

**FACULDADE DE ENGENHARIA DA UNIVERSIDADE DO PORTO**



**FEUP**

**Multi-Touch Mobile Devices As Toys:  
Creating and Prototyping a Digital  
Tool for Play**

**Filipa Campos**

Mestrado em Multimédia

Orientador: Doutor Rui Pedro Amaral Rodrigues (Professor Auxiliar Convidado da Faculdade de Engenharia da Universidade do Porto)

Outubro de 2012



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# **Multi-Touch Mobile Devices As Toys: Creating and Prototyping a Digital Tool for Play**

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Mestrado em Multimédia

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## Abstract

Children are, nowadays, a very significant percentage of the users of multi-touch mobile platforms. Although many applications and products target these age groups and try to create a stimulating and didactic environment, they do not grow with them or take into account the physical and developmental needs of their users.

The purpose of this thesis is to analyze the possibilities of approaching the development of kid's games as if they were a child's play platform. Research focuses mainly on interaction with an emphasis on content and mechanics so that children's constraints as users are safeguarded along with their learning needs.

## **Resumo**

As crianças representam uma percentagem significativa dos utilizadores de plataformas móveis interativas. Embora muitas aplicações e produtos se dirijam a elas, tentando criar ambientes estimulantes e criativos, não crescem com elas ou têm em atenção as necessidades de desenvolvimento dos seus utilizadores.

Esta tese tem como propósito a análise de hipóteses para uma abordagem ao desenvolvimento de jogos para crianças como plataformas para brincar. A pesquisa foca-se em questões relacionadas com a interação, com ênfase no conteúdo e mecânicas para que, as limitações das crianças, enquanto utilizadores, estejam salvaguardadas e respondam às suas necessidades de aprendizagem.

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## I. Introduction

*“If you want to be creative, stay in part a child, with the creativity and invention that characterizes children before they are deformed by adult society.”*

— Jean Piaget

To better design for the end user, one must understand him.

In the particular case of this research, the users, are children and the purpose is to try to understand what can be done to ensure better play experiences for them through multi-touch mobile devices.

To reach this purpose, one must first understand how they grow up, develop, learn, play, their preferences and, most of all, their needs.

This work starts by analyzing play and toys by documenting and gathering relevant literature, theories and evolution throughout the last two centuries. Many theories that were relevant in the beginning of the twentieth century, are still relevant today and constitute great tools to better design digital experiences to play with.

Being a research around children’s play habits preferences and needs, it is of paramount importance to include them in the project. To do so, one must first understand how children have been included in design teams and research projects and why. Children have played many different roles in the advances of technology and in many different ways.

There is already a considerable number of applications that attempt to bridge play and the digital realm. Only in the past year we have seen a growing number of mobile applications that ease the appropriation of mobile multi-touch devices as toys.

The fact that, nowadays, technology targets children in unprecedented ways, only makes emphasizes the relevance of studies that include them and consider their interests and needs.

### 1.1. Motivation

As new technology invades the common homes through recent mobile platforms, it becomes very clear that designers need to look at the new usability problems raised by these interactive platforms and new ways of interaction.

Multi-touch is very popular among the young because it takes direct manipulation of objects on screen to another level, but applications and interfaces are only as usable as we make them and what we make of them. This becomes more evident when we look at the amount of new products, equipped with multi-touch and digital pens, that target these very young users.

Children should be able to play and use these platforms in ways that can help them grow and learn while still having fun and games and toys allow them to do just that.

Furthermore, games have an incredible potential as learning tools when we add the factor of a fun user experience adequate to the age of the user.

These transformations allow for the appropriation of mobile multi-touch devices as tools for play, a new type of toy that brings a new type of experience and new ways one can imagine play and play with imagination.

### **1.3. Research Goals**

Through literature research and work with children, prototype a tool for playing and creating games for multi-touch devices.

To reach this goal I will:

- (a) Identify the key points, along with existing design patterns, for working and designing for with children for interactive learning and playing through games on multi-touch platforms.
- (b) While investigating with children about their preferences on playing and learning, define gameplay and describe interaction based on the results of the research gathered from point (a) and the children's suggestions.
- (c) Implementation of a simple prototype derived from the findings of the previous research for continued testing and improvement.

## II. On Play And Toys

### 2.1. Play

Play is very hard to define. Not only because, in the English language, it has multiple meanings according to different contexts of use, but also because there isn't one definition of play that all authors, scholars and theorists agree on.

In Portuguese, for example, we use different words for child's play "brincar" and playing games "jogar". This distinction implies a conceptual difference between the two actions.

Generally, we can describe play as activities performed throughout our lives.

Kowitz Rapeepisarn et al. gathered some of the most relevant definitions of play from different authors from different fields:

- (a) "Work and play are words used to describe the same thing under differing conditions." Mark Twain, novelist, journalist, river pilot;
- (b) "It is a happy talent to know how to play." Ralph Waldo Emerson, philosopher, poet, essayist;
- (c) "When kids play, they remember. They may not be aware they are learning, but they sure are aware they are having fun." Rebecca Krook, play facilitator for kids with disabilities;
- (d) "It is a paradoxical that many educators and parents still differentiate between a time for learning and a time for play without seeing the vital connection between them." Leo Buscaglia, author, educator;
- (e) "Play permits the child to resolve in symbolic form unsolved problems of the past and to cope directly or symbolically with present concerns. It is also his most significant tool for preparing himself for the future and its tasks." Bruno Bettelheim, child psychologist;
- (f) "You can discover more about a person in an hour of play than in a year of conversation." Plato, Greek philosopher;
- (g) "The activities that are the easiest, cheapest, and most fun to do – such as singing, playing games, reading, storytelling, and just talking and listening – are also the best for child development." Professor Jerome Singer, Yale University;
- (h) "Play is the highest expression of human development in childhood, for it alone is the free expression of what is in a child's soul." Friedrich Fröbel "father" of modern kindergarten;
- (i) "All play means something. It goes beyond the confines of purely physical or purely biological activity. It is significant function – that is to say, there is some sense to it." Johan Huizinga, cultural historian;
- (j) "I played with an idea, and grew willful; tossed it into the air; transformed it; let it escape and recaptured it; made it iridescent with fancy, and winged it with paradox." Oscar Wilde, playwright, novelist;
- (k) "In every real man a child is hidden that wants to play." Friedrich Nietzsche, philosopher, poet;
- (l) "Play is like a reservoir full of water. The deeper the reservoir, the more water can be stored in it, and used during times of drought." Tina Bruce, Professor, London Metropolitan University (Rapeepisarn 2006, 1).

Children play naturally. Some even argue that play is part of the child's natural need to learn (Montessori 1912). Through play, the growing child explores the world gathering experiences and understanding about it. Children play to: "explore intellectually and physically; to extend their skills of communication; to give free run to their imagination; to promote their physical and healthy development; to demonstrate their knowledge; to represent their experience; to develop all skills children need, including literacy,

mathematical reasoning, creating and social skills; to manage environment through cooperation, helping, sharing and social problem-solving; to further explore their world.” (Rapeepisarn et al. 2006, 29).

Throughout the last decades of the nineteenth century and early twentieth century, many scientists, pedagogues and child-rearing experts, artists and writers (Lauwaert 2009), turned their attention to the development of the child and child’s play, growth, development and learning (Squire, 2011). These studies gradually changed society’s image of the child (Lauwaert 2009).

The most prominent researcher was Jean Piaget who, “defines pretend play as an act of ‘pure assimilation’ in which activities are repeated solely for the functional pleasure which the reenactment of sensory-motor schema brings” (Saracho et al. 1998).

