



Using Exergames to Promote Healthy Habits in Schools

Nazaret Gómez del Río¹, Carina S. González-González²(✉) ,
Yeray Barrios Fleitas³ , Pedro A. Toledo-Delgado², Francisco J. García-Peñalvo³ ,
and Fernando Moreira^{4,5}

¹ Group GRIAL, Universidad de Salamanca, 37008 Salamanca, Spain
ngomrio@usal.es

² Group ITED, Universidad de La Laguna, 38200 San Cristóbal de La Laguna, Spain
{carina.gonzalez,petode}@ull.edu.es

³ Faculty of Electrical Engineering, Mathematics and Computer Science, University of Twente,
Zilverling, P.O. Box 217, 7500 AE Enschede, The Netherlands
y.d.c.barriosfleitas@utwente.nl, fgarcia@usal.es

⁴ REMIT, IJP, Universidade Portucalense, Porto, Portugal
fmoreira@upt.pt

⁵ IEETA, Universidade de Aveiro, Aveiro, Portugal

Abstract. Educating children in healthy lifestyle habits is one of the most effective ways to prevent future diseases such as obesity and improve their health. This chapter presents an educational intervention project to promote healthy lifestyle habits using active video games and gamified activities as a motivational tool towards healthier habits. In particular, we describe the workshops carried out in different primary schools using an active video game called TANGO:H and other gamified tools. The results of these workshops have shown a very high satisfaction with the intervention itself and the active video game .

Keywords: Exergames · Healthy habits · Gamification · Childhood obesity

1 Introduction

Childhood is the stage of life where habits that will be consolidated throughout our lives begin to develop. Educating children in healthy lifestyle habits from an early age is the most effective preventive measure to improve their health and quality of life [1].

In 2004, the WHO declared obesity as the epidemic of the 21st century after reaching global proportions, although as early as 1998 in its World Health Report, it spoke of obesity as an emerging health problem [2].

This epidemic mainly affects developed and developing countries. However, it is no longer exclusive to high-income countries and is beginning to be present in developing countries, affecting the entire population from childhood to adulthood.

Overweight and obesity are the fifth leading risk factors for death globally and are attributed to nearly three million deaths per year. Health problems from being overweight

or obese are estimated at 58% of the burden of diabetes, 21% of ischemic heart disease, and between 8% and 42% of some cancers, and these risks grow in proportion to the increase in body weight [3]. Obesity has been increasing progressively in recent decades. It has become one of the most severe public health problems in the pediatric population, estimating that about 41 million children under five years of age were overweight or obese in 2016. If current trends continue, the number will increase to 70 million by 2025.

The Spanish Society for the Study of Obesity (SEEDO) confirms that 44.5% of Spanish children suffer from excess weight; this means that practically one out of every two children are overweight, concerning the growth patterns established by the WHO. These results are added to those given by the ALADINO study [4]. It specifies that the child population aged between 6 and 9 years has a prevalence of 26.2% overweight and 18.3% of obesity. In the Canary Islands, the results were 21.2% and 28.4%, respectively, being the Spanish autonomous community with the highest rate of childhood obesity, together with Andalusia. In its latest update in 2019, there is a downward trend in overweight since 2011 and stabilization for 2015. However, the prevalence of overweight and obesity in schoolchildren aged 6 to 9 years in Spain remains high (the prevalence of overweight is 23.3%, and obesity is 17.3%).

The association between childhood obesity and risk factors for chronic diseases, its persistence in adulthood, and the scarce success in its treatment makes the efforts of governments and health organizations focus on prevention at this stage of life, knowing that most behaviors and habits are acquired at an early age, it becomes crucial to promote healthy lifestyles from all spheres. For some years now, social policies, research, and educational programs have appeared for their prevention and treatment from different areas (school, society, families) [5].

Therefore, the project we have developed seeks to:

Promote the acquisition and permanence of healthy lifestyle habits in children with overweight and/or obesity through health education.

Promote social awareness about the importance of childhood obesity prevention in our society.

