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Research on User Experience for Children

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TECNOLOGIAS
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Department of Information Science and Technology

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“Look at a day when you are supremely satisfied at the end. It's not a day when you lounge around doing nothing; it's a day you've had everything to do and you've done it.”

Margaret Thatcher

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Resumo

Português

Num mundo tecnologicamente avançado, é compreensível que as crianças estejam a crescer rodeadas de dispositivos eletrónicos como computadores, telemóveis e *tablets*, e eventualmente os utilizem no seu dia a dia. Enquanto que a acessibilidade destas poderosas ferramentas é uma questão antiga, a maioria dos recursos de investigação e aprendizagem existentes está centrada nos adultos.

Nesta dissertação exploramos uma abordagem centrada na criança, através de um jogo sério sobre sustentabilidade com vários níveis de dificuldade gradual. A conceção participativa, protótipos e avaliações fazem parte do processo onde exploramos o comportamento e feedback relativos às tarefas solicitadas. Os nossos resultados indicam que as crianças se empenharam ativamente nos nossos protótipos, dando feedback e novas ideias para que o jogo sério seja melhor e mais fácil para as outras crianças.

Palavras-chave: Interação Computador-Criança; Experiência de Utilizador; Usabilidade; *Design Thinking*; Design Participativo

Abstract

English

In a technology-advanced world, it is understandable that children are growing up surrounded by electronic devices such as computers, mobile phones and tablets, and eventually use them in their daily lives. 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 dissertation we explored a child-centred approach through a serious game about sustainability with several levels of gradual difficulty. Participatory design, prototyping and evaluation are part of the process where we explore behaviour and feedback regarding the requested tasks. Our results indicate that the children actively engaged with our prototypes, giving feedback and new ideas to make the serious game better and easier for other children.

Keywords: Child-Computer Interaction; User Experience; Usability; Design Thinking; Participatory Design

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Glossary of Acronyms

CCI	Child-Computer Interaction
DT	Design Thinking
HCI	Human-Computer Interaction
ICT	Information and Communication Technologies
ISO	International Standards Organization
SG	Serious Game
UX	User Experience
UI	User Interface
WoS	Web of Science

Chapter 1

Introduction

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]. In the history of technology, the pace at which they have access to these devices is unparalleled. 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.

From a young age, most children in developed countries live in a “digitally fluent” [4] setting both in their own homes [5], [6]. Children as young as one year old are exposed to screens, as they have access to laptops, smartphones, consoles, and other internet-connected gadgets [7], using them at an increasingly younger age [8]. According to Findahl (2013), children are accessing digital devices at an increasingly early age: in Sweden in 2011, half of three-year-olds accessed the web and, in 2013 the age of children decreased, with half of two-year-olds accessing the web [9]. 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 [10]. 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. Although the user makes the decision to install a specific software application, the user also tests and evaluates each action performed and ultimately decides whether 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 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”* [11]

The concept of UX is gaining more and more relevance in the world of interaction design. As stated by ISO 9241-210[12], 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. According to Norman and Nielsen, the first requirement for a successful user experience is to meet the exact needs of the consumer, without fuss or bother [13]. Next comes simplicity and aesthetics that create goods that are a pleasure to own and to use. True user experience goes far beyond, giving users what they say they want or offering checklist features. As reported by Norman and Nielsen, there must

be a seamless merging of services from multiple subject area, including engineering, marketing, graphical and industrial design, and interface design, in order to achieve a high-quality user experience in the offerings of an organization [13].

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? 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. According to Stone, the UI is a vital part of almost all computer systems. The architecture of the UI has been blamed for several accidents and disasters. Weak UIs result in every day, higher error rates, higher cost of instruction, and decreased output. This brings costs for businesses and creates stress for the users who communicate with the UIs[14].

To achieve the purpose of this research, it is necessary to conduct research in this area but with children. Following that, it will be important to incorporate and demonstrate it through the creation of a Serious Game (SG) that will explore the challenges of interaction and usability for this age group.

1.1. Objectives and Research Questions

This research aims to investigate the entire user-centred life cycle from the participatory design of, to the evaluation of, a SG. In terms of participatory design, the aim is to explore the challenges of interaction and usability for children between the ages of seven and twelve since cognitive and social development have different needs within this age group. The success of the participatory design activity would be measured in terms of the extent to which children could learn about sustainability.

This study focuses on two research questions:

1. To what extent, does participatory design influences the engagement rates of children between seven and 12 years old in SGs on sustainability?
2. Can we use direct feedback from children to fine-tune our design process and achieve a better overall satisfaction with the tool (i.e., meeting the children's expectations)?

1.2. Outline of the Dissertation

The structure of this dissertation consists of seven chapters. In chapter two, we analysed and summarised the existing research material that is relevant to this research. Chapter three explains the theme chosen for this SG: sustainability. The Design Thinking process and the respective phases applied in this study are also addressed. Still in the same chapter, all the conception and development for the first test phase is presented. Chapter four presents the participants, the whole evaluation method, the results extracted from this study and its analysis. Chapter five covers the whole process of designing the high-fidelity prototype, as well as a mood board with some graphic elements that are part of the prototype. At the

end, it shows a flowchart of the developed SG. Chapter six discusses the process of the second testing phase of this study, the high-fidelity prototype and the qualitative data collected. Finally, chapter seven includes the conclusions of the study, contributions, limitations of the research, and also a proposal for future research.

Chapter 2

Literature Review

In a world marked by technologies, it is easy to understand that children grow up surrounded by electronic devices, such as computers, smartphones and tablets, and end up using them in their daily routines. Although research on the use of digital technologies by younger children has been increasing in recent years, studies with children up to 8 years old are still scarce [6]. The purpose of this work is to conduct a Systematic Literature Review (SLR)[15] of publications on the topic of usability and user experience in young children in the last decades. The Web of Science (WoS) and b-on were used in this research. The main keywords of this research were: child-computer interaction, SGs, usability and design thinking for children. Firstly, we searched on WoS with the main keywords from which 25 articles were selected. Within this search, we found it difficult to find articles from the Journal of Child Computer Interaction - a key part of this research. Thus, we searched on b-on platform with the keyword "Journal of Child Computer Interaction" where it was possible to extract 5 articles related to this research. For both searches we decided to filter to get articles only in Portuguese, English and Spanish, since these languages could be understood without the use of external resources.

After filtering documents from the WoS database and B-on, we were able to obtain 30 documents. These documents include conference papers from Interaction Design and Children Conference (IDC). Table 1 shows the number of citations aggregated by year of publication, which we will examine in better detail.

Table 1: Number of citations aggregated by year of publication

Year	Publications	Citations	% Citations
2012	6	35	19%
2013	3	98	54%
2014	2	3	2%
2015	1	0	0%
2016	1	8	4%
2018	6	17	9%
2019	4	4	2%
2020	6	18	10%
2021	2	0	0%
TOTAL	30	183	100%

We went to the analysis of 30 results by reading the abstracts of the documents and see if there was a connection between the papers and what we wanted to look into. We can see in the next table, the 30 articles that were selected, sorted by the number of citations.

Table 2: Selected articles, sorted by number of citations

Publications				
Nr.	Authors	Title	Year	Citation
1	Doc et al.	Child-computer interaction	2013	52
2	Antle	Research opportunities: Embodied child-computer interaction	2013	45
3	Sim, Gavin; Horton, Matthew	Investigating Children's Opinions of Games: Fun Toolkit vs. This or That	2012	20
4	Hallinger P, Wang R, Chatpinyakoo C et al.	A bibliometric review of research on simulations and serious games used in educating for sustainability, 1997–2019	2020	13
5	Read, Janet C.; Cassidy, Brendan	Designing Textual Password Systems for Children	2012	9
6	Sim, Gavin; Read, Janet C.; Gregory, Peggy et al.	From England to Uganda: Children Designing and Evaluating Serious Games	2016	8
7	Bossavit, B.; Parsons, S.	Outcomes for design and learning when teenagers with autism codesign a serious game: A pilot study	2018	8
8	Sudarmilah et al	A Review: Is There Any Benefit in Serious Games?	2018	7
9	Marhan, A; Micle, M; Popa, C. et al.	A review of mental models research in child-computer interaction	2012	5
10	Potter, L; Korte, J; Nielsen, S.	Great Expectations: What Do Children Expect From Their Technology?	2014	2
11	Rubegni, Gentile, Malizia et al.	Child-display interaction: Lessons learned on touchless avatar-based large display interfaces	2020	2
12	Trappe, C.	Co-design with Children: Using Participatory Design for Design Thinking and Social and Emotional Learning	2019	2
13	Abidin, S; Noor, S; Ashaari, N.	Low-fidelity Prototype Design for Serious Game for Slow-reading Students	2019	2

14	Doc et al.	Child-Computer Interaction in times of a pandemic	2020	2
15	Fang; Luo and Xu J.	A structure for children-oriented Human Computer Interaction	2012	1
16	Frauenberger et al.	Ethics in Interaction Design and Children: A Panel and Community Dialogue	2018	1
17	Andersen, Khalid and Brooks	Considerations and Methods for Usability Testing with Children	2018	1
18	Zaman	Designing Technologies with and for Youth: Traps of Privacy by Design	2020	1
19	Tse	Special issue on child computer interaction	2013	1
20	Endrass, Hall, Hume et al	A Pictorial Interaction Language for Children to Communicate with Cultural Virtual Characters	2014	1
21	Cano, Naranjo, Henao et al.	Serious Game as Support for the Development of Computational Thinking for Children with Hearing Impairment	2021	0
22	Kantosalo and Riihiaho	Usability Testing and Feedback Collection in a School Context: Case Poetry Machine	2019	0
23	Lehnert	User Experience challenges for designing and evaluating Computer-Based Assessments for children	2019	0
24	Correa De Lima et al.	AccessEducation: Educational Platform Based on CCI Principles and Web Accessibility	2018	0
25	Yasir	Child Computer Interaction: A Case of Preschool Edutainment Systems	2018	0
26	Godinez et al.	Evaluation of a Low Fidelity Prototype of a Serious Game to Encourage Reading in Elementary School Children	2015	0
27	Sim	Designing The Anti-Heuristic Game: A Game Which Violates Heuristics	2012	0
28	Jost et al.	Ethological evaluation of Human-Robot Interaction: are children more efficient and motivated with computer, virtual agent or robots?	2012	0
29	Giannakos, Horn, Rubegni	Advancements on Child-Computer Interaction research: Contributions from IDC 2018	2020	0
30	Giannakos et al.	Movement forward: The continued growth of Child-Computer Interaction research	2020	0

2.1. Background Concepts

In this section, we start with some relevant preliminary definitions. Despite having already been mentioned in the first chapter globally, this section aims to go into more detail on these topics with a focus on children.

