GameTown: A Technology to Support Brainstorming during (Distributed) Participatory Design with Children with Autism

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Abstract

Children diagnosed with Autism Spectrum Condition (ASC) generally struggle with social communication and experience restricted interests. These core impairments often make it difficult for these individuals to express their ideas and to maintain focus on specific tasks. As a result, children with autism are not generally included in the design process of new technological tools. Several studies have shown that, despite these challenges, the contributions of children with autism to the design of new tools can be very valuable in ensuring their needs are met. One of the techniques to design with users is (Distributed) Participatory Design ((D)PD). In (D)PD, users are considered equal partners throughout the design process, from the early stages to the evaluation. Previous research reveals that involving children with ASC in (D)PD can not only ensure the product meets the children's needs, but also provide them with valuable skills, such as helping them unlock their creativity, increasing their engagement, and improving their communication skills.

Therefore, this project explores how a technology-based tool can be designed to support both children with ASC and designers during (D)PD. The tool focuses on creating a gamified digital narrative to aid in the brainstorming stage of (D)PD for developing new educational games, ensuring that children can express their ideas and be engaged.

The project employed an adapted version of Informant Design, involving typically developing (TD) children, experts in Human-Computer Interaction (HCI), ASC and Education, and the parent of a child with ASC, at various stages. The data gathered from the participants, as well as guidelines for designing with children with ASC, the framework for creating Serious Games, and the HCI Usability Heuristics, resulted in the development of a high-fidelity prototype of the tool ("GameTown"). The results from the evaluation studies with children and experts revealed that the tool has potential to be used to support both children with ASC and designers during the brainstorming stage of (D)PD.

Research Ethics Approval

This project obtained approval from the Informatics Research Ethics committee.
Ethics application number: 2021/42480.
Date when approval was obtained: 2021-12-10.
The participants' information sheets and a consent forms are included in the appendix.

Declaration

I declare that this thesis was composed by myself, that the work contained herein is my own except where explicitly stated otherwise in the text, and that this work has not been submitted for any other degree or professional qualification except as specified.

(*Alejandra Amaro Patiño*)

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Chapter 1

Introduction

1.1 Children with Autism and Participatory Design

Autism Spectrum Condition (ASC) is a group of developmental conditions that are characterised by social communication impairment, restricted interests and repetitive behaviour. Typically, individuals with autism struggle with expressing their ideas [6]. Technology has been proven to help children with ASC to learn new skills if it is designed to suit their needs [39]. For this reason, there has been a rising interest in involving children with ASC in the design of new tools through (Distributed) Participatory Design ((D)PD).

(D)PD is a technique for designing that involves the direct participation of users throughout the design process, even if they are co-located. Designing with children with autism means they can gain not only a feeling of ownership and develop new skills, but also provide valuable insight for new technologies [43]. Despite this, technology designed for this population does not usually involve children with autism in the process, due to their difficulties with communication [13]. Recent studies aim to understand how (D)PD can be adapted to enable children with autism to contribute to the design of new tools. While some research has worked towards designing tools to support children with autism in (D)PD [19], these have not been developed. This projects aims to research the existing methods for (D)PD with children with autism to design and implement a new technology to address the needs of these individuals.

1.2 Project Goals and Research Questions

The main goal of this project is to explore how a technology-based tool can be designed to support children with ASC and designers in (Distributed) Participatory Design ((D)PD). Based on previous studies, it has been shown that there is potential to involve children with ASC in (D)PD. Moreover, children with ASC tend to favour the use of technology to learn new skills [39]. Hence the following research questions will be addressed to meet the goal of the project:

- **RQ1:** How can a technology-based tool be designed to empower children to participate in and support designers during (Distributed) Participatory Design?
- **RQ2:** To what extent does this new technology support children with ASC and designers in (Distributed) Participatory Design?

  RQ2.1: To what extent is the new tool suitable for the target population?

  RQ2.2: To what extent is the tool perceived as fun and engaging for the target population?

  RQ2.3: To what extent does the tool elicit ideas from children to brainstorm about new educational games in comparison to traditional methods of participatory design?

  RQ2.4: To what extent does the tool support designers to gather ideas for new educational games?

1.3 Structure of Dissertation

The dissertation is divided into seven chapters:

Chapter 1 presents the problem, sets up the context, and introduces the research questions that the project aims to answer.

Chapter 2 critically reviews the literature on ASC and (D)PD. This chapter focuses on describing the current interventions, both educational and technological, for including children in participatory design. The chapter identifies the gaps to fill in the literature. It concludes with the methodology employed in this project.

Chapter 3 describes the design workshop conducted with four typically developing (TD) children. The outcome of the study, in combination with the literature review presented in Chapter 2, result in the first set of requirements for the tool to be developed.

Chapter 4 focuses on the design of the low-fidelity prototype based on the initial requirements and its evaluation. The chapter begins by describing the implementation of the prototype in Figma. Then, it describes the formative evaluation of the prototype with two experts, the parent of a child with autism, and a TD child. This chapter discusses implications of the formative evaluation for the high-fidelity prototype.

Chapter 5 describes the high-fidelity implementation of the tool in Unity. It presents the different components of the tool and the justifications for their decisions.

Chapter 6 outlines the final evaluation conducted for the high-fidelity prototype. This included a study with five experts in the fields of Human-Computer Interaction (HCI), ASC and Education, and a study with four TD children.

Chapter 7 discusses the results of the project by answering the research questions. This chapter also includes the limitations of the project, proposes different directions for future work, and presents the project contributions.

Chapter 2

Literature Review

This chapter critically reviews the literature on ASC and (D)PD. It describes the different methods and tools that have been developed to involve children in the design process. This chapter contributes to answer **RQ1**: *How can a technology-based tool be designed to empower children to participate in and support designers during (Distributed) Participatory Design?*

2.1 Autism Spectrum Condition

Autism Spectrum Condition (ASC) is a group of neurodevelopmental disorders that affect the way individuals experience the world around them. While Asperger Syndrome, Pervasive Developmental Disorder - Not Otherwise Specified (PPD-NOS) and autistic disorder were all once diagnosed separately, they are now included in ASC, which describes the different ranges of severity of autism [37, 50].

According to the Diagnostic and Statistical Manual of Mental Disorders-V (DSM-V) [6], the diagnosis of ASC focuses on two main areas:

- **Social communication impairment:** "Deficits in socio-emotional reciprocity" (including difficulties in having a back-and-forth conversation and reduced sharing of interests and emotions), challenges in nonverbal communication, and deficits in developing, maintaining, and understanding relationships [6]. This can have repercussions in their ability to generate new ideas [36, 51] .
- **Restricted interests and repetitive behaviour:** An "insistence on sameness, adherence to routines, and fixated interests" [6]. Examples include repetitive movements, being distressed by change, and strong attachment to objects.

These symptoms typically arise in the early development period (between 12-24 months of age) and they result in difficulties in social, occupational, and other areas of the individual's lifestyle. In fact, 70% of individuals with ASC have been diagnosed with comorbid conditions, such as language deficits, anxiety, or learning difficulties [6].

Despite their deficits in communication and repetitive behaviour, some individuals with ASC excel in other ways, including outstanding skills in the areas that interest them,

attention to detail, and a desire to deepen their knowledge on specific topics [9].

2.1.1 Interventions to Support Children with ASC

Although ASC does not have a medical cure [6], there are educational interventions to support individuals diagnosed with it, including traditional and technology-based tools to improve their quality of life and enhance their skills. However, since ASC represents a heterogeneous group of conditions, it can be difficult to create solutions that support their individual needs.

Children diagnosed with ASC often struggle to express their emotions and thoughts due to the difficulties they face with social communication. They also display difficulties with joint-attention, which refers to having a conventional and shared meaning for symbols. As a consequence, children on the spectrum display limited interest in activities that are linked to imagination, such as pretend play [21]. In fact, according to studies conducted by Craig et al., children with ASC were found to struggle more with imaginative creativity than reality-based creativity [22].

One existing intervention is the TEACCH (Treatment and Education of Autistic and Communication Handicapped Children) approach, which focuses on finding methods to support learning and development for individuals with ASC. It was developed in the School of Medicine of the University of Northern Carolina in 1966. This approach values the importance of the individual's needs, skills, and interests of those diagnosed with ASC. This includes using visual structures to organise tasks, flexibility in teaching, and appreciating the uniqueness of autistic culture [42].

Other studies reveal that focusing on the strengths of these children allows designers to develop methods and tools to help children with ASC overcome their difficulties in communication. According to Wetherby et al., children with ASC outperform typically developing children in combining objects to create a product, such as puzzles [58]. Studies also report good outcomes using single-word vocabulary, describing objects and pictures, and responding to questions. Overall, to stimulate communication, children with ASC value predictability and routine, as well as following a functional approach [21].

2.2 Participatory Design

Participatory Design (PD) refers to the participation of users in the design process, where the aim is to empower them to co-design solutions. In the 1970s, work began in Norway that strove to enable workers to have more influence on decisions at their workplace, such as the introduction of computer systems. This increased sense of social responsibility resulted in the development of several projects around Scandinavia which focused on finding the most effective way for computer system designers to collaborate with the workers [52].

According to Fails et al., there are different levels at which individuals can be involved in the design process, ranging from user to informant to design partner [28]. These levels represent at what stage of the design process individuals are asked to contribute,

as well as how their ideas are included in the design. PD aims towards individuals being design partners, that is, active participants and equal stakeholders throughout the design process. While users are involved in defining the problem and evaluating proposed solutions, design partners are involved in every aspect, including the creation of solutions.

One of the goals of PD is to empower users and to enable them to have a voice throughout the development process [26]. Since designers are usually adults, their perception of the world is very different from a child's. Not only that, but with the rising use of technology, the way children interact with the world has changed drastically over the past years. This means that it is imperative to involve children in the design process in order to gain knowledge from their perspective of the world.

Involving children with special needs as design partners is also important, since non-disabled designers cannot fully understand their experience of the world. These children are considered experts in their fields, their needs and their personal experiences. It is important to adapt the design approach to enable them to express their ideas and contribute effectively [31, 40].

2.2.1 Methods and Techniques for (Distributed) Participatory Design with Children

In order to involve children in the design process, there are techniques that focus on specific parts of the design, such as brainstorming, iteration and evaluation [28].

One of the techniques used for designing with children is *Fictional Enquiry*, a brainstorming technique, focused on asking children to participate in a make-believe scenario through which a narrative is set up to gather requirements for the product.

Other important techniques include *Bags of Stuff*, used to build low-tech prototypes using a variety of craft supplies, *Mixing Ideas*, which involves combining several prototypes, and *Storyboarding*, focused on gathering design ideas by using stories. One variation of the latter is called *Comicboarding*, where the graphics are in the form of a comic that children have to fill out partially. It allows different levels of scaffolding depending on the children's needs [14, 45].

In addition to the aforementioned techniques, there are others that focus on iteration and evaluation. One example is *Layered Elaboration*, where designs are interchanged between groups, who then build on top of the previous teams' design, enabling them to add new ideas to already created work without changing the work of previous designers. *Sticky Notes* is a technique used to provide feedback to the design partners about a mock-up or prototype [28].

Due to the COVID-19 pandemic, PD sessions have not been able to be carried out as usual. However, this has given rise to new opportunities for PD, such as Distributed Participatory Design (DPD). DPD offers participants the opportunity to contribute to the design of a product while being located in different geographies [18].

There are many benefits to DPD, such as the possibility to have a broader inclusion

across different cultures, languages and abilities. However, there are also many challenges, mainly due to technological difficulties, ethical considerations, resource management, and, when designing with children, the need for adult intervention. Constantin et al. outlined key themes for DPD with children: participation in online environments, maintaining engagement, sense of connectedness/together, accessibility diversity and inclusion, power dynamics, developing skills, and administration, pragmatics, and logistics [18].

2.3 Participatory Design Interventions

There have been various studies relating to the creation of techniques to carry out PD sessions with children. One example is *KidReporter*, used both to generate user requirements and as a way to determine the content for a product. It consists of creating a scenario in which, given a type of product to design, children become members of a team of reporters and photographers who have to create a newspaper about the product idea [11]. Another well-known technique is *Mission from Mars*. Children, who take on the role of design partners, present their ideas to a martian, who is in a separate room observing. This technique was proved to work well with children since they would get excited to explain new concepts to someone foreign to their world, a martian, thus encouraging them to provide more detailed descriptions of their ideas [23].

Due to the variable nature of the characteristics displayed in children with ASC, it can be challenging to design products to meet their specific needs. Recent studies have worked on researching whether it would be beneficial to involve children with ASC in the design process. One of the most well-known interventions is IDEAS, which presents a new method specifically adapted to support children with ASC [13]. IDEAS is a means of involving children with ASC in the design of technology through participatory design. It is based on the TEACCH approach (Section 2.1.1). The goal of IDEAS was to understand whether it would be possible to include children with ASC in the design process and to conclude whether these children would benefit from participating in the session. These studies demonstrated that children felt empowered after the sessions and that it was possible to include them as design partners [13].

2.4 Technology-Based Interventions

Over the past years, there have been various technological interventions to allow children that are co-located to contribute to the design process. This is especially important when designing for an international audience or during the pandemic. However, these technological tools can also be used during in-person sessions to facilitate PD.

One of the exemplary tools created to support prototyping during DPD is *DisCo*, a computer-based design tool that enables participants to collaborate asynchronously while being in different locations. Based on *Layered Elaboration* [28], this tool enables designers to iterate on other designs, annotate and communicate with each other from within the tool, connecting both children and adult designers from around the world [57]. Other technologies that support collaborative brainstorming and prototyping are

BrainDraw [38] and *TelePICTIVE* [44], which support collaborative design through a shared interface.

Another tool developed to support DPD is *PDot*. This tool focuses on the evaluation stage of PD by giving designers an interface where they can provide feedback through annotation. There are different ways to provide feedback using *Pdot*, including sticky notes and drawing on top of the prototype [32].

There have also been various developments in the field of collaborative storytelling, allowing children to use technology to put together narratives. For instance, *Teatrix* enables children to tell stories and participate in performances in an online environment. Similarly, applications such as *Mobile Stories* and *StoryKit* allow children to create stories by using pictures and texts that they generate with a device [33]. In more recent work, Pittarello et al. developed *CASTOR*, an application that enables children to choose different types of stories and add pictures, new characters or audio recordings to them [48].

While these tools have enabled broader inclusion in PD while being co-located, they are not aimed at supporting PD for children with ASC. Constantin et al. propose a prototype of a technology to support idea generation during PD for children with ASC. The work focuses on a storytelling approach in which a virtual character guides the child through a fictional story to gather ideas [19].

2.5 Purpose

There are many techniques to involve children in participatory design, and other interventions to include children with ASC in the design process, such as IDEAS [13]. However, due to the challenges posed by having to cater for the specific needs of children with ASC, these methods have some limitations. In fact, most of these methods require being in person. Although some technologies such as *DisCo* and *Pdot* have helped in distributing PD, they do not focus on the needs of children with ASC.

According to findings by the National Health Center for Health Statistics in 2016, 1 in 36 children could have ASC [50]. Hence, with the rising prevalence of children diagnosed with ASC, it is important to address this gap. The purpose of this research is to create a technology-based tool to support children with ASC to participate in the brainstorming stage of the design process by helping them unlock their creativity, and thus enhance their communication skills. The target age group is children between the ages of 7 and 11, the third cognitive development stage defined by Piaget [47]. When designing with children, it is very important to consider the balance between empowering and overburdening [30]. This is why we will explore a game-based approach to answer **RQ1:** *How can a technology-based tool be designed to empower children to participate in and support designers during (Distributed) Participatory Design?*

2.6 Methodology

The methodology used for this research follows the framework known as Informant Design (ID), which focuses on the contributions of users at various stages of the design process [49]. The reason for using this framework rather than PD was due to the limitations of the study, meaning it was difficult to collaborate with children at all stages of the process. Likewise, due to the difficulties in recruiting children with ASC, typically developing (TD) children participated in the workshops as proxies [29].

In ID, children are considered "native informants", meaning their goal is to inform about things the researchers did not know about. The framework consists of four phases: 1. define domain and problems, 2. translation of specification, 3. design low-tech materials and test, and 4. design and test hi-tech materials. This framework was adapted for both experts and children to act as informants for the design of the tool:

1. Gathering requirements

The aim of this stage was to understand the current gaps in the literature in order to define the problem the tool would target. This meant reviewing both the background on ASC and the existing methods and techniques for (Distributed) Participatory Design with children, as was described in this chapter. This stage also involved several workshops with typically developing children to further understand how to best design a tool to support children with ASC during (D)PD (Chapter 3). Based on the literature review and the design workshops, an initial set of requirements for the tool was created.