This intervention program was designed, conducted, supervised, and analyzed by professional researchers in the areas of health (medicine, physiotherapy, nursing, psychology, physical education, and sports), education, and computer science [6]. Each area of this study focused on analyzing different characteristics of the intervention.

This paper will present background about gamification and healthy lifestyle habits, the reference project, the experience developed in different educational centers that participated in the project, and the main results. Likewise, the tool used as an active video game in the project will be described.

2 Gamification, Exergames and Healthy Lifestyle Habits

Non-pharmacological interventions should be the basis of obesity treatments, especially in children, where they are considered the first-line treatment [7]. The goals to be achieved include long-term changes in lifestyles, especially in eating and physical exercise habits. Generally, only when these are profound, long-term weight changes are observed [8].

According to the review of controlled trials of lifestyle interventions, despite multiple methodological limitations, family-based behavioral lifestyle interventions targeting dietary change, physical activity, and thought patterns could lead to a significant and clinical decrease in overweight in children and adolescents [9]. Although this review includes 6- and 12-month follow-ups, follow-up studies with longer time frames are desirable. From a review of trials carried out with overweight and obese adults, with follow-up of changes in weight over a minimum period of two years, it is concluded that modern interventions aimed at changing lifestyles cause a modest but sustained decrease in weight over time, with clinical significance, as it has a positive impact on complications such as diabetes and hypertension [10]. The interventions reviewed combine specific dietary changes, calorie restriction, exercise, and counseling using behavioral techniques. Some of these techniques include self-monitoring, modeling, environmental restructuring, and group and individual support. In addition to being effective, these interventions generate participant acceptance, low dropout rates, and compliance in attending sessions. There are some factors that, according to the authors, favor the long-term maintenance of the changes achieved. Firstly, suppose the goals set are simple and involve small weight changes. In that case, this facilitates their achievement and maintenance, and this small success can favor the feeling of self-efficacy and promote both the maintenance of weight change and the acceptance of new changes. On the other hand, the long-term efficacy of the interventions was related to the maintenance of contact with the participants during the entire follow-up period, rendering obsolete the idea that a lifestyle modification intervention can take place in a limited time and maintain its benefits for life. One of the complications of maintaining professional care is its cost; in that sense, minimal monthly or bi-monthly telephone or group contacts seemed effective in maintaining weight reduction [10].

Feelings of autonomy linked to healthy eating and physical exercise are positively related to short- and long-term weight loss. This implies the establishment of an internal locus of control and self-regulation for weight control. Weight control is also predicted by considering physical exercise as intrinsically reinforcing, exciting, and a source of enjoyment and feelings of confidence in its performance [11, 12].

According to a review of papers on mediating variables of the effectiveness of interventions to promote physical activity in children and adolescents, self-efficacy is a target to be established in interventions to increase physical activity. Although the generalization of the results should be considered caution because most of the works reviewed were implemented in a female population, self-efficacy was the only cognitive variable that acted as a mediator in the relationship between change in physical activity and weight. Outcome expectancy behaved as a mediator in only one paper. However, it was related to changes in physical activity, as were attitudes, changes in perceived barriers, and changes in the enjoyment of the physical activity. Among the behavioral variables, only commitment to planning acted as a mediator and, among the interpersonal variables, none played this role [13].

Another critical factor in the success of intervention with children with obesity is the inclusion of parents in the programs. It has been found, for example, that parental motivation, especially their confidence in achieving changes in lifestyle behaviors in

the early phases of treatment, can reduce treatment dropouts and improve treatment outcomes [14].

Interventions have even been designed to work only with parents. For example, West et al. (2010) [15] intervene with parents to improve their skills and confidence in managing their children's weight-related behaviors. Compared to a non-intervention group, improvements in children's weight, weight-related problem behaviors, parental self-efficacy, and decreased ineffective parenting practices are evidenced immediately and at 12-month follow-up.

