ISCTE IUL
REPOSITÓRIO
INSTITUTO UNIVERSITÁRIO DE LISBOA

Repositório ISCTE-IUL

Deposited in *Repositório ISCTE-IUL*:
2022-08-29

Deposited version:
Accepted Version

Peer-review status of attached file:
Peer-reviewed

Citation for published item:
Vieira, S., Alexandre, I. M. & Cardoso, E. (2022). The child in charge: The case of child-participatory design of an environmental sustainability serious game. In IDC '22: Interaction Design and Children. (pp. 485-491). Braga: Association for Computing Machinery.

Further information on publisher's website:
10.1145/3501712.3535314

Publisher's copyright statement:
This is the peer reviewed version of the following article: Vieira, S., Alexandre, I. M. & Cardoso, E. (2022). The child in charge: The case of child-participatory design of an environmental sustainability serious game. In IDC '22: Interaction Design and Children. (pp. 485-491). Braga: Association for Computing Machinery., which has been published in final form at https://dx.doi.org/10.1145/3501712.3535314. This article may be used for non-commercial purposes in accordance with the Publisher's Terms and Conditions for self-archiving.

Use policy

Creative Commons CC BY 4.0
The full-text may be used and/or reproduced, and given to third parties in any format or medium, without prior permission or charge, for personal research or study, educational, or not-for-profit purposes provided that:

- a full bibliographic reference is made to the original source
- a link is made to the metadata record in the Repository
- the full-text is not changed in any way

The full-text must not be sold in any format or medium without the formal permission of the copyright holders.

Serviços de Informação e Documentação, Instituto Universitário de Lisboa (ISCTE-IUL)
Av. das Forças Armadas, Edifício II, 1649-026 Lisboa Portugal
Phone: +(351) 217 903 024 | e-mail: administrador.repositorio@iscte-iul.pt
https://repositorio.iscte-iul.pt

The child in Charge

User Experience: the child is the user

Sandrina Vieira

Instituto Universitário de Lisboa (ISCTE-IUL), Lisboa, Portugal, scpva1@iscte-iul.pt

Isabel Machado Alexandre

Instituto Universitário de Lisboa (ISCTE-IUL) && Instituto de Telecomunicações, Lisboa, Portugal, isabel.alexandre@iscte-iul.pt

Elsa Cardoso

Instituto Universitário de Lisboa (ISCTE-IUL) && CIES-IUL, Lisboa, Portugal, elsa.cardoso@iscte-iul.pt

ABSTRACT

In a technology-advanced world, it is known that children are growing up surrounded by electronic devices such as computers, mobile phones, and tablets, and eventually use them in their daily routines. Whereas the accessibility of these powerful tools is a long-standing issue, the majority of existing research and learning resources are focused on adult users. In this paper we explore a child-centred design approach through a serious game on sustainability. Participatory design, prototyping and evaluation are part of the process where we explore behaviour and feedback regarding the requested tasks. The preliminary results indicate that the children actively engaged with the prototypes, giving feedback and new ideas to make the serious game more engaging and easier for other children.

CCS CONCEPTS • Human-centred computing • Interaction design • Interaction design process and methods • Participatory design

Additional Keywords and Phrases: Children, Design-thinking

1 INTRODUCTION

Since the late twentieth and early twenty-first centuries, there have been numerous social, economic, and technological changes around the world, resulting in changes in children's childhoods. Nowadays, children are surrounded by technology. As a result of this rapid technology development, children find themselves in a world where they are completely immersed and use this technology in their daily lives [1], [2], [3]. From a young age,

most children in developed countries live in a “digitally fluent” [4] setting in their own homes [5]. Children as young as one year old are exposed to screens, as they have access to laptops, smartphones, consoles, and other internet-connected gadgets [6], using them at an increasingly younger age [7]. As shown in a survey of 2014 conducted in 656 homes with children aged 3 to 8 years old in Portugal, 63 percent of children have a personal tablet and 18 percent have a smartphone [8]. With this growth in technological devices, there is an immediate increase in the number of applications. These applications replace activities that used to occupy more time and make society increasingly glazed in a virtual environment by the ease of access, entertainment, and the need to belong to a technological society. All these applications are always developed for a single target: the user. It is the user who makes the decision to install certain software, who tests and evaluates each action performed by the clicks given on the screen and who decides if that software will bring benefits in any way. The concern with what is presented to the user and how the interaction will be carried out arose with the concept of user experience (UX) and user interface (UI). According to Norman, “*Poorly designed objects can be difficult and frustrating to use. They provide no clues or sometimes false clues. They trap the user and thwart the normal process of interpretation and understanding*” [9].