2.1.1. Child-Computer Interaction

There was a significant increase in research into Child–Computer Interaction (CCI) through gesture, touch, movement, and other modalities in the first decade of the twenty-first century, which had not yet been tapped into by standard Human-Computer Interaction (HCI) [16]. CCI is a research field that studies the phenomena surrounding children's interactions with computer and communication technologies. It brings together ideas and viewpoints from various scientific disciplines to enlighten and support a field of research and industry activity concerned with the creation of interactive systems for children [17]. CCI and HCI are still developing, and as such, they demand knowledge from a variety of fields, as well as the ability to remain adaptable and account for technological developments [18]. In CCI, children are designated as individuals between the ages of five and twelve, although toddlers and adolescents increasingly included in this focus. As technology becomes more pervasive in society, there are growing concerns regarding the necessity for children to utilise Information and Communication Technologies (ICTs) at critical developmental stages [19]. Children are surrounded by technologies and adults may be concerned about this [20]. This access and abundance of screens, and questions or concerns about CCI, may be partially dependent on various factors, but children in the most developed countries are among the most frequent users, and consumers caught up in the challenges and opportunities presented by CCI.

2.1.2. User Experience

As already referred to in the introduction, the concept of UX is gaining more and more relevance in the world of interaction design. As stated by ISO 9241-210[12], UX includes all the thoughts, values, desires, attitudes, physical and psychological reactions, actions and accomplishments of the users before and during using a good or service after use. UX is the method used by design teams to produce products that provide people with meaningful and relevant experiences. UX includes features of branding, design, usability, function, and the entire process of obtaining and integrating the product. There is no widely recognized definition of a good user experience. A good user experience, on the other hand, fits a specific user's needs in the context in which he or she utilizes the product [21]. According to Carroll (2004), things are fun when they attract, capture, and hold our attention by eliciting unique or uncommon emotions in situations where none usually are elicited [22]. In children's games, one crucial quality of user experience to measure is fun, as it is one of the primary motivations for children to interact with technology [23].

2.1.3. Usability

Usability is a metric that measures how well a particular user in a specific situation can utilise a product/design to achieve a defined goal effectively, efficiently, and satisfactorily. Through guarantee optimal usability, designers typically test a design's usability throughout the development process, from wireframes to the final delivery [24]. Let us focus on two commonly accepted definitions of usability: an ISO standard for usability and Jacob Nielsen's usability attributes. The ISO 9241-11 [25] standard

specifies how to determine the information that needs to be considered when defining or evaluating usability. The aim is to provide a standardized framework for significant usability metrics. Usability, according to it, is comprised of three quantitative elements: effectiveness, efficiency, and satisfaction [25]. Although ISO definition contains three components, Nielsen breaks usability down into five components, or "attributes", that can be quantified and utilized to define usability goals. Learnability, efficiency, memorability, errors, and satisfaction are the factors to consider. Learnability is a crucial usability attribute because most systems must be simple to understand, and it has an impact on a system's first impression. Ease of learning simply means that a user should learn how to use a system as quickly and readily as feasible. Once a person has learned how to utilise a system, efficiency refers to how quickly one can complete tasks. Some users do not need to learn everything there is to know about a system; instead, they are satisfied with learning the basics. Memorability refers to people who are already familiar with a system but have had some difficulties in utilising it or using it seldom. Memorability is a metric that assesses how effectively people can recall various functions after learning them. Errors refer to how many errors users make, how severe these errors are, and how easily they can recover from the errors. The UI should be simple enough that users make as few mistakes as possible. A user mistake can be described as a function that does not produce the desired outcome. When the quantity of errors in a system is counted, the error frequency of the system is determined. Satisfaction has an impact on the user's motivation and, as a result, the effectiveness of their use. This element is related to visual design, trends, brand image, and feelings, and it is similar to the emotional components of the UX [26].

2.1.4. Design Thinking

In recent years, Design Thinking (DT) has grown in popularity, and it is now recognized as an interesting problem-solving technique in a variety of fields [27]. This concept is closely associated with the IDEO consulting firm in North America, which uses design thinking to develop new products, services, and enterprises. Design has traditionally been thought of as an afterthought in the development process. DT encourages involving the designer in the project from the beginning. The essence that topic is the design-driven innovation strategy [28]. DT, according to Brown [29], has a strategic benefit above traditional use of designers in that it provides dramatic new kinds of value for end users. This is possible because designers must collaborate with the product or service's end consumers from the beginning of the project. DT also can be defined as a way of thinking that leads to change, evolution, and innovation, as well as new ways of living and doing business. As a consequence, DT has the advantage of suggesting innovative alternatives to assumptions established in sophisticated markets.

2.1.5. Serious Games

Nowadays, the term “SGs” is becoming more and more popular. The term has been accepted, yet there is no single definitive description of the term. SGs are meant to operate on personal computers or video game consoles and are used for training, advertising, simulation, or education. The ability of SGs to promote learning in situations where traditional learning has been demonstrated to be inefficient, such as in health, has long been acknowledged [30]. The evaluation of SGs is also a relatively new area; for example, in one study, multiplayer online role-playing games for second language acquisition were assessed using essential fun, learning, and validity concepts [31]. According to Statista (2021), SGs are currently one of the fastest-growing segments of educational media, with a market predicted to expand from 3.5 billion dollars in 2018 to 24 billion dollars in 2024 [29].

2.2. Related Work

In this section, we will review in various academic approaches for UX with children and the creation and testing of SGs that explore the challenges of interaction and usability across different age groups, as cognitive and social development differs by age group. New research with children demonstrates that they have improved significantly in using websites and apps, though many designs are still not optimal for younger users. Designing for children requires unique usability approaches, such as tailoring information to specific age groups [33]. There is a need for research to understand better how to build products that allow children to offload parts of cognition to action in the world so that they can focus on other activities or master challenging tasks [17]. According to Tse (2013), new HCI strategies will need to revisit children's developmental cognitive skills, particularly those between the ages of 4 and 12. Cognitive skills, for example, must be appropriate for the age group. Similarly, response time varies by age group; hence, proper engagement periods are critical. Interface designers must consider proper target selection methods, large widgets, and simple drag-and-drop actions [34]. As the CCI has grown in efficiency, four future challenges for the CCI community have been identified: (1) bridging the gap between theory and design by developing models and guidelines that could be used to guide the design of interactive artifacts for children; (2) investigating children's participation in CCI research (e.g., as social actors, designers, users, and so on); (3) investigating the role of mobile and pervasive technologies, tangible, and embodied interaction, and the opportunities these technologies provide [35]. After setting out a vision for the coming years, as well as reflecting on the future of CCI as a research field, Giannakos and his colleagues [36] state that CCI research has never been more relevant than today, not just because of the influence it has on children, families, and society as a whole, but also because it helps to relieve the isolation, misery, and loss that the Pandemic has imposed in recent months. Other authors have referred that this pandemic has also identified new opportunities and a clear understanding of where research is needed to fill in the gaps [36]. Recognizing that children as users require technology, services, goods, and processes tailored to their specific needs and capacities, we can understand how crucial CCI research is to the long-term growth of our communities [36]. In Marhan [37] refer that with

children emerging as a significant technology consumer group, parents and teachers must provide help in appropriate, effective, and relevant ways for their needs. The same authors conclude that by looking into children's mental models of new technologies, designers can develop a better understanding of their cognitive and conceptual development and encourage parents and teachers to guide and support their children as they explore the new technological environment [37]. Kantosalo and Riihiäho [38] suggest adopting a variety of group-based methods to test new ideas, detect missing functionality, and focus on specific concerns that perplex the development team. In other publication [39], [40], the literature study results suggest that when dealing with children, much consideration should be given to involving children in usability testing situations. Other authors [40], [41],[42] also emphasise the importance of CCI design research before the development of educational software for children. They also mention the use of HCI-based principles and some methods as focus groups, usability testing, and co-designing workshops to evaluate the prototype. Other studies [43] conclude that when using participatory design methods with children in SGs, other stakeholders' input, such as teachers and game developers, is still needed. There are some evaluation methods that could be adopted to measure user experiences, however it is important that the methods have been validated with children, and therefore the Fun Toolkit and This or That methods were selected for some studies [43], [44], where it was possible to conclude that there is a need to use more than one method to increase the reliability of the results and any recommendations coming from them.

Since several authors propose further studies and refer to various methods based on HCI, we will conduct an identical analysis by designing a SG, through low-fidelity prototypes, aimed at sustainability. In Hallinger [45] literature review of research was conducted on simulations and SGs used in sustainability education, where they realised that SGs are ideally suited to meet this challenge - how we can inform, motivate, and change the attitudes and behaviours of current and future generations towards the sustainability challenges that threaten life on our planet.

2.3. Summary

In this chapter, we presented a SLR of publications on the topic of usability and user experience in young children in the last decades. After that, we addressed relevant definitions related to this research and discussed some methodologies for UX with children. The creation and testing of SGs that explore the challenges of interaction and usability in different age groups, were also mentioned. It was found that most of these methodologies are geared towards the adult, which made us explore child-centred approaches through low-fidelity prototypes on sustainability.

Chapter 3

Design and Development: Iteration 1

3.1. Sustainability

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 [46]. 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 recognise the urgency of environmental duty. According to a study [47], 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 [48]; the presence of pedagogical principles in game design [49]; and access to shared social practices for knowledge construction [50].

SGs 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 [51]. In order to understand the need for a SG on sustainability, ten children were asked to answer an online questionnaire to analyse their knowledge and interest in this subject in their daily life (Appendix A). This questionnaire includes three questions, all with multiple choice answers: "yes"; "no" and "maybe":

1. Do you know what Sustainability is?
2. Do you recycle in your school or do anything to help/protect the environment?
3. Would you like to play a game on this subject?