In addition to including self-esteem, eating habits, and physical activity, it has been shown that group exercise programs can be a helpful tool, and parental involvement is required for the effectiveness of obesity treatments [16]. Likewise, intervention should pursue behavioral changes because knowledge does not guarantee them [16]. This is consistent with the self-determination theory, from which it is proposed that the feeling of autonomy and self-defined will during changes, the feeling of effective and optimal challenge and feeling connected in a meaningful way with other people, have an intrinsic value for the self and are essential for well-being and behavioral persistence [11].

The promotion of change can be approached and promoted from two approaches, not necessarily mutually exclusive. On the one hand, the implementation of desirable behaviors and reducing the frequency of undesirable behaviors can be promoted from classical behaviorist paradigms, administering reinforcers contingently to behaviors. From this approach, behaviors are managed according to extrinsic motivations. On the other hand, as we have just seen, intrinsic motivation can help the change to last. The achievement of feelings of autonomy and competence, social recognition, and evidence of the positive impact of behavioral change become intervention objectives. Both types of approaches are easily combined in the design of intervention programs. Furthermore, both are addressed when designing programs that use play to promote healthy lifestyles.

Research reports positive results in video games that promote healthy lifestyle habits [1, 16]. In the studies reviewed by Baranowski et al. (2008) [16], the objectives varied between changes in diet, increased physical activity, the combination of both, and other health-related habit changes (i.e., in the management of asthma or diabetes). The designs and methodology used are very varied. Video games differ, for example, in aspects such as whether they are contextualized in a narrative, interactivity, and whether the player assumes roles. They also vary in the behavioral theories guiding the approach (i.e., trial-and-error learning with reinforcers, goal direction, social cognitive theory, action through practice, self-regulation theory) and the methods used to promote change (i.e., increasing knowledge, increasing preference by associating positive stimuli, practice, modeling, goal setting, problem-solving, rewards, persuasive communication, social support). Despite this variability, in general, video games increased knowledge and changed attitudes and behaviors. The authors suggest that video games could influence behavior by

two mechanisms: by including the behavior change procedure in the game, for example, by establishing goals, or employing a story that includes change concepts. The story's usefulness that can contextualize a video game is highlighted since the narrative can help capture and maintain the interest of the student/player and allows the modeling of desirable behaviors through the characters. Thus, the characters guided by the player face the challenges through habit change, favoring the player's actual habit change. When the story is presented in an episodic structure, it favors attention and strengthens behavior change messages, interrelating them by appearing in different stories. The immersion, which favors intrinsic motivation, and the interactivity characteristics of video games, allow the story to be experienced in the first person and encourage learning through planning skills, decision making, and cause-effect relationships. Added to this is the powerful tool of feedback that can be offered in different formats and immediately. One difficulty of this type of tool is that its design is costly in terms of time and varies significantly in economic terms [16].

Gamification is a growing trend nowadays, which is proving its usefulness in educational and health promotion contexts. It is understood as the design of non-game activities using elements of game design to achieve behaviors that can be considered "playable" in contexts where they are generally not considered "playable" [17–21]. It has been applied to achieve results in designing tools to improve physical skills and increase physical activity [22]. In this way, some applications and websites allow sharing and reinforcing behaviors linked to physical activity, making it more fun. These applications involve earning points, overcoming levels and achievements, and earning badges for social and physical activities [21, 22].

Likewise, some applications and communities include a broader ratio of healthy habits, making it possible to set individual weekly or biweekly goals and rewarding (reinforcing) healthy behaviors and for example, not giving in to temptations generated by stress, taking hypercaloric food, but carrying out a healthy behavior, such as drinking a glass of water or going for a walk [22].

Intervention programs based on gamification have been designed to promote healthy habits from the school context [23, 24]. This is the case, for example, of the FIT Game, a program aimed at increasing vegetable and fruit consumption in the school cafeteria [25]. In it, each day, a fruit, or vegetable was set as a goal for consumption. The days when none was chosen constituted the experimental control situation (does consumption increase differently when promoted?). The program had a narrative context, with heroes (FIT) who had to capture the villains (VAT, vegetable annihilation team). Moreover, a format was proposed with three phases of competition against other schools, although these were fictitious. The winning school would help the heroes. The fictitious competition phase lasted seven days.