The concept of UX is gaining more and more relevance in the world of interaction design. As stated by ISO 9241-210 [10], before and throughout the usage of a product or service, users' thoughts, values, desires, attitudes, bodily and psychological reactions, actions, and accomplishments are all part of the UX.

Although UX stands for user experience, it is the framework for designing a user-friendly user experience. On the other hand, UI works on how users communicate with the platforms. How many of us would claim that it is easy to use all the technology we experience and easy to learn? Do you find it more difficult to use certain sets of software than others? Have you ever seen anyone struggling to program the clock or their video recorder? A badly designed architecture is the cause of most of these problems. Weak UIs result in every day, in higher error rates, higher cost of instruction, and decreased output. Which in turn, increases costs for organizations and creates stress for the users who communicate with the UIs [11]. The Child-Computer Interaction community affirms that children are not only digital consumers but can also actively participate in the design process [12]. Moreover, Giannakos et al. [13] state that it is crucial to deepen the understanding of the respective methodological design process and to center the child in the process and empower them during such process. Giannakos et al. also state that children are growing together with digital devices and, hence, they urge the need to account for a responsible and ethical research when involving them during the creation process. We propose to further study these issues with the development of a serious game. Researchers advocate that STEAM education prepares today’s children to develop the right skills to work in 21st century [14]. Applying a STEAM approach to education aims at helping students to develop critical thinking, creative problem-solving, collaboration, among other skills [15]. To elicit such skills, we propose that the serious game to be developed for studying user experience should portray a STEAM theme: sustainability.

2 THE GAME

2.1 Theme

Governments have adopted the concept of sustainable development, defined as "*meeting the needs of the present without compromising future generations' ability to meet their needs*," as a result of a growing global recognition of the importance of maintaining an ecologically balanced environment while still using natural

resources to meet the demands of a growing population [16]. One method to bring ecology to the forefront of our world is through social movements and innovative initiatives, but we also have an even better instrument at our disposal: teaching children how to live sustainably. It is critical to educate the next generation to become environmentally conscious, self-sufficient global citizens who recognize the urgency of environmental duty. According to a study [17], conducted into the potential of digital games as learning environments for sustainability, games can provide critical circumstances and opportunities for encouraging sustainability learning. Various authors have highlighted a variety of reasons why games can be considered learning tools, including the experiential learning that occurs while playing [18]; the presence of pedagogical principles in game design [19].

2.2 The Process

Serious Games (SG) can play an important role in raising awareness and promoting attitudinal and behavioural changes on sustainable issues by allowing players to experience unknown circumstances that are not possible in real life, such as the ability to change a city to be more sustainable by balancing pollution, energy productivity, and the happiness of the population. Usually, these games divide the challenge into numerous "missions" of increasing difficulty. Games can provide children with a glimpse of the challenges they will face in the future, mainly by putting them in the positions of characters who must be able to think strategically, plan, and make long-term decisions, thanks to its immersive storyline and interaction [20].

For the development of this SG we used the d.School process, Stanford Institute of Design, which is composed of five phases: Create empathy or understanding; Define; Ideate; Prototype and Test. This method is a quick and effective way to clearly define an important business challenge as well as a prototype that has been tested. Below outline the details that were included in each phase.

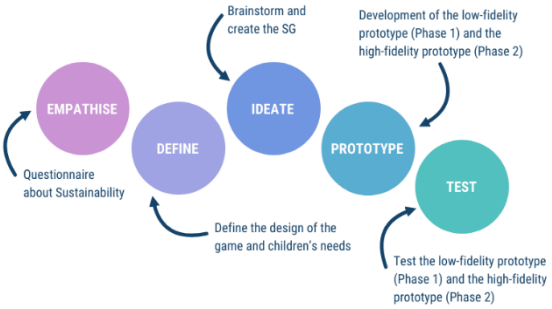

Figure 1 - Design Thinking Application. Adapted from Hasso Plattner Institute of Design at Stanford University

Empathise or understanding: It is essential to consider the users' demands, what they are looking for, what they require, and what they enjoy. This phase was important for learning about the importance and necessity of having a prototype of this SG to raise environmental consciousness in children.