As we can see in Figure 1, in the first question we got 70% positive answers, 20% corresponding to "maybe" and 10% as "no". Regarding the second question (Figure 2), we got 80% positive answers and 20% "maybe". Finally, with the third question (Figure 3) "Would you like to play a game on this subject?" 80% answered "yes", 10% answered "maybe" and the other 10% answered "no". Overall, we obtained positive data that led us to design a SG about sustainability for children.

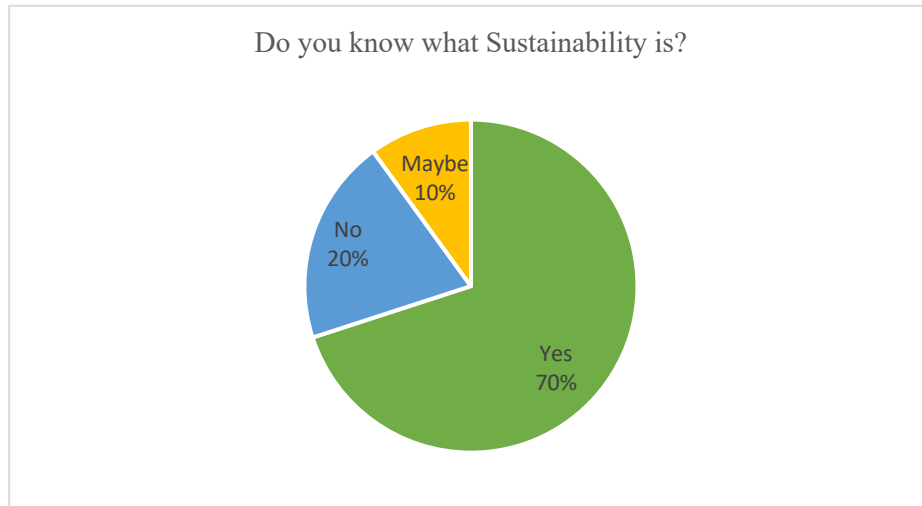


Figure 1: "Do you know what Sustainability is?"

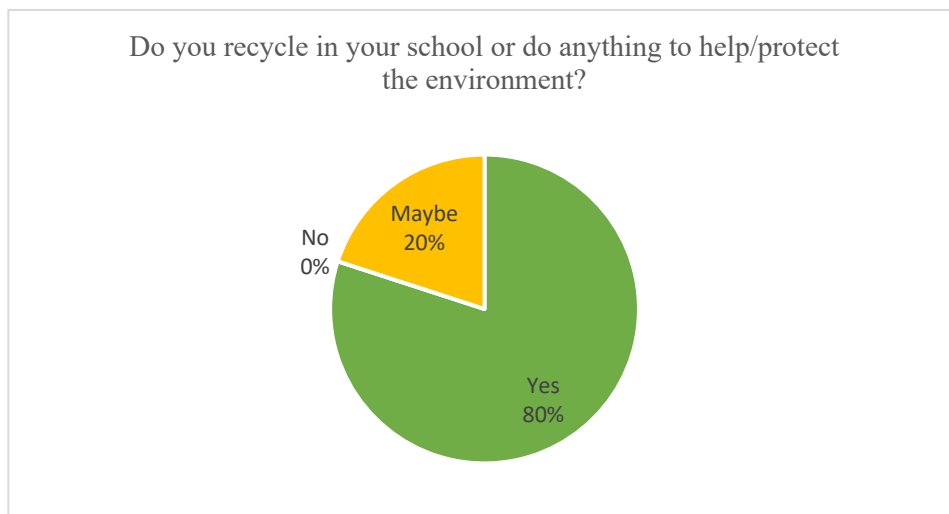


Figure 2: "Do you recycle in your school or do anything to help/protect the environment?"

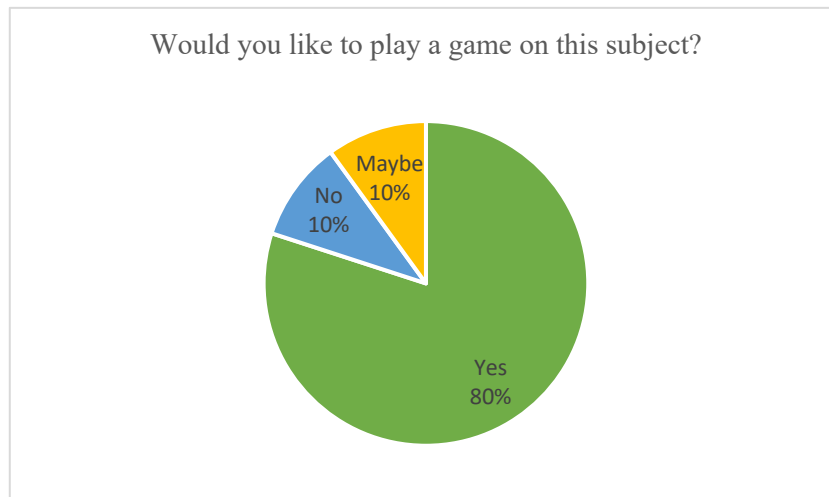


Figure 3: “Would you like to play a game on this subject?”

3.2. Design Thinking Application

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.

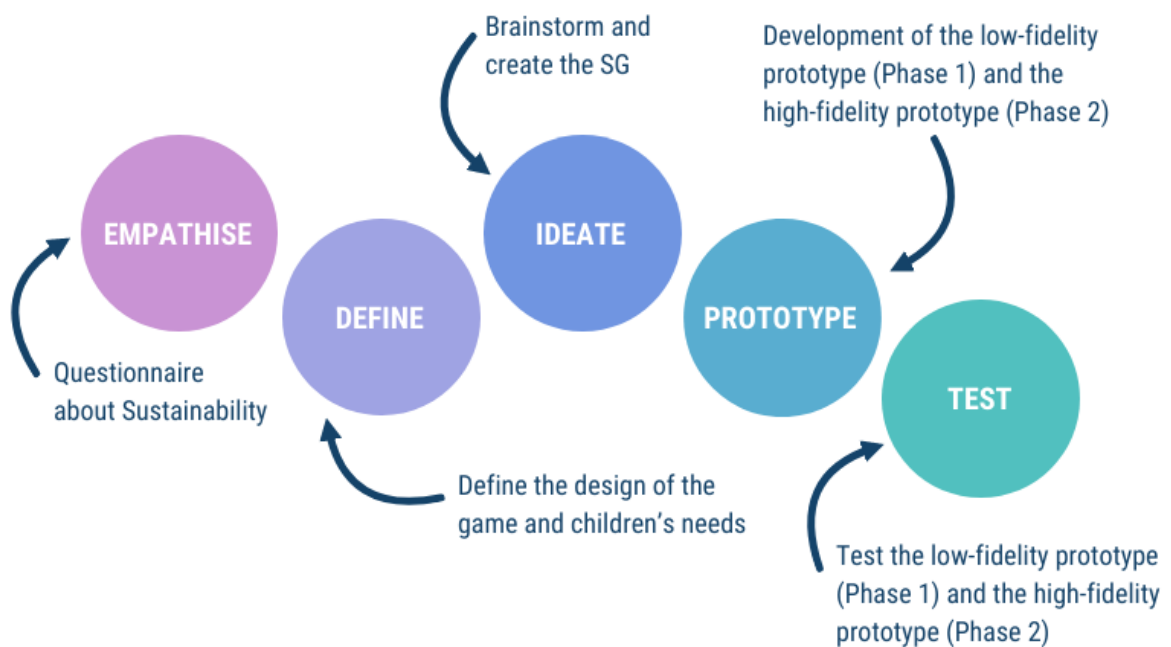


Figure 4: Design Thinking Application. Adapted from Hasso Plattner Institute of Design at Stanford University

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 developed.

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 designed the high-fidelity prototype.

After realising the importance and necessity of developing a prototype on sustainability and subsequently defining what needs to be solved and created based on the children's needs, we proceeded to the SG brainstorming – Ideate Phase. During this 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. Although this game is not exactly a SG, it is one of the most popular tools for incorporating gamification features in learning. Thus, we decided to design a SG about sustainability aimed at children between seven and 12 years old. The goal of this game is to motivate them to recycle and adopt ecological actions. This game contains 20 levels, where each level is composed of three phases. These phases are made up of three different game types. The player needs to drag the rubbish (glass bottles, paper, plastic, etc.) into the respective bins in the first phase. In the second phase, the player has to answer a multiple-choice quiz, and finally, in the third phase, the player has to click on the mole that contains the right message, for example: "I like throwing rubbish on the floor" and "I should save water by taking short showers". Also, at each stage, there is a timer. The less time the player takes on each level, the more coins they earn at the end. Upon receiving these coins and after a certain amount, the player can exchange them for gadgets, such as recyclable bottles and cloth shopping bags. The more levels the player moves up, the more difficult they become. Since it was defined that we would design a SG through low-fidelity prototypes, we decided to choose the paper prototype technique.

3.3. Paper Prototype

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 in order to obtain input in order to enhance usability and address

concerns with game balancing and motivation [48]. The UX may not be effective and the game's objectives may not be met if feedback does not exist. UX is usually assessed after a working prototype has been implemented and is ready for testing [49]. 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. The fidelity of the prototype being developed is frequently influenced by time restrictions and skill limits. 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 focuses on low-cost usability testing methods that provide quick results for enhancing an interface design. 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 [50].

3.4. Prototype Design

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.

To allow a clear visualisation of the game interaction, we decided to organise it in six phases that we present in the following diagram (Figure 5). In the first phase we developed the "Start" screen (Figure 6) and the "New Game" screen (Figure 7); In the second phase we included the screen to enter the name and choose the avatar (Figure 8) as well as screen to select the level to play (Figure 9). The third, fourth and fifth phases include the games and the rules for each game that are part of the first level. (Figure 10- Figure 15). Finally, the screen to go to the next level is included in the sixth phase (Figure 16).