2. Low-fidelity prototyping and evaluation

The aim of this stage was to create a low-fidelity prototype of the tool in Figma based on the requirements defined through the literature review and the design workshops [1]. This prototype was then evaluated by experts in Human-Computer Interaction (HCI), ASC and Education, the parent of a child with autism, and a child. The feedback and suggestions gathered were then used to further define the set of requirements for the tool. This stage is described in Chapter 4.

3. Implementation of the high-fidelity prototype

The third stage of the project aimed to implement the high-fidelity prototype based on the requirements gathered from the evaluations. This stage is described in Chapter 6.

4. Evaluation

Finally, the goal of this stage was to evaluate the high-fidelity prototype with typically developing (TD) children and experts in HCI, ASC and Education. These evaluations were used to measure the usability of the tool, its appropriateness for the target users, the benefits of the tool in comparison to existing methods of (D)PD, and identify any usability issues. The evaluation consisted of two parts: an evaluation with five experts and an evaluation with four TD children. This stage is presented in Chapter 6. These evaluations resulted in many suggestions on how to improve the tool, discussed in the "Future Work" section of Chapter 7.

Chapter 3

Design Studies

This chapter presents the gatherings from workshops carried out with four typically developing (TD) children as proxies for children with ASC. The main goal of these studies was to inform the design by identifying the requirements for the tool. This chapter aims to contribute to answering the research question **RQ1:** *How can a technology-based tool be designed to empower children to participate in and support designers during (Distributed) Participatory Design?*

3.1 Design Workshops

3.1.1 Aims

The overall goal of these workshops was to gather ideas for the tool in order to inform the design of the low-fidelity prototype. The aims for these studies were to identify:

1. Types of characters to include in the tool.
2. A story line for the tool.
3. Game features that children want to design in new games.
4. The ways in which children prefer to express their ideas, such as drawing, text or audio recording.
5. Suitable rewards to make the tool fun and engaging while providing enough information about the game ideas for the designers.

3.1.2 Participants

The participants of the design workshops were four TD children between the ages of 6 and 11 who acted as proxies for children with ASC [29]. To ensure anonymity, the participants have been assigned a code (P1, P2, P3 and P4) as shown in Table 3.1. The participants were recruited through family and friends of the researchers conducting the study.

Participant	Age	Gender
P1	8	Female
P2	11	Male
P3	6	Female
P4	9	Female

Table 3.1: Design workshop participants.

3.1.3 Procedure

Due to the ongoing COVID-19 pandemic, the workshops were carried out online through the video-conference tool Microsoft Teams [5]. The sessions were recorded using the built-in recording available on Teams. Two researchers participated in the workshops, alternating between leading the workshop activities and taking notes on the children's comments.

To ensure the participants and their parents were informed about the workshops, information sheets were sent out by email prior to the study. The email also contained a parent consent form and a child consent form, which they were asked to sign and return before the workshops took place (Appendices B, C.1 and C.2). The workshops lasted for 30 to 40 minutes and consisted of a pre-defined set of activities which were displayed on Power Point slides (Appendix D). Children were asked to present and explain their ideas to allow the researchers to further understand the children's preferences.

The workshop started with an introductory icebreaker where both the children and the researchers introduced themselves and were asked to draw and share their favourite character. The goal was to ensure the children felt comfortable with the workshop and with sharing their drawings and opinions with the researchers. After the icebreaker, the researchers explained why it is important to include children when designing new games. Then, the following activities took place:

Activity 1 - Brainstorming about games: In the first activity, children were asked to reflect on their favourite games, including what they liked and disliked about them. The aim of this activity was for children to think about what they enjoy from games. This would help the researcher understand what features of games children would like to have more control over.

Activity 2 - Redesigning games: The workshop proceeded with an activity to allow the children to become game developers. Children were introduced to an alien from Mars named "Al" who wanted to learn more about children's games to create them back in their home planet. The purpose of including a fictional character was to help the children express their ideas to someone who has no experience with games, as explained in the PD technique *Mission from Mars* [23]. Then, the children were asked to think of three things they would want to change in their favourite game. They were then encouraged to draw how they would design their new game, reminding them to think of how they would explain the new features to Al.

Activity 3 - Identifying rewards: The final activity consisted of asking the children how to make their game more fun. The children were asked to draw or write about what

kind of rewards they would like to include in their game. This helped the researchers be able to identify what kinds of prizes children enjoy in games.

At the end of the workshops, the children were thanked for their participation and were given a certificate to acknowledge their contributions (Appendix E.1). The parents/guardians were asked to send photographs of the children's work after the workshop.

3.1.4 Data Collection and Analysis

During the workshops, the researcher took notes about the children's ideas. These were later combined with the transcriptions of the recordings and with the photographs of the work sent afterwards by the children's parents. Then, qualitative analysis was needed to extract the most essential information. The researcher employed Thematic Analysis, a method that analyses data by grouping it into themes of similar topics or ideas [16]. This resulted in the themes presented in the following section.

3.1.5 Results

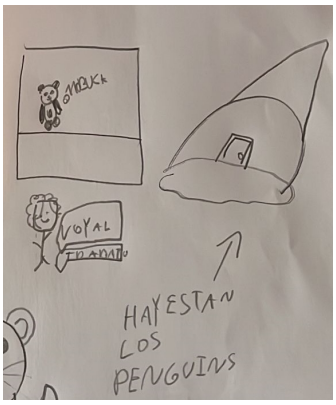
Based on the thematic analysis described above, the following themes were identified:

Characters: The workshop helped to identify the types of characters children would like in the tool. All four participants mentioned animal characters that could accompany them throughout the game. P2 pointed out that he enjoyed monster-like characters as well. P1, P3 and P4 mentioned the importance of customising their characters. P4 wrote that she would like to be able to *"change their clothes"*. P1 said that she would like to have *"a pet and be able to give it a name"*.

Story line: Through the activities, the participants gave many ideas as to what kind of environments they enjoyed in their games, providing the researcher with ideas for what kind of story line to use for the tool. P1 suggested having different locations around town where the player could do different jobs to get rewards. For instance, she suggested *"an ice cream place with penguins"* (Figure 3.1a). The idea of having various locations for a character to complete a set of tasks was also supported by P3, who mentioned that her favourite game has different locations with tasks to take care of your pet, such as feeding it. P2 mentioned the importance of different game levels that unlock as you progress, as well as including animation and graphics to *"motivate players to play more"*.

Game features that children want to design in new games: With regards to creating their own game, the children remarked how important it was for them to be able to personalise their characters. For instance, P1 said: "*I would like new animals, like a type of snake but rainbow coloured"*. Likewise, P3 drew a bunny with blue eyes and polka dots, suggesting that she enjoyed being able to colour her pets (Figure 3.1b). P4 emphasised the importance of being able to personalise their characters through *"putting on whatever clothes you choose"*. When P1 was asked to redesign her favourite game, she said she would like to draw new buildings. P4 mentioned the option of

creating your own stories. These observations reflect the children's desire to be able to have freedom with expressing their ideas for the game.



(a) Town-like environment designed by P1.

(b) Bunny with polka dots designed by P3.

Figure 3.1: Drawings from the Design Workshop.

Rewards: The workshop served as a way to gather ideas for what types of rewards children prefer. P2 suggested that as the game progresses, you are able to *"unlock characters"*. P2 also emphasised the importance of graphics and animations after achieving a level in the game. P1 mentioned that she wanted to collect the rewards as the game progressed by having a *"backpack where we can keep everything"*.

3.2 Design Principles

3.2.1 Framework for Serious Games

To ensure the tool can help children with autism express their ideas in participatory design while staying engaged, the guidelines for designing serious games were considered. Serious games are those designed to promote learning and improve certain skills. Thus, though their purpose is not solely to entertain, it is important that they are engaging for users. The following recommendations for designing serious games for children with autism developed by Whyte et al. [59] were considered:

- SG-1. Storylines Enhance Motivation and Contextualise Learning: Including a narrative can increase enjoyment and immersion in the tasks' context.
- SG-2. Goals Direct Learning Around Targeted Skills: The tool should have a combination of medium-term goals (completing tasks in the tool) and long-term goals (gaining new skills).
- SG-3. Feedback and Rewards Shape Learning: These should include both immediate rewards and feedback about the child's progress to enhance their intrinsic motivation.
- SG-4. Provision of Choice: This can allow users to have a sense of control over their experience, thus increasing their intrinsic motivation.

3.2.2 Human-Computer Interaction Design Principles

Before narrowing down the requirements gathered from the participants, it was important to decide on a set of principles with regards to the user interface of the tool. *Nielsen's 10 Usability Heuristics* are widely used in Human-Computer Interaction (HCI) and serve as a basis for designing usable tools [46].

- HCI-1. Visibility of system status: The user should be informed about what is happening in the tool.
- HCI-2. Match between the system and the real world: The system should use words familiar to the user and tasks should appear in a logical order.
- HCI-3. User control and freedom: Users should be able to leave an unwanted state easily.
- HCI-4. Consistency and standards: The tool should follow a similar structure throughout each task.
- HCI-5. Error prevention: Eliminate error-prone situations in the tool.
- HCI-6. Recognition rather than recall: Make options visible to the user.
- HCI-7. Flexibility and efficiency of use: Allow experienced users to speed up interaction.
- HCI-8. Aesthetic and minimalist design: Dialogues should not contain irrelevant information.
- HCI-9. Help users recognise, diagnose, and recover from errors: Error messages should be precise.
- HCI-10. Help and documentation: Any information should be concrete and easy to find.

3.2.3 Autism-Specific Design Principles

It was also important to consider the target user when narrowing down the design requirements. Hence, a set of principles specific for designing applications for children with ASC were used to inform the design. These were determined based on the guidelines established by Bartoli [10] and Benton [12]:

- ASC-1. Unique goal: Children should have a unique goal to reach.
- ASC-2. Instructions: Understanding the goal and tasks should be facilitated before playing and reinforced throughout the game.
- ASC-3. Rewarding: Offering rewards increases motivation.
- ASC-4. Repeatability and Predictability: This improves the child's mastery while also setting clear expectations of the future.
- ASC-5. Minimalist graphics: Visual items should be aesthetically pleasing but strictly functional to the goal.

- ASC-6. Dynamic stimuli: Animations should be provided along the tool to help the children engage.
- ASC-7. Navigation: It should be easy for the child to move between levels.
- ASC-8. Starting point in tasks: Tasks should provide either a basic wireframe structure or examples they can use as a guide.
- ASC-9. Methods to express ideas: Ensure children can share their ideas through their preferred methods including writing, drawing and verbally.
- ASC-10. Supplementary activities: The tool should include options for children who can generate ideas more quickly.

3.3 Design Requirements

Based on the workshops with children, the recommendations for designing serious games, the HCI design guidelines, and the ASC-specific principles, the following set of initial requirements for the tool were established:

No	Design Requirement	Relevant Principles
1	The target population are children with ASC between the ages of 7-11.	Literature Review [47].
2	The tool should have an underlying story line.	SG-1, ASC-2, ASC-4.
3	The tool should be customisable.	Design workshops, SG-2.
4	The tool should make use of visuals to indicate progression through the tasks.	ASC-2, ASC-6, ASC-7, HCI-1, HCI-6, HCI-7.
5	The tool should contain comprehensive help and instructions.	ASC-2, HCI-5, HCI-9, HCI-10.
6	There should be rewards and encouraging feedback throughout the tool.	SG-3, ASC-3, HCI-9, Design workshops.
7	The tool should include animations and dynamic stimuli.	ASC-6, Design workshops.
8	The tool should be visual with minimalist design.	ASC-5, HCI-8, Design workshops.
9	Language must be clear and appropriate for the target user.	ASC-2, ASC-7, HCI-10.
10	The rewards should be progressive.	SG-2, ASC-3, Design workshops.
11	The tool should include different levels of scaffolding to cater for children's need of support.	SG-4, ASC-3, ASC-8, ASC-9, ASC-10, HCI-3, HCI-7, Design workshops.

Table 3.2: Initial design requirements.

Chapter 4

Low-Fidelity Prototype

This chapter describes the design and evaluation of the low-fidelity prototype of the tool. First, a prototype was designed in Figma based on the list of requirements gathered in Chapter 3. Then, an evaluation was conducted with one parent of a child with autism, experts in the field of HCI, ASC and Education, and with a child. Lastly, the design requirements were updated to reflect the results gathered during the evaluation. This chapter aims to answer **RQ1:** *How can a technology-based tool be designed to empower children to participate in and support designers during (Distributed) Participatory Design?*

4.1 Low-Fidelity Prototype Design

After gathering an initial set of requirements for the tool (Section 3.3), a low-fidelity prototype was designed in Figma [1]. Figma is a tool that enables designers to create different frames and establish interactions between them. This allows users to click on buttons and navigate through different parts of the prototype, allowing for a more realistic representation of the tool. This is important to help discover usability issues.

Tool Concept: Based on the participatory design technique of fictional inquiry [24], a tool has been designed ("GameTown"). This tool aims to motivate children with ASC between the ages of 7-11 (requirement 1) to brainstorm about new games in a fictional town where they become design partners, as defined by Druin [27] (requirement 2). Children are guided by a virtual pet that takes them through locations in "Game Town", each representing different features of a new game (suggested by P1 in the design workshops).

"Game Town" Map: When a child opens the tool, the map of "Game Town" is displayed, as shown in Figure 4.1 Each of the locations represents a task that the child has to complete. The icons on this screen were created by the researcher on Power Point. The other clip-art used in the tool was downloaded from sources with licenses such as Clipart Library [2]. By clicking on each location, the child can read instructions about the tasks they should complete. After saving their work, the child is taken back to the map. The map also has a help button that explains the different tasks to the child,

and an exit button to close the tool (requirement 5).

Figure 4.1: "Game Town" Map.

1. "Home": The first location in "Game Town" is "Home". It represents a place where the children can set up their own profile, including their name, age, favourite game, and choose a pet character to accompany them throughout the tool (Figure 4.2a). In this location, children complete a "Game Town Identity Card" with the aim of making them feel like they have become official "Game Town" members (requirements 3, 8).

2. "Character House": The "Character House" is where children can design characters for the new game. When clicking on this icon, their virtual pet gives them an introduction to the task. Children can choose whether to draw their own characters or colour an existing template (requirement 11). This range of options allows children to explore their creativity, while ensuring they do not feel overwhelmed by a blank screen (ASC-8). Figure 4.2b shows the screen for drawing a character.

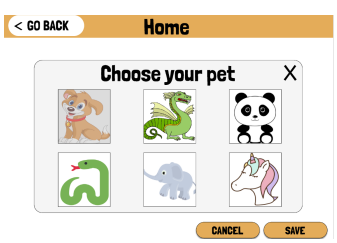
3. "You Decide": This location contains a game where children are given two options to choose from. These contain different features that the game they are designing can include. For example, they can choose whether the game should be single player or multiplayer, and whether it should be a desktop or a mobile app (Figure 4.2c). Each option appears on a large button. On click, the choice is recorded and the user is taken to the next question. Additionally, there is a progression bar at the top that highlights in green the questions the child has already completed (requirements 4, 7, 8).

4. "Rewards House": This location encourages children to think about what happens when someone wins the game. For instance, there is a game of sorting rewards depending on how much children like them for the game they are designing (Figure 4.2d). The bins are green, yellow and red, indicating whether the user likes, is neutral, or dislikes the reward, respectively (requirements 7, 9). In addition, there is an option to use sticky notes to write about their own ideas about what happens when someone wins their game. The back button takes the child back to choosing whether to recycle or to write sticky notes (requirement 11).

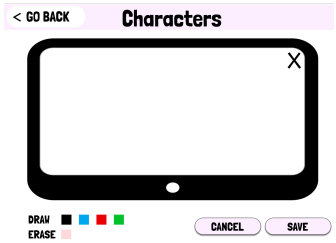
5. "Game Factory": This location is where children can draw various game elements, such as levels, actions, activities and environments. As in the "Character House", this location also has an option for children who need more scaffolding [14]. In fact, children can choose to draw on a blank screen or to fill in three comics, namely a start,

middle, and end screen of the game, as shown in Figure 4.2e (requirements 8, 11). This idea emerged from *Comicboarding* [45].

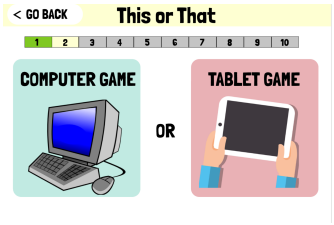
6. "Game Gallery": The "Game Gallery" is where children can give a name and a description to the game, and explain why other children should play it (Figure 4.2f). This location aims to give children ownership about what they have created (requirement 6).



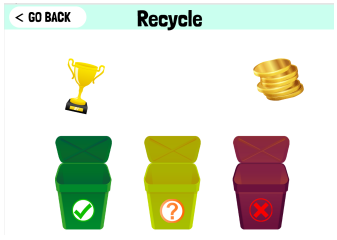
(a) Choosing virtual pet.



(b) Drawing characters.

