the specific needs of obesity in children (between 9 and 12 years old).

Besides, in order to enhance and assess the impact on the solution, health professionals are involved as a core part of the project. We started to design the gamification strategy based on the health requirements provided by the professionals and perform several validation workshops with children. The received feedback was very promising, with a positive engagement from children to use the app and complete the challenges related to healthy habits.

As future work, we are working on the final piloting phase to be completed next year in order to evaluate the empirical evidence on the effect of gamification on childhood obesity and healthy habits acquisition.

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REFERENCES

1. GD Foster, AP Makris, BA Bailer. 2005. Behavioral treatment of obesity, *Am J Clin Nutr.*, 82(1 Suppl):230S-235S.
2. C. Maramis, C. Diou, I. Ioakeimidis, I. Lekka, G. Dudnik, M. Mars, N. Maglaveras, C. Bergh and A. Delopoulos. 2014. *SPLendid: Preventing Obesity and Eating Disorders through Long-term Behavioural Modifications*. MobiHealth 2014, Greece, 2014.
3. D. Sola, J. Couturier, G. Scarso, C. Raiciu. 2012. How can the Internet of Things help in overcoming current challenges ... and make healthcare sustainable, *ESCP Europe*, September 2012.
4. L. H. Daniel Johnson. 2016. Gamification for health and wellbeing: A systematic review of the literature. *Internet Interventions*, vol. 6, pp. 89-106.
5. S. M. d. Salud. 2014. Diseño del estudio Eloin y prevalencia de sobrepeso y obesidad en la población infantil de 4 años de la comunidad de Madrid.
6. R. M. Ortega Anta, A. M. López-Sobaler, A. Aparicio Vizuete, L. G. González Rodríguez, B. Navia Lombán, J. M. Perea Sánchez, N. Pérez Farinós, M. Á. Dal Re Saavedra, C. Villar Villalba and Santos. 2015. *Estudio ALADINO 2015: Estudio de vigilancia del crecimiento, alimentación, actividad física, desarrollo infantil y obesidad en España*. 2016. Ministry of Health, Social Services and Equality. Spanish Agency of Consumption, Food Security and Nutrition.
7. KC. Kowalski, PRE Crocker, RA Faulkner. 1997. Validation of the physical activity questionnaire for older children. *Pediatr Exerc Sci.*;9:174–186.
8. J. Wardle, CA. Guthrie, S. Sanderson, L. Rapoport. 2001. Development of the children's eating behaviour questionnaire. *Journal of Child Psychology and Psychiatry*, 42, 963-970.