Each day a teacher read a very short script (less than 1 min) in which he communicated the progress. Phases were won by eating more of the selected fruits or vegetables compared to the other schools. When they met or exceeded the consumption criteria established by the researchers, they were informed that they had won, and the school was rewarded with a badge placed on the project screen. Once the competitive phase

was over and the school had won, the hero support phase began. Before lunch, teachers would read a 3-min story to their students, highlighting their role in achieving the goals (eating fruit or vegetables). When the goal was met or exceeded, teachers would read an episode the following day. Each episode began by congratulating the school on its success, progressed through the narrative, and usually ended in a moment of suspense. When the goal was not reached, the reading encouraged students to eat more of the selected food than usual because the heroes needed it. Each gram that exceeded the consumption criterion was bonused with a game currency unit placed on the game screen. Every four days, students voted on spending that “money” or the direction of the narrative. An increase in vegetable and fruit consumption was observed, linked to the intervention (restricted to target days). However, the starting point of group vegetable and fruit consumption at school was not low. One relevant limitation is that it does not capture individual improvements because this study was conducted in a group setting; also, we lack follow-up information [25].

As we can observe above, gamification and exergames can help in the promotion of healthy habits. Thus, in the following section, we will describe the structure of the PROVITAO “Educational Intervention Program using Active Video Games and Motor Games to Support the Outpatient Treatment of Obesity” project, which includes effective interventions for treating obesity and promotion of healthy habits in children.

3 PROVITAO Project

The research project entitled PROVITAO is a project of a research group called Interaction, Technology, and Education (ITED) of the University of La Laguna formed by computer scientists, education professionals, health professionals, designers, pedagogues, and psychologists are working on the design of active video games and motor games with an educational and health approach.

The project aims to improve children’s physical, emotional, affective, and cognitive states through active video games and other ICT-based educational activities. To this end, in this project, we carry out an educational intervention focused on the acquisition of healthy lifestyle habits in primary school children with childhood obesity and other interventions to raise awareness in society about this health problem. The study consists of different phases: the initial evaluation phase, the intervention phase, differentiated for parents and children, the final evaluation phase, and the follow-up evaluation phase. Figure 1 shows an outline of the intervention carried out.

In addition, the PROVITAO team carried out theoretical and practical workshops with the students and teachers at the schools participating in the study to promote healthy lifestyle habits, prevent and raise awareness of childhood obesity. The following is a description of the experience carried out in the different schools participating in the project.



Fig. 1. Diagram of the intervention carried out in the PROVITAO project.

4 Experience

The schools that participated in the project were the following: CEIP Las Mercedes, CEIP Aguere, CEIP Aneja, CEIP San Rosa de Lima, CEIP Samoga, and CEIP La Verdellada belonging to San Cristobal de La Laguna, Tenerife, Spain. Activities were carried out for grades 3 to 6 of primary school (boys and girls between the ages of 8–12 years). A total of 581 students and the teachers responsible for each class (16 teachers) from the four schools involved participated for three months. The age range of the teachers was 38 to 59 years, although 75% were older than 50 years (mean age = 51.62). Most of the teachers participating in the study were women (81.25%).

The activities carried out in the schools, aimed at students from third to sixth grade of primary school and the teachers responsible, were structured as follows:

- School hours and 45 min.
- Theoretical-practical gamified activities: included a brief presentation on the subject focused on healthy eating and games to improve healthy lifestyle habits in a gamified

way using the Kahoot tool in group form (4–5 students per tablet) (Fig. 2) and continued with the realization of motor games and active video games using TANGO:H individually (Fig. 3) [26].