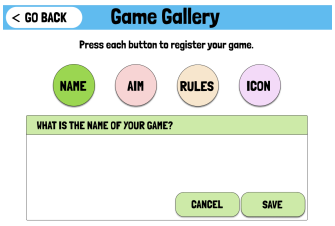


(c) This or That Game.



(d) Sorting rewards.

(e) "Game Factory" comic.



(f) "Game Gallery".

Figure 4.2: Screens from the low-fidelity prototype of "GameTown" implemented in Figma.

Additional screenshots of the low-fidelity prototype can be found in Appendix F.

4.2 Evaluation with Experts and Parents

To identify any usability issues with the initial prototype, an evaluation was conducted with experts in the field of Human-Computer Interaction (HCI), ASC and Education, and the parent of a child with autism.

4.2.1 Aims

The goal of these studies was to gather feedback on the initial prototype of the tool. In particular, the following aims were established:

1. Evaluate if the tool is appropriate for the target user.
2. Determine the kinds of rewards to include in the tool.
3. Determine the most appropriate way to visualise the progression through the tool.
4. Identify possible usability issues in the design.
5. Gather feedback on how to improve the design.

4.2.2 Participants

The participants were two experts and one parent of a child with autism. To ensure anonymity, they have been assigned a code (E1, E2 and E3) as shown in Table 4.1:

Participant	Area of Expertise
E1	Human-Computer Interaction and Education
E2	Human-Computer Interaction and ASC
E3	Parent of a child with ASC

Table 4.1: Participants in the low-fidelity prototype evaluation.

4.2.3 Procedure

The meetings were carried out online and recorded using the video-conference tool Microsoft Teams [5]. To conduct the study, the experts were sent an information sheet and a consent form prior to the evaluation (Appendix G). They were asked to return a signed copy of the consent form prior to the evaluation. Each session was held individually with each participant and lasted for 30 to 40 minutes.

To start, the participants were informed about the project and the main aims of the workshop. Then, the researcher gave a description of the prototype, focusing on the different aspects of the tool that were targeted at supporting children with autism to be able to communicate their ideas for new games.

Then, the participants were asked to familiarise themselves with the tool displayed through the screen-sharing functionality on Teams. In order to gauge their opinions on the tool, the experts were encouraged to employ "Think Aloud", speaking as the researcher showed them the tool [55]. Finally, the studies concluded with a semi-structured interview made up of the following questions: What did you like the most? What did you like the least? How easy/intuitive the tool was to use on a scale from 1-5? Do you believe this tool is appropriate for the target users? Is there anything the users would find hard? What rewards would you believe are suitable for this tool?

4.2.4 Data Collection and Analysis

After the session finished, the notes and transcriptions were combined to analyse the resulting data using Thematic Analysis [16]. As in the design workshops, the researcher analysed the transcriptions through Open Coding [35] to identify themes throughout the data, which were extracted from the aims set out for the studies. The findings are presented in the following section.

4.2.5 Results

The following themes were identified in the evaluation:

Instructions and ease of use: Both E1 and E2 expressed that the tool was intuitive and simple to use. E1 mentioned that the setting of the tool was *"calming"* and structured

step by step. However, both E2, an expert in the field of ASC, and E3, a parent of a child with autism, noted that there was *"quite a lot of text for the target users"*, indicating that it would be important to reduce the text and have more visuals throughout the tool. E2 suggested to use a combination of text and pictures in the instructions to make it less overwhelming for children.

Appropriateness of tasks for the target user: With regards to the appropriateness of the tasks for the target users, the three participants pointed out that the interactive aspects of the tool would enable children to be more engaged. E1 mentioned that drawing can help children *"visualise their thoughts"* as well as explore their creativity. She also mentioned that sorting was another *"mechanic that is very appealing to this user group"*. E2 said that children with autism often struggle if they are given *"the so called blank piece of paper"*. Thus, having a variety of templates for them to choose when drawing characters for the game would allow children to explore their creativity while also providing some structure.

Story line and progression: Another theme that was identified through the studies was about the story line and progression throughout the tool. This was one of the guidelines for designing serious games (Section 3.2.1). E1 mentioned that *"alternating between the passive engagement of the narrative and interaction"* of the tool was key to engage children. Furthermore, E2 mentioned it was important to give children *"time between tasks to ensure they can process their achievements"*, recommending that they should be taken back to the map screen after completing each location.

Rewards: With regards to in-tool rewards, both experts mentioned the importance of visually unlocking the locations. E2 said that it was *"a way of having structure and also engaging the child to complete all stages"*. She expressed that visual rewards tend to be preferred by children with autism, remarking the importance of feedback on the screen to remind the children of their achievements. Moreover, according to E1, children expect the rewards system to be an enabler for something bigger at the end. This is accordant with research from Constantin et al. that showed the importance of progressive rewards for children with ASC [20].

Impact of the tool: E1 and E2 both mentioned the possibility of the tool being used alongside a parent or practitioner who would be able to do some scaffolding to elicit responses from the children. This was important to note since both experts identified the opportunity to use the tool for participatory design sessions, not only alone and remotely, but also in groups and in a classroom environment. From her experience, E2 mentioned that this could be very beneficial for children with ASC, who often struggle to transition to new settings. Thus, having this tool that would not require the researcher to be in the session might help children complete the tasks more easily and maximise their contribution and gains.

General suggestions to improve the design: Finally, the experts gave constructive feedback on potential improvements to the tool. In particular, E2 mentioned that there should be a way to show the children what they have created using the tool. She also mentioned that the pet options were very limited, which could cause children with autism to disengage with the tool. This expert pointed out that children with autism have a *"tendency to stick with certain things they like"* (one of the characteristics of

autism according to the DMV-5 [6]). Hence, it is important to ensure that children are given options. She suggested allowing the children to take photos to overcome this.

4.3 Evaluation with Children

4.3.1 Aims

The aims of this study were to:

1. Determine whether the story line within the tool is easy to understand.
2. Determine whether the tool is engaging for the children.
3. Determine whether the language of the tool is appropriate for children.
4. Identify the rewards system for the tool.
5. Gather feedback on how to improve the design.

4.3.2 Participant

For the evaluation with children, there was one child participating. This child, who will be referred to as P1 to ensure anonymity, had already participated in the design workshops described in Chapter 3.

Participant	Age	Gender
P1	8	Female

Table 4.2: Participant in the low-fidelity prototype studies.

4.3.3 Procedure

As in the expert evaluation, the workshop was carried out online using Microsoft Teams [5] and recorded using the in-built recording functionality. To recruit participants, their parents were contacted by email, which contained consent forms and information sheets for both parents and children, slightly modified from the ones used in the design workshops (Appendices B, C.1, and C.2). These forms gave the researcher permission to record the workshops.

The workshop began with an icebreaker asking the child to share her favourite activity of the winter holidays. Although P1 had already participated in the initial design workshops, it was still important to create a safe space where she would be able to express her opinion. After the icebreaker, the aims of the workshop were explained to the child. Due to the technical difficulties in asking the child to access the Figma prototype virtually, it was decided to show the prototype using the share screen functionality on Teams. The child was asked to perform six tasks (Appendix H.1) in which she identified where to go next in the tool and what steps she would take to complete each task. The researcher followed the child's instructions in the prototype. The process followed

the Think Aloud method [55], encouraging the child to express her thoughts as she completed the tasks.

After completing each task, the child was asked to rate how easy she found it using an emoji Likert scale with words to support the meaning of the pictures [41] (Appendix H.2). Then, the child was asked some follow-up questions about her experience with the tool. These can be found in Appendix H.3.

4.3.4 Data Collection and Analysis

The data from the recordings was transcribed and combined with notes taken during the workshops. As in previous studies, the researcher conducted a Thematic Analysis [16].

4.3.5 Results

Names of locations: One of the themes identified relates to the names of the different locations across "GameTown". Generally, the names of the locations were obvious to P1. When asked about the purpose of the "Game Factory", she said *"we create the games"*. Likewise, when asked about the purpose of the "Game Gallery", she mentioned *"you save your game"*. P1 struggled to identify the content of the "Rewards House", which she believed would store the rewards she collected within the tool. This suggests there is a need for a clearer introduction as to what the goal of the tool is.

Story line: Another theme that was identified from the workshops is the story line of the tool. While the idea of having to go to different locations in town was initially suggested by P1, she mentioned that it would be easier to understand how to progress through the tool if a character guided her through each location. In general, the progression throughout the tool was not clear. When asked where to go to next after "Home", P1 did not know which house to choose. When informed that the locations could initially be black and white to indicate that they are not accessible, the child seemed to think this was a good idea by suggesting to *"make the locations glow when unlocked"*.

Customisation: P1 showed a lot of interest in customising the tool. She mentioned being able to personalise her own character by changing its clothes and adding accessories. In terms of choosing a pet, P1 was disappointed that her favourite animal (a panda) was not an option. This suggests it might be beneficial to add Google Search so that children can browse for pictures of different animals to choose as their characters. P1 expressed that she liked that she could name her game in the "Game Gallery".

Freedom to express ideas: Another theme identified from the study relates to allowing the children to freely express their ideas. P1 particularly enjoyed being able to draw her own characters and the game itself. In both cases, she had a preference for using a blank screen instead of a template. This could be due to the fact that she said *"I love drawing"*. Another observation was that P1 mentioned she would like to be able to drag her own ideas into bins in the "Rewards House". She then suggested that it would be a good idea to *"drag the notes into bins to say what you like and don't like"*.

Gamification: Gamification was also identified as one of the themes through the analysis. Since P1 participated in the initial design workshops, the researcher decided

to ask her to compare the experience of doing a participatory design workshop on paper versus using the tool. P1 expressed that *"it would be more fun than doing it in a paper"*. She particularly enjoyed the gamified locations, including "You Decide", where she could tap the buttons and visualise her choices, and the "Rewards House", since she enjoyed the idea of dragging and dropping the items. When asked about her least favourite task, P1 said: *"there was nothing that I did not like"*.

Rewards: Finally, the last theme identified was the rewards in the tool. There was a preference for progressive rewards. P1 suggested that *"as you play, you gain more prizes"*. When asked whether collecting puzzle pieces at each location and being able to solve the puzzle at the end as an idea for a reward, she nodded in approval and suggested that the puzzle pieces should be stored in a "GameTown" backpack. This need for a specific place to store in-tool rewards become even more apparent when the child thought that the "Rewards House" would also store her own prizes.

4.4 Revisited Design Requirements

Overall, the experts, parent and child welcomed the idea for the tool. In fact, E1 indicated that the tool could address the fact that *"there is a generic struggle at the moment to understand what tools and platforms to use for remote participatory design"*. Hence, following the evaluation, the design requirements discussed in Section 3.3 were updated to reflect the feedback received from the experts, child and parent. These requirements as well as the relevant principles to support them can be seen in Table 4.3.

No	Design Requirement	Relevant Principles
12	Locations in the menu screen should be darkened and unlock as children progress.	HCI-1, HCI-6, ASC-3, ASC-4, ASC-6, ASC-7.
13	Rewards should be incremental and lead to a bigger reward at the end.	ASC-3, Literature [20].
14	There should be pop-ups and visual indications that children have completed a task.	HCI-1, ASC-2, ASC-6.
15	The instructions should contain a combination of minimal text and pictures.	HCI-8, HCI-10, ASC-2, ASC-5.
16	In-tool rewards should be clearly visible to the child in the menu screen.	HCI-1, HCI-6, ASC-4.
17	Include ability to upload or take photos for the child's character.	HCI-3.
18	Enable children to write about their own reward ideas in the "Rewards House".	SG-4, HCI-7, ASC-9, ASC-10.

Table 4.3: Additional Design Requirements.

Chapter 5

High-Fidelity Prototype

This chapter describes the high-fidelity prototype implementation of the tool based on the design requirements presented in Section 3.3 and the additional requirements explained in Section 4.4. First, some technical justifications and decisions were made for the development of the tool. Then, the tool was implemented in Unity. This chapter aims to answer the research question **RQ1:** *How can a technology-based tool be designed to empower children to participate in and support designers during (Distributed) Participatory Design?*

5.1 Software and Resources

Initially, the tool was intended to be developed for an Apple iPad. Studies show that the use of iPads can lead to an increase in engagement and participation in learners [53]. In fact, a project that aimed to create an iPad tool to present Social Stories for young children with autism indicated that presenting the content using an iPad resulted in an increase in the attention children payed to the task they were set [56]. Further research supports the use of iPads to target communication skills for individuals with autism [34]. However, due to the ongoing pandemic, the evaluation sessions had to be carried out virtually. Thus, the tool was developed as a web application. This meant it could be hosted on an external website and be available to participants during the studies.

5.1.1 Unity

The prototype was developed using Unity. Unity is a cross-platform game development tool that uses C# for scripting [54]. One of the challenges faced by the researcher was the novelty of developing an application. The researcher did not have previous experience with app development. However, due to the benefits of Unity as a cross-platform engine, its ability to include games, the vast amount of resources and documentation available (such as Unity Learn [4] and Youtube tutorials for implementing functionality such as “Drag Drop”, quizzes, and drawing [15, 17, 60]) and the researcher’s previous experience with similar object-oriented languages such as Java, it was decided that Unity was the most suitable software for the development of “Game Town”.

5.2 Description of the High-Fidelity Prototype

Based on the updated design requirements gathered from the evaluation studies (Section 4.4), a high-fidelity prototype of the tool was implemented in Unity. “Game Town” aims to emulate an environment where children are encouraged to unlock their creativity to brainstorm about new educational games. The tool aims to help designers gather ideas for a new game while ensuring that children are engaged. The tool makes use of a story line, gamified activities, and in-tool rewards. It also ensures that children are able to feel empowered about their contributions to the creation of a new game by providing various options at each step of the brainstorming process ranging from giving them the chance to express their thoughts to guiding them using pre-established templates and hints.

5.2.1 Tool story line and Instructions

The prototype design follows a story line, where children can progress through the six different locations in the tool (requirement 2). “GameTown” begins with a screen where the child or practitioner can choose to either find out more about the tool or to begin the tasks, as shown in Figure 5.1a. In the “About” screen, there is general information about the purpose of the tool (Figure 5.1b). Including this screen was a decision made after the expert evaluations, where it was suggested that the tool should be used alongside an adult to support the children.

When a child chooses “Play”, they are greeted by Charlie, a character that represents a game designer (requirement 15) (Figure 5.1c). Charlie introduces the child to “Game Town”, explaining that there are six locations where they will create different features of a new game. Charlie also explains the topic of the game that the child will be brainstorming about. In the current implementation, children are asked to design a game about climate change. Charlie then guides the child through the rest of the tool, explaining the tasks the child has to complete at each of the locations (requirement 5). They also remind the child how useful their contribution is to the design of the new game, providing them with a feeling of ownership (requirement 6).

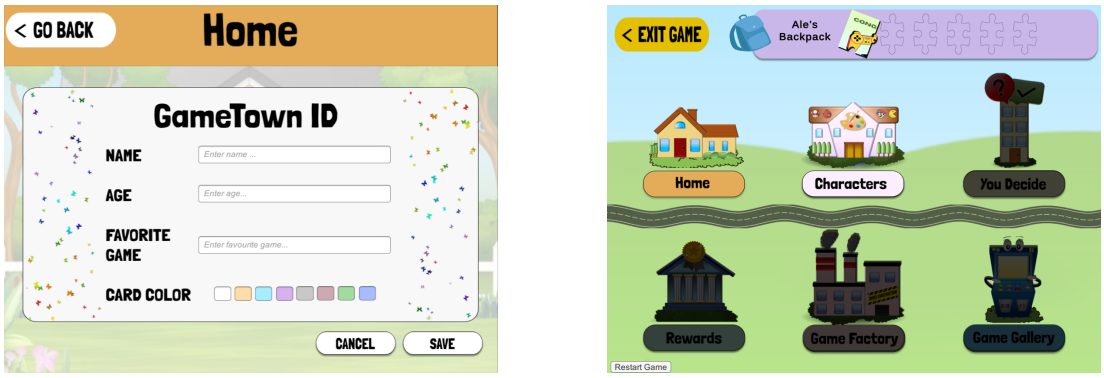
(a) Menu scene. (b) “About” scene. (c) Charlie welcoming a child.

Figure 5.1: The menu scene, “About” scene, and Charlie’s introduction to “Game Town”.

5.2.2 "Game Town" Locations

"Home"

The first location in the map is called "Home". Here, the child is asked to set up their "Game Town" ID, which contains their name, age, favourite game, and favourite colour (Figure 5.2a). This allows the child to personalise their experience with the tool (requirement 3). After writing their name and choosing a colour, the child's name will appear in the "Game Town" map screen and the backpack will change to their favourite colour (Figure 5.2b).