Define: At this point we define the problem as well as what needs to be solved and created based on the children's needs and skill development.

Ideate: It was a vital phase because it was during this time that the thinking concepts were brought together, and the prototype was designed. During a brainstorming, a review of games that could serve as inspiration for the design of this prototype was made. For instance, the number of levels and degrees of difficulty were inspired

by the game Duolingo[1]. The proposed SG is focused on Piaget's concrete operational stage (from 7 to 12 years old) [21], because in this stage children have already started to develop their literacy skills.

Prototype: During this phase the low-fidelity prototype was developed for the first test phase and then a high-fidelity prototype for the second test phase.

Test: This phase is relevant to detect problems or misunderstandings by observation of users' interactions which may lead to prototype design changes. In a first phase, we evaluated the first prototype (low-fidelity), collected the data from the observations and usability tests and included them in a second phase in which we design the high-fidelity prototype.

2.2.1 Phase 1: Low-fidelity prototype

Design. It is crucial to playtest games as early and as often as possible during the creation process to ensure that they are successful. This is required to obtain input in order to enhance usability and address concerns with game balancing and motivation [18]. The user experience may not be effective, and the game's objectives may not be met if feedback doesn't exist. User experience is usually assessed after a working prototype has been implemented and is ready for testing [19]. Prototypes can be in the form of game sketches in the early phases of development, and hence a fully working prototype may not be required for some testing. Paper prototyping is a usability testing technique in which representative users engage with a paper version of the interface that is managed by a person "playing computer," who does not explain how the interface is supposed to work. Paper prototyping is beneficial to anybody involved in the design, implementation, or support of UIs because it encourages the development of products that are more helpful, intuitive, efficient, and pleasing [22].

For the development of the SG, it was necessary to take into account the age range of the children as well as the physical and motor skills for each age. Here are below some aspects that we consider to be important for the design of the SG:

1. **Reading:** a seven-year-old child has fewer reading skills than a twelve-year-old. It is important to adapt the written content to the vocabulary of these children and to take into consideration that many of them are still in an early learning phase;
2. **Colours:** It is important to consider the colours to be applied to the game, because unlike adults who need subdued colours to not distract from the main tasks, children need bright colours to catch the attention and carry out the tasks;
3. **Actions:** Since children do not have fully developed motor coordination, it is important to include actions that are intuitive and easy to use, such as: clicking, scrolling and dragging;
4. **Size:** The size of the content becomes an important factor due to accessibility limitations by children;
5. **Navigation:** The game should have a simple and accessible flow in order to understand the context and the necessary tasks.

Protocol. The protocol was divided into three parts: (1). Providing an Informed Consent Form to the parents, preparing the materials, and identifying the objective of the test, describing the tasks to the user, providing an initial questionnaire about the user's views of this SG were all part of the first part. In the second part, we conducted a test in which the user interacted with the SG, talking about all the actions she/he took, while the

[1] https://pt.duolingo.com/

researcher registered all of the important discoveries made during the test, including the user's reactions, behaviours, and conversations. In the third part, it was conducted a questionnaire similar to the one conducted in the first phase to see if the user's expectations had changed significantly after interacting with the SG and, this being the Fun toolkit questionnaire technique. The Fun toolkit is a collection of tools that quantify the three characteristics of fun: expectations, engagement, and endurance [23] In the following figure (Figure 2) the several screens of the app are presented.