He identified the following stages of the young child’s development:

- (a) The Sensory Motor Stage, from 0 to 2 years of age. In which I will not focus since I consider children this age to be too young to interact with mobile devices.
- (b) The Preoperational Stage, from 2 to 7 years of age. Children in this stage can only see the world from their own perspective finding it difficult to put themselves in another person’s place. They also have some difficulties in partnering with other children the same age. Another important characteristic is the fact that they can only concentrate on one particular aspect of an object at a time and find it hard to follow hierarchic information structures used, so many times, in the construction of interfaces.
- (c) The Concrete Operations Stage, from 7 to 11 years of age. At this stage, children acquire the ability to understand hierarchical structures and mentally reverse actions. Children in this developmental stage are also able to better understand others by trying to put themselves in other people’s situations (Hourcade 2007).

Piaget described maturation, experience, social aspects, and emotions as being the four key factors that influence the development of the child as she or he grows and acquires knowledge through adaptation to different environments and stimuli.

He also described levels of play that correspond to each development stage:

- (a) Functional or Practice Play, repetitive motor movements with or without objects, characteristic of the sensorimotor stage;
- (b) Symbolic, Pretend or Make-believe Play, children start to engage in this kind of play in the pre-operational stage. Vygotsky defined two types of symbolic play: role play and play with objects. Symbolic play develops symbolic function and representation, laying grounds for abstract thinking.
- (c) Games With Rules, activities like board games or cards, which also may be played socially (Verenikina 2003).

Dr. Stuart Brown has devoted his life to the understanding of play and its role.

Although Stuart Brown’s studies focus on general aspects of play, and not necessarily on child’s play, they start from there (Brown 2009). He makes a distinction between the following types or elements of play:

- (a) Movement Play;  
Has a parallelism with the type of play Piaget describes as the characteristic play of the Sensory Motor Stage.

It is a part of all elements of play. Through movement play we learn to understand self-movement structures our knowledge of our surroundings and relationship with others. It makes us think in motion, space and time. “Our knowledge of the physical world, based in movement, explains why we describe emotions with terms like ‘close,’ ‘distant,’ ‘open,’ ‘closed.’ We say we ‘grasp’ ideas, or ‘wrestle’ with them, or ‘stumble’ upon them” (Brown 2009, 59)

Besides intellectual stimulation, it promotes “learning, innovation, flexibility, adaptability, and resilience” (Brown 2009, 59).

#### (b) Object Play;

Is also described by Piaget as a characteristic play in the Sensory Motor Stage. Manipulating objects is in our nature. It springs from our curious nature and is an intrinsic pattern of playfulness.

Our brain circuits develop as our skills to manipulate objects refine.

Brown uses the story of a machine store owner and his employees to demonstrate the importance of play in the development of problem solving. The owner of a store that specialized in precision racing and Formula One tires, started to notice that his new and youngest employees had enormous difficulty in problem solving. He and his wife, startled by the observed phenomenon, started questioning their employees to try to understand what had changed.

The difference was very simple but significant: those who had grown up playing with their hands could more easily find solutions than those that didn't.

They decided to look at their retired engineers and found out that most of them had grown up with a strong interest for building and taking things apart. The young engineers with the same interests, also felt more comfortable and engaged in problem solving. Questions about play habits later became part of the job interview. One of the aspects of play that is so important to problem-solving is its improvisational potential.

#### (c) Imaginative Play

Starts to manifest in the Pre-operational Stage of development. Kids start making up silly or nonsense stories in a fragmented way. Stories, usually, don't have structure: beginning, middle and end.

Later on, they acquire the ability to tell structured stories with coherent content. The imperative to create narrative occurs worldwide in children and is an integral aspect of their play. It is also a sign of verbal experimentation, a sign of the child's desire to play with words.

Older children become involved in imaginative play often, easily jumping between reality and pretend. As they continue to grow, the line between reality and pretend becomes clearer but pretend play, usually, remains with us for the rest of our lives assuming many different forms.

Pretend or Imaginative play works as a way to understand how the world works and how we can interact with it. It is a kind of simulation of real situations that helps us enrich experience.

#### (d) Storytelling

Stories are part of the way we make sense of the world, “It occupies a central place in early development and learning about the world, oneself, and one's place in it.”

In adulthood, we use narratives to structure our thoughts and to relate otherwise separate events and situations.

In Brown's words, "storytelling has the capacity to produce a sense of timelessness, pleasure, and an altered state of vicarious involvement that identifies narrative and storytelling with states of play" (Brown 2009, 64).

(e) Transformative-Integrative and Creative Play

When engaging in play, we are free from rules, patterns and even time. It allows us to experience different behaviors. Children, while playing, change and grow. Fantasy and make-believe, make us step out of our world and, while doing it, create new things, "germinate new ideas and ways of being" (Brown 2009, 65).

(f) Social Play.

Because we are social beings, social play helps us improve our social abilities. There are three types of social play: friendship and belonging, rough-and-tumble play, and celebratory and ritual play.

(i) Friendship and Belonging

Social play begins in parallel play, that is, children remain close to each other but without interacting among them. Slowly they start collaborating and including each other in play.

By the age of six, playing with others — mutual play — becomes a crucial activity. It helps children relate to each other and allowing others to contribute to their imaginative world and extend their understanding of their surroundings. This type of play lays the grounds that will teach us how to form friendships and strong bonds with others.

(ii) Rough-and-Tumble Play

This is the most unappreciated type of play by both parents and teachers. It can often become violent and our natural reaction is to stop rough-and-tumble play. But this type of play is "necessary for the development and maintenance of social awareness, cooperation, fairness, and altruism."

Studies indicate that lack of rough-and-tumble play may be one of the causes for later violent behaviour in life.

Joe Frost, a passionate advocate for this type of play, conducted intensive studies in playground play. His work is behind today's playground design.

This type of play can take many forms. It may be a race, super-hero play where "the good" fight against "the bad," it can take the form of "any active play that includes body contact among children."

"Children know the difference between friendly and real aggression, and when allowed, engage in rough-and-tumble play very actively, changing the nature of the game to accommodate interest and/or demands by a self-appointed leader" (Brown 2009, 63)

As children get older, this type of play tends to stop or take the form of practicing sports or other group activities.

(iii) Celebratory and Ritual Play

This type of play is seen very often. Children may pretend they are celebrating a birthday, marriage, a special dinner, etc.

Celebratory play comes from the pleasure of reenacting the pleasure of the celebratory experience (Brown 2009).



When children feel comfortable and safe, self-initiated play will develop naturally. When we play, whether as adults or children, we feel we are completely “in the moment, in the zone,” we experience *Flow*.

*Flow* is the state in which an individual is “so involved in an activity that nothing else seems to matter; the experience itself is so enjoyable that people will do it even at great cost, for the sheer sake of doing it” (Cowley 2008, 13).

The phenomenology of *Flow*, according to Mihaly Csikszentmihalyi's has eight major characteristics:

“A challenge activity that requires skills;