Overall satisfaction with the workshops was measured using a Likert scale (1 = Very insufficient/inadequate; 5 = Very good/Very adequate), and we can say that in the case of the overall intervention, it was very high (4.69), as well as with the use of the active video game TANGO:H (4.75). Other variables measured concerning the satisfaction with the intervention were: time (4.69), duration of the session (4.44), use of Kahoot (4.67), educational contents (4.63), goals of the program (4.63). Also, we measured variables related to the dynamization, such as the knowledge of facilitators (4.88), the skills of

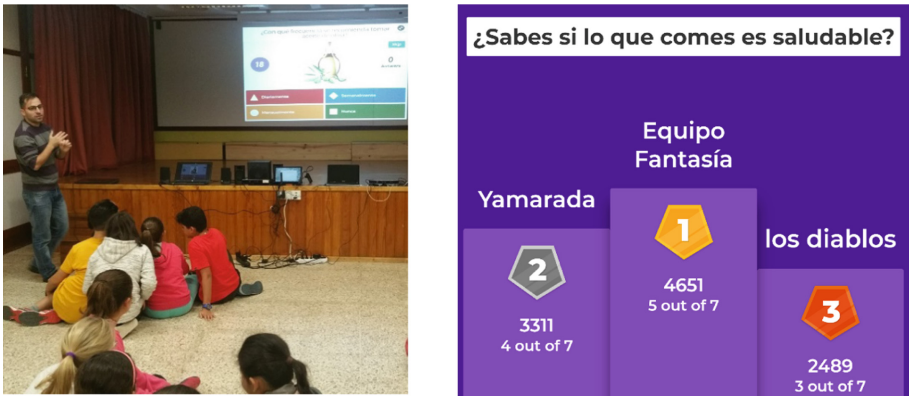


Fig. 2. Use of the Kahoot gamification tool as a group activity in schools.



Fig. 3. Use of the active video game TANGO:H in schools.

communication (4,63), their capacity to answer questions (4,67), and their capacity to create interest (4,75).

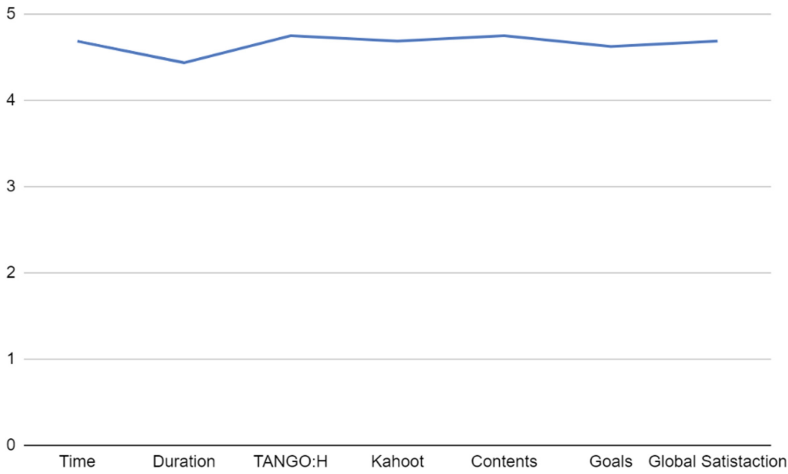


Fig. 4. Use of the active video game TANGO:H in schools.

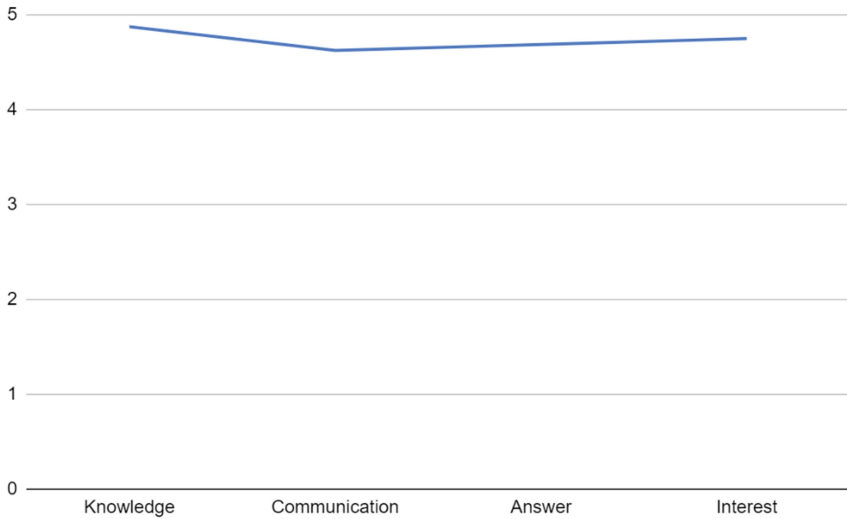


Fig. 5. U Use of the active video game TANGO:H in schools.