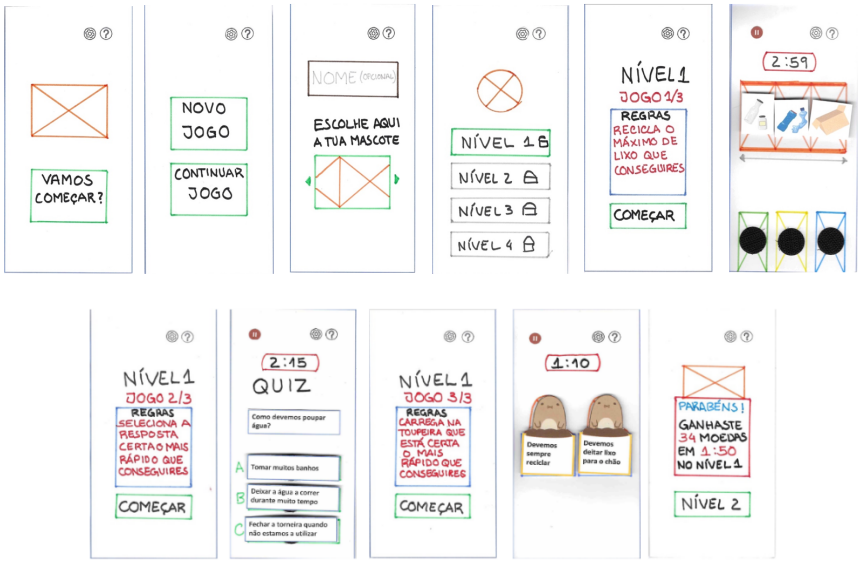

Figure 2 -Low-fidelity prototype

Experience. According to Nielsen, it is enough to test three to five users with qualitative user testing [24] Five children (three girls, and two boys) who were 7-12 years old participated in the paper prototype test. Due to the COVID-19 pandemic, there were some constraints throughout the process. It was necessary to use a convenience sample and to limit the testing sessions to 40 minutes. At the parents' request it was necessary to drive to each parent's home as they felt safer. Four out of five children asked their parents to be present but without interfering with the test. In **Error! Reference source not found.** and **Error! Reference source not found.** show the paper prototype and children interacting with it.

Figure 3 – Material and Paper prototype

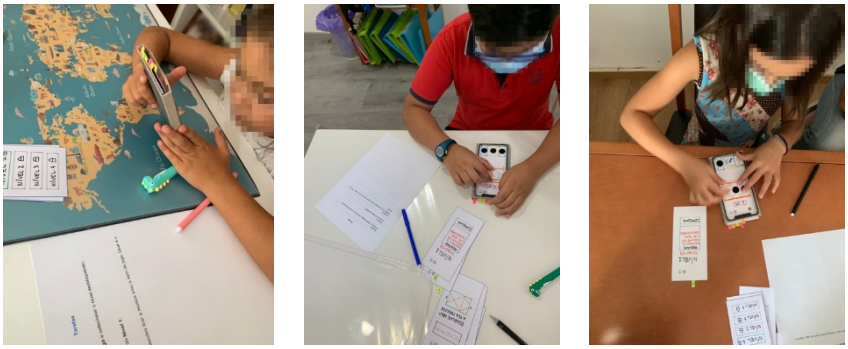

Figure 4 - Children interacting with the paper prototype

There are a range of evaluation methods for measuring user experiences; nevertheless, it is critical that the methods have been validated with children. Thus, we chose to use the Fun Toolkit. The Fun Toolkit is a collection of tools that quantify the three characteristics of fun: expectations, engagement, and endurance [25]. The Smilyeometer is a visual analogue scale with coding based on a 5-point Likert Scale, with 1 corresponding to 'Awful' and 5 corresponding to 'Excellent'. This scale is typically applied before and after the youngsters interact with the technology. The justification for utilizing it previously is that it can be used to estimate their expectations, however when used after, it is assumed that the child is reporting having fun. Because it is simple to use and needs no writing on the part of the youngsters, the Smilyeometer has been widely adopted and used in research studies to assess satisfaction [26] and fun [27]. The second tool from the Fun Toolkit - Fun Sorter - asks children to evaluate technology, or in this case, a SG, based on a variety of characteristics (Figure 5). The children would rank the SG according to the various structures, deciding which was the best and which was the worst. The last tool is the Again-Again Table (Figure 5). This table asks children to choose between "yes", "maybe" or "no" for each activity they have experienced.