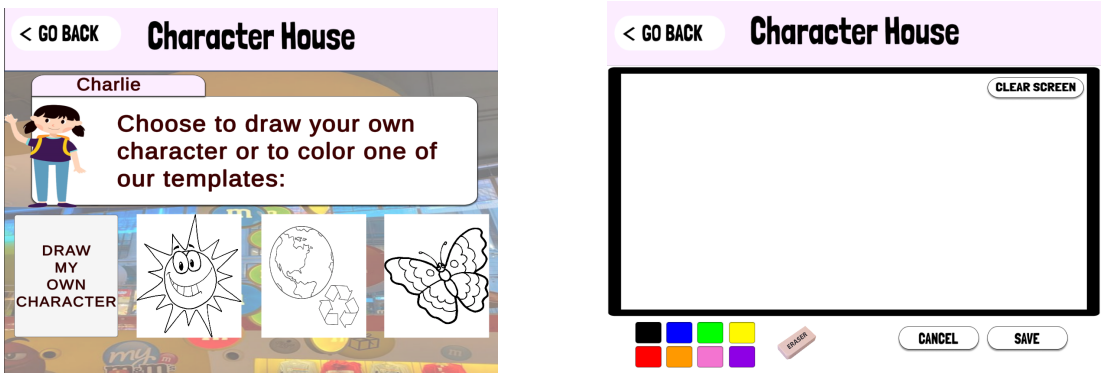
(a) "Home" scene.

(b) Unlocked "Character House".

Figure 5.2: "Home" house and the results of saving this task in the high-fidelity prototype.

"Character House"

The next task the child will have to complete is in the "Character House". Here, the child will be asked to design the characters they would like in the new game. There are two options that the child can select, either to draw their character in a blank screen (Figure 5.3b) or to colour a template, as shown in Figure 5.3a. These templates represent a character that the game designers have started to create for the game, but need the child's help to complete. This ensures that children do not feel overwhelmed in the process of idea generation (requirement 11).



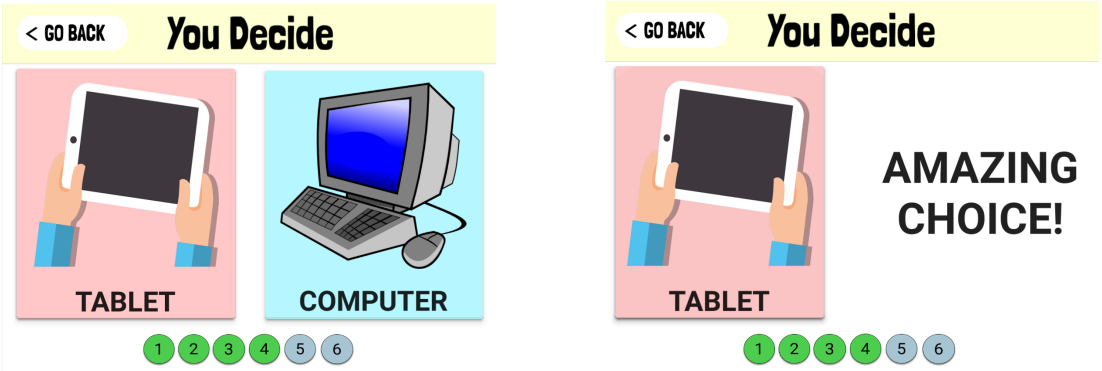
(a) Options in the "Character House".

(b) Drawing a character.

Figure 5.3: Screens of the "Character House".

"You Decide"

The third location in the tool is called "You Decide". This task is a game where the child is prompted to select their favourite option, out of two, for different features of the new game. This enables the designers to gather information about what attributes are important for children to have in the new game. The two options are shown in large buttons containing both an image and words (Figure 5.4a). In the current implementation, the questions ask about features that children with autism normally have a preference on, such as whether to include sounds and whether the game should be multiplayer. As the child makes their choice, the option they did not choose slides off the screen and feedback such as "Amazing choice!" appears as a way of stimulating engagement, as shown in Figure 5.4b (requirements 6, 7). Moreover, the buttons with each question number turn green as the child progresses (requirements 4, 8).



(a) A question of the "You Decide" game.

(b) Feedback after selecting an option.

Figure 5.4: Screens of "You Decide".

"Rewards House"

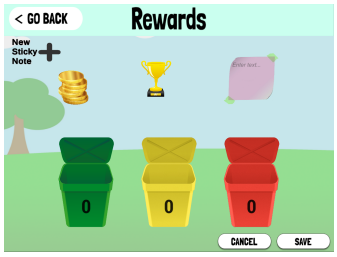
The "Rewards House" aims to encourage children to think about the prizes that can be included in the game they are brainstorming about. In order to make the task more interactive, children are asked to drag and drop potential rewards to different bins, depending on whether they like them (green), dislike them (red), or are neutral about them (yellow) (requirement 7). As a means of allowing children to express their ideas (following on from P1's suggestion in the evaluation workshops), children can also use sticky notes to write about their own ideas for rewards for the game (requirement 11) (Figure 5.5a). The number on each bin increases to show the child that they have added an item to that bin (requirement 4).

"Game Factory"

The fifth location is the "Game Factory", where the goal is for children to draw what the game should look like (in this case, the climate change game). Here is where children are incentivised to explore their creativity, as they can freely draw any aspect of the game, such as the background or a specific scene. In order to make sure that children do not feel overwhelmed by a blank screen, this task provides an option to draw on top of templates that contain some clip-art related to the game's theme, as can be seen in Figure 5.5b (requirement 11).

"Game Gallery"

Finally, the last location in the tool is the "Game Gallery". This aim is to enable children to feel empowered and owners of their contributions (requirement 3). Children are asked register their game into the "Game Gallery", which represents where all games created in "Game Town" are stored. They can give their new game a name, a description, and explain why children should play it (Figure 5.5c).



(a) Recycling rewards into bins.

(b) Comic option in "Game Factory".

(c) "Game Gallery" registration form.

Figure 5.5: Screens of the "Rewards House", the "Game Factory" and the "Game Gallery".

5.2.3 Rewards

To keep children engaged while brainstorming for new games, the tool includes various types of rewards.

Unlocking locations

As suggested in the evaluations of the low-fidelity prototype, one of the rewards implemented is the visual progression through the map of "GameTown". When a child first accesses the tool, all the locations except "Home" will be darkened, as shown in Figure 5.6a. As the child completes the tasks set in each location, the next task they can access will unlock and have colour (requirements 12, 16). After the child completes all locations, the map will be completely unlocked and the child will be able to access any location to re-do any of the brainstorming tasks, as shown in Figure 5.6b.

Incremental pop-ups

Another way to reward the children throughout the tool is by including text rewards in the form of pop-ups after saving their work at each location (requirement 14) (Figure 5.6c). If the child goes back to a location they have already completed to re-do a task, the pop-up window will not appear again, as they have already completed the level. In research conducted by Constantin et al., it was found that children with autism tend to prefer rewards that reflect their progress [20]. Hence, the pop-up windows in the tool contain text-only in the first location ("Home"), and then contain text with stickers such as stars, emojis, and fireworks as the children unlock more locations (requirement 10). Thus, as the children progress, the pop-up windows contain more colour and stimulating visuals (requirement 7). After completing all the locations, the children are congratulated for officially becoming game designers.

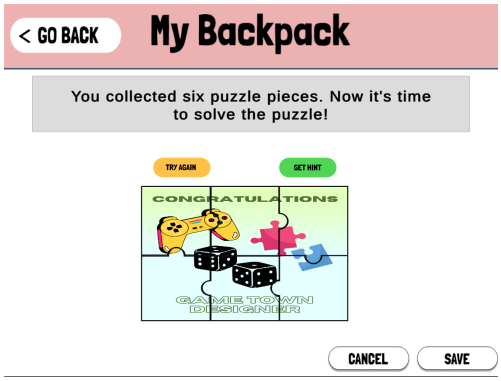
Puzzle

The pop-ups mentioned above also give the child a visual reward, namely a puzzle piece. After completing each location, the child gains a puzzle piece to save in their backpack, as suggested by P1 in the evaluation workshop. Initially, the backpack has empty puzzle piece placeholders (Figure 5.6a). The puzzle pieces appear on top of these placeholders as the child completes the different activities (requirements 4, 8, 16). The research conducted by Constantin et al. also found that it was important for children with autism to have a bigger reward at the end to recognise their achievements [20]. This was also mentioned during the expert evaluation. Therefore, in "Game Town", children can solve the puzzle using the pieces they have collected through the tool. In case the children get stuck, they can click "Get Hint" to help them solve the puzzle by placing one piece at a time in the correct slots (requirement 11). When solved, the puzzle is a certificate that congratulates the child for becoming a game designer (requirement 13) (Figure 5.6d). In the aforementioned study, the children showed interest in having a *"certificate of achievement"* when completing the final tasks [20].

(a) Initial map of "GameTown".

(b) Unlocked map of "GameTown".

(c) Pop-up in the "Game Gallery".



(d) Solved puzzle.

Figure 5.6: Screens of the types of rewards throughout the tool.

Additional screenshots of the high-fidelity prototype can be found in Appendix I.

Chapter 6

Evaluation

This chapter presents the evaluation studies of the high-fidelity prototype with experts and typically developing (TD) children. The goal of this chapter is to answer the final research question **RQ2:** *To what extent does this new technology support children with ASC and designers in (Distributed) Participatory Design?*

6.1 Evaluation with Experts

To determine whether the tool was appropriate for target users and effective in supporting designers and children with autism in (D)PD, a workshop was set up with experts.

6.1.1 Aims

The following aims were set for the evaluation workshops with experts. Determine:

1. Whether the tool is appropriate for children with autism between the ages of 7 and 11.
2. If the tool can elicit ideas from children to brainstorm about new educational games.
3. The extent to which the tool can help designers gather ideas for new educational games.
4. The extent to which the tool drives engagement for children in the process of brainstorming.
5. Whether there are any usability issues and gather suggestions to improve the tool.

6.1.2 Participants

The participants were five experts in the fields of Human-Computer Interaction (HCI), ASC, and Education. Two of the participants, E1 and E2, had already taken part in the evaluation of the low-fidelity prototype, while three more experts were recruited

through the School of Informatics. Table 6.1 summarises the areas of expertise of the participants.

Participant	Area of Expertise
E1	Human-Computer Interaction and Education
E2	Human-Computer Interaction and ASC
E3	Human-Computer Interaction
E4	Software Engineering, Human-Computer Interaction and ASC
E5	Human-Computer Interaction

Table 6.1: Participants in the high-fidelity prototype evaluation.

6.1.3 Procedure

As in the previous evaluation, the workshop was carried out virtually through Microsoft Teams [5]. After the experts agreed to participate in the study, they were sent an Expert Information Sheet and Consent Form through email (Appendix J), which they had to sign prior to the evaluation. Each meeting was held with an individual expert and lasted between 30-45 minutes.

The workshops began by giving the participants an overview of the tool and explaining the aims of the study. The tool was uploaded to the Itch.io hosting platform to allow participants to use it on their own computers [3]. Each session followed the Cooperative Evaluation method, an adaptation of the Think Aloud method used in previous workshops. With Think Aloud, users are asked to speak about their actions while using the tool, while with Cooperative Evaluation, they are encouraged to ask questions for clarification. The researcher can also interrupt to ask the participants the reasoning behind their actions [25, 55]. This gave the researcher the chance to gather more insight into the struggles the experts faced using the tool.

The experts were asked to familiarise themselves with the tool using the instructions provided by the character. Then, the researcher conducted a semi-structured interview using the questions found in Appendix K. These questions focused on the perception of the researchers regarding the appropriateness of the tool for the target group, how intuitive and easy the tool was to use, its effectiveness in helping children with ASC to contribute to the design process, and the potential the tool has for helping designers to gather ideas. Finally, the experts were asked to provide suggestions to improve the tool.

The researcher also gathered quantitative data about the tool's usability. This employed a System Usability Scale (SUS), a measure of usability designed by John Brooke [8]. It contains ten questions that are answered using a five-point Likert scale, ranging from strongly disagree (1) to strongly agree (5). The questions can be found in Appendix L.1. The experts were asked to fill in the SUS questionnaire after the study. Likewise, attendees to the School of Informatics' Project Day who interacted with the tool were also asked to fill in the questionnaire. In total, seven participants completed the form.

6.1.4 Data Collection and Analysis

The results from the recordings were transcribed and combined with notes taken by the researcher during the workshops. Then, as in the evaluation of the low-fidelity prototype, the data was grouped into themes using Thematic Analysis [16].

6.1.5 Results

From the analysis of the workshops, the following themes emerged: appropriateness, usability, ease of use and intuitiveness, rewards, instructions, tasks, customisation, benefits for designers, and further improvements. Likewise, the results from the SUS questionnaire are also discussed.

Appropriateness: All experts mentioned they perceived the tool as appropriate for the users. According to E5, the tool was *"predictable, repeatable and engaging"*, which are important aspects when designing for children with ASC. E2 mentioned that the tool met the guidelines of designing for children with autism, empathising its structure, the use of visuals and *"providing a limited number of choices"*.

Usability: E4 and E5 expressed concerns over the "About" screen, saying that it was a bit crowded for children to read. However, they both praised the fact that there was a place where practitioners or parents could go to find out more about the tool. E5 also remarked that there was some inconsistency in the naming of the buttons in the dialogue boxes. She said that when Charlie asks questions such as "Are you ready?", the button should say "Yes" or "No" rather than "Continue".

Additionally, E1 and E5 expressed some concerns over the instructions in the "Game Factory". Both experts said they were confused by the name "comic", and E1 suggested that it should be renamed *"something along the lines of filling in drawings of the game"*. She also suggested that it would be good to have a demo in case the child needs more help. E2 also experienced some difficulties with understanding the purpose of the "Game Factory", saying that it was not clear whether she had to draw the background of the game or to choose of the comic strips. As a suggestion, she mentioned it would be helpful to give the children a narrative to fill in that would provide them with more context.

Ease of use and intuitiveness: Generally, the experts gave very positive feedback about the tool. Four experts rated the tool a 5/5 in terms of ease of use, with only one expert rating it a 4/5. Overall, all the experts gave positive feedback regarding the User Interface (UI) of the tool. E3 mentioned that the interface was very *"friendly with lovely light colours"*, highlighting that she found the colours *"gentle and not too shocking"*. Likewise, both E3 and E4 remarked that the font was quite large and easy to read.

E1 and E3 noticed that the locations were shadowed when opening the tool, indicating that they were not accessible. They also both mentioned the hovering effect over all the buttons, which they believed was important to reinforce the fact that they are clickable. E3 enjoyed that she would return to the map of locations after completing each task, expressing that this was *"intuitive and allows you to recognise where you are in the tool"*.

Rewards: Another theme identified during the analysis was the rewards. As an expert in ASC, E2 praised the use of puzzle pieces as rewards, expressing that it was *"generally one of the interests of children with autism"*. E3 also mentioned that it was good to have the puzzle pieces accumulating visually on the map screen since this was a *"clear indication of the rewards achieved"*. E4 suggested adding some additional rewards that would emulate *"real life rewards, such as emojis, stars, or trophies"*. This would also make the rewards be incremental as the children completed more tasks, in line with Constantin et al. [20]. They all agreed that the tool would drive engagement in children with ASC when brainstorming about new educational games, partly due to the rewards.

Instructions: Overall, the experts mentioned that the instructions were clear and enabled them to successfully complete each task, in line with heuristic HCI-10 (Section 3.2.2). E3 mentioned that it would be good to only provide the instructions at each location until the child completes the task. Then, if they wanted to re-do or modify a task, they would be able to access the house without going through the introduction again. E4 expanded on this thought by explaining that it was important to *"replay the dialogue until the child saves the task"*. Nevertheless, E2 said that she did not think the instructions were necessary, as the tasks were self-explanatory. She pointed out the use of a button to "Go to Activity" as very useful to enable children to be in control.

All the experts were pleased to see there was a character guiding the children throughout the brainstorming process. E1, E2, E3 and E4 mentioned the importance of empowering the children through phrases such as "we need your help". E1, E2 and E3 expressed that it would be *"helpful to add screen reading to hear Charlie speak"*.

Tasks: Another theme that emerged was about the tasks, especially at the "Character House" and "You Decide". Regarding the "Character House", E3 said that she would have liked to have more options when drawing, such as *"lines or circles, or any kind of shapes"*. She also pointed out that the pen colour should be defaulted to black, rather than having the user click on a colour to be able to start drawing. In "You Decide", E1 remarked that it was *"good to have two options side by side to avoid overwhelming the children"*. In addition, she said it would be good to allow the children to justify their choices as a way to provide the designer with more feedback. E3 expressed that she had a difficult time choosing only one answer in "You Decide", and it would have been beneficial to have a button to choose both.