Next, the active video game TANGO:H used as a tool in these workshops will be described (Fig. 5).

5 TANGO:H

As we have previously described, PROVITAO is an educational intervention program that uses gamified physical exercises, stimulating body movement and more active participation through active digital games or exergames, which allow capturing, virtualize, and reproduction the physical movements of the player to carry out the challenges presented in the game.

Therefore, all the sessions carried out were designed from a ludic point of view; this means that after each theoretical content, an active game was carried out to reinforce it, using an active video game or exergame called TANGO:H [26].

TANGO:H is a platform created through a collaboration agreement between the Instituto Tecnológico y de Energías Renovables (ITER) and the Interaction, Technology and Education (i- TED) Research group of the Department of Systems and Automation Engineering and Computer Architecture and Technology of the University of La Laguna. TANGO:H allows the user to interact with the application without a physical intermediate medium through gestures using his own body.

The system allows the user to play both individually and in a multiplayer mode in a sequential, collaborative, or competitive way. There is also an intelligent game mode, using the recommender system, which recommends exercises based on the user's skills.

Likewise, TANGO:H provides the user with a gamified system, which stimulates the user to improve his evolution in the game using a reward system, which he will obtain by redeeming points. This system is used to increase motivation in the physical exercises' performance through challenges in the game.

The exercises and the reward system (prizes) can be created and modified through an application called TANGO:H Designer (Fig. 4). This allows teachers or specialists to design customized exercises that meet their specific needs and objectives (Fig. 6).

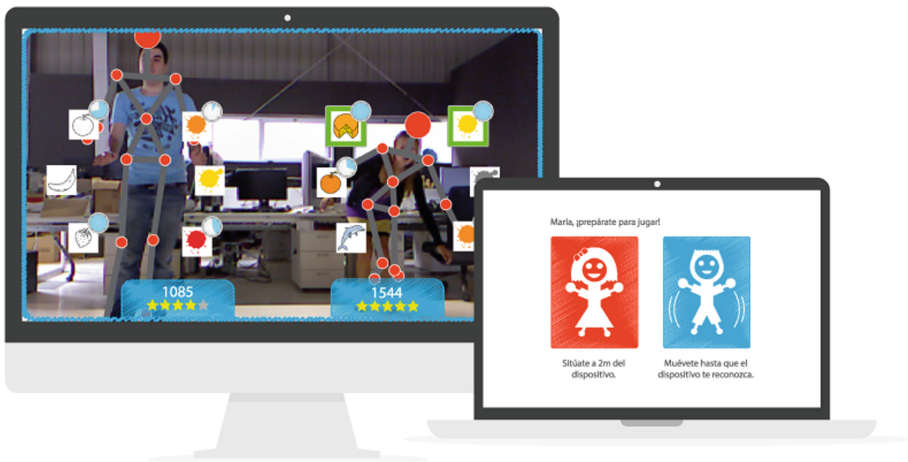


Fig. 6. TANGO:H application. Source [27].

6 Conclusions

As conclusions, we believe that there is a need for greater awareness and mobilization of society about problems derived from sedentary lifestyles, overweight, and child obesity. The interest of the educational intervention program presented does not aim to promote interaction with active video games or exergames for their purposes. However, with the motivation, they can awaken students' awareness of the health problem in question. We see that interaction with exergames can generate a motivating environment that can translate into effective changes in people's lifestyles who interact with it.

Nevertheless, we believe that it is necessary to perform an intervention only on active video games. However, different strategies are needed to achieve a real change in the lifestyle habits of minors. In schools, it is possible to replicate this type of intervention by combining different gamification tools and active video games that motivate students to acquire knowledge and practice healthy physical activities. We believe that it would be interesting to integrate this type of program into the educational model of the centers, as it is a program that educates and motivates behavioral change from an early age using the dynamics of games, which are so close to children.