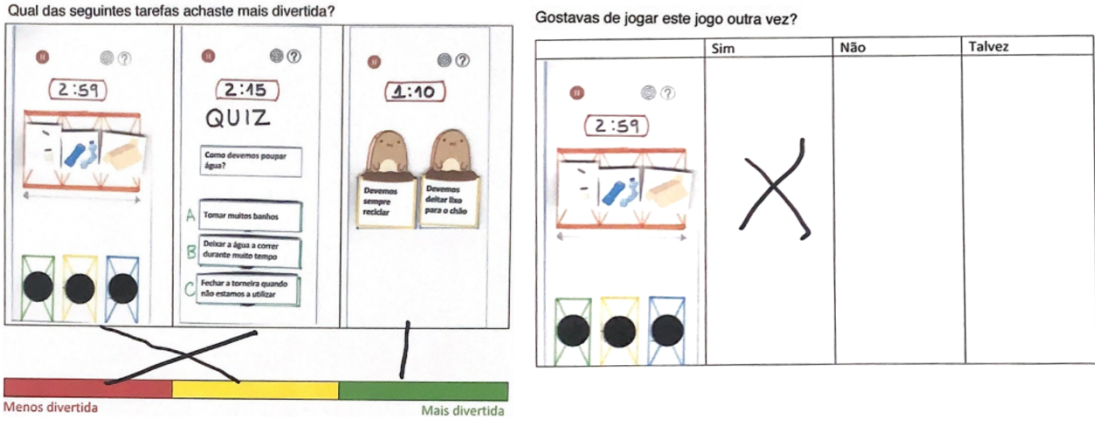

Figure 5 - : Fun Sorter from Fun Toolkit to rank the tasks based on the Fun aspect;

Results. By analysing the questionnaires pre and post tests the responses were almost the same. In terms of preferred games, the tendency was that animated games are more engaging than the static quizzes. This result

can be associate to the fact that there is a greater difficulty in quickly interpreting the questions/words. One of the children found this SG easy to understand and would like to play more levels to see if he could earn lots of coins. Another child, aged seven, was curious when explained about the aim of the game and the tasks to be performed. She quickly wanted to interact with the prototype even though it took twice as long as the other users, as some words were difficult to interpret but she questioned their meaning. However, she showed an enormous facility in understanding the actions to perform "because she usually plays other games with the same buttons".

2.2.2 Phase 2: High-fidelity prototype

The purpose of the high-fidelity prototyping was to provide children a more engaging experience and to utilise the prototype as a tool for evaluating the design changes. This prototype was designed with Figma[2], taking into account the feedback received by the children during and after the test with the paper prototype.

Figure 6 - Mood board

Design. This game was thought and developed in the Portuguese language because it is our mother tongue. The name of the SG is *"Terramiga"*, a concatenation of the Portuguese words *"Terra"* (Earth) and *"Amiga"* (Friend). Regarding the graphic language, we designed a smiling planet Earth logo and, because this is a SG for children, we included two children embracing the planet with bright colours to make it more attractive. Sea green was the colour chosen for this SG, as it reminds us of the nature of the ocean. The Poppins font was chosen, since it is open source and widely used in website development. Figure 6 displays a few visual elements used in the prototype, including the SG's logo.

Protocol. Two children were invited for this test, one of them (S1) had already participated in the first iteration and the other one (S2) had not yet participated and saw the game for the first time, giving us a new perspective on the SG. As with the first iteration, these tests were also conducted during the week and after school. These tests had to be performed online, due to further restrictions imposed by the COVID-19 pandemic. During this testing phase with the child who had already interacted with the prototype in iteration 1 (S1), it was not necessary to deliver the Interview Protocol, because she already knew the rules and the game interaction. Afterwards, it was possible to validate that the improvements made in the SG met her expectations and her feedback given in the first iteration. With the second child (S2), it was necessary to present the Interview Protocol and answer additional questions. At the end, we asked both children some open-ended questions about their experience with the prototype (e.g., would you change any aspect of this game?; would you like to receive physical rewards, e.g., a recyclable bottle to take to school or rewards where you gain more time/lives to play the game?; would you mention this game to your friends?).

[2] Htpps://www.figma.com

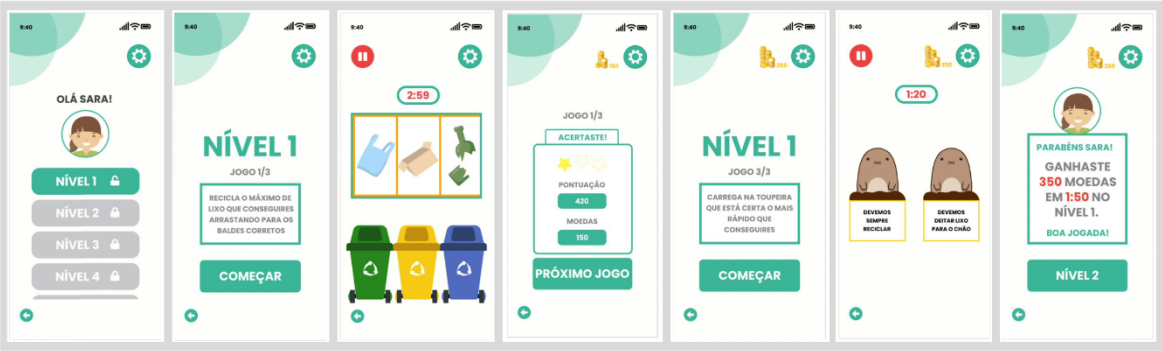

Figure 7 - High-fidelity prototype (a few screens)