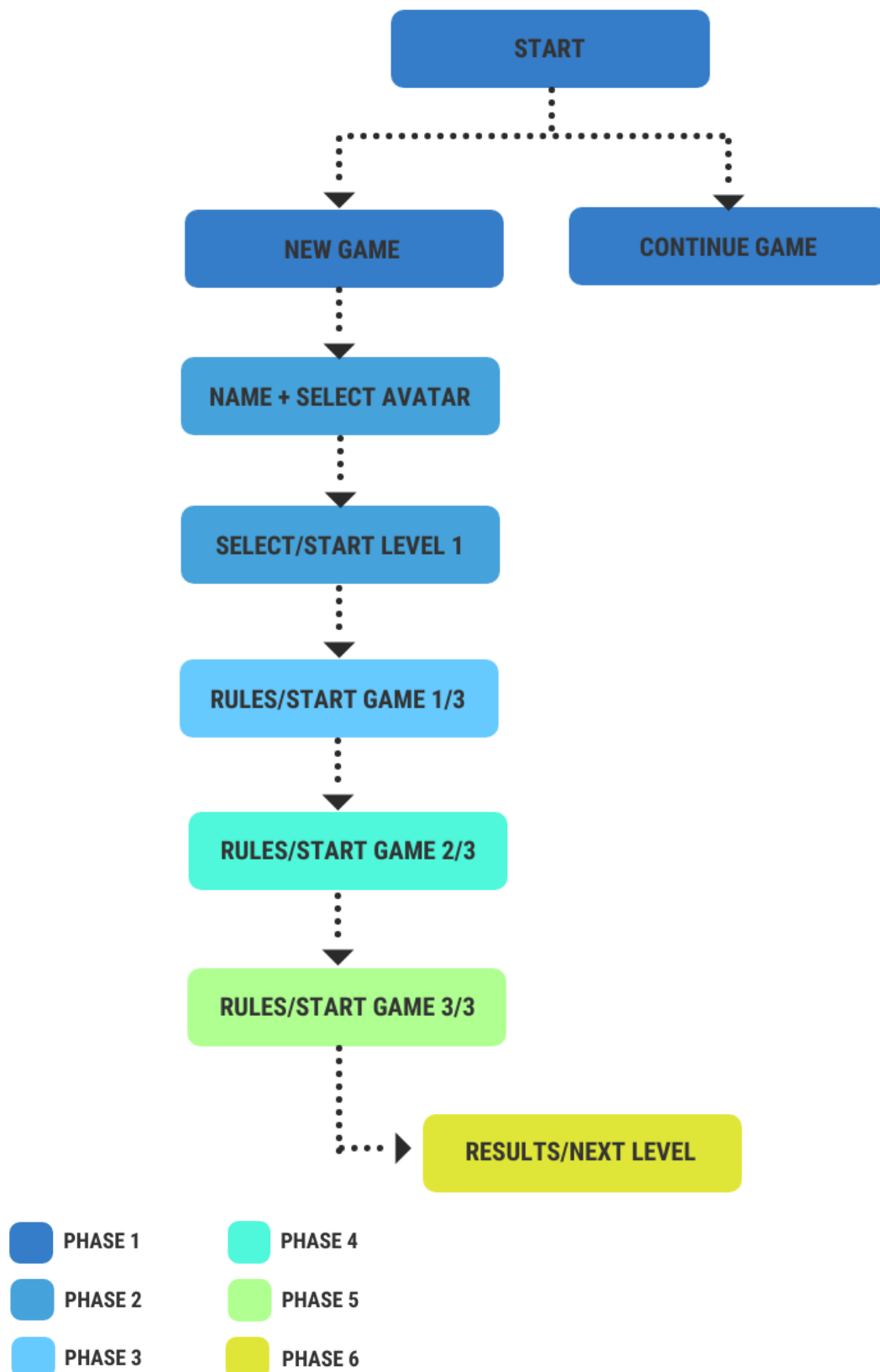


Figure 5: Flowchart of the low-fidelity prototype

Phase 1:



Figure 6: Screen composed of game logo and start button

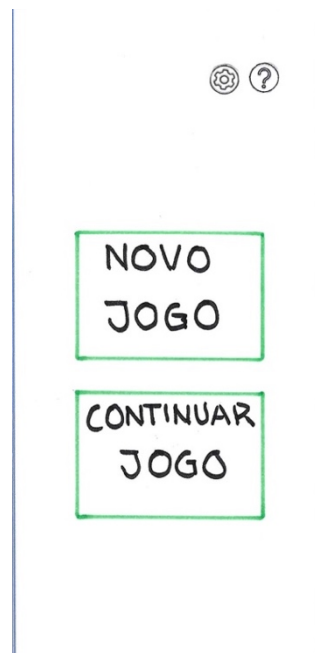


Figure 7: Screen composed of two buttons – New Game and Continue Game

Phase 2:



Figure 8: Screen composed of a slider with several mascots and an optional name field

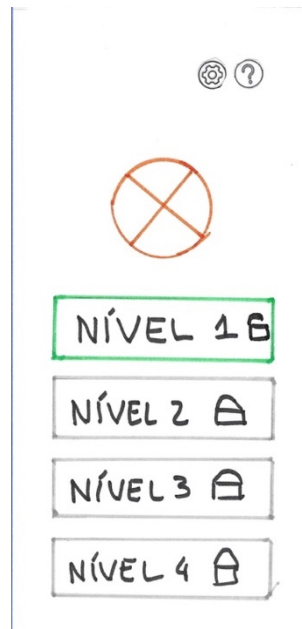


Figure 9: Screen composed of the chosen mascot and the various scrollable levels

Phase 3:

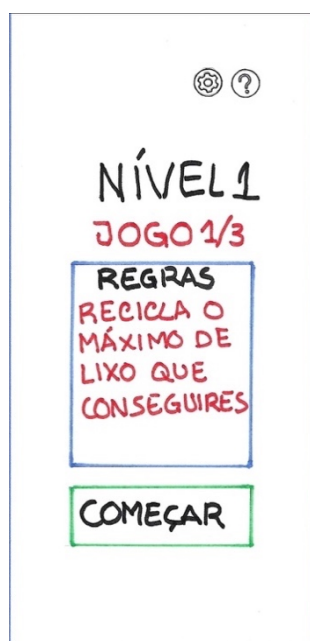


Figure 10: Screen where the rules of the first phase of level 1 are included and also a button to start



Figure 11: Screen with the first stage of level 1 composed of a slider with various elements at the top for the player to drag into the correct containers below

Phase 4:

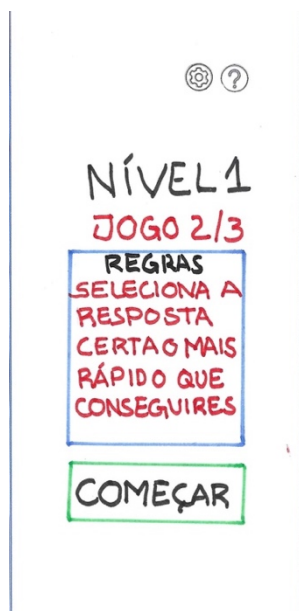


Figure 12: Screen where the rules of the second phase of level 1 are included and also a button to start

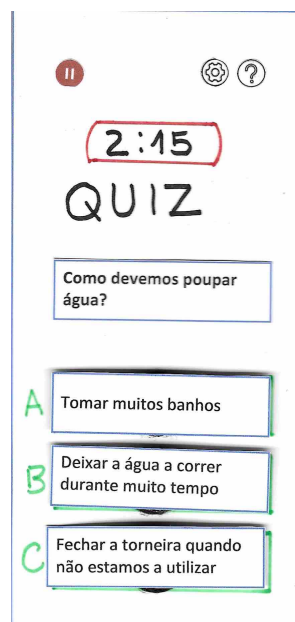


Figure 13: Screen composed of a quiz

Phase 5:

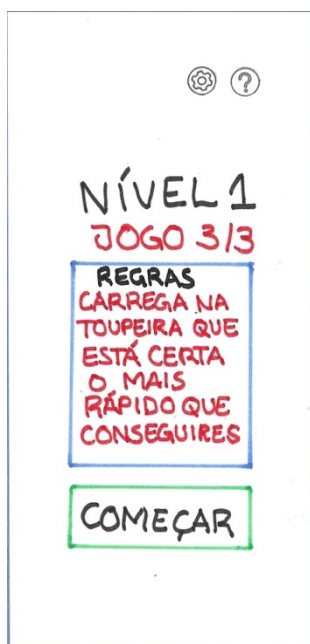


Figure 14: Screen where the rules of the third phase of level 1 are included and also a button to start



Figure 15: Screen composed of the game “Beat the mole”

Phase 6:

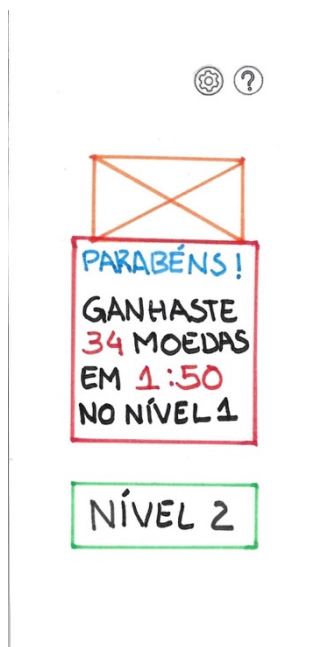


Figure 16: Screen composed of a pop-up with the result of the level and a button for the next level

3.5. Procedure

The paper prototype test was divided into three parts. Providing an Informed Consent Form to the parents, preparing the materials, 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 he took, while we registered all of the important discoveries made during the test, including the user's reactions, behaviours, and conversations, in a file (Appendix C) created specifically for that purpose. In the third part, we 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 [55]. We will address them in the next chapter. Finally, we asked some open-ended questions (Appendix D) about their experience with the prototype after they had completed all the tasks.

3.6. Summary

This chapter presented the main theme of the SG – sustainability – as well as the definition of Design Thinking and how it was applied in this research. It also covered the design and development process of the SG. It was explained that we decided to build a paper prototype and the respective advantages of this low-fidelity method. Then the whole paper prototype and its screens were presented as well as the testing procedure.