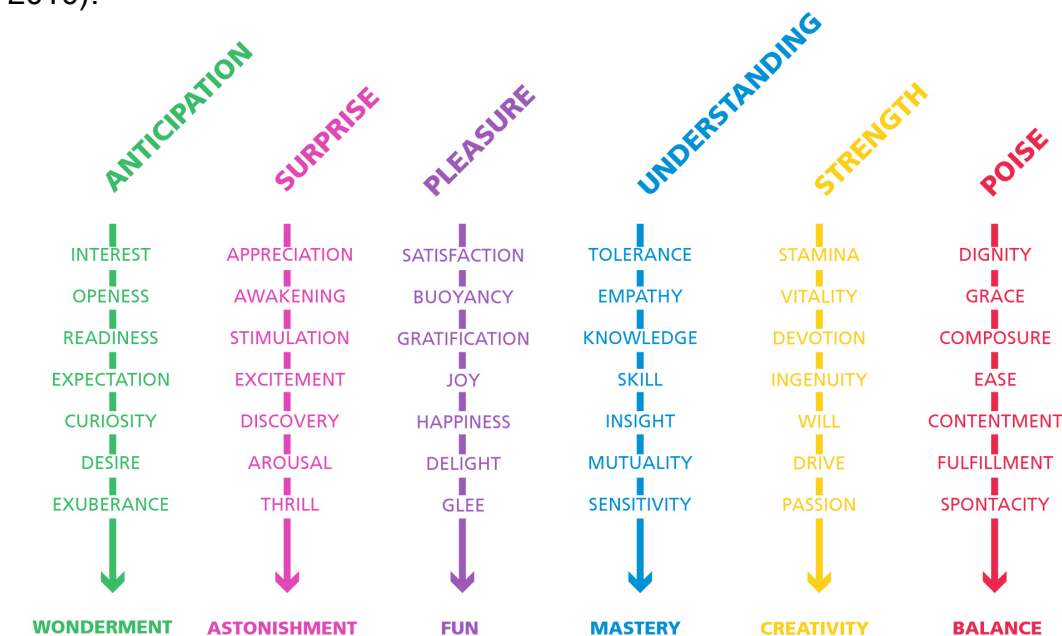
- (a) The merging of action and awareness;
- (b) Clear goals;
- (c) Direct feedback;
- (d) Concentration on the task at hand;
- (e) The sense of control;
- (f) The loss of self-consciousness;
- (g) The transformation of time”

(Chen 2007, 31).

Play is important to every aspect of the child’s development (Verenikina 2003). It fosters imagination, agility and strength. In free play and role-play children learn to interact with each other (Ginsburg 2007).

Because play has no rules, it is opened to serendipity, to the unexpected and doesn’t necessarily occur inside any specified barriers.

Eberle proposes six different steps to describe the process of play. The diagram bellow describes the evolution of sentiments humans experience during play (Brown 2009 and Eberle 2010):



1. Eberle’s Play Elements. © 2010 The Strong®

### 2.1.2. The Importance of Play

Two studies that highlight play's importance in brain development are Marian Diamond's and John Byers'. Both worked with animals and concluded that play enhances brain activity (Brown 2009).

Marian Diamond drew attention to her study with rats in the 1960s by demonstrating that rats brought up in "enriched" environments, with more stimuli, and toys, became smarter rats with larger brains and a thicker and more developed cortex, than rats who didn't.

John Byers discovered that the amount of play is correlated to the development of the brain's frontal cortex, which is responsible for cognition: "discriminating relevant from irrelevant information, monitoring and organizing our own thoughts and feelings, and planning for the future." Species that play until an older age, have a bigger cerebellum.

We can conclude that children, from the moment they are born, need to be given the right conditions to play. Such is the importance and relevance of play.

Nowadays, there is evidence that children's free play time is reducing worldwide. The rise of educational toys and concerns for children's security, seem to be two of the major causes of this reduction.

When choosing toys and content for children, parents seem to prefer toys, computer programs, educational videos, specialized books that, although trying to ensure an optimal development, steal time away from free play and start molding the child's interests from a very early age.

Content for children for smart devices also focus mainly on educational content and less on offering children tools to play (Brown 2010, Resnick 2006, and Strommen 2004).

## 2.2. Toys

With industrialization “the design, development, marketing and selling of diverse toys on a larger scale than witnessed ever before” (Lauwaert 2009, 128), was facilitated.

Toys are used as “tools for play,” designed and built to be used in a specific way. However, very often, they are used outside their original purpose. Players appropriate their toys in very surprising ways. They are taken to a kind of periphery, driven away from their core. These are the terms used to describe and classify the ways players use toys (Lauwaert 2009).

In the periphery we include explorations with a toy (and games) that deflect from their original purpose. This is why users cannot be seen as simple consumers of objects, they manipulate them creatively and create different discourses with them (Lauwaert 2009).

When designing toys, this divergence of use should be considered that is, the core design must expect these different appropriations.

The design of a toy is actually an exercise shared between the designers or builders and the end users.

Interestingly, although today there seems to be a declining of free play, toys gained success in the late nineteenth century because they were a simple way to entertain upper class children. These toys were mostly thought for boys. For girls there were only miniature houses and dolls .

For boys there were miniatures of the latest technologies (bridges, trains, factories, cars, etc.) (Lauwaert 2009).

Alphabet blocks and construction toys have been a part of play since the eighteenth century and became popular throughout the nineteenth century. The growing popularity of this kind of toy goes hand in hand with the rise of consumerism and the new interest in children’s growth, development and play (Lauwaert 2009).

The psychologist Vygotsky (Vygotsky 2002) highlighted the role of objects, such as toys, and artifacts as cognitive enhancers. He was also, along with Piaget, a constructivist. Constructivists believed that the process of learning is about assembling words and ideas independently and exchanging those ideas with others, as opposed to simple reception and memorization of ideas and information (mediated through language, in Vygotsky’s point of view).

The success of these toys comes partly from the fact that the act of building is a highly praised human activity, thus the labeling of this kind of toys as educational toys.

“Construction toys force children to think about fit, angle, gravity, size, space, cause-and-effect (connect what you see with what you can do) while stimulating eye-hand and small muscle coordination, thereby developing self-esteem, independence and increasing language skills, social abilities and imagination” (Lauwaert 2009, 46).

It was Frederich Fröbel who established the first kindergarten and popularized construction toys. Fröbel was a firm believer in the importance of play in children’s development. In 1887, Fröbel wrote: “play at this time is not trivial, it is highly serious and of deep significance. From this belief Fröbel designed a set of construction toys” (Lauwaert 2009).

Maria Montessori was a scientist who dedicated her life to the observation of children and development of adequate responses to children's needs. Because of her interest for the role of toys and materials for children to manipulate and play with she started observing children using the cubed designed by Fröbel and later came to design her own set and theory (Squire 2011, Lauwaert 2009 and Zuckerman 2010).

Both are responsible for the most influential work on children's toys existent to date.

### 2.2.1. Frederich Fröbel

Fröbel advocated for independent learning. His toys were designed to encourage exploration. Building kits played a central role in Fröbel's educational model, children were encouraged to construct freely or imitate real life designs and mechanisms, their core functionality also supports peripheral activities (Zuckerman 2010).

He organized activities into three categories: forms of life, forms of knowledge and forms of beauty. To each type of activity the adequate materials were provided. Fröbel's designed twenty different didactic materials that he called the "Fröbel Gifts": wooden blocks, wooden sticks and cardboard geometric shapes and corresponding activities geared towards the creation of two and three-dimensional models of natural and man-made forms" (Zuckerman 2010).



2, 3, 4 and 5. Fröbel Gifts

### 2.2.2. Maria Montessori

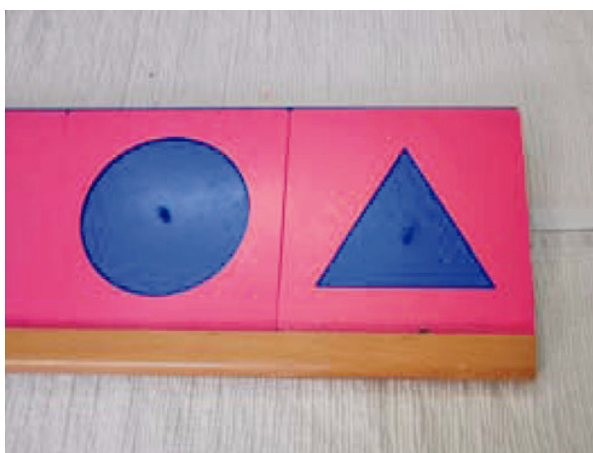
Maria Montessori believed in what she called “normal development” (Squire 2011; Montessori 1912). A child, left to herself, if given the appropriate conditions and materials, will have a natural will to explore her surroundings and learn about them.

With this idea she developed the Montessori Program with toys and materials to support exploration and normal or natural learning.