We also consider that it is necessary to introduce in the short-term space for education in healthy lifestyle habits in the educational curriculum of minors. This type of education should not be left to chance and to the teacher's interest in training his or her students in this subject. The fact that education in healthy lifestyle habits is part of the curriculum would ensure the long-term acquisition of healthy behaviors and the prevention of non-communicable diseases related to bad habits, resulting in improved health for society.

Finally, we conclude that active video games and gamification can increase motivation towards physical activity, learning, and healthier lifestyle behaviors in children.

Acknowledgments. The authors would like to thank researchers and participants involved in the project PROVITAO, from different areas: Health (Raquel Martín González, Carmela Quirce González, Norberto Marrero Gordillo, Honorio Armas Ramos, Mariana E. Cairós González, Josué Monzón Díaz, Mercedes Murray), Technology (Alberto Mora Carreño, Belén Armas Torres, Vanesa Muñoz Cruz, Lorenzo Moreno Ruiz, Jesús Rodríguez Álamo, Miguel A. Padrón, Niobe Jerez, Pablo V. Torres Carrión) and Education (Vicente Navarro Adelantado, Luis Navarro Campillo, Elisenda Espino Espino, Silvia Vera González, Isa Neves). We would also like to thank the Department of Education of the Government of the Canary Islands and the schools and teachers who collaborated with the project. This work has been funded by the Fundación CajaCanarias, Project PROVITAO OBE05.

References

1. González, C.S., et al.: Learning healthy lifestyles through active videogames, motor games and the gamification of educational activities. *Comput. Hum. Behav.* **55**, 529–551 (2016). <https://doi.org/10.1016/j.chb.2015.08.052>
2. Organización Mundial de la Salud: Obesidad y sobrepeso. <https://www.who.int/es/news-room/fact-sheets/detail/obesity-and-overweight>. Accessed 11 Jan 2022