Chapter 4

Evaluation and Results Analysis: Iteration 1

4.1. Participants

According to Nielsen, it is enough to test three to five users with qualitative user testing [51]. Five children (three girls, and two boys) who were 7-12 years old participated in the paper prototype test. As a way of thanking them for their time and effort, the children received a dinosaur pen of their choice and a gift card worth €7.5 to use in a shopping centre.

Table 3: Demographics of the users in the paper prototype test

P#	Age	Gender
P1	10	Girl
P2	7	Girl
P3	12	Boy
P4	9	Boy
P5	10	Girl

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. These tests were carried out during the week and after the school day. As already mentioned, in a first phase we gave parents an Informed Consent Form to inform that the data collected during the test did not compromise the identity of the children. Then, we delivered an Interview Protocol about the SG saying what would happen during the test phase and what stages they would have to go through. We then explained the tasks and how the interaction with the SG would be. Figure 17 and Figure 18 show the materials used for this evaluation phase. Finally, Figure 19 displays three children interacting with the paper prototype.



Figure 17: Materials used for evaluation



Figure 18: Paper Prototype

4.2. Children's Feedback

P1 seemed excited when she saw the prototype. She carefully read through the Interview Protocol and the tasks she had to complete. She said everything she was thinking out loud as she interacted with the SG. She also managed to complete all the tasks successfully and immediately suggested that she would like to see how many coins she had already won on each screen and not just at the end as it was designed.

P1: *I would like to play this game with my friends.* – 10-yr girl

P3 and P5 had a similar reaction. They completed level 1 in no time and at the end said they really enjoyed playing this SG and would not change anything.

P3: *It is such a nice game to play at school with my classmates* -12-yr boy

P5 mentioned that at school they talk more and more about sustainability, and she would like to play this game in real life.

P5: *I do not know what my friends would think of the game, but I would find it really fun.* - 10-yr girl

P4 found this SG easy to understand and would like to play more levels to see if he could earn lots of coins. P2, aged seven, was curious when we explained 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 and she questioned their meaning: for example, what "mascot" meant. However, she showed an enormous facility in understanding the actions to perform "because she usually plays other games with the same buttons".

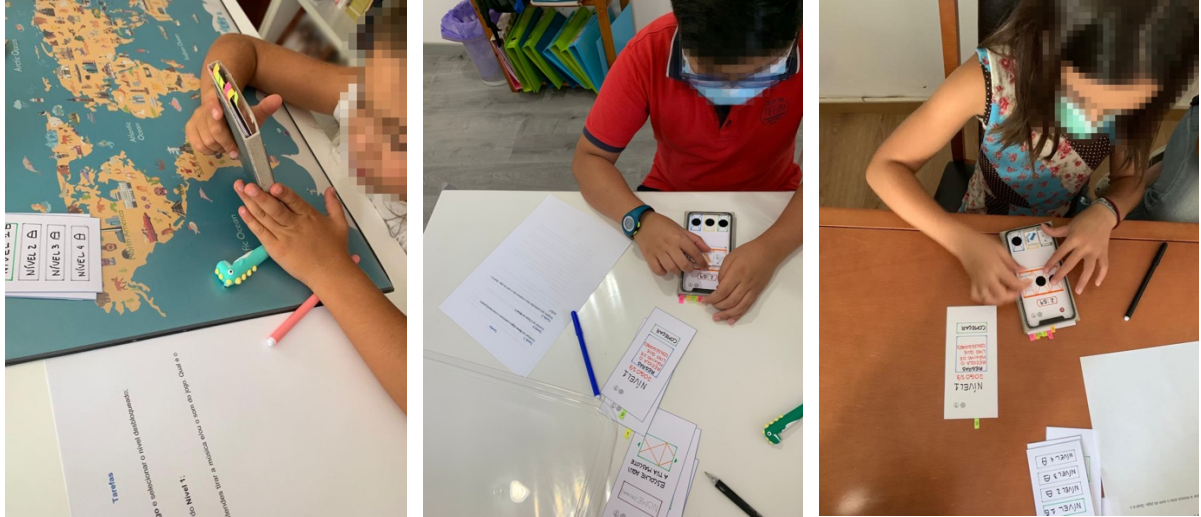


Figure 19: Children interacting with the paper prototype

4.3. Evaluation

This section covers a usability metric that we used to evaluate our prototype, as well as the user experience methods applied on children during their interaction with the SG.

4.3.1. Usability Metric: The Simplest One

Nielsen suggests collecting metrics using a very simple usability statistic for users: Success Rate. This Success Rate is the percentage of tasks completed correctly by users. Although the Success Rate is an admittedly simplistic indicator that reveals nothing about why users fail or how well they do the activities they do finish, it is a very significant statistic [51]. According to Nielsen, failure occurs when a user does not complete a task (marked with F); success occurs when a user completes a task correctly (marked with S). For users who complete only part of the task they are considered partially successful (marked with P). If the Success Rate is greater than 50%, the test is regarded successful and can help the user in achieving the game's goal.

$$Success\ Rate = \frac{\sum S + 0.5 \times \sum P}{\sum User \times \sum Task}$$

Equation 1 - Success Rate

For this paper prototype test, we defined three main tasks for the participants:

1. Start a new game and select the unlocked level;
2. Complete all 3 phases of Level 1;
3. Understand and be able to select an appropriate button (sound button).

Table 4: Results of the three tasks on the paper prototype test

P#	Task n. ° 1	Task n. ° 2	Task n. ° 3
P1	S	S	S
P2	S	S	S
P3	S	S	S
P4	S	S	S
P5	S	S	S

Table 4 shows that all users completed the tasks successfully, thus indicating that the success rate is over 50%.

4.3.2. User Experience Methods for Children

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. As already mentioned, the Fun Toolkit is a collection of tools that quantify the three characteristics of fun: expectations, engagement, and endurance[55]. The Smilyeometer (Figure 20) 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 [57] and fun [58]. 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 21). 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 22). This table asks children to choose between "yes", "maybe" or "no" for each activity they have experienced. For this SG they were asked "Would you play this game again?" as shown in Figure 22.

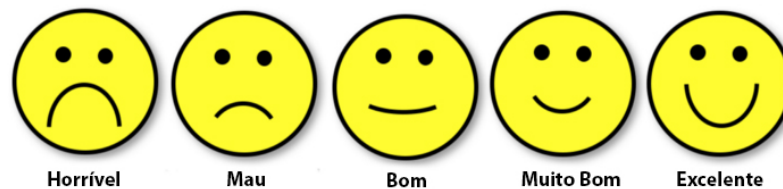


Figure 20: Smilyeometer from Fun Toolkit used by the participants

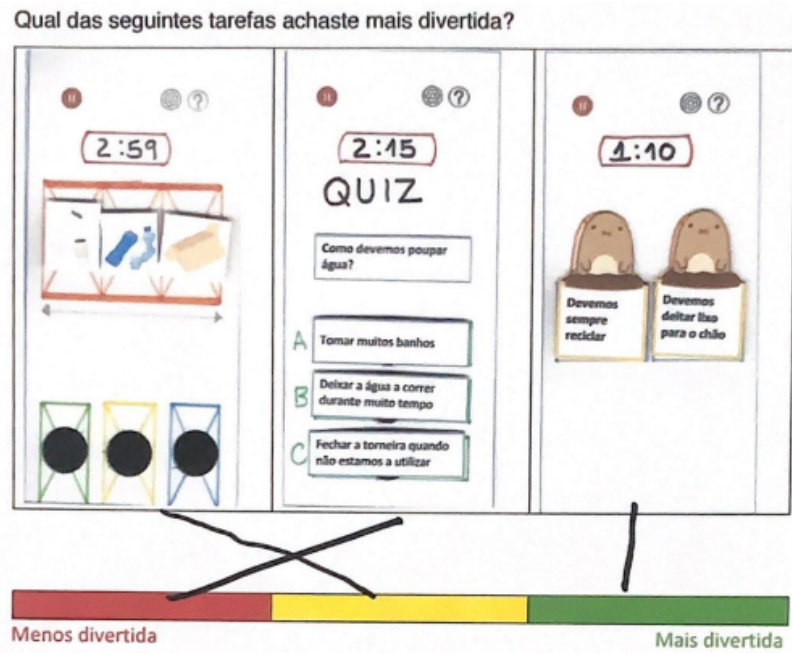


Figure 21: Fun Sorter from Fun Toolkit to rank the tasks based on the Fun aspect

Gostavas de jogar este jogo outra vez?

	Sim	Não	Talvez
	X		

Figure 22: Again-Again Table from Fun Toolkit to ask users if they would like to play again a specific game

In summary, we asked eight questions covering the following topics:

- How did they feel playing this game (Smilyeometer shown in Figure 20);
- Which game they enjoyed playing the most (Fun Sorter shown in Figure 21);
- Would they like to play this game again? (Again-Again Table shown in Figure 22).

The children completed the Smilyeometer before interacting with the paper prototype and after completing all the tasks. The remaining questions were answered at the end of the process.

4.4. Results Analysis

The qualitative data collected throughout the study's interview served as our primary source of information. Throughout the interaction with the SG, we marked and documented all reactions, behaviours, and statements. Finally, we used the questionnaires to collect structured data on the children's reactions to the paper prototype.

4.4.1. Questionnaire Results

With the questionnaire conducted before and after the interaction with the paper prototype it is possible to verify that the data has changed a little bit. With the questions "How do you think the game is?" (Figure 23) and "How do you feel playing this game?" (Figure 26) there was a small difference between the before and after. After interacting with the prototype, the children gave a better response than they had initially. With the questions "Do you think the rules are easy to understand?" (Figure 24) and "Would you like to play the game with your friends?" (Figure 25) the data remained the same. It can be concluded that, in general, the children were positive both at the beginning and at the end of the paper prototype test.

Furthermore, we found that 3/5 children considered the Drag and Drop game funniest, while 2/5 chose the Beat the Mole game as the funniest (Figure 27). Quiz was the least funny game (3/5) as it is a question game and does not contain animation like the other games. On the other hand, in the question "Would you like to play it again?", all games received a "Yes" except for the quiz game that received a "Maybe" (Figure 28). This answer potentiates a greater difficulty to interpret questions/words quickly. However, in general, we can consider that the answers were positive, as there was no negative answer, besides the enthusiasm maintained after the test with the paper prototype.