Montessori’s method also values stimulation of the senses. She believed knowledge came from our senses and was best acquired through them than through the conceptualization of ideas (Zuckerman 2010).

There are four categories of didactic materials: cultural, language, mathematics and sensorial. In Montessori Schools, children have everything available for them to use freely without teacher intervention. For example, the materials used to teach mathematical concepts are number rods, fraction circles and multiplication boards, while those used for sensorial stimulation and exploration consist of wooden cylinders and stairs, colour tablets and a variety of fabrics and materials (Zuckerman 2010).

These materials are designed to work in a progressive way and fit to the different stages of a child’s development. They were built to promote the Montessori concept of Polarization of Attention: learning through the unmediated (by teacher or instructor) repetition of the child’s action and reflection upon the action (Zuckerman 2010).



6, 7, 8 and 9. The Montessori Materials

### 2.3 Construction Toys: Children as Designers

The LEGO brick is probably the most popular toy in the world. Lego was created by Ole Kirk Christiansen (1891-1958) a craftsmen from Denmark. Originally he built common wooden toys to dispose of leftovers from his workshop. The factory, later specialized in toys and changed its name to “LEGO” — the combination of the words “leg godt”, “play well” — the name we nowadays still know it by (Lauwaert 2009).

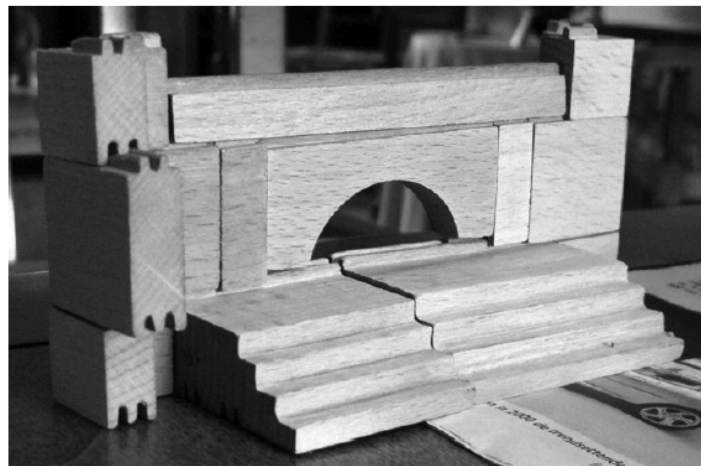
Construction bricks weren't invented by LEGO, they have been around since the nineteenth century (Lauwaert 2009). The first generation of these toys consisted of wooden blocks without an interlocking system. Later versions of these bricks were also released in stone and steel.

The succeeding generation of construction toys consisted of toys to construct miniatures of complex engineered structures and mechanisms characteristic of the industrial times. *Meccano* toys are one good example of such toys. Like the *Meccano*'s of today, there were multiple types of pieces — like curved pieces and wheels — that could be interlocked to design and construct such structures in many different ways.

Wooden versions of these construction toys were also available, just as there were plastic building blocks. This first wave of construction toys served mostly for abstract and architectural structures. The second generation of construction toys took it one step further. All these toys were marketed for boys until the 1930s when *Firma's Stabila* construction sets brought construction toys to girls.



10. Meccano construction toys.



11. Wooden construction toys.

*LEGO* started producing plastic toys after the Second World War — when this material became common — but the production of wooden toys was still the companies main activity. The first construction brick produced by *LEGO* was the *LEGO Automatic Binding Brick*. It was sold in two different sizes, but the locking mechanism was very different from the one we know today.

These bricks were a version of the ones designed and patented by Hillary Fisher Page — a child psychologist that designed a variety of plastic toys — in 1932 called *Kiddicraft Self-Locking Bricks* (Lauwaert 2009).

The real shift came with *LEGO*'s interlocking mechanism we know today. It allowed for the building of stabler, bigger and more complex constructions and was first introduced in the *LEGO System of Play*. This System also included pieces other than building blocks (like vehicles, for example) (Lauwaert 2009).

All *LEGO* pieces worked, and still do, together. A child with different *LEGO* systems could combine them in every way she wanted expanding the play experience and design possibilities. Its generic appearance made them appropriate for every type of play. In the 1990s the brand expanded their construction toys to facilitate role-playing.

*LEGO*'s bricks are the perfect representatives of Fröbels and Montessori's ideas. They combine simple aesthetics, modularity, sensory interaction, developmental appropriateness in a form of an open-ended puzzle-like system.

Children may create constructions and designs by following instructions or to play and explore freely.

The building brick logic also eases their introduction to novice users and allows the user to gradually construct at his or her own pace and everything is stripped down to the essential. Toys have always gone hand in hand with the most recent technologies, easing their introduction in children's lives (Lauwaert 2009). Whether steel, plastic, the complex engineered structures brought by industrialization or, as we will see in the next chapter, computer technologies and, in recent years, mobile multi-touch technologies.

### III. Children and Technology

On February 24th, 2012, David Pogue, a contributor for the NY Times Technology blog wrote a post entitled "A Parent's Struggle With a Child's iPad Addiction."<sup>1</sup>

In this article he explained he was starting to suspect his six year old child was becoming addicted to his iPad and, having read a series of articles<sup>2</sup> on the same topic exposing the risks of such technologies for young minds, he could not help but to be worried. It was not the child's addiction that worried him, but the consequences that the long exposure to such a technology could have.

Children seem to have quickly adapted to the content manipulation possibilities offered by the iPads and iPhones' multi-touch screens.

Since the early 1970s children have been seen as very important target for software and hardware usage. The idea that software could help children and be designed taking into account children's needs and that every child should have a computer, was expressed by Alan Kay in his text "A Personal Computer for Children of All Ages" (Kay 1972).

It is also with children that we can observe the "natural interaction" possibilities brought by the inclusion of multi-touch in recent mobile technology. Although we can assess their enthusiasm, we still know little about the requirements for designing applications oriented to young ages and their always changing needs.

Because very young children have limited motor abilities and different cognitive needs, they are also limited users. Approaching interfaces and specific software for children as if they were small adults may have harming consequences to their development, and should be done after careful study about what they need and want.

Given the greater exposure of children to these technologies, it is imperative that they be designed taking into account children's abilities, interests, and developmental needs (Hourcade 2007; Gilutz et al, 2010).

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<sup>1</sup> Pogue, David. 2011. "A Parent's Struggle With a Child's iPad Addiction". Technology - Pogue's Posts Blog - The NY Times. (accessed November 15, 2011). <<http://pogue.blogs.nytimes.com/2011/02/24/a-parents-struggle-with-a-childs-ipad-addiction/>>.

<sup>2</sup> Richtel, Matt. 2011. "Your Brain on Computers - Series" Technology - The NY Times. (accessed November 15, 2011). <[http://topics.nytimes.com/top/features/timestopics/series/your\\_brain\\_on\\_computers/index.html](http://topics.nytimes.com/top/features/timestopics/series/your_brain_on_computers/index.html)>.



### 3.1. Constructionism

From Piaget's theory of Constructivism, Papert derived what he called 'constructionism' sustaining that children adapt best when they are "consciously engaged in constructing a public entity" (Papert 1991, 1), helping them to construct knowledge.

"Constructionism—the N word as opposed to the V word — shares constructivism's view of learning as 'building knowledge structures' through progressive internalization of actions... It then adds the idea that this happens especially felicitously in a context where the learner is consciously engaged in constructing a public entity, whether its a sand castle on the beach or a theory of the universe" (Ackerman 2001, 4).

Focus, is given to learning by doing.

Concepts become grounded and ideas shaped and adapt better when expressed in a variety of media or acted out and discussed upon. Learners appropriate knowledge to transform it and the projection of the individual's ideas facilitates the learning process (Ackerman 2001).