3. Organización Mundial de la Salud: Informe de la Comisión para acabar con la obesidad infantil: Informe de la Directora General (No. A69/8). Organización Mundial de la Salud (2016)
4. Estudio ALADINO 2019: Estudio sobre Alimentación, Actividad Física, Desarrollo Infantil y Obesidad en España 2019. Agencia Española de Seguridad Alimentaria y Nutrición. Ministerio de Consumo, Madrid (2020)
5. del Río, N.G., González-González, C.S., Martín-González, R., Navarro-Adelantado, V., Toledo-Delgado, P., García-Peñalvo, F.: Effects of a gamified educational program in the nutrition of children with obesity. *J. Med. Syst.* **43**(7), 1–12 (2019). <https://doi.org/10.1007/s10916-019-1293-6>
6. Gómez del Río, N., et al.: PROVITAO: a research program based on active games for help the ambulatory treatment of childhood obesity. In: 1st Workshop on Gamification and Games for Learning (GamiLearn 2017). Universidad de La Laguna (2017). ISBN: 978-84-697-3570-1. <http://riull.ull.es/xmlui/handle/915/4786>
7. Han, J.C., Lawlor, D.A., Kimm, S.Y.: Childhood obesity. *Lancet* **375**(9727), 1737–1748 (2010)
8. Weigel, C., et al.: Childhood obesity: concept, feasibility, and interim results of a local group-based, long-term treatment program. *J. Nutr. Educ. Behav.* **40**(6), 369–373 (2008)
9. Oude Luttikhuis, H., et al.: Interventions for treating obesity in children. *Cochrane Database Syst. Rev.* **1**, CD001872 (2009)
10. Powell, L.H., Calvin, J.E., Calvin, J.E.: Effective obesity treatments. *Am. Psychol.* **62**(3), 234–246 (2007)
11. Teixeira, P.J., et al.: Motivation, self-determination, and long-term weight control. *Int. J. Behav. Nutr. Phys. Act.* **9**(1), 22 (2012)
12. Navarro, V.: El juego en el desarrollo: entre el juego motor y el videojuego active. En “Uso de las TIC para la atención educativa, hospitalaria y domiciliaria. Eds. Carina González y Verónica Violant. Ed. McGrawHill, Madrid, pp. 165–184 (2015)
13. Lubans, D.R., Foster, C., Biddle, S.J.H.: A review of mediators of behavior in interventions to promote physical activity among children and adolescents. *Prev. Med.* **47**(5), 463–470 (2008)
14. Gunnarsdóttir, T., et al.: The role of parental motivation in family-based treatment for childhood obesity. *Obesity (Silver Spring, Md.)* **19**(8), 1654–1662 (2011)
15. West, F., et al.: Randomised clinical trial of a family-based lifestyle intervention for childhood obesity involving parents as the exclusive agents of change. *Behav. Res. Ther.* **48**(12), 1170–1179 (2010)
16. Baranowski, T., et al.: Playing for real. Video games and stories for health-related behavior change. *Am. J. Prev. Med.* **34**(1) (2008)
17. Deterding, S., et al.: From game design elements to gamefulness: defining “Gamification”. In: Proceedings of the 15th International Academic MindTrek Conference on Envisioning Future Media Environments - MindTrek '11. Anais: MindTrek '11. ACM, New York (2011)
18. Llorens-Largo, F., Gallego-Durán, F.J., Villagrà-Arnedo, C.J., Compañ-Rosique, P., Satorre-Cuerda, R., Molina-Carmona, R.: Gamification of the Learning Process: Lessons Learned. In: IEEE Revista Iberoamericana de Tecnologías del Aprendizaje, vol. 11, no. 4, pp. 227–234, November 2016. <https://doi.org/10.1109/RITA.2016.2619138>
19. Firwana, A., Abu Shouqer, M., Aqel, M.: Effectiveness of E-learning environments in developing skills for designing E-tivities based on gamification for teachers of technology in Gaza. *Educ. Knowl. Soc. (EKS)* **22**, e23907 (2021). <https://doi.org/10.14201/eks.23907>
20. Samboní, G.R.M., Ordóñez, C.A.C., González, C.S.G.: Propuesta para la gamificación de actividades educativas colaborativas en CSCM. *Campus Virtuales* **5**(2), 18–28 (2016)

21. González González, C.S.: Gamificación en el aula: ludificando espacios de enseñanza-aprendizaje presenciales y espacios virtuales. Análisis e implementación de elementos del juego. Universidad La Laguna (2019). https://www.researchgate.net/publication/334519680_Gamificacion_en_el_aula_ludificando_espacios_de_ensenanza-_aprendizaje_presenciales_y_espacios_virtuales. <https://doi.org/10.13140/RG.2.2.34658.07364>
22. Morford, Z.H., et al.: Gamification: the intersection between behavior analysis and game design technologies. *Behav. Anal.* **37**(1), 25–40 (2014)
23. González, C.S.G., del Río, N.G., Adelantado, V.N.: Exploring the benefits of using gamification and videogames for physical exercise: a review of state of art. *IJIMAI* **5**(2), 46–52 (2018)
24. González-González, C.S., Gómez del Río, N., Toledo-Delgado, P.A., García-Peñalvo, F.J.: Active game-based solutions for the treatment of childhood obesity. *Sensors* **21**(4), 1266 (2021)
25. Jones, B.A., Madden, G.J., Wengreen, H.J.: The FIT game: preliminary evaluation of a gamification approach to increasing fruit and vegetable consumption in school. *Prev. Med.* **68**, 76–79 (2014). <https://doi.org/10.1016/j.ypmed.2014.04.015>. Epub 2014 Apr 24. PMID: 24768916 (2014)
26. González-González, C.S., Toledo-Delgado, P., Padrón, M., Santos, E., Cairos, M.: Including gamification techniques in the design of TANGO: H Platform. *J. Teknol* **63**, 77–84 (2013)
27. Website of the platform TANGO:H. <https://www.iter.es/portfolio-items/tango-h/>. Accessed 11 Jan 2022