Customisation: Another theme that stood out was the customisation the tool. E1 and E3 mentioned that the theme of the map should be related to theme of the game. E3 would have liked to see *"wind turbines, solar panels, and locations more relevant to climate change"*. E1 said that *"designers should be able to adapt the background depending on the theme"* of the game children are expected to design. E2 mentioned that it would be beneficial to allow children to upload their own templates to the "Character House". E4 liked that the user could have some customisation in the tool, such as changing the colour of the backpack and displaying their name on the map screen.

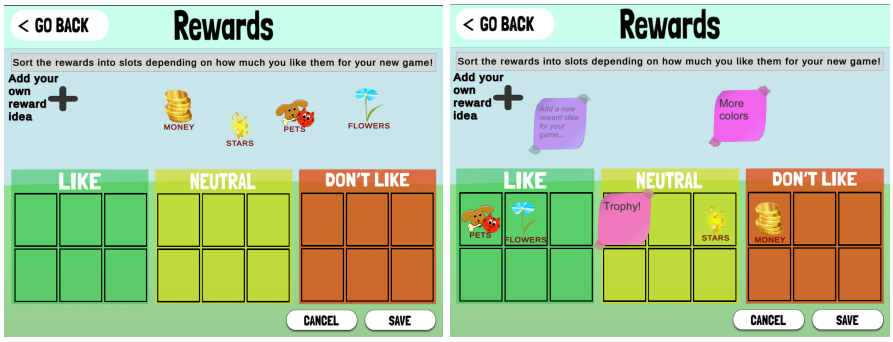
Benefits for designers: One of the key findings from the studies with experts was the potential benefits this tool could have for designers. All experts were very positive about the use of the tool in replacement of paper worksheets that are often used in participatory design. However, E1 mentioned that in order to make the most of the tool, it would be

important to have a practitioner to support the child during their brainstorming process, both to *"support children depending on their abilities and allow them to explain their decisions"* so the designer can gather more information.

E2, E3 and E4 pointed out that this tool could allow children to be engaged, in part due to the *"visuals, characters, rewards, and activities"*. E4 also praised the fact that having each location focused on a specific task would *"help maintain the children's focus on what they are doing by limiting their options"*. According to E4, this is a huge benefit for designers as it can ensure *"the children do what you are expecting them to do"*. Likewise, E2 mentioned that designers would be able to save time and gather ideas from a larger group of children by using this tool.

Further improvements: Although the experts were generally appreciative of the high-fidelity prototype of the tool, they also had many suggestions for improvement. Some of these were implemented before the evaluations with children. However, some of them were left as future work due to the time limitations of the research project.

All experts pointed out that it was important to show the children the work they had done in the tool. E3 said *"it would be really rewarding to show the child how much they have achieved after completing the tasks"*. She suggested that this could be an additional location within the "Game Town" map. E4 suggested that the tool should allow children to save their drawings to their own computers. E3 also noted that the sorted items in the "Rewards House" did not stay in place after saving. Hence, she suggested that the bins should be replaced with boxes, where children can see the items they have sorted and are able to change them. She also suggested adding names to the rewards. These changes were implemented before the evaluation with children, as shown in Figure 6.1.



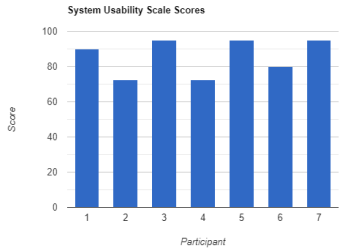
(a) "Rewards House" with boxes. (b) Sorted rewards.

Figure 6.1: Modified "Rewards House".

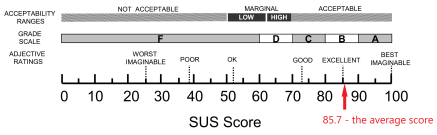
E5 made further suggestions about how to improve the tool in the future, mentioning that it would be very beneficial to include *"a room where you can talk to other children brainstorming for the game"*, allowing them to collaborate.

SUS questionnaire: The results are calculated individually for each participant, following the formula in Appendix L.2. The graph in Figure 6.2a shows the score for each participant, with an average of 85.71. According to the 7-point adjective rating

scale developed by Bangor et al. [7], this score would fall into the "Excellent" category, suggesting that the tool was perceived as usable by participants (Figure 6.2b).



(a) SUS score per participant.



(b) SUS adjective scale from Bangor et al. with score pointed out in red.

Figure 6.2: SUS Results.

6.2 Evaluation with Children

To evaluate the high-fidelity prototype, a workshop with four typically developing (TD) children was conducted. Due to the burdens children with autism can experience by being involved in these sessions [29], the TD children served as proxies for children with ASC.

6.2.1 Aims

The aims were to determine:

1. The likes and dislikes of the tool.
2. Whether the navigation in the tool is intuitive for the target users.
3. If the tool is engaging for children.
4. Whether the tool is effective at enabling children to brainstorm ideas for a new game.
5. How children would improve the tool.

6.2.2 Participants

For this evaluation, four TD children were recruited. Two of these children, P1 and P2, had already participated in the initial design workshops presented in Chapter 3. The other two participants were recruited via the School of Informatics. Involving both children who had previously participated in the project and those who had not been involved allowed the researcher to investigate whether the results differed due to the sense of ownership P1 and P2 may have felt. The details about the participants are displayed in Table 6.2.

Participant	Age	Gender
P1	8	Female
P2	11	Male
P3	10	Male
P4	13	Female

Table 6.2: Participants in the high-fidelity prototype evaluation.

6.2.3 Procedure

As in the previous evaluations, the sessions took place using Microsoft Teams and were recorded and transcribed. Prior to the workshop, the parents were sent the information sheets and consent forms for both parents and children to sign before the studies took place (modified versions of the forms presented in Appendices B, C.1, and C.2). Sessions lasted between 20-30 minutes each.

The studies began with an icebreaker asking the children if they had ever designed their own games, with the goal of ensuring that the children felt comfortable with the researcher as well as with the theme of the workshop. Then, the children received an overview of the goal of the tool. The researcher explained that the children would have to perform some tasks using the tool to brainstorm for a game about climate change.

The workshops consisted of a task-based evaluation (Appendix M.1). The children were sent a link to the tool hosted on Itch.io [3] and were asked to share their screen, enabling the researcher to analyse the child's interaction with the tool. The children were encouraged to explore the tool outside of the tasks by asking questions and talking about their observations. This helped the researcher gather valuable information about the usability and the children's perception of the tool. After the children finished interacting with the tool, the researcher asked some follow-up questions which can be found in Appendix M.2. These questions were focused on gathering feedback on the children's favourite and least favourite tasks, how easy and intuitive they found the tool, and what they would change in the tool. Finally, the children were asked whether they would prefer this tool over traditional methods, such as using worksheets, and if they had any suggestions. At the end of the workshops, the children were thanked for their participation and were given a certificate for their contribution (Appendix E.2).

6.2.4 Data Collection and Analysis

The data from the recordings were transcribed and combined with the observations noted by the researcher throughout the workshop. The files were then analysed using Open Coding [35] to extract the most essential information. These codes were then grouped into themes using Thematic Analysis [16].

6.2.5 Results

Based on the thematic analysis, the following themes emerged: usability, favourite tasks and features, engagement, ability to generate ideas, and suggestions on improvement.

Usability: Throughout the workshops, the children made many comments on the ease of use and the instructions within the tool. All participants rated the ease of use a 5/5. P1 expressed how it was easy to see where to go next due to the buttons unlocking on the map. P3 mentioned that the instructions were very clear and that he *"would not need help to understand them"*. He said that it would be good to more options in the "Game Factory", such as *"drawing the background, drawing the menu screen, or drawing the end screen"* to make the task more specific. The researcher noted some usability issues as the children interacted with the tool. For instance, the functionality of the "Clear Screen" button in the drawing tasks was not clear to any of the children. In fact, when P3 wanted to erase the screen, he used the eraser until the researcher told him about the button. This indicates that the the top-right corner may not be a good location. Similarly, the children did not use the button "Go to Activity" in the instructions.

Favourite tasks and features: P1 and P4 both preferred the drawing activities. In fact, P1 suggested that there should also be an option to draw in other locations. She said it would be useful to *"draw your own rewards instead of only writing about them in Sticky Notes"*. When asked if she would remove the Sticky Notes in exchange for drawing, she said that she would have both options, as she also enjoyed writing down her ideas. She said the "Rewards House" was also one of her favourites because she enjoyed sorting the rewards. P2 and P4 answered that their favourite was "You Decide", both pointing out the animations in the task. Some children struggled to choose a favourite, and P2 said: *"I do not particularly have a favourite, I actually liked it all"*. Overall, there was a tendency to favor the interactive locations ("Character House", "You Decide", and "Rewards House") over the ones with direct questions ("Home" and "Game Gallery"). All participants said that they enjoyed the puzzle as a reward system.

Engagement: All children rated the tool 5/5 in terms of engagement. When asked whether they would prefer to use this tool to brainstorm for new games or to use a worksheet, they all chose the tool. P1 mentioned that this was because she *"liked to use technology and be able to draw with many colours"*. P4, who had participated previously in participatory design sessions in person, said that the tool made it easier *"to rub things out, restart everything, and have options such as colouring the templates"*. P2 said that interactive activities such as "You Decide" and the "Rewards House" were very fun and would be *"very engaging for children."* After interacting with the tool, P3 said *"I love it, it's so good!"* and P4 said *"it's really cool, I really like it."*

Ability to generate ideas: One of the aims of the study was to investigate whether the tool could help elicit ideas from children for the creation of a new game. It was found that the children were able to generate both relevant and divergent ideas. In terms of relevance, all children were able to use the tool to brainstorm about a new game about climate change, for instance through drawing characters such as a bonfire. Likewise, the children were able to generate divergent ideas. For example, some children focused on drawing realistic characters such as a humans and a sun, while others drew things that can be found in nature such as volcanoes and fire (Appendix N). Similarly, the children expressed different kind of ideas for rewards using Sticky Notes, from money that can be used in the game to different *"elements to save the planet"*. This implies that the tool can help designers gather a broad range of ideas for designing a new game.

Suggestions for improvement: The children all agreed that the tasks that involve drawing should have more options, including additional colours and shapes. P1 and P3 both expressed that *"there was no brown"*, hence drawing trees was difficult. P3 and P4 said it would be easier if there was an option to fill in the background with a colour automatically. As expressed by E3 in the expert evaluation, P3 and P4 both mentioned that they would have liked the option to select both alternatives in "You Decide", as they often did not have a preference. In addition, P1 said that she would have liked to have more customisation within the tool by *"being able to design your own avatar to go with Charlie to the locations"*. P3 also mentioned that it would be good if the "Game Town" map was related to the theme of the game, as *"the name 'Game Factory' does not make much sense if I am designing a game about climate change"*.

Some children struggled to understand the purpose of the "Game Factory". P2 attempted to click on one of the comic strips rather than draw on them. P3 also struggled to understand what he had to do, asking whether he had to draw the background of the game or something else. When the researcher explained the goal of this task, the children were able to complete it successfully, which may imply that the instructions in this location are not clear enough.

6.3 Discussion

Two different studies were organised to evaluate the high-fidelity prototype. The first was an evaluation with experts, where the aim was to answer **RQ2.1**, **RQ2.4**, and discover any usability issues. Generally, the experts found the tool intuitive, rating it 4.8/5 in this aspect. The SUS questionnaire resulted in the tool receiving an "Excellent" score. The tool was also praised for its engagement, and all participants believed that the tool would help keep children focused during PD sessions. Moreover, the experts perceived the tool as appropriate for its target users. The evaluations also revealed that the instructions in the "Game Factory" were not clear. The second evaluation, a study with children, aimed to answer **RQ2.2** and **RQ2.3**, as well as to uncover any usability issues. The children rated the tool 5/5 in terms of engagement, with all of them expressing that they preferred the tool over traditional PD workshops where they would normally complete a worksheet. Likewise, the children also enjoyed the rewards system.

The participants were generally positive about the tool, and provided valuable suggestions for the future, focusing on the designer interface and showcasing the children's work. A key observation was that there was no noticeable difference in the perceptions of the tool between the participants who had already been involved in the project and those who were new, both for the experts and for the children. This, alongside the results described above, suggests that the tool has potential to support both children with ASC and designers during the brainstorming stage of (D)PD.

Chapter 7

Conclusion

The goal of this project was to investigate how a technology-based tool could be designed to support designers and children with autism in the brainstorming stage of (Distributed) Participatory Design ((D)PD). To achieve this, two main research questions were established. This chapter will answer these research questions, explain the limitations of the project, and present directions for future work.

7.1 Research Questions

RQ1: How can a technology-based tool be designed to empower children to participate in and support designers during (Distributed) Participatory Design?

This question was answered through the findings of the literature review in Chapter 2 and the results of the workshop to inform the design with 4 typically developing (TD) children reported in Chapter 3. First, through analysing and comparing existing methods and techniques for participatory design with children, the researcher identified the gaps in the existing strategies. This allowed the researcher to focus on developing a tool to facilitate the brainstorming stage of (D)PD. Then, the researcher conducted a study to gather ideas from TD children for how to best design the tool. The results from this study, as well as the Human-Computer Interaction (HCI), ASC, and Serious Games design guidelines, resulted in a set of requirements for the tool. From these requirements, a low-fidelity prototype was developed and evaluated with a child, experts, and the parent of a child with autism (Chapter 4). The feedback from the studies resulted in a revised set of requirements, which were used to develop a high-fidelity prototype.

RQ2: To what extent does this new technology support children with ASC and designers in (Distributed) Participatory Design?

This question was answered through the evaluation of the high-fidelity prototype with five experts in the fields of HCI, ASC, and Education and four typically developing children. This question was divided into three sub-questions:

RQ2.1: To what extent is the new tool suitable for the target population?

From the evaluation with experts, it was found that the tool was perceived as appropriate

for the target users. The experts rated the tool 4.8/5 with respect to ease of use, remarking the structured nature of the tool, the use of visuals, and the predictability of the tasks. The children rated the ease of use with a 5/5, pointing out the natural progression through the tool and the clarity of the instructions. Hence, this shows that the tool was perceived as suitable for the target population.

RQ2.2: To what extent is the tool perceived as fun and engaging for the target population?

In the evaluation with experts, all participants agreed that the tool could drive engagement for children with ASC. They highlighted the use of a puzzle, the visuals in the tool and the story line as particular features that made the tool engaging. The children rated the tool 5/5 in terms of engagement. Likewise, the experts also perceived the tool as fun and engaging for the target users.

RQ2.3: To what extent does the tool elicit ideas from children to brainstorm about new educational games in comparison to traditional methods of participatory design?

From the expert evaluations, it was found that the tool could help children stay motivated in comparison to traditional methods. The participants praised the use of technology for participatory design, highlighting the rewards and gamification to distinguish the tool from traditional methods of (D)PD. In addition, some experts mentioned that it would be beneficial to use this tool along with a practitioner to elicit ideas from children. All children agreed that they would prefer to use this tool over designing on paper, mentioning that they liked using technology, with the benefits of colouring on a device, and the interactive activities. These findings suggest that the tool can help to gather ideas from children when brainstorming.

RQ2.4: To what extent does the tool support designers to gather ideas for new educational games?

The final question was answered through the evaluation with experts. The perception of the experts was that using this tool would support designers in gathering ideas during (D)PD because the tool would help keep children more engaged. They mentioned that this was because of the structure and interactive aspects of the tool. They also remarked that the tool would allow designers to save time by not having to be there physically. It would also help them gather more ideas from children, since the tool ensures that children are focused on one task at a time. These results demonstrate that the tool has a variety of potential benefits for designers.

7.2 Limitations and Future Work

Due to the limited time available to carry out this research project, a number of limitations arose. First, the focus of the tool was on the user interface. Consequently, the designer interface was not implemented. However, a lot of ideas and suggestions were identified through the evaluation for future work. Second, due to the ongoing COVID-19 pandemic, the evaluations had to be carried out remotely. This resulted in various limitations, such as having to develop the tool for a website rather than an iPad.

In addition, the evaluation participants were typically developing children who acted as proxies for children with ASC, due to the challenges in recruiting children with autism. Finally, another limitation is the lack of a longitudinal study to evaluate the tool over a longer period of time with different design projects and involving more children. In spite of these limitations, the tool was shown to be suitable in supporting both designers and children with ASC in the brainstorming stage of (D)PD.

The results from the research studies, including the evaluation, enabled the researcher to identify future directions the tool could take. One theme identified in the expert evaluation was the interaction of the children with the character that guides them through the tool. Several experts mentioned that the character should be able to read the instructions for each task out loud to the children. Thus, it would be useful to add voice-over in the tool. Another important suggestion from the evaluations was to highlight the work of the children. In the future, this could be done by either allowing the child to save their work to their own device or by creating an additional location in "Game Town" where they can store all of the features they have designed for each game. Finally, another key area identified for future work is the creation of a designer interface. Multiple experts suggested that the tool should be customisable for the theme of the game that the children are designing. This interface would enable developers to modify the content in each location in "Game Town" according to their own requirements.