Papert's interest in computers comes from his belief that the computer can be an important learning tool because it lets children learn by doing, empowering them by letting them be the authors instead of just presenting facts (Hourcade 2008). To him the computer can be transformed into a "mathland", a simpler and engaging way to teach mathematics to children by letting them create and play with mathematical concepts.

Children create with whatever materials are available to them and use to create their personal intellectual structures. These intellectual structures change and adapt as they grow and learn about the world.

To Papert it is the interest in this process of restructuring knowledge that leads to a new interpretation of the world and in the different ways they learn new things (Papert 1991).

## 3.2. Designing for Children

Whether designing content, gameplay or interfaces, the case of children users is always a very particular one. Children of very young ages do not read and cannot rely on textual information. They do not always interpret visual hierarchies correctly, do not have fine motor skills developed yet, they absorb knowledge from everything around them.

Providing information at the right time and in an adequate level is essential not only to allow children to act independently, but also to ensure they reflect on their actions and interactions.

People create mental models of the systems they are working with and interact with them accordingly. People interact with technology based on their mental models of its system. Novice users differ from expert users specially on this point (Norman 1983; Gilutz 2010). Children's early contact with technology will help them adapt and learn novel interfaces and ways of interaction but, as shown previously, their capacity for creating mental models changes and adapts as they grow and learn about the world.

### 3.2.1. Digital Natives

The distinction between digital natives and digital immigrants is simple.

Someone who grows up using any kind of technology is more likely to feel comfortable with it, than someone who doesn't. The first is, of course, the digital native (Druin 2009).

Although, in literature, these concepts appear as "black and white," with no "in between" stage, this doesn't mean that there isn't a wide variety of different digital natives that must be considered in the design process (Druin 2009).

### 3.2.2. The Roles of Children In the Design of New Technologies

This chapter is based on Allison Druin's homonymous report (Druin, 1999) where she makes an extensive analysis of all roles children have come to have in the design of new technologies, the methodologies used, their evolution throughout history and their impact.

In the design of new technologies, children have had several different responsibilities and roles: the role of user, tester, informant, and design partner.

These roles are not necessarily different from that of adult users, but the methods, context, and challenges can be different, because of the involvement of children.

#### (a) The Child As User

This is the oldest known role of children in the design of new technologies. In this role, children are observed while they use technology.

It is commonly used to assess the impact of particular technologies on children.

Methods for observation vary from direct observation by adults, observation from one-way mirrors, videotaped sessions screened in live television monitors, videotaped sessions with the researchers in the room. These are usually chosen according to "the information of interest, the size of the user population involved, the research philosophy, and the experience of the researchers involved"(Druin 1999, 6).

Researchers and teachers are in the room with the users, taking part in the activities, making software demonstrations, answering questions, etc. The teachers' role is to collect data taking advantage of their own experience.

The data collected may concern user impressions, qualitative surveys, may be used to investigate children's personal opinions and tastes, interviews may be conducted to spot children's specific reactions to certain features, formal quantitative surveys to which children answer using numerical scales or choosing from various options.

Quantitative surveys represent an added difficulty when working with children because language has to be clear and age appropriate.

It is also common to give children surveys before and after the sessions or the use of technology for defined periods of time.

Results of children's work in computers or thoughts collected from children's journals may be used too.

In some cases, ethnographical studies and descriptions of children as users are conducted through the observation of small groups of children for long periods of time.

Nowadays, this method is commonly used in child psychology and applied to educational research. It is still considered to be a useful tool for the design of new technologies and new uses of technology in educational context.

In this role, children have very little input in the development process of the technology. It is also a strange situation that children are not accustomed to and that may lead to frustration and, consequently, less focus.

If children are only invited to test already existing technology, feedback will only be useful to be used in future projects and not have an immediate impact on the tested technology.

The greatest advantage of the child as user is that, in situations in which the child only has to use the technology, there won't be any real changes to the school day. It is also the most structured role. The researcher controls the process an order of actions to perform. And last, but certainly not the least, researchers come to better understand children and their behaviour with technology, which may have great impact in the development of future technology.

#### (b)The Child as Tester

As testers, children are asked to test prototypes. Observation is made with technology or through directly commenting the experiences and answering researchers questions.

The results are then used to “change the way future iterations of the pre-released technology are developed” (Druin 1999, 4). This is not a role children occupy in the initial design stage, it is only after adult brainstorming and design that prototypes are built.

To ask children to test prototypes was an attempt that, before the late 1980s had only been tried in a few projects that are nowadays considered pioneer work. One such example is Seymour Papert and his Logo research group: In their research for a programming language designed for children, learnt of ways to improve the project by sharing it with their users (Druin 2009, 3). Another good example comes from the experiments conducted by Alan Kay and Adel Goldberg at Xerox PARC in the 1970s, using children as testers of a programming language called SmallTalk (Druin 2009, 11).

Children's role as testers only became an accepted practice in the late 1990s, coinciding with general efforts to bring better interfaces to end-users. It gradually became common in academic context and industrial context and is nowadays a widely accepted practice.

Researchers also try to understand the child's use patterns and preferences, but in this case, with a deeper involvement of the children. This approach is concerned with specific issues of the technology being tested: if it is confusing, where can children find bugs, etc. According to specific purposes of the project, certain aspects may be more heavily tested.

Tests with children have an immediate impact in the tested technology because as testers, children have a lot more input and influence in the development of the technology. Children's opinions are also valuable insights on how to make technology more accessible and appealing to them, although they are still minimal. When prototypes are tested in early stages of the design, tests with smaller groups of children for a few hours might suffice.

Teachers may also need to be involved. For them this is also a challenging task because time has to be taken from teaching to be spent testing technology. It may also be problematic for parents that need to take time of their lives to attend to the researchers' requests — children may need to be in the laboratory or researchers ask to make the tests in their homes.

Because children are bluntly honest, and their opinions are heard in an advanced stage of the project, this may prove to be a very harsh task on developers and designers. Still not every aspect is problematic. Like when children occupy the role of users, they only have to use the technology and initial results may come forward quickly.

Children feel empowered by the opportunity of being asked for their opinion. This allows for the tests to occur in more relaxed circumstances, sometimes without the need of teacher presence and without having to take children away from classes for a very long time.

Giving the role of tester to children, even though a limited approach, ensures better technology that they will enjoy using.

#### (c) The Child as Informant

In this role, children play an important part in several stages of the design process. Children may be called in to be observed using existing technologies, asked for opinions on low-tech prototypes, or in more advanced stages of the design.

Although literature defining the role of the child as informant only started in 1997, the role emerged in the mid 1990s, coinciding with the multimedia industry growth worldwide. Scaife et al. brought this possibility to light in 1997 by questioning what contributions would be relevant for the design of technology and in what part of the process children should be included. From their contributions, this role became better defined.

Observation is conducted in similar ways to previously described roles. The great difference lies on the fact that children's observations, opinions and considerations are regarded throughout the whole design process.

Teams may find it useful to use low-tech prototypes and materials to help expressing ideas or sketching.

Although children play a more prominent role, the decisions are still made by the research team.

This type of research depends on flexibility. For teachers, this may prove to be a problem since researchers may suddenly need to spend time in the classroom.

This is an even more challenging role for children, but it is also enriching. Adults will listen carefully to their observations and considerations. Children may also be asked to enroll in team's brainstorming activities. This also means more flexibility for researchers because activities don't necessarily need to be performed in schools.

As informants, children may have a greater impact on new technologies designed for "themselves."

#### (d) The Child As Design Partner

When children are design partners they are considered actual designers, sharing "responsibilities" with the adult design team.

As partners, children perform the role of informants throughout the whole research and development process. They are actual designers of new technologies for children. Their opinions are seriously considered and they have equal opportunities to contribute.

Allison Druin's intense research with children as design partners has led to the development of technology design methodologies.