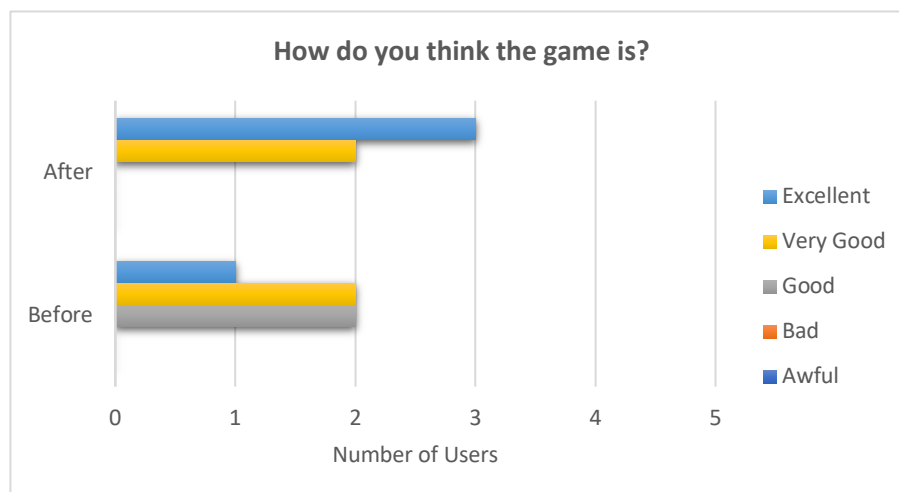


Figure 23: Users' reactions to the question "How do you think the game is?" included in the Smilyeometer

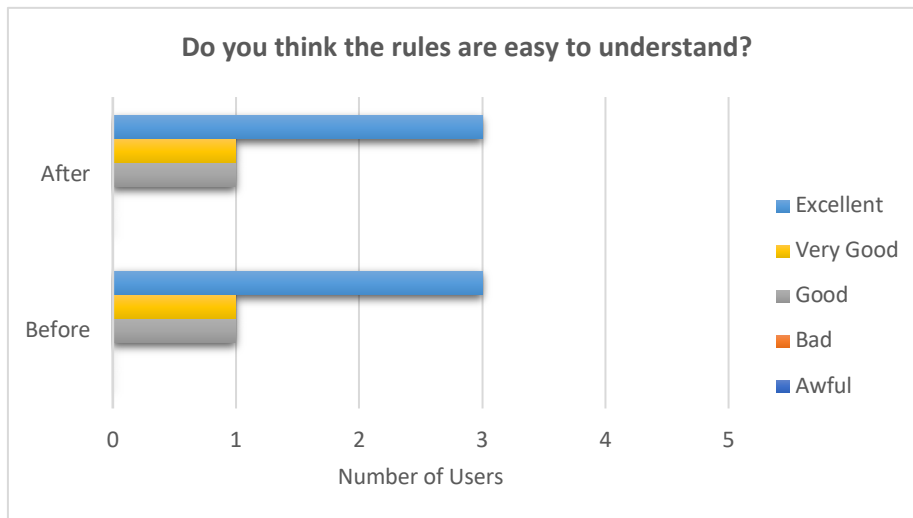


Figure 24: Users' reactions to the question "Do you think the rules are easy to understand?" included in the Smilyeometer

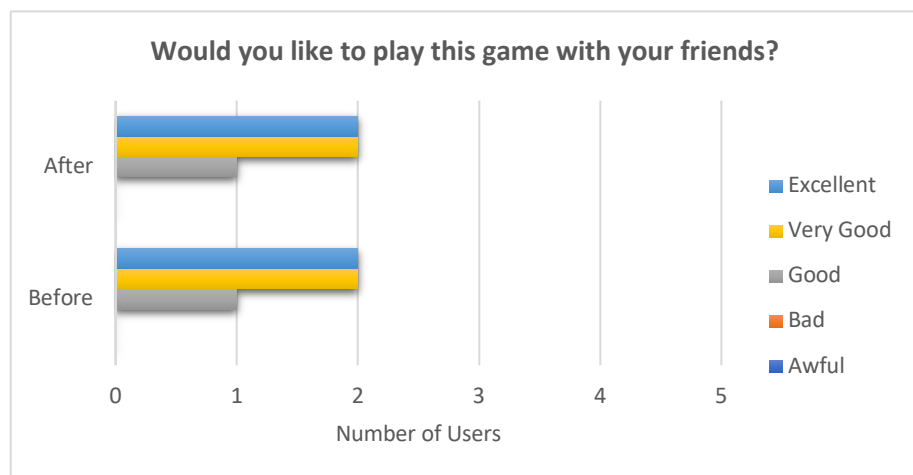


Figure 25: Users' reactions to the question "Would you like to play this game with your friends?" included in the Smilyeometer

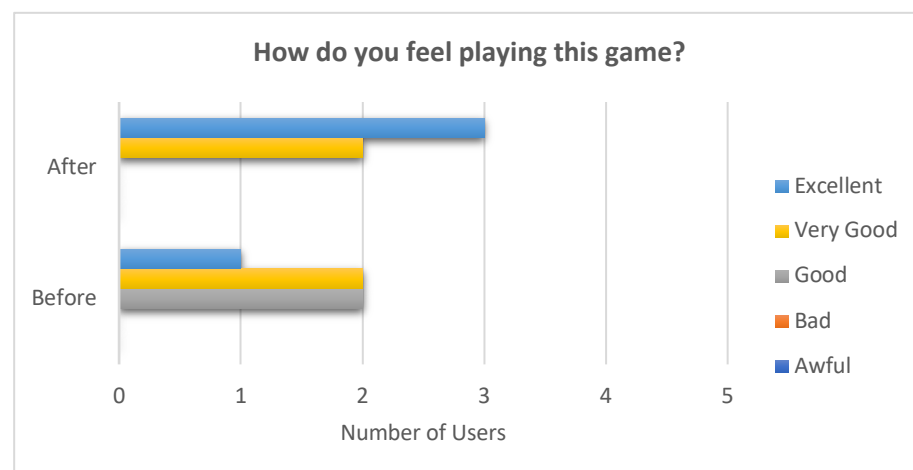


Figure 26: Users' reactions to the question "How do you feel playing this game?" included in the Smilyeometer

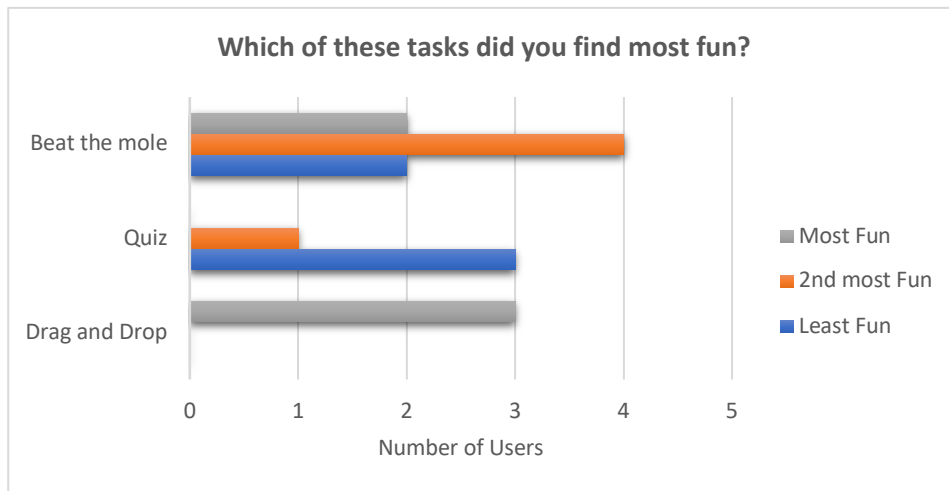


Figure 27: Users' reactions to the question "Which of these tasks did you find most fun?" included in the Fun Sorter

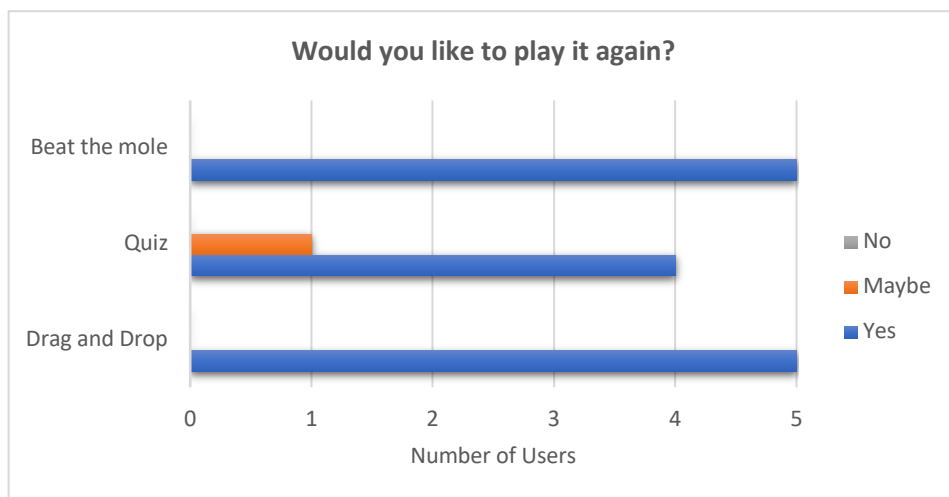


Figure 28: Users' reactions to the question "Would you like to play it again?" included in the Again-Again Table

4.5. Summary

This chapter introduces some data from the participants invited to test the paper prototype, as well as a description of the evaluation process. The children's feedback is another topic addressed in this chapter, besides the evaluation methods applied in the testing phase and the respective results. It was concluded that, in general, the children were positive both at the beginning and at the end of the test with the paper prototype. The game "Drag and Drop" was considered the funniest, with the game "Beat the Mole" in second place. We can associate this positive result to the fact that both games are interactive and with animation. The quiz game, despite no negative answers, had more "Maybe" votes on the question "Would you like to play it again?". We can associate this result to the fact that there is a greater difficulty in quickly interpreting the questions/words. In general, it is possible to conclude that the answers were positive, apart from the fact that the children's enthusiasm was consistent.