While these were considered the most important features for future work, other potential areas for development include: evaluating the tool with children with ASC, involving more stakeholders in the evaluation, testing the benefits of using the tool across more design projects, allowing children to take photos and upload their own templates, adding more animations and sounds, randomising the puzzle from a variety of options, allowing children to justify their decisions at each location through voice-recording or writing, adding more customisation for the child's "Game Town" profile, and expanding the tool to be multiplayer, where children can collaborate on different tasks.

7.3 Conclusion

This project investigated how a technology-based tool could be developed to support designers and children with autism during (Distributed) Participatory Design ((D)PD). This project began by identifying the existing interventions for (D)PD and the requirements for the tool. An initial prototype was designed and evaluated based on these findings. Then, the tool was implemented as a web application and evaluated with four typically developing (TD) children and five experts in Human-Computer Interaction (HCI), ASC, and Education. These evaluations showed that the tool is engaging, usable and can assist children with ASC to express their ideas in the design process. The contributions of the research project is threefold: 1. Identification of the need for a technological tool to support children with ASC during the brainstorming stage of (D)PD. 2. Design and implementation of such a tool based on the literature review and workshops with children. 3. Evidence from the evaluation with children and experts which revealed that the tool has the potential to support both children with autism and designers in the brainstorming stage of (Distributed) Participatory Design, hence setting the base for future developments in the field.

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Appendix A

Informatics Ethics Form

We thank you for your time spent taking this survey.
Your response has been recorded.

Below is a summary of your responses Download PDF

Informatics Ethics Application Form

Please note that you can only work on one application at a time.

The "Save and Continue" option uses cookies to store the current progress of your application, so in order to return to a form, you must be using the same browser.

In addition, you cannot go back and correct mistakes you made in earlier parts of the form after the survey has branched. If you do notice a mistake in your form, just email ethics-query@inf.ed.ac.uk with your reference number 2021/42480 and we will assess your application based on the correction.

All of these shortcomings will be addressed in a new, University wide system for filing Ethics applications. Until this system is in place, this is the preferred form.

Project Title

Toward a Technology to Supports Users and Designers during (Distributed) Participatory Design

Principal Investigator Name and Affiliation (for students/visiting researchers: this is your supervisor)

Dr. Aurora Constantin

Principal Investigator email

Aurora.Constantin@ed.ac.uk

Additional non-student investigators

N/A

Email of additional non-student investigators (separate emails by commas)

N/A

Project Type (tick all that apply).

- [x] **Undergraduate/MInf final year project**
- [ ] MSc final year project
- [ ] Study conducted as part of a PhD
- [ ] Study conducted as part of research visit / internship
- [ ] Grant-funded research
- [ ] Unfunded research
- [ ] Research Grant
- [ ] Other

Students involved (list names AND student IDs, using their official Edinburgh student ID, e.g. Abel Student s1234567. Separate multiple students with commas).

Alejandra Amaro Patiño s1863962, Ioana Buzduga s1751102

Is there a sponsor or a funding body?

- (●) **No**
- ( ) Yes, their name(s) is / are:

What is the relevant code of conduct for your research?

- (●) Informatics Ethics Code of Conduct
- ( ) Other

Are other institutions or Ethics Committees involved?

- (●) **No**
- ( ) Yes, their name(s) is/are:

Level 0 Check

These questions help determine whether you need to submit a full Level 1 or Level 2 Ethics application, and whether the School of Informatics is the appropriate institution for granting permission.

We cannot process studies that involve collecting data from live animals (the only exception being Homo sapiens sapiens), but members of the wider Ethics Panel can help you with applying for such approval from appropriate sources.

Does your work involve human participants?

- (●) **Yes**
- ( ) No

Does your work involve animals?

- ( ) Yes, and we will collect new data from animals
- ( ) Yes, but only secondary data
- (●) **No**

Does your work involve military applications?

- ◯ Yes
- ◉ **No**

Does your work involve confidential or personal data? This includes, for example, information about physical and mental health, race, ethnicity, political opinions, religious beliefs, trade union membership, sexual orientation, genetic data, biometric data.

- ◯ Yes
- ◉ **No**

Does your work involve developing countries? (List: PDF of ODA recipients Note that India also counts as a developing country).

- ◯ Yes
- ◉ **No**

Does your research concern terrorist or extremist groups, or groups that are regarded as terrorist or extremist in the countries where they operate?

- ◯ Yes
- ◉ **No**

Will you need to use tools or services that do not comply with General Data Protection Regulations (GDPR) 2018 to collect data from human participants or to collect secondary data (e.g., from Social Media)?

- ◯ Yes
- ◉ **No**

You need Level 1 or Level 2 Ethical Approval.

Make sure that you prepare a study plan, a participant information sheet, a plan for collecting consent, and a plan for managing the data collected

a plan for collecting consent, and a plan for managing the data collected in your study before you work through the rest of the questionnaire. Templates for all of these can be accessed from the Informatics Ethics webpage.

If you don't have these ready, we recommend that you save the form at this point and return to it once you've prepared the information.

About Your Research

Much of the work in Informatics is iterative. This can mean different versions of studies that follow the same pattern, a set of experiments that are part of a bigger study, or the iterative development of a product.

We encourage you, if you can, to submit an Ethics Application that covers all of your work, and phrase your Participant Information Sheet and Consent Forms accordingly. It is also possible to submit multiple information sheets and consent forms at the same time.

Example 1: Student Kim Doe makes a spaced repetition app. They want to test several versions of the app with participants. Kim should write a generic participant information sheet that covers several iterations, and submit it - this will cover the entire project.

Example 2: Dr Sandy Doe wants to run a perception experiment, but first needs to collect and validate stimuli. If Sandy provides sufficient documentation for the validation step and for the actual experiment, both can be approved in one go.

Please provide a brief summary of the goal and methods of your research. You should cover the following:

- What is the goal of the study?
- If you have human participants, what will you ask them to do?
- If you perform data analyses, what methods will you use?
- To what extent will the design of later parts of your study be affected by the findings of earlier parts?

It's enough to give high level descriptions of tasks and analysis methods. It helps if you can provide references.

Recommended length: 100 words. Required length: at least 200 characters

The purpose of this study is to gather ideas from typically developing children about the best ways to involve them in the design process (share their ideas for developing games). This will help the researched design and evaluate a tool to support children with ASC and designers in (distributed) participatory design. We will gather these ideas by running workshops, where the children will take part in online activities using pen and paper and Miro such as: drawing, completing worksheets, creating and participating in games, mindfulness exercises. We will be using an online environment (eg: Zoom) for audio and video communication. The proposed ideas will then be presented to experts in semi-structured interviews for evaluation.

Are you using secondary data (e.g., social media data, corpora, data sets from repositories, ...)

- ○ Yes
- ◉ **No**

Are you working with partners that are not from the School of Informatics? Tick all that apply.

- ☑ **No**
- ☐ Yes, academic partners
- ☐ Yes, non-academic partners

Who will directly benefit from your research?

Direct benefits include compensation for participation that is used to advertise the study, e.g., money, chance to win an Amazon voucher, or free pizza.

Think about academic partners, non-academic partners, participants, participants' local communities, and other potential beneficiaries (recommended length: 50 words)

The main parties that will benefit from this research are academic partners and future UG4/Minf/Master's students in this research area.

UG4/MInf/Master's students in this research area.

Permissions for research outside of the UK (tick all that apply)

- [x] **All research will take place within the UK. This also covers crowdsourced work where all the participants are from the UK / resident in the UK.**
- [ ] Some research will take place in other countries, and we will obtain in-country Ethical Approval before starting the work there.
- [ ] Some research will take place in other countries where it is not possible to obtain in-country Ethical Approval. This covers crowdsourced research where not all participants are from the UK.

Working with Human Participants

This section applies to you if your research involves working with people or actively observing people (e.g., ethnography).

Note that you need consent so that you can collect data ethically form participants. However, consent is no longer the legal basis for processing data - this is Article 6(1)(e), the public task of the University.

Consent can be withdrawn - the University's public task remains.

Are all participants aged 18 and over?

- ○ Yes
- ◉ **No, but we will seek consent from both children and parents/guardians for those who are under age**
- ○ No, and we will not seek consent from parents/guardians

Will you recruit participants through organisations that require specific permissions, such as schools or the NHS (both patients and NHS employees)?

- ○ Yes, and we have already secured permission
- ○ Yes, but we still need to secure permission and approval
- ◉ **No**

- (●) **No**

How do you ensure confidentiality? Describe your procedures for anonymisation / pseudonymisation, ensuring differential privacy, and other relevant procedures. Recommended length: 50 words.

We ensure all identifying information will be pseudonymised on all workshop materials, audio transcripts and written reports. All data will be stored on a password-protected encrypted computer, on the School of Informatics' secure file servers.

How do you obtain informed consent? This also involves telling your participants about your obligations under the General Data Protection Regulation Act (GDPR, 2018). Tick all that apply.

- [ ] Participants will complete a paper consent form
- [x] **Participants will consent using an electronic form**
- [x] **Participants will provide verbal consent. Please explain why this is necessary and sufficient.**

Parents will receive an electronic consent form for the children. The kids will have the consent form explained to them verbally, where they will be able to verbally agree to take part, and also write in the chat.

- [ ] No need for informed consent; we will observe people as part of an ethnographic study
- [ ] Other, please explain

Will you deceive participants as part of your research? (e.g., Wizard of Oz Study)

- (●) **No**
- ( ) Yes, and they will be debriefed at the end of the study (please say how)
- ( ) Yes, and they will not be debriefed at the end of the study (please explain why)

Is there clear potential for significant psychological harm or stress for

anyone who is involved in the research (including the researchers themselves?)

- ○ Yes
- ◉ **No**

Is there clear potential for significant physical harm or discomfort for anyone who is involved in the research (including the researchers themselves)?

- ○ Yes
- ◉ **No**

Is there clear potential that you will violate the social or cultural norms or practices of anyone who is involved in the research (including the researchers themselves)?

- ○ Yes
- ◉ **No**

Is there clear potential for negative consequences, conflict, or other discomfort for those people on whom your research will impact?

- ○ Yes
- ◉ **No**

Do you have a moral responsibility to provide feedback or results to research participants? (Examples: administering validated diagnostic tests)

- ◉ **No**
- ○ Yes, but none of the research team is professionally qualified to interpret the results and communicate them to participants.
- ○ Yes, and a member of the research team is professionally qualified to interpret the results and communicate them to participants.

Will you disseminate your findings to the study participants?

- (●) **Yes -- We will directly disseminate to participants or organisations**
- ( ) Yes -- Publications resulting from our work will be made available via Pure or other public website
- ( ) No -- Findings will be in a project report which may not be published
- ( ) No (explain why)

Data Protection Impact Assessment

This assessment is required for all studies that involve data. Before you answer these questions, make sure that you have a data management plan that minimises transfer of data outside of the UK, EU, and EEA, and that you have completed basic training in data protection that is available via LEARN (go to the Self-Enrol tab and search the page for "dp training research" - alternatively, check out the University's Data Protection Training web page.) .

The questions are based on the standard University Template. They will be difficult to interpret unless you have done the training - the wording is a compromise between being understandable and fitting in with the legal requirements.

As a reminder:

- The legal basis for all academic research using personal data is Article 6(1)(e) - the public task of the University.
- The legal basis for using special categories of personal data is Article 9(2)(j) - that processing is necessary for research purposes.

If you collect or use NHS data, please refer to the ACCORD website for further information. You are highly likely to need special permissions (e.g., Caldicott Guardian approval).

Research data can be stored indefinitely as long as it is stored securely - more information can be found at the Research Data Service website.

Please give the reasons why your research is in the public interest. Tick all that apply.

- [x] **Public interest will be confirmed by the School of Informatics Ethics Panel**
- [ ] Research Ethics Committee approval (not involving School of Informatics Ethics Panel)
- [ ] Confidentiality Advisory Group (CAG) recommendation for support in England and Wales
- [ ] Favourable opinion from Public Benefit and Privacy Panel for Health and Social Care in Scotland
- [ ] Other, please explain

We confirm that all researchers from the University of Edinburgh have completed the mandatory data protection training on LEARN. If you are not sure what the training is or what it involves, the link will take you to the University web page that explains what is involved.

- (●) **Yes**
- ( ) No

How have you trained all researchers who have access to the data on their responsibilities for safe data handling and storage? Listing training programmes and certificates is enough.

All participating researchers have completed the data protection training on LEARN and have taken a course on the subject. All researchers are aware that information must be securely stored on University handled services and will ensure anonymisation.

Will you collect or use NHS data?

- (●) **No**
- ( ) Yes, it is an audit that only requires minimal approvals.
- ( ) Yes, and I have all necessary approvals.
- ( ) Yes, but I do not yet have all necessary approvals

What information about participants or data subjects will you collect or use?

We will know the ages and genders of all participants for the purposes of reporting in our dissertations. We will collect the audio, audio transcript and video recording of the workshop which will be conducted using an online environment such as Zoom. We will also be collecting all completed workshop materials for analysis.

How will you store data securely?

All data will be stored on a password-protected encrypted computer and on the School of Informatics' secure file servers. Moreover, the anonymity of the participants is assured. All participants will be given a pseudonym such as 'Participant 1', 'Participant 2' etc.

Risk of participant identification

Please identify and list all risks to the privacy of research participants, consider how likely it is that these risks will manifest, and what the harm to participants could be when the risks do manifest. Consult with your collaborators if necessary. The statements below represent possible causes. If you are not sure about what those risks are, start your research by consulting the University's materials on handling sensitive data.

	Likelihood of Risk			Severity of Harm		
	Remote	Possible	Probable	Minimal	Significant	Severe
Data linkage	◉	○	○	◉	○	○
Low participant numbers	○	◉	○	◉	○	○
Geographical location	◉	○	○	◉	○	○
Transfer of data	◉	○	○	◉	○	○
Access of data	◉	○	○	◉	○	○
Other (please explain)	○	○	○	○	○	○

You are nearly done, make sure to click next below!

Your reference number is **2021/42480**. Please mention this in any correspondence with infkm+ethics@inf.ed.ac.uk. We will do our best to

send you feedback within ten working days. Please do not start data collection or analysis before we have confirmed successful self-certification. Your response has been recorded by the Qualtrics system and in the Ethics Panel RT system.

Here is a list of the documents you have to send to ethics-query@inf.ed.ac.uk, Header: "Supporting documents for application 2019/42480". Tick them off to tell us that you have prepared them. Even if no supporting documents are listed on this page, we still strongly encourage you to send us your data management plan. Templates for participant information sheets and consent forms can be found on the Informatics Ethics webpage.

- [x] **Participant Information Sheet / Consent Form**

Any other ethics-related issues or aspects you would like to state? (Optional)

Please contact the Ethics Panel at inf-ethics@inf.ed.ac.uk with any further questions.

Appendix B

Children Information Sheet and Consent Form

Designing and Testing Games to Help Children

(to be read aloud to the child)

This page is for children. We will ask you to help design and test new computer games, take part in different activities, and answer a few questions. You can decide if you want to say “yes” or “no” to helping and can change your mind at any time.

Who is organising the event? This is Aurora, Alejandra, and Ioana. They want to make computer games and tools that can help children. You can help them by providing ideas for new computer games and tools, taking part in different activities, helping to test them, and answering some questions.

		
Aurora	Alejandra	Ioana

How can I help?

Some children with autism can find that lots of different things can make them worried. Sometimes they find it hard to understand and manage what they are feeling. We would like to design some fun games to help these children express their ideas, and we would like you to help us! We would like to hear your ideas for ways to make some of these situations less scary and we would like you to help us to make our games fun.

What will happen if I help?

You will get to take part in game design and testing workshops and participate in other activities. You will get to talk with other children about your ideas, and we might ask you to do some drawings to show us your designs.

You can tell Aurora or one of the researchers if you want to stop doing any of the activities. You do not have to tell them why. Please tell them if you want to take a break. You can also say you do not want to be a game developer or tester anymore, and that is OK.

The researchers will ask if it is OK to make a video recording of you helping design the game and answering questions. This is because it is too hard for them to write down everything that happens. They will listen to and look at the recordings later to help them understand what you thought about the game.

What will happen after I am finished helping?

The things you make, do, and say in the game testing workshops will help them. They will write about what they have learned and use it to design and evaluate their games.

Your mum or dad said it is OK for you to help us.

Do you want to be a game developer/tester? You can say "yes" or "no". It is OK to say "no". It will not hurt the researchers' feelings.

Do you want to ask a question about being a games developer/tester?

It is OK to have more questions. You can ask the researchers as many questions as you want about being a game developer. Ask your mum or dad to help you call them on the phone or write an email with your question.

Child Consent Form

To be used as a guide for securing consent or refusal after the child has had a chance to get information about the study. The child may mark (or be helped to mark) this form, or the child's consent/refusal may be video recorded.