The integration of the technology users in the research and design process isn't new. It started in Scandinavia in the 1970s when efforts were made to include industry workers in the process of development of specific technologies by approaching the design problems in cooperation with them. This method, called Cooperative Inquiry, supported the development of many new technologies that considered the unique intake of those that best know their workplace and workflow.

Nowadays, the Maryland's Human-Computer Interaction Lab has an "Intergenerational Design Team" with researchers joining efforts with children from seven to eleven years old that create new technologies together.

Methods developed for this approach, now called Cooperative Inquire, had to be adapted to work with children.

The impact of this approach is enormous: more than two hundred design suggestions had been gathered when Druin's report was published.

Rules for researchers include small notepads for notes (to lower impact) and informal clothing, simple ways of leveling power between adults and children and changing the way children perceive adults.

Children and adults need to adapt to their new roles and learn to work together. They do this by "introducing the notion of invention, by asking such questions as: What is an invention? How are inventions created? When do we know something needs to be invented? Children work with team members on introductory design experiences, such as inventing a new sandwich; redesigning a new milk carton; and finding objects in their classroom to fix. In each case, children and adults work together in small groups to brainstorm and discuss "what is wrong" with the existing 'technologies.'"

The team uses low-tech prototyping tools to sketch ideas. All team members have journals where they take notes and write their ideas that can be used in future projects.

Although this may be a long process — about six months — gradually, children start picturing themselves as design partners and feeling comfortable in this role.

Cooperative inquiry activities include:

- (a) Contextual Inquiry, observing what children do with the technology they have. Adults observe children and children observe children as they interact with technology. Drawings, video and words are used instead of the usual notes.
- (b) Participatory Design, adults and children collaborate in building low-tech prototypes. It is also essential to hear from children directly. This is a useful way to explore ideas that can then be pursued in prototyping. These prototyping sessions gather three to four children with two to three adults. The resulting prototypes will be used as starting points for the design process. One technique used in this stage, is layered elaboration. Children may use low-tech materials to add information to existing prototypes, interfaces or prototypes created during these sessions.
- (c) Technology Immersion, to observe what children do when surrounded by technology in an effort to understand how they use it in a given period of time. Children must be free to perform whatever tasks they wish to with this given technology.

Even though children's impact as design partners is immense it also raises some problems. Adults don't naturally adapt to having children as working partners and children don't always respond well when facing difficult situations. The actual consideration of children's suggestions throughout the design process depends on the design partner.

Because no one is “in charge”, adults and children negotiate to make decisions as a team. This is a particularly difficult task because children are used to being told what to do by adults just as adults are used to having some authority over children. Another difficulty of working with children is setting working hours. These have to be scheduled outside school hours and steal some of the children’s free time.

Finding the right researchers for the job is also a laborious task. Educators don’t fit the profile because they do not know how to partner with a child and other specialists must enjoy the messy side of working with children.

Children enjoy being treated “like adults”, it strengthens their self esteem.

Teams that partner with children enjoy immediate feedback, thus enjoying more flexibility while working on a project.

### 3.2.3. Mobile Multi-Touch Interfaces

Though touch interfaces allow the user to directly manipulate objects on screen with their fingers without the need of any other type of tool such as a mouse or a pointing device, they do not guarantee a more adequate experience.

Such an experience must be designed so they can feel as “natural” (Lee 2010, Widgor et al. 2011) as possible to the user.

The success of these mobile devices is unquestionable and they appear to be here to stay. Some argue that they will eventually find their place and specific function (Norman 2010), but given the obvious success these devices are enjoying among children, this future will most probably involve them.

Because we create meaning from our interactions with others, we will also tend to create meaning in our interaction with technology.

When discussing educational software for children, and ways to make content more accessible and finding ways to support children's independent reading, Druin talks about educational scaffolds that can be used to help this independent exploration without the need of adult support: “immediate word- and sentence-level audio support, embedding game-like interaction patterns that extend the literacy experience” (Druin 2009, 177).

From her research with children for designing for mobile technologies, Allison Druin defined the following lessons:

- (a) Use clear and frequent audio prompts;
- (b) Use specific, concrete instructional language;
- (c) Program events to occur on touch, not tap;
- (d) Avoid caching of touches/taps;
- (e) Use caution with multitouch;
- (f) Avoid hotspots near the edge of the screen;
- (g) Immediate feedback is necessary;
- (h) Carefully design tilt functionality;
- (i) Use visual cues to help the user understand when she's in control;
- (j) Rethink placement of icon labels (Druin 2009, 281).

Druin also stresses that:

- (a) Interaction should be fast, easy and short;
- (b) The aim should be the transferral and expression of ideas through the device;
- (c) Although growth isn't static, software is, and ways of overcoming this stability should be studied;
- (d) Supporting parent-child relationships is essential for early adoption of mobile devices;
- (e) Software must support multiple users and the sharing of devices;
- (f) Connecting digital and physical resources should be taken into consideration;
- (g) Interaction styles should involve handling, manipulation and construction;
- (h) Interfaces should be multimodal;
- (i) Design should allow personalization and appropriation.
- (j) Interaction styles should be age-specific: menus, fonts, interface type, color, etc.
- (k) Children should be involved in the design process (Druin 2009, 94, 119).



Gilutz et al. suggested that one solution would be the use of layered design that could evolve with the child. Their study identified that there were four factors that influence children's comprehension of novel interfaces: age, technology-experience, complexity and familiarity. They also highlighted the importance of addressing the needs of more inexperienced or young users to avoid leaving them frustrated, losing motivations and being left behind. This study also shows the importance of user testing with the product's audience to better understand their comprehension level and adjust the design.

In "Investigating Investigating Children Preferences of a User Interface Design", the authors stress that when designing for children's play, group play has to be a possibility. Children aged between eight and twelve years old, become gradually more interested in group play and competition (Taslim et al. 2009).

Mobile Multi-touch devices detect fingers and gestures and are, therefore, gestural interfaces. A gesture, in this context is "any physical movement that a digital system can sense and respond to without the aid of a traditional pointing device such as a mouse or stylus"(Saffer 2009).

As mentioned previously, gestural interfaces enjoy great popularity with young users. Partly, this is because they take the concept of "direct manipulation" to another level by allowing the user to manipulate objects on screen by actually touching "them". This is partially why they are many times called "natural interfaces."

According to Ben Shneiderman, to design systems that:

- (a) "Novices can learn basic functionality quickly, usually through a demonstration by a more experienced user;
- (b) Experts can work rapidly to carry out a wide range of tasks, even defining new functions and features;
- (c) Knowledgeable intermittent users can retain operational concepts;
- (d) Error messages are rarely needed;
- (e) Users can immediately see if their actions are furthering their goals, and, if the actions are counterproductive, they can simply change the direction of their activity;
- (f) Users experience less anxiety because the system is comprehensible and because actions can be reversed so easily;
- (g) Users gain confidence and mastery because they are the initiators of action, they feel in control, and the system responses are predictable" (Shneiderman 1997, 33).

He defined the following three principles:

- (a) "Continuous representation of the objects and actions of interest;
- (b) Physical actions or presses of labeled buttons instead of complex syntax;
- (c) Rapid incremental reversible operations whose effect on the object of interest is immediately visible" (Shneiderman 1997, 33).

The term "natural interaction" is more related to the feeling the user experiences when using a well designed and calibrated system that is adjusted to his or her needs: "natural interaction is achieved through clever designs that constrain the problem in ways that are transparent to the user but fall within the capabilities of technology"(Lee 2010, 12).

As defined by Mike Kuniavsky: “The user experience is the totality of end users' perception as they interact with a product or service. These perceptions include effectiveness (how good is the result?), efficiency (how fast or cheap is it?), emotional satisfaction (how good does it feel?), and the quality of the relationship with the entity that created the product or service (what expectations does it create for subsequent interactions?)” (Kuniavsky 2011, 14).