Chapter 5

Design and Development: Iteration 2

5.1. High-Fidelity Prototype

Based on the feedback received by the children during and after the test with the paper prototype and the results obtained from the questionnaire, we decided to improve the SG and design a high-fidelity prototype, to be used as a research method in a subsequent study. The prototype was designed with Figma¹, an online vector graphics editor and prototyping tool. The purpose of the high-fidelity prototyping was to provide children with a more engaging experience and to utilise the prototype as a tool for evaluating our design changes. We gathered qualitative data from two children to see if the changes and improvements fulfilled their expectations. Because of the COVID-19 pandemic, this data was collected remotely. We were able to see that the changes met the children's expectations, and we still received some more data to implement in the future.

5.2. Design Development

The name for this SG was chosen by joining the words "Terra" and "Amiga", originating "Terramiga" - taking advantage of the letter A that both words contain. This game was thought and developed in the Portuguese language because it is our mother tongue. 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.

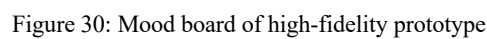


Figure 29: Logo of the SG "Terramiga"

Sea green was the colour chosen for this SG, as it reminds us of the nature of the ocean. The Poppins font was the font chosen for this prototype because besides being an open source it has also long been a

¹ <https://www.figma.com/>

30



The following flowchart shows all the interaction of the high-fidelity prototype, as well as captions indicating which images on the following pages correspond to each interaction. The black circle "Settings" means that it is transversal to all screens and the blue circles mean that they are only available in certain screens. Both are secondary buttons, as shown in the pictures below.

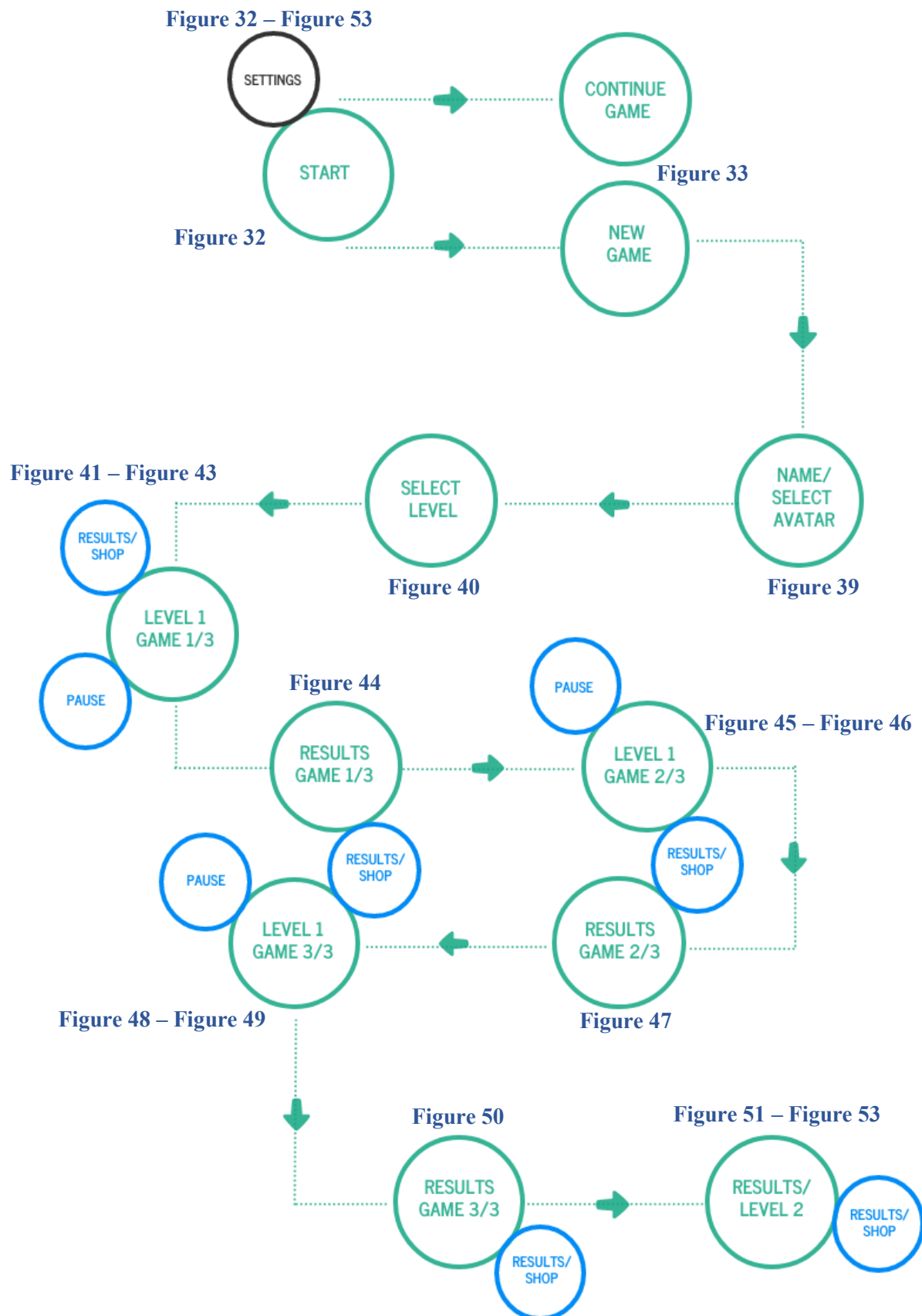


Figure 31: Flowchart of high-fidelity prototype

The images below represent each screen of the SG that was developed for the second test phase. It is possible to see some improvements, which were implemented based on the feedback given by the children in the first test phase. As already mentioned, some words were difficult for the younger child to interpret, such as "mascot", and therefore we changed this word to "doll". Through other feedback received, the coins icon is now present on all game screens and not just at the end of level conclusion.



Figure 32: Screen composed of game logo and start button



Figure 33: Screen composed of new button and continue game button



Figure 34: Screen composed of the definitions button



Figure 35: Screen composed of the options button

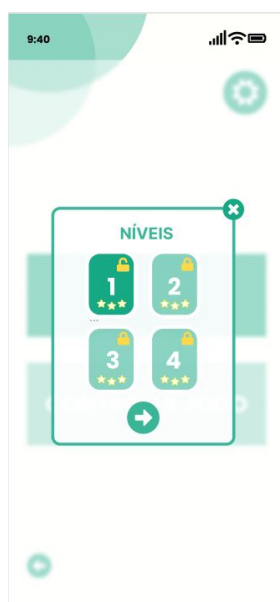


Figure 36: Screen composed of the levels button



Figure 37: Screen composed of the level button



Figure 38: Screen composed of the rules button



Figure 39: Screen composed of a slider with several mascots and an optional name field



Figure 40: Screen composed of the chosen mascot and the various scrollable levels



Figure 41: Screen where the rules of the 1st phase of level 1 are included and also a button to start

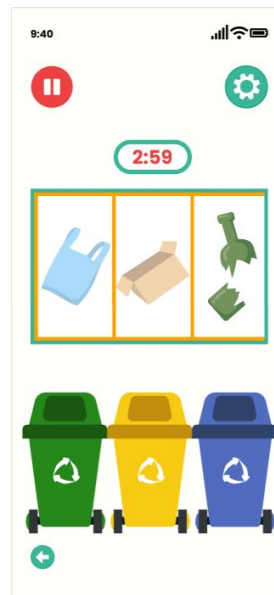


Figure 42: Screen with the 1st stage of level 1 composed of a slider with various elements at the top for the player to drag into the correct containers below

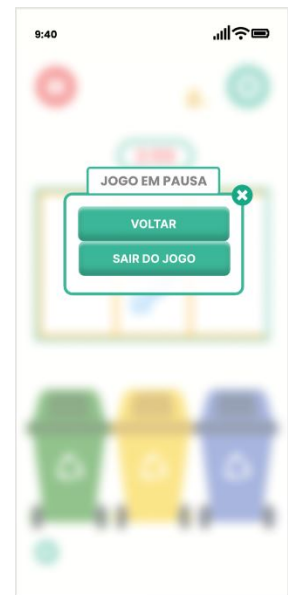


Figure 43: Screen composed of the pause button



Figure 44: Results screen and next 2nd game button

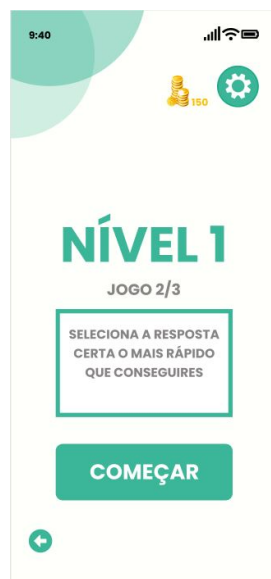


Figure 45: Screen where the rules of the 2nd phase of level 1 are included and also a button to start



Figure 46: Screen composed of a quiz



Figure 47: Results screen and next 3rd game button



Figure 48: Screen where the rules of the 3rd phase of level 1 are included and also a button to start



Figure 49: Screen composed of the game “Beat the mole”



Figure 50: Results screen and next level button



Figure 51: Screen composed of a pop-up with the result of the level and a button for the next level



Figure 52: Screen composed of the total coins earned



Figure 53: Screen composed of the awards

5.3. Summary

This chapter covers the whole design process of the high-fidelity prototype. A mood board is presented with some graphic elements that were part of the prototype and others that served for inspiration. Next, a flowchart is introduced to facilitate the interaction perception of the developed SG and at the end, each developed screen is detailed.

Chapter 6

Evaluation and Results Analysis: Iteration 2

6.1. Participants

As already mentioned, because to the COVID-19 pandemic, there were some constraints throughout the process. Two children were invited for this test, one of them (P6) had already participated in the first iteration and the other one (P7) had not yet participated and saw the game for the first time in order to give us a new view on the SG. As with the first iteration, these tests were also conducted during the week and after school. During this testing phase with the child who had already interacted with the prototype in iteration 1 (P6), it was not necessary to deliver the Interview Protocol, because she explained she already knew the rules and the game interaction. Afterwards, it was possible to validate that the improvements would be in accordance with her expectations and after the feedback given in the first iteration. With the second child (P7), it was necessary to present the Interview Protocol and answer additional questions. At the end, we asked both children some open-ended questions (Appendix D) about their experience with the prototype.