I can choose to be a game developer.

I do not have to help if I don't want to.

I can decide to stop taking part or take a break if I want to, I do not have to say why.

It is okay if I change my mind later and say I do not want to be a game developer anymore.

It is okay if some parts of the game are hard for me!

There are no wrong answers to questions.

Anything I can do is very helpful.

Do you want to be a game developer? YES NO

Aurora, Alejandra, and Ioana will listen to/watch the recordings later. They will not show them to other people.

Is it okay to take video recordings? YES NO

Write your name:

_____

THANK YOU 😊!!

Appendix C

Parent Information Sheet and Consent Form

C.1 Parent Information Sheet

Designing Educational Games and Tools for Children

Information sheet for parents and guardians

This information sheet is for parents and guardians; it explains the research project at the University of Edinburgh, in which we would like your child to participate. It gives information about the project in the form of questions you might have and their answers. If you have further questions, we are happy to discuss them and give you more information.

This study was certified according to the Informatics Research Ethics Process, RT number 2021/42480. Please take time to read the following information carefully. You should keep this page for your records.

The researchers on this project and their contact details are as follows:

- Alejandra Amaro Patiño: s1863962@ed.ac.uk (Lead Researcher)
- Ioana Buzduga: s1751102@ed.ac.uk (Lead Researcher)
- Dr. Aurora Constantin: aurora.constantin@sms.ed.ac.uk (Research supervisor)

University of Edinburgh, School of Informatics

Please return the parent consent form to one of the researchers if you give permission for your child to participate in the project.

Overview of the project

We are two UG4/MInf students from the University of Edinburgh working on creating tools for children who struggle with communication and social interaction as a part of our Honours projects. We are focusing our research on creating applications to make it easy for children to share their ideas for designing games.

What are the goals of the project and the purpose of the workshops?

Many different circumstances can cause children with autism to struggle to become equal stakeholders in the design process. These include social situations, changes to their routines, and a different way to experience the world. The goal of our project is to design an application to help children who struggle with communication and social interaction participate in the design session. We want to ensure the application can help any child be creative, share their ideas, and make sure it's fun!

The purpose of our tool is to help children to expand their problem-solving, brainstorming and communication skills as well as provide a fun and comfortable environment to make sure they can contribute to the design of educational games proposed by a researcher.

The workshops will guide the children towards identifying the key areas they would like to contribute to when designing, such as rewards or characters, as well as what the tool needs to include to help children generate ideas. This will be useful when designing the tool to target what will make children eager to engage in the brainstorming of what they would like to see in a game.

How can my child help?

The design workshops will comprise a variety of activities that will help to inform the design of our prototype tools and provide potential ideas to enhance the fun and engaging gameplay for these tools.

Workshop Information

What happens during the workshop?

Workshops will take place in small groups (3 – 4 children) using online environments (e.g. Zoom). At least one researcher and one supervisor will be present for all workshops. Your child will get to engage in some game development activities, such as group discussions and drawing designs, and provide feedback and ideas for c. 30 minutes. In order to facilitate these activities, we would request that you provide sheets of blank paper and colouring pencils for your child to use during the session. We may request that any materials created by your child during the session be uploaded for our review after the session. If your child is willing to talk to us about the activities, we will ask them a few questions. They will each participate in X (will edit depending on each workshop structure) workshops, if they are happy to do so.

Video and audio recordings

We would like to video record the session, to provide a record for later analysis and allow us to freely interact with your child during the session without worrying about taking notes. Most of the online environments do not allow for solely audio to be captured, but the video recording will only be used to transcribe the audio from the session, and then will be deleted. The video would be seen only by us during the analysis. If you are not comfortable with your child being video recorded at all, then your child should not participate in this particular study. Although we will only be video recording for the purpose of transcribing the session, we would ask that your camera is switched on throughout the session, so that we can ensure your child is not becoming upset or distracted.

We ask parents to read this information sheet so you can make an informed decision about whether participation as a game designer is a good idea for your child.

If you say "yes" when returning the permission form, we will explain the game designer role to your child and ask them if they want to help. We will remind your child that they can stop being a developer at any time, without having to give any reason, and that we will always listen to them. We will check that the child agrees to be video recorded. This explanation will be based on the child information sheet included in this packet. We feel strongly that children should be given a real choice about whether to participate. Even if you say "yes" on the permission form, your child may still say "no" if s/he does not want to be a game developer. We will respect your child's decision.

If you say "no", we will not contact you again about this study and will not ask your child to be a games designer.

Will this project teach my child new skills?

This project is not a type of therapy or intervention. We will not be teaching children new skills or improving existing skills. The information we learn from this project may be used in future games/smart objects that could help children who struggle with communication and social interaction.

What happens when the project is over?

After the study has finished and we have analysed the information we collected, it will be used to evaluate and further develop the design of the game/smart object and eventually be presented in a final report. This report along with the data and transcripts may be shared or presented in scientific journals or conferences. We never share children's names, schools or other personal information.

How will personal information be protected?

Confidentiality is extremely important to us and all data will be processed in accordance with Data Protection Law. Recordings and other information (such as forms with children's names) will be stored safely on password-protected encrypted computers. Your consent information will be kept separately from your responses in order to minimise risk. Access will be limited to the people involved in the research (listed above). Recordings and other information will be identified only by participant codes or pseudonyms, and will be separated from identifying information (such as name). Your data may be archived for a maximum of 1 year.

Who paid for this research?

This study is part of the undergraduate work for the main researchers (listed above). It is indirectly paid for by the University of Edinburgh and the funding is not attached to a specific project or to any outcomes of that project. Conducting this research brings no financial benefit to the researchers or to the university.

Who can I contact?

If you have any further questions about the study, please contact any of the lead researchers or the research supervisor Dr. Aurora Constantin.
If you wish to make a complaint about the study, please contact inf-ethics@inf.ed.ac.uk. When you contact us, please provide the study title and detail the nature of your complaint.

What are my data protection rights?

The University of Edinburgh is a Data Controller for the information you provide. You have the right to access information held about you. Your right of access can be exercised in accordance Data Protection Law. You also have other rights including rights of correction, erasure and objection. For more details, including the right to lodge a complaint with the Information Commissioner's Office, please visit

www.ico.org.uk. Questions, comments and requests about your personal data can also be sent to the University Data Protection Officer at dpo@ed.ac.uk.

Updated information.

If the research project changes in any way, an updated Participant Information Sheet will be made available on https://web.inf.ed.ac.uk/infweb/research/study-updates.

Alternative formats.

To request this document in an alternative format, such as large print or on coloured paper, please contact any of the lead researchers or the research supervisor.

General information

Once again, this study is completely voluntary, and you and your child are under no obligation to take part. Even if you say yes now, you may withdraw your child from the study at any time and for any reason by contacting us. Your child may also withdraw at any time by saying that s/he does not want to be a game developer any more.

For general information about how we use your data, go to: edin.ac/privacy-research

Thank you for taking the time to read this.

C.2 Parent Consent Form

Parent Consent Form

* Required

* This form will record your name, please fill your name.

1. Have you read the information sheets? *

- ◯ Yes
- ◯ No

2. Have you received enough information about the study? *

- ◯ Yes
- ◯ No

3. Do you understand that participation is completely voluntary and your child can leave the study at any time, without having to give a reason? *

- ◯ Yes
- ◯ No

4. Do you consent for your child to take part in this study? *

- ◯ Yes
- ◯ No

Details

By filling in the sections below, you indicate that you understand and accept the conditions of this study, including video recording. You agree that the researchers may explain this study to your child and invite him or her to take part as a game developer.

5. Full name of participating child *

6. Child's date of birth *

Format: M/d/yyyy

7. Your relationship to the child *

8. Your full name *

9. Email address *

10. Date *

Format: M/d/yyyy

Appendix D

Design Workshop Slides

Game Design Workshop

What are we going to do today?

01 Get to know each other more!

02 Choose our favorite game.

03 Develop a new game!

04 Make our game fun.

Does everyone have pencils and paper?

Let's get to know each other more

Activity 1.1

What is your favorite game or app?

Activity 1.2

My favorite things about the game/app are...

1. _____
2. _____
3. _____

ACTIVITY 1.3

My least favorite things about the game are...

1. _____
2. _____
3. _____

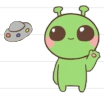
Let's Redesign the Game

"Hi, my name is Al and I am from Mars. It is my first time becoming a game developer, so I need your help to redesign the game you choose. Can you help me?"

ACTIVITY 2.1

Al wants to know what you would you like the game to be about!

Remember that Al is from Mars and he does not get to play many online games there!



ACTIVITY 2.1

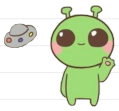
Al wants to know what you would you like the game to be about!

Do you need help?

- It can be about your favorite
- animal
- About your favorite sport
- Favorite class at school

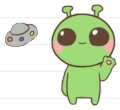
ACTIVITY 2.2

"What characters would you like the game to have?"



ACTIVITY 2.2

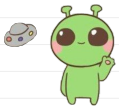
"What characters would you like the game to have?"



I really like when the characters are animals!

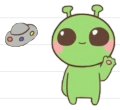
ACTIVITY 2.3

"What activities should the new game include?"



ACTIVITY 2.3

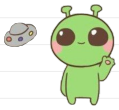
"What activities should the new game include?"



I really like games are like a quiz and I have to choose answers!

ACTIVITY 2.4

What happens if you do well in the game?

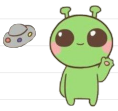


ACTIVITY 2.5

Using all the ideas you came up with before, can you draw what your game would look like?

ACTIVITY 3.1

How can we make it fun?



QUESTIONS

- What activity did you enjoy least?
- What other activities would you enjoy being a part of?

Appendix E

Child Certificates

E.1 Design Workshop Certificate

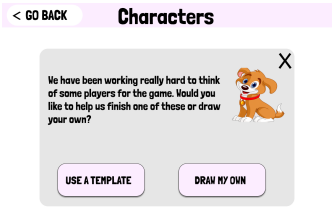
Figure E.1: Certificate for participating in the design workshops.

E.2 Evaluation Workshop Certificate

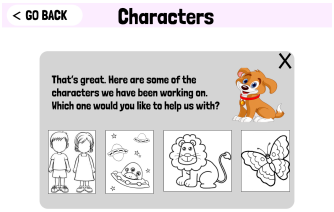
Figure E.2: Certificate for participating in the evaluation workshops.

Appendix F

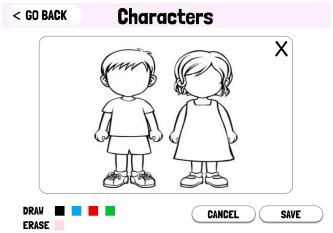
Low-Fidelity Prototype Screenshots



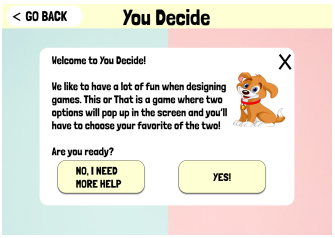
(a) “Character House” Options.



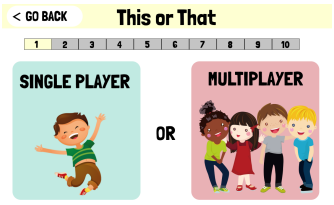
(b) Choosing a template.



(c) Drawing screen with template.

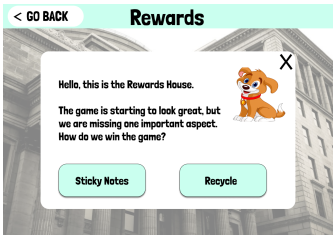


(d) “You Decide” Instructions.

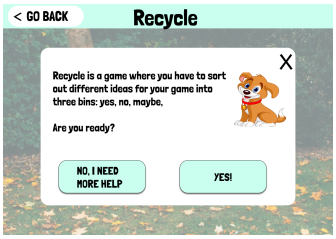


(e) “You Decide” example.

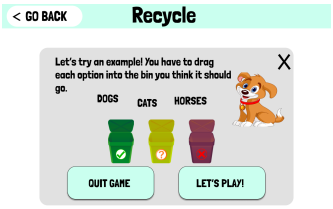
(f) “You Decide” help.



(g) Rewards Instructions.

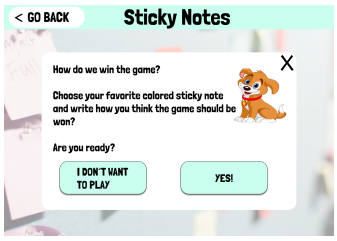


(h) Recycle introduction.

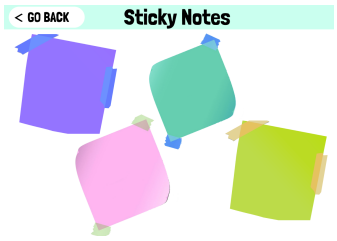


(i) Recycle help.

Figure F.1: Screens of the “Character House”, “You Decide” and “Rewards House”.



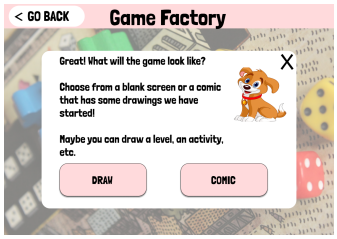
(a) Sticky Notes instructions.



(b) Choosing a sticky note.

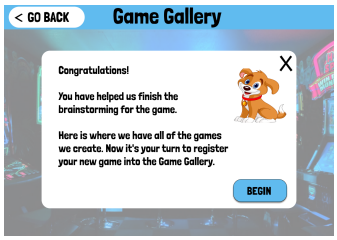
(c) Sticky Note example.

(d) "Game Factory" instructions



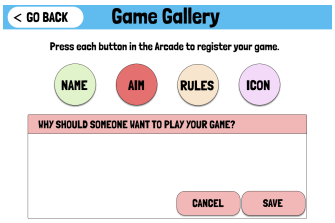
(e) "Game Factory" options.

(f) "Game Factory" drawing.



(g) "Game Gallery" Instructions.

(h) Name of the game.



(i) Aim of the game.

Figure F.2: Screens of the "Rewards House", "Game Factory" and "Game Gallery".

Appendix G

Experts Consent Form - Low-Fidelity Prototype Evaluation

Participant Consent Form

Towards a Technology to Support Users and Designers in (Distributed) Participatory Design

Researchers:

Alejandra Amaro Patiño (s1863962@sms.ed.ac.uk)

Ioana Buzduga (s1751102@sms.ed.ac.uk)

Supervisor:

Dr. Aurora Constantin (Aurora.Constantin@ed.ac.uk)

This interview is to gain insight on developing an online tool to aid both designers and children with ASD in (distributed) participatory design. All data will be anonymised with pseudonyms (such as E1, E2, etc.). The interview will take place on Microsoft Teams or on the phone for your preference. If you consent to being audio recorded, recordings will be stored safely on password-protected computers. You may withdraw from this research study at any time without explanation and you can ask any data you have supplied to that point be withdrawn/destroyed. You can omit or refuse to answer to any question that is asked of you. All data from this study may be archived for a minimum of two years. Please feel free to ask any question related to this study at any time.

I confirm that I have been informed about this project by the researchers and that I have had the opportunity to ask questions, and that any questions I had were answered to my satisfaction.

Please Select: YES / NO

I understand that my participation is voluntary and that I can withdraw at any time without giving a reason. Withdrawing will not affect any of my rights.

Please Select: YES / NO

I consent to my anonymised data being used in academic publications and presentations.

Please Select: YES / NO

I understand that my anonymised data can be stored for a maximum of one year.

Please Select: YES / NO

I agree to take part in this study.

Please Select: YES / NO

I agree to being audio recorded.

Participant's Signature: **Date:**

_____ _____

Appendix H

Children Low-Fidelity Prototype Evaluation Tasks and Questions

H.1 Tasks

1. You are new to "Game Town"! This is so exciting. You get to design your own game (allowing the child to choose the type of game they wish to design). Where would you go first to set up your "Game Town" account?
2. Now that you are helping with creating games, the first thing you have to do is create your own game players. Can you tell me the steps you would take to do this?
3. You will now get to play a game of choosing between two options. Where do you think you can find this game?
4. The next step is to create new rewards to include in your new game. Can you tell me the steps you would follow to do this?
5. In "Game Factory", what do you think we do? Do you like the idea of filling in a template?
6. Now you're done! You get to register your game in the "Game Gallery".