### 3.2.4. Content

The definition of content for children is a complex matter and should be defined after careful study and consideration. The fact that, for this research, I am concerned with the interaction with mobile multi-touch devices and, consequently, short periods of use, content related decisions must consider these aspects.

Working for mobile devices also requires considering that there is a “sense of ownership” and participation associated with the device and the possibilities offered by its technical specifications. These technical specifications provide a variety of ways to access information and to manage it. For example, a mobile device will allow the child to more easily use the built-in camera, store photographs and reuse them, than a personal computer. This means that the outside world’s activities and elements can more easily be brought into the digital realm and reused for different contexts. It gives the child new and interesting ways of integrating her surroundings in whatever activity she is performing with the device.

When it comes to motivation and experience of use, this particularity may allow us to construct richer experiences for children because “they are able to interact with and analyze data that they helped create as part of the simulation” (Druin 2009, 12). Furthermore, it makes the child choose what is relevant to her, becoming part of the process of the understanding of her own tastes and preferences.

Another aspect to consider is the act of sharing. Content created inside the device is easily shared through social media and specific websites, which is simultaneously a blessing because it enhances the experience, and a concern to both parents and designers.

If we consider that digital applications and software can behave as toys, that children use “to bridge the real and imagined worlds, taking symbols of things that exist into fantasy worlds and allowing us to express our internal worlds in tangible ways” (Druin 2009, 107), it is worth considering ways these can behave more like ‘real’ toys that can be collected, traded, displayed and used for “storytelling - entertainment, self-expression” (Druin 2009, 119).

Because children are growing and becoming able to achieve different levels of motor control and intellectual challenges, a toy or game for these young users should grow with them and allow them to reinvent it as they grow, to guarantee they feel in control. Ackerman et al. identified four principles that should be considered when designing digital experiences:

- (a) Granularity: making it possible for users to choose the level of specificity when engaging with an experience, recognizing that these may be different at different times and in different contexts.
- (b) Extensibility: allowing users to extend their experience through other technologies, channels, modes of engagement as well as create entirely new functionalities themselves.
- (c) Linkage: connecting related events in multiple ways from a user’s point of view and over time, in addition to making it easy for users to invent new ways of doing this themselves.
- (d) Evolvability: shaping experiences around users’ needs and preferences, rather than vice versa and enabling an evolution of the experience as users’ levels of sophistication increase (Ackermann 2009, 78).

Researchers at the *LEGO*® Learning Institute, argue that when we take play and gaming to the digital realm, we should try to create resources that stimulate “curiosity, mental readiness, confidence, positive framing and commitment” to enable children to “become self-directed in their learning and creativity, and more likely to achieve the *Flow* state of intense, rewarding engagement”. This can only happen when “a balance between challenge and ability, as well as between stability and change” is achieved to guarantee the child does not feel frustrated (Ackermann et al. 2009, 71).

For games to generate *Flow* they must guarantee that:

- (a) The task fits the player’s abilities;
- (b) The game’s goals are clear;
- (c) There is instantaneous feedback;
- (d) Deep involvement;
- (e) Player experiences a sense of control and concentration;

(Chen 2007).

Studies have also shown that well-designed computer games can offer very engaging, creative, open-ended or problem-solving challenges to children, which are likely to share some of the benefits of problem-solving or constructional play with objects (Gauntlett et al. 2010).

Petter Bae Brandtzæg and Jan Heim conducted a study to evaluate what type of content children preferred in games and its relationship with their psychosocial development. Their initial observation was that most of the research on this subject revolved around time spent playing computer games and not on whether some types of content could be harmful to them in any way.

They also stress that “children of today exercise an unparalleled degree of control over how they use their media” (Brandtzæg 2009, 70). Its called “The age of egocasting” which is related to the wide array of possibilities and options offered by today’s media industry. In their study they try to establish the relationship between children’s preferences and psychosocial development regarding:

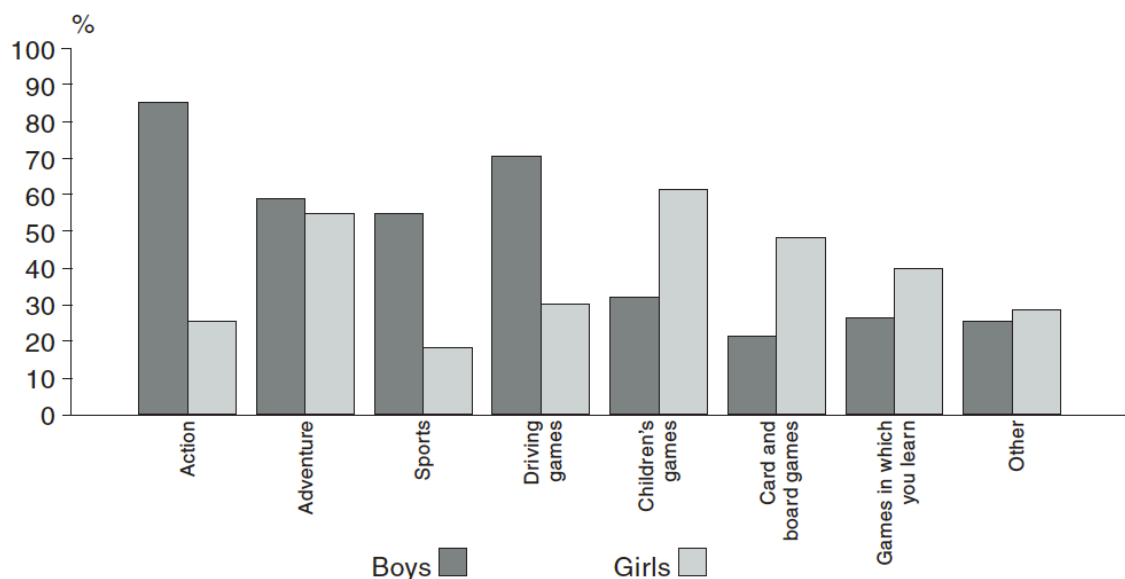
- (a) Self-concept, individual perception of social acceptance;
- (b) Parental Monitoring, children’s own perception of their parents knowledge of the way they occupy their free time;
- (c) Social Competence, children’s perception of how they socialize and interact with other children.

On gathering research on these subjects they found that:

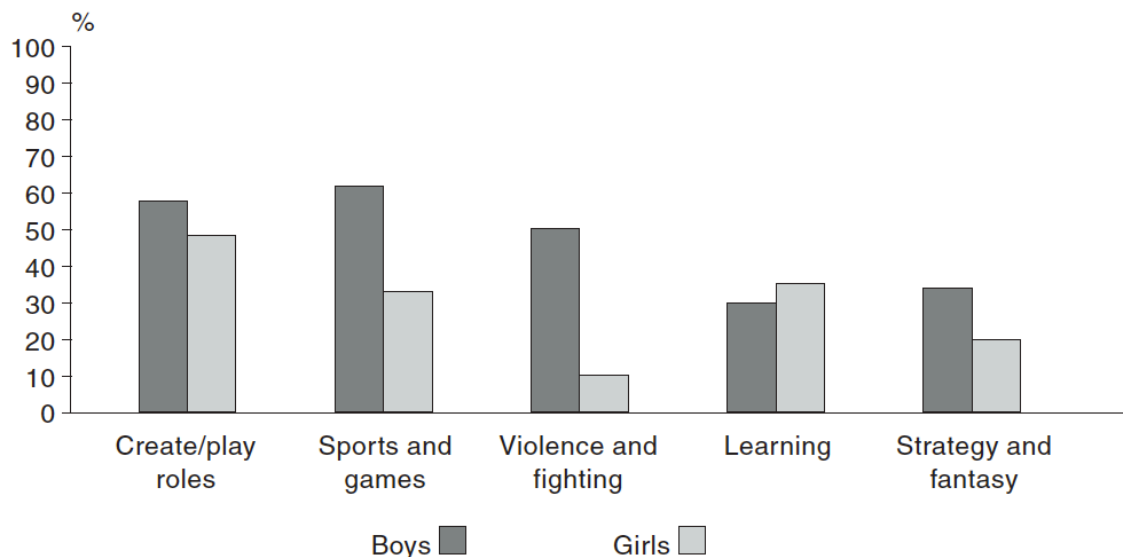
- (a) One study demonstrated that there may be an increase in self-esteem that “pairs self-relevant information with smiling faces”;
- (b) Video games promote co-operative behaviour and stimulate discussion (specially strategy games);
- (c) There is general disagreement on whether gaming culture has positive or negative effects in psychosocial factors.