Experience. S1 managed to complete all the tasks successfully and seemed excited as she realised the differences between this prototype and the paper prototype. S1 mentioned *"I liked the part where I got to the end of the level and was able to press the coins to realise how much I had already earned. Now I'm curious to know what the prizes are ad the next levels."* S2 said aloud everything he was thinking while interacting with the SG. As it was his first time interacting with the SG, it made him explore all the buttons and what each one included, which took more session time than the first child. S2 final comment was *"It is a very cool game and also easy to play. I think I would want to play it with my friends."* Regarding the open-ended questions, the general feedback was positive. When asked "Would you like to receive physical rewards (e.g., recyclable bottle to take to school) or rewards where you gain more time/lives to play a certain level?", S1 immediately responded that she preferred physical rewards because, although she was used to playing everyday games where she gains lives/time, she would rather play something new that gave her physical rewards. However, S2 responded that he preferred to gain more time/lives to play certain levels. S2 justified his answer to the fact that he is used to playing other games with rewards in game (lives/time) and not so much with real props.

3. CONCLUSIONS

In this paper, we presented a child-centred approach to designing and evaluating a SG about sustainability. We began our research by developing a low-fidelity paper prototype through brainstorming and informing our design decisions through extensive literature research. Almost all the children were enthusiastic to participate in this study, but even in a situation where one of the younger children was more apprehensive and nervous before the evaluation, as the interaction progressed, she became more comfortable, finishing the game excited and wanted to know more about the SG. This work-in-progress participatory design and evaluation with children of the high-fidelity prototype of the SG shows promising results. We believe that this kind of participatory design process can be applied to the development of new products with the direct intervention of children at all stages (and not only for the testing and validation phases). In the testing phases, the children showed interest in the tasks and challenges that the SG could bring, even though only presented with one level. Future work entails the design of all the game levels (with an increasing difficulty) and rewards. It would be interesting to explore the interaction of more children of the specified age range with a complete version of the game to validate any changes and usability errors that may arise.

REFERENCES

[1] T. Rudd, F. Colligan, and R. Naik, “Learner voice,” *Futur. Learn. voice Handb.*, pp. 1–39, 2006, [Online]. Available: http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Learner+voice#0.

[2] L. Plowman, O. Stevenson, C. Stephen, and J. McPake, “Preschool children’s learning with technology at home,” *Comput. Educ.*, vol. 59, no. 1, pp. 30–37, 2012, doi: https://doi.org/10.1016/j.compedu.2011.11.014.

[3] D. Holloway, L. Green, and S. Livingstone, “Zero to eight: Young children and their internet use,” *EU Kids Online*, no. August, p. 36, 2013, [Online]. Available: http://eprints.lse.ac.uk/52630/1/Zero_to_eight.pdf.

[4] I. Palaiologou, “Children under five and digital technologies: implications for early years pedagogy,” *Eur. Early Child. Educ. Res. J.*, vol. 24, no. 1, pp. 5–24, 2016, doi: 10.1080/1350293X.2014.929876.

[5] L. Plowman, “Researching young children’s everyday uses of technology in the family home,” *Interact. Comput.*, vol. 27, no. 1, pp. 36–46, 2015, doi: 10.1093/iwc/iwu031.

[6] S. L. Connell, A. R. Lauricella, and E. Wartella, “Parental co-use of media technology with their young children in the USA,” *J. Child. Media*, vol. 9, no. 1, pp. 5–21, 2015, doi: 10.1080/17482798.2015.997440.

[7] W. Sanders, J. Parent, R. Forehand, A. D. W. Sullivan, and D. J. Jones, “Parental perceptions of technology and technology-focused parenting: Associations with youth screen time,” *J. Appl. Dev. Psychol.*, vol. 44, pp. 28–38, 2016, doi: 10.1016/j.appdev.2016.02.005.

[8] V. R. Cristina Ponte (coordenação científica), Ana Jorge, Ana Nunes de Almeida, Andrea Basílio, Bieke Zaman, José Alberto Simões, Maria João Leote de Carvalho, Marije Nouwen, Nelson Zagalo, Peter Nikken, Sofie Vandoninck, Susana Batista, Teresa Sofia Castro, *Boom Digital*. .