H.2 Likert Scale

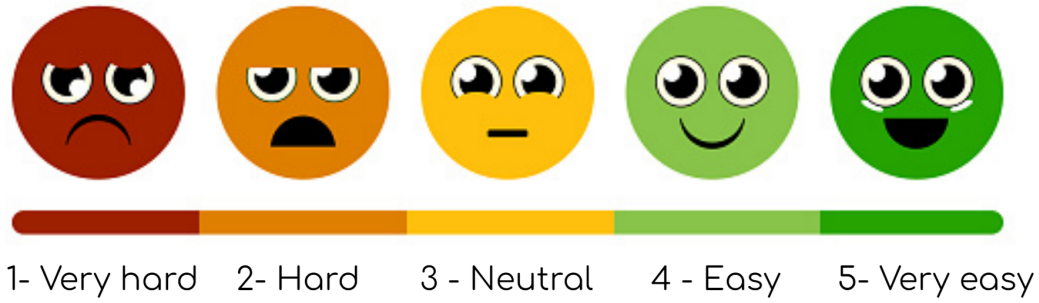


Figure H.1: Likert scale used in the workshop.

H.3 Follow-up Questions

1. Is it clear what you need to do to help the people of “Game Town” create games?
2. What did you like the most?
3. What did you like the least?
4. Is there anything you would like to change?
5. Is there anything you would want me to do to make the experience more fun?
6. Do you like the idea of solving a puzzle as a reward system?

Appendix I

High-Fidelity Prototype Screenshots

Figure I.1: Screens of Charlie's introduction to "GameTown".

Figure I.2: Screenshots of “Home”.

Figure I.3: Screens of "Character House".

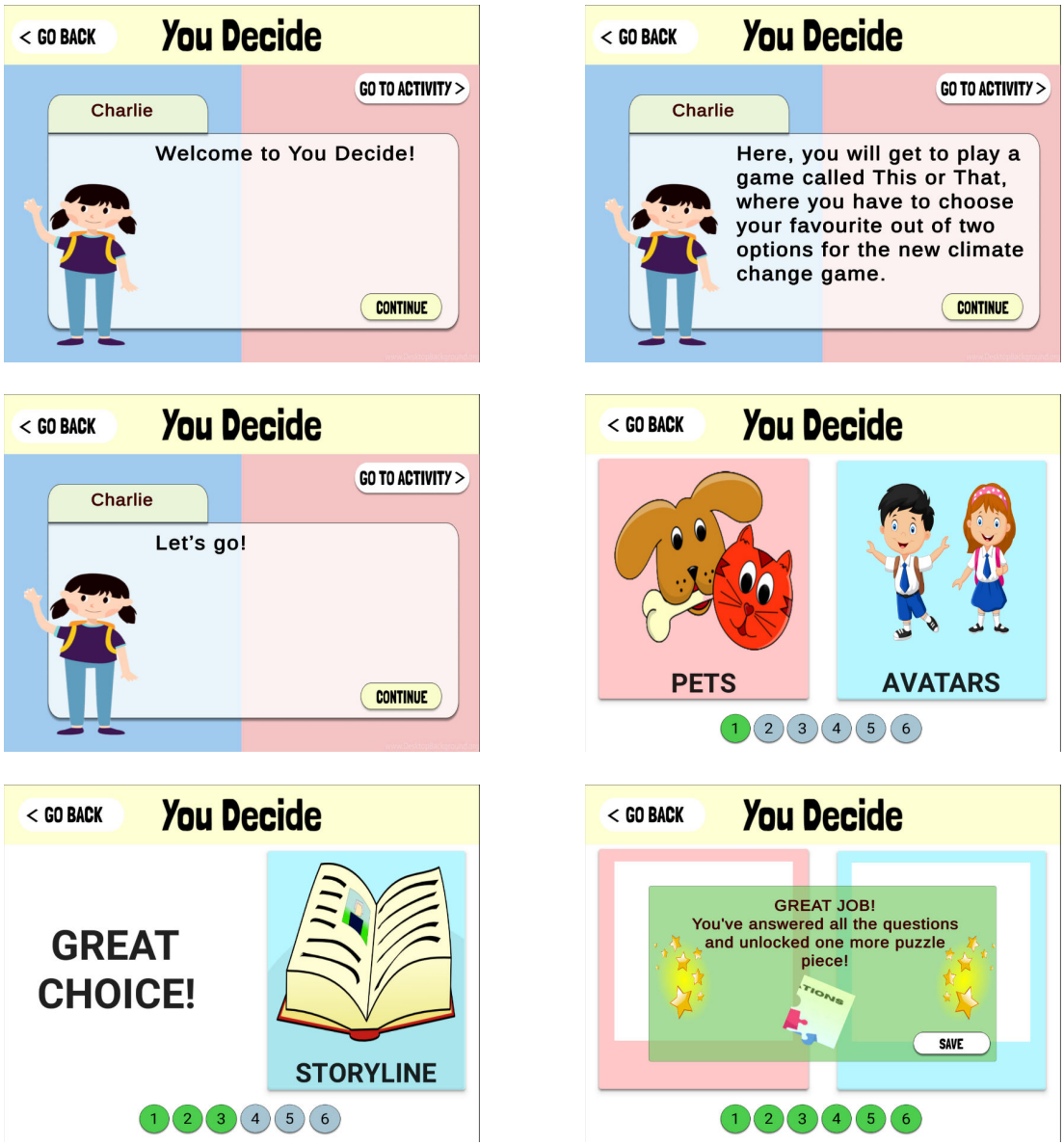


Figure I.4: Screens of "You Decide".

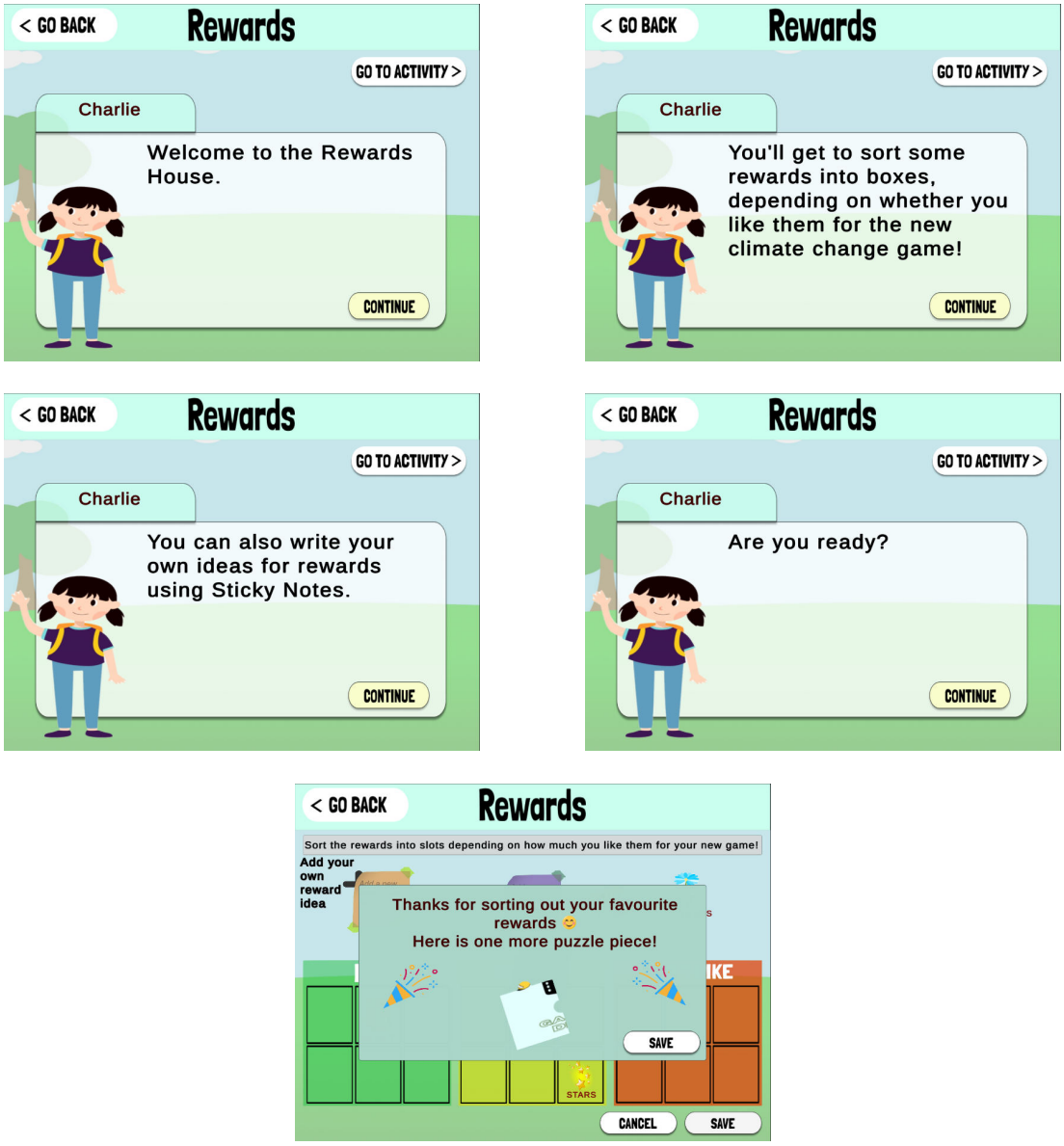


Figure I.5: Screens of “Rewards House”.

Figure I.6: Screens of “Character House”.

Figure I.7: Screens of “Game Factory”, “GameTown” map and “Game Gallery”.

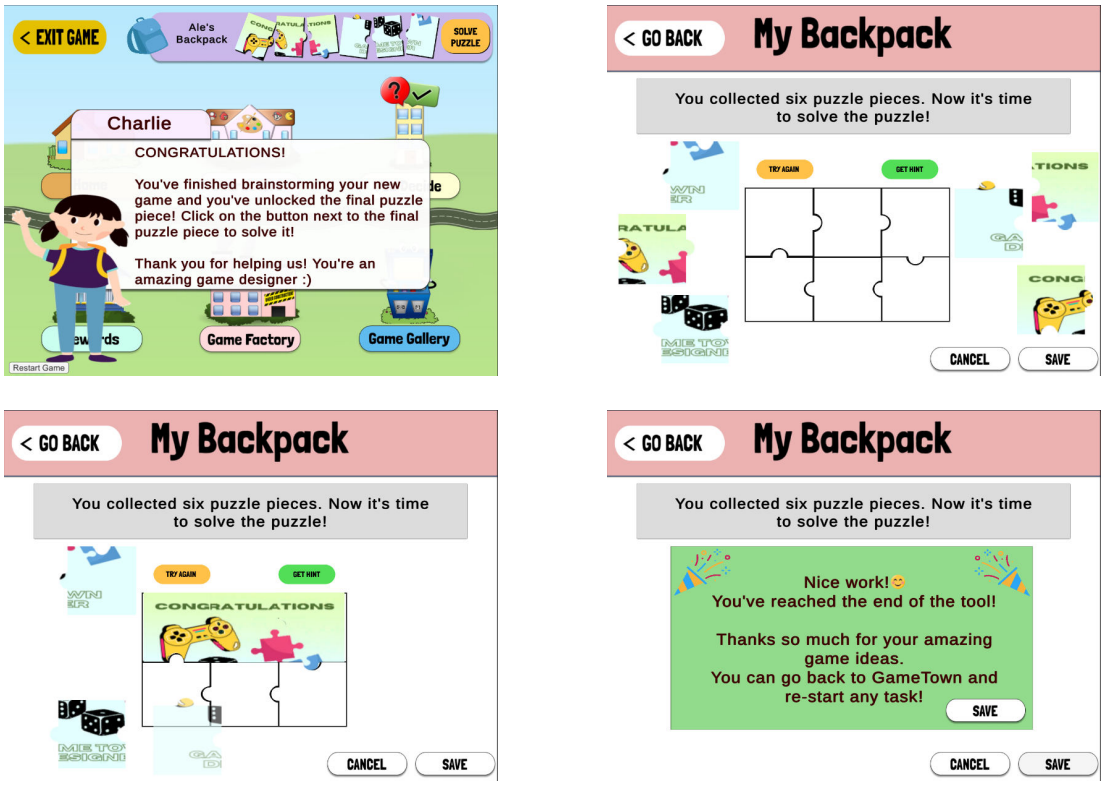


Figure I.8: Screens of the puzzle.

Appendix J

Experts Information Sheet and Consent Form - High-Fidelity Prototype

Participant Consent Form

Towards a Technology to Support Users and Designers in (Distributed) Participatory Design

Researchers:

Alejandra Amaro Patiño (s1863962@sms.ed.ac.uk)

Ioana Buzduga (s1751102@sms.ed.ac.uk)

Supervisor:

Dr. Aurora Constantin (Aurora.Constantin@ed.ac.uk)

Alejandra: I have developed a tool to support both children with autism and designers during the brainstorming step of Participatory Design. The purpose of GameTown is to enable children to express their ideas for new educational games. Rather than writing down their ideas on paper, the aim of my tool is to guide them through brainstorming for different parts of a game (such as what characters to include, the rewards within the game, etc) in a more engaging way. The goal of the evaluation is to measure the general usability of the tool, as well as potential engagement from children, and up to what extent the tool is an improvement from traditional methods of participatory design.

Ioana: The aim of this project is creating a gamified tool in Unity that will support designers in evaluating tools for children with ASD using a storytelling approach. The app will allow the designer to upload their app into the game and customize the evaluation tasks. The app will allow the designer to generate gather all the data just in one platform and generate charts or reports with regards to the evaluation.

The purpose of this study is to evaluate various usability aspects of the tools we have created. All data will be anonymised with pseudonyms (such as E1, E2, etc.). The interview will take place on Microsoft Teams or on the phone for your preference. If you consent to being audio recorded, recordings will be stored safely on password-protected computers. You may withdraw from this research study at any time without explanation and you can ask any data you have supplied to that point be withdrawn/destroyed. You can omit or refuse to answer to any question that is asked of

you. All data from this study may be archived for a minimum of two years. Please feel free to ask any question related to this study at any time.

I confirm that I have been informed about this project by the researchers and that I have had the opportunity to ask questions, and that any questions I had were answered to my satisfaction.

Please Select: YES / NO

I understand that my participation is voluntary and that I can withdraw at any time without giving a reason. Withdrawing will not affect any of my rights.

Please Select: YES / NO

I consent to my anonymised data being used in academic publications and presentations.

Please Select: YES / NO

I understand that my anonymised data can be stored for a maximum of one year.

Please Select: YES / NO

I agree to take part in this study.

Please Select: YES / NO

I agree to being audio recorded.

Participant's Signature: **Date:**

_____ _____

Appendix K

High-Fidelity Prototype Experts Interview

1. Do you believe the application is appropriate for its target users (children with ASC between the ages of 7-12)?
2. From 1 to 5, how easy to use was the tool?
3. In your perception, to what extent would children find this tool intuitive to use?
4. To what extent do you think the tool could drive engagement for children in comparison to traditional methods of participatory design?
5. From 1 to 5, how effective would this tool be to help children with ASC to contribute to the design of new games?
6. From 1 to 5, how effective do you believe the tool would be in allowing designers to gather ideas for new educational games in participatory design?
7. Do you have any suggestions for improvement?

Appendix L

System Usability Scale

L.1 SUS Questionnaire

- I think that I would like to use this system frequently.
- I found the system unnecessarily complex.
- I thought the system was easy to use.
- I think that I would need the support of a technical person to be able to use this system.
- I found the various functions in this system were well integrated
- I thought there was too much inconsistency in this system.
- I would imagine that most people would learn to use this system very quickly.
- I found the system very cumbersome to use.
- I felt very confident using the system.
- I needed to learn a lot of things before I could get going with this system.

L.2 SUS Formula

For each participant:

- Add up score for the odd-numbered questions. Then, subtract 5.
- Add up the score for the even-numbered questions. Then, then subtract that value from 25.
- Add up these values and multiply by 2.5.

Appendix M

High-Fidelity Prototype Evaluation with Children

M.1 Tasks

Introduction: You are new to GameTown! This is so exciting. We are creating a new game about climate change. GameTown is a tool that you can use to help us create new games. There are six different locations, each for a different part of a game. I want you to use GameTown to brainstorm for your new game.

Task 1: Let's start the game! First, you have to set up your "GameTown" ID:

Task 2: Now that you are getting started with your new game, the first thing you have to do is create your own game players.

Task 3: Now, the people who make games have set up a game for you to choose more aspects about the game. It's where "You Decide"! Is it clear what you have to do?

Task 4: You have designed half of the game! It's time to choose what rewards you would like to include in your game.

Task 5: You have unlocked the "Game Factory". Try and complete this level to unlock the last house.

Task 6: Now you're done! You get to register your game in the last location on the map.

M.2 Semi-structured Interview

1. What tasks did you enjoy the most?
2. What tasks did you enjoy the least?
3. From 1 to 5, where 1 is very bad and 5 is very good, how easy/enjoyable/engaging was the tool?

4. Is there something you would like to add to the tool?
5. Is there something you would like to remove from the tool?
6. From 1 to 5, how much more did you like using this tool to think of new game ideas than using worksheets on paper?
7. Do you have any other suggestions for the tool?

Appendix N

Drawings from High-Fidelity Prototype Evaluation

Figure N.1: Drawings from the high-fidelity prototype evaluation.