Table 5: Demographics of the users in the high-fidelity prototype test

P#	Age	Gender
P6	10	Girl
P7	11	Boy

6.2. Children's Feedback

P6 managed to complete all the tasks successfully and seemed excited as she realised the differences between this prototype and the paper prototype. P7 said everything he was thinking aloud 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.

P6: 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 and the next levels. – 10-yr girl

P7: It is a very cool game and also easy to play. I think I would want to play it with my friends. – 11-yr boy

Regarding the open-ended questions, in general the feedback was positive. However, 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?", P6 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. Nonetheless, P7 responded that they preferred to gain more time/lives to play certain levels. P7 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 goodies. This will be a further aspect to investigate in the future and find out with more samples what the general preference of the children is, as it would be worth considering including both options.

6.3. Summary

This chapter approaches the process of the second phase of testing of this study, more specifically the evaluation of the high-fidelity prototype. Since only qualitative data was collected in order to understand if the changes were accepted by the participants, the reactions and respective feedback is only presented.

Chapter 7

Conclusions

In this dissertation, we present the design and participatory evaluation of a SG about sustainability, oriented towards children. Our results indicate that the children in our studies actively committed themselves to our paper prototype, giving feedback and new ideas for the SG to be better and easier for other children.

We started our research with iterative brainstorming of a low-fidelity prototype and used an exhaustive literature review to influence our design selections. We used this low-fidelity paper prototype to understand if their opinions and feedback could impact the final design and thus create something interesting and appealing to children. We seek to answer the following questions as a result of our effort:

1. To what extent, does participatory design influence the engagement rates of children between seven and 12 years old in SGs on sustainability?
2. Can we use direct feedback from children to fine-tune our design process and achieve a better overall satisfaction with the tool (i.e., meeting the children's expectations)?

In response to the first question, it is possible to see through the Fun Toolkit questionnaires and feedback collected throughout the study that the children would like to play this game with friends and that they felt confident and motivated about playing the SG on this subject. As earlier mentioned, there was a slight difference/increase in positive responses about their feelings after interacting with the SG in the questions "How do you feel playing this game?" and "How do you think the game is?". In other words, this SG exceeded the participants' expectations.

To answer the second question, it was necessary to analyse all the feedback and comments received throughout the interaction with the paper prototype and then develop a high-fidelity prototype with the improvements and changes received during the first phase. Once the high-fidelity prototype was developed, two children were asked to interact with it and it was possible to validate that the improvements met their expectations.

7.1. Contributions

This dissertation introduces a child-centred approach to designing and evaluating a SG about sustainability. We began our research by developing a paper prototype (low-fidelity) through brainstorming and informing our design decisions through extensive literature research. We used this prototype to teach children aged 7-12 years more about sustainability. Almost all of 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 proves 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 (not only for the testing and validation phases).

7.2. Limitations

Our research took place during the peak of the COVID-19 restrictions, which brought certain challenges. We had planned to bring several children together and test the prototypes simultaneously in several phases, but the pandemic forced us to adjust our plans, so we ended up testing each child individually and in less than 40 minutes. Also, the last evaluation phase was done online. A future study might consider including more methodologies used with children and also more phases of testing to make sure we have a fully adequate SG designed for children.

7.3. Future Work

In the testing phases, the children showed interest in the games and challenges that the game could bring, since the two prototypes were developed with only one level. In future work, the game should include all the levels, difficulty levels, as well as all the screens developed. It would be interesting to explore the interaction of children with a complete version of the game to validate any changes and usability errors that may arise. It is also suggested that several test phases be carried out in order to achieve a game designed appropriately for children between seven and 12 years old, through feedback from them.

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Appendices

Appendix A - Sustainability for Children Form



Sustentabilidade para Crianças (7-12 anos)



Sabes o que é a Sustentabilidade?

- ☐ Sim
- ☐ Não
- ☐ Talvez

Na tua escola fazem reciclagem e outras ações para ajudar o planeta?

- ☐ Sim
- ☐ Não
- ☐ Talvez

Gostarias de jogar um jogo sobre este tema?

- ☐ Sim
- ☐ Não
- ☐ Talvez

Submeter

Limpar formulário

Appendix B – Interview Protocol

GUIÃO

Muito obrigada por aceites participares neste teste de uma aplicação para crianças – um jogo sobre sustentabilidade. A tua ajuda será muito importante para aperfeiçoarmos o jogo e para assim entendermos melhor o que funciona e o que não serve.

POR FAVOR, LÊ ESTE GUIÃO COM CUIDADO E ATENÇÃO

Ao longo do teste não é possível responder a nenhuma dúvida ou pergunta, pois as dificuldades que poderás ter com o jogo é exatamente o que estamos a avaliar na aplicação. Ou seja, se tiveres uma dúvida num botão, poderá significar que esse botão tem de ser melhorado da nossa parte.

É importante referir que a aplicação/jogo é o que está em teste e não tu. Não hesites em fazer as tarefas da forma que entenderes.

Durante a atividade:

- Faz uma tarefa de cada vez, na ordem apresentada;
- Pedimos que fales em voz alta para percebermos o que estás a pensar ou o motivo de cada ação. Caso o resultado não seja aquilo que esperes, diz o que esperavas que acontecesse;
- Não esperes respostas do entrevistador durante as tarefas;
- Quando finalizares uma tarefa, avisa o entrevistador para considerar a tarefa concluída;
- Se estiveres com dificuldade na realização da tarefa pedida, podes desistir a qualquer momento. Avisa o entrevistador e avança para a próxima tarefa;
- No final de cada tarefa, concluída ou não, o entrevistador poderá fazer algumas perguntas sobre o processo e escolhas que fizeste durante a execução das tarefas.

Obrigada.



Tarefas

Tarefa 1:

Começar um **Novo Jogo** e seleccionar o nível desbloqueado;

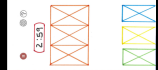
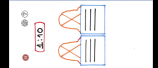
Tarefa 2:

Concluir as 3 fases do **Nível 1**;

Tarefa 3:

Imagina que pretendes tirar a música e/ou o som do jogo. Qual é o botão?

Appendix C - Interview Data File

ETAPAS ESPERADAS		Entrevista Inicial											OBSERVAÇÕES GERAIS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
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Appendix D – One-Ended Questions

Sample Open-Ended Questions

1. Did you have any difficulty finding a button that could have been on a different way?
3. Would you change any aspect of this game?
4. 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?
5. Would you mention this game to your friends?

Appendix E – Informed Consent Form

Declaração de Consentimento

Dados de Identificação

Nome: _____

Projeto: _____

Instituição: _____

Orientadores: _____

Eu, _____, declaro ter sido informado(a) e concordo em que o(a) _____ participe na entrevista e/ou testes de usabilidade – bem como todas as informações recolhidas e que não comprometam a identidade do(a) menor sejam utilizadas para fins académicos – no âmbito do projeto acima mencionado.

Assinatura do(a) Responsável pelo(a) Entrevistado(a)

Assinatura do(a) Entrevistador(a)

Appendix F – Fun Toolkit Questionnaire

QUESTIONÁRIO 1

Questão 1:

Como é que achas que o jogo é?



Horível



Mau



Bom



Muito Bom



Excelente

Questão 2:

Achas que as regras são fáceis de compreender?



Horível



Mau



Bom



Muito Bom



Excelente

Questão 3:

Gostavas de jogar este jogo com os teus amigos?



Horível



Mau



Bom



Muito Bom



Excelente

Questão 4:

Como é que te sentes a jogar este jogo?



Horível



Mau



Bom



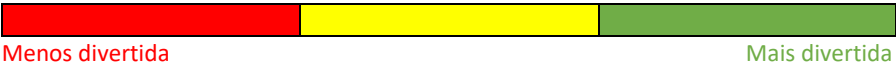
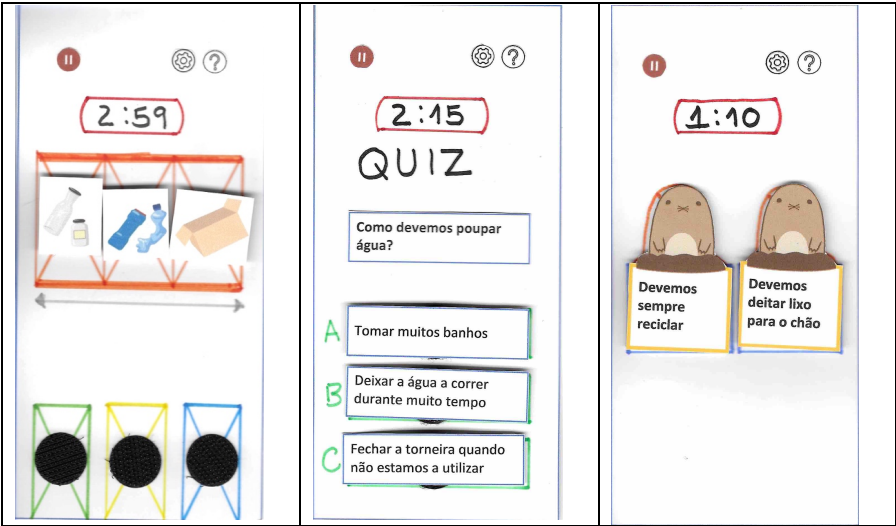
Muito Bom



Excelente

Obrigada.

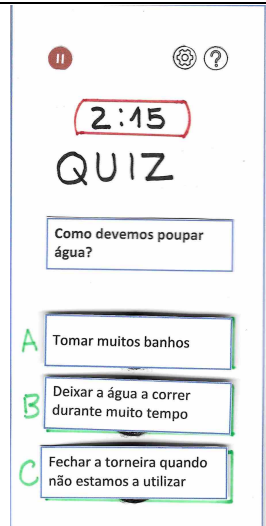
Qual das seguintes tarefas achaste mais divertida?



Gostavas de jogar este jogo outra vez?

	Sim	Não	Talvez

Gostavas de jogar este jogo outra vez?

	Sim	Não	Talvez
			

Gostavas de jogar este jogo outra vez?

	Sim	Não	Talvez
			