[9] D. A. Norman, *The design of everyday things*. [New York]: Basic Books, 2002.

[10] “‘ISO - ISO 9241-210:2010 - Ergonomics of human-system interaction — Part 210: Humancentred design for interactive systems.’” https://www.iso.org/standard/77520.html (accessed Mar. 14, 2022).

[11] D. Stone, C. Jarrett, M. Woodroffe, and S. Minocha, *User interface design and evaluation*. Elsevier, 2005.

[12] M. Van Mechelen, M. Høiseth, G. E. Baykal, F. Van Doorn, A. Vasalou, and A. Schut, “Analyzing children’s contributions and experiences in co-design activities: Synthesizing productive practices,” *IDC 2017 - Proc. 2017 ACM Conf. Interact. Des. Child.*, pp. 769–772, 2017, doi: 10.1145/3078072.3081314.

[13] M. N. Giannakos, M. S. Horn, J. C. Read, and P. Markopoulos, “Movement forward: The continued growth of Child–Computer Interaction research,” *Int. J. Child-Computer Interact.*, vol. 26, p. 100204, 2020, doi: 10.1016/j.ijcci.2020.100204.

[14] T. R. Kelley and J. G. Knowles, “A conceptual framework for integrated STEM education,” *Int. J. STEM Educ.*, vol. 3, no. 1, 2016, doi: 10.1186/s40594-016-0046-z.

[15] M. Dell´Erba, “Preparing Students for Learning , Work and Life Through STEAM Education,” *Policy Brief, Educ. Comm. States, Arts Educ. Partnersh.*, pp. 1–12, 2019.

[16] B. R. Keeble, “The Brundtland Report: ‘Our Common Future,’” *Med. War*, vol. 4, no. 1, pp. 17–25, 1988, doi: 10.1080/07488008808408783.

[17] C. Fabricatore and X. López, “Sustainability Learning through Gaming, an exploratory study, Fabricatore & Lopez, 2012,” *J. e-learning*, vol. 10, pp. 209–222, 2012.

[18] H. Dieleman and D. Huisingh, “Games by which to learn and teach about sustainable development: exploring the relevance of games and experiential learning for sustainability,” *J. Clean. Prod.*, vol. 14, no. 9–11, pp. 837–847, 2006, doi: 10.1016/j.jclepro.2005.11.031.

[19] K. Becker, “Pedagogy in Commercial Videos,” in *Games and Simulations in Online Learning*, IGI

Global, 2007, pp. 21–48.
[20] T. Ouariachi, M. D. Olvera-Lobo, and J. Gutiérrez-Pérez, *Analyzing Climate Change Communication Through Online Games: Development and Application of Validated Criteria*, vol. 39, no. 1. 2017.
[21] B. P. J. Inhelder, *The Early Growth of Logic in the Child: Classification and Seriation*. Taylor \& Francis, 2013.
[22] J. P. Gee, “What video games have to teach us about learning and literacy,” *Comput. Entertain.*, vol. 1, no. 1, pp. 20–20, 2003, doi: 10.1145/950566.950595.
[23] R. Nielsen, Jakob; Budiu, “Success Rate: The Simplest Usability Metric,” *NNGroup*, 2021. .
[24] J. Norman, Don; Nielsen, “The Definition of User Experience (UX).” https://www.nngroup.com/articles/definition-user-experience/ (accessed Mar. 14, 2022).
[25] J. Read, S. Macfarlane, and C. Casey, “Endurability , Engagement and Expectations : Measuring Children ’ s Fun,” *Interact. Des. Child.*, vol. 2, no. January, pp. 1–23, 2002.
[26] W. Barendregt, T. Bekker, D. Bouwhuis, and E. Baauw, “Identifying usability and fun problems in a computer game during first use and after some practice,” *Int. J. Man. Mach. Stud.*, vol. 64, pp. 830–846, 2006, doi: 10.1016/j.ijhcs.2006.03.004.
[27] G. Metaxas, B. Metin, J. Schneider, G. Shapiro, W. Zhou, and P. Markopoulos, “SCORPIODROME: An exploration in mixed reality social gaming for children,” *ACM Int. Conf. Proceeding Ser.*, vol. 265, pp. 229–232, 2005, doi: 10.1145/1178477.1178514.