A study in Danish children and one on Norwegian children gaming preferences, were used to structure Brandtzæg and Heim’s study.

The results were as seen on pictures 10 and 11 displayed bellow.



### 12. Danish children preferences



### 13. Norwegian children preferences

These charts show a clear preference for sport and action related games in boys, while girls clearly prefer educational and card like games. Both appear to enjoy games in which one can role play and create roles, adventure games and strategy games.

The study concluded that, pedagogical games are a parent's favorite and are related to both high academic and athletic competences. High academic competences are also associated to fantasy games and competitive games to athletic competences.

Children's personality and personal preferences have an obvious impact on their gaming choices. Those that are naturally interested in creative and intellectual pursuits will obviously reflect those interests on their gaming preferences.

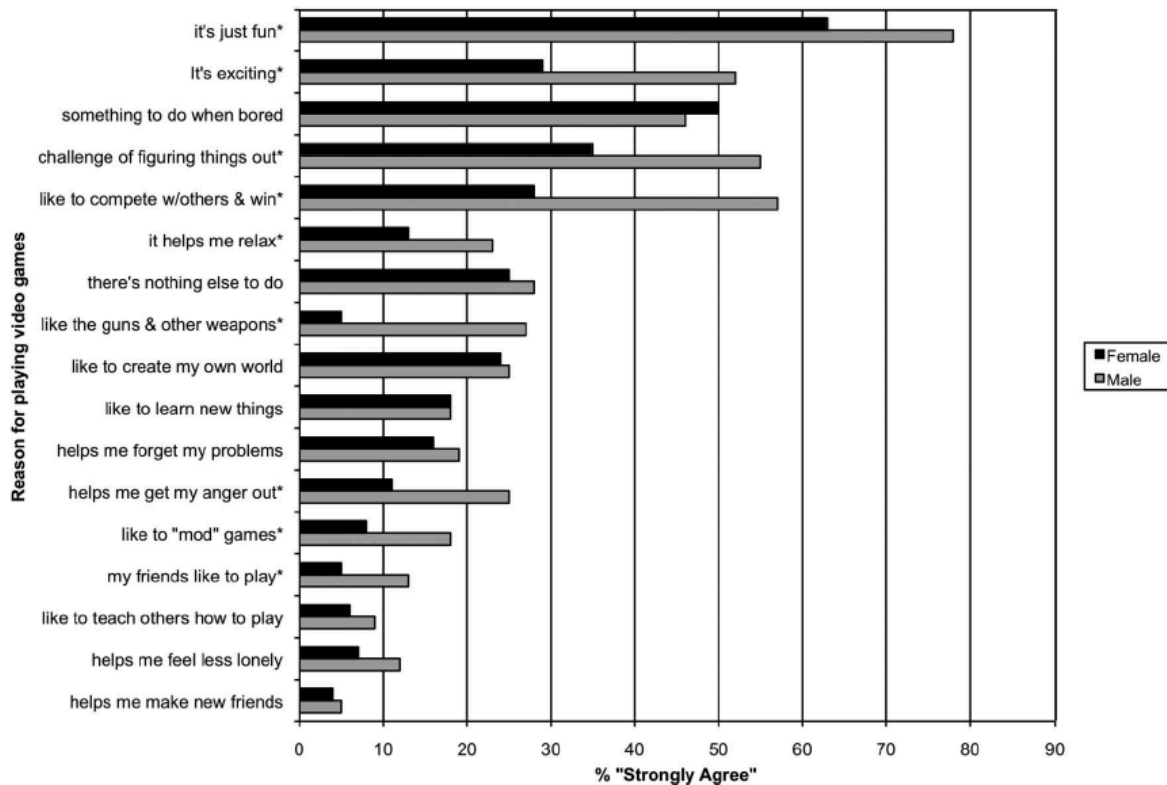
Their findings also confirm that children with difficulties in socializing look to games as a way to cope and escape from socialization with others, but that this difficulty is not related

to their content preferences. Only violent video games were mildly connected to low social acceptance.

Generally, games may positively reinforce self-concept and even more so when it comes to scholastic and athletic competence (Brandtzæg et al. 2009).

Another study conducted in the U.S.A. tried to understand the motivations behind playing games (Olson 2010). The study involved 1254 students organized in focus groups of boys and girls.

The resulting answers and distribution of percentages can be seen on picture 11.



#### 14. Motivations for playing video games

Competition ranked highly amongst boys while girls tended to prefer friendly competition and not necessarily playing to win.

Both genders enjoy great satisfaction from teaching and explaining others how to play and making new friends was one of the main reasons for video game play, which was also a frequent topic of conversation between friends (Olson 2010).

The key finding of this study is the role that emotions play as motivators for video game play. This aspect was particularly striking for boys. Children and young people use video games as a mean to relax, deal with anger or loneliness and forget problems.

Those that looked to video games as a way to deal with anger had a clear tendency to prefer violent content.

Challenge was presented by most boys as the most important factor to ensure fun in a video game.

The possibility of creating customized content or "modding" was also very popular amongst the interviewed. When it came to characters it was about more than the customization, it was also about the possibility to try new identities and play different roles.

Enacting a fantasy world by performing actions and decisions that would be impossible in the real world, along with learning or “discovering and feeding interests” (Olson 2009, 184) was also addressed by the study’s subjects was a very important aspect of gaming.

What this study demonstrates is that, when approached with moderation and parent supervision, playing video games may be a very stimulating way of exercising creativity, socialization, self expression and learning.

### 3.3. From *LEGO* to Logo

When telling the story about the relationship between technology and children, there is one project that cannot be left out: The Logo Programming Language Project.

When Papert was working in a Junior High School, he became fascinated with the art classes and their hands on approach. He began envisioning a way to do the same for teaching mathematical and geometrical concepts. A few years later, Logo was born (Papert, 1991).

Seymour Papert co-founded with Marvin Minsky the MIT Artificial Intelligence Lab in the 1960s. The team led by Papert created the first version, a dialect of Lisp, in 1967. This first version was then perfected through several different efforts: the collaboration with different research sites and research in schools.

Logo, thought to work as a learning language, required considering several different levels of comfort with, not only programming, but also working with computers. Its structure is modular, extensible, interactive and flexible, with a "low threshold and no ceiling," This ensures that both novice and experienced users can use it.

To make Logo more engaging to children, later in the project, the Turtle was introduced. Initially it was a robotic turtle that would move in response to the program's commands, it later became a part of the computer program's graphics as a drawing tool.

It was Grey Walter who invented the first "Tortoise" in its robotic form "looking very much like a big yellow cannister-type vacuum cleaner on large wheels with a pen in the middle of its belly."

The Tortoise's movements were accompanied by a virtual turtle on screen that left the described path visible to the user<sup>3</sup>.

The turtle gained relevance as the project evolved. The user could choose from other types of animals and shapes that could be used to create animations, game characters or even collections.

In the late 1970s, it became a widely used program in personal computers.

Training was offered to teachers that wanted to use the program in their classes.

In his book "Logo Philosophy and Implementation" where he describes and evaluates the implementation of the Logo project in several schools and locations, he resumes Logo's features in the following way:

"We know that children of all ages and from all social backgrounds can do much more than they are believed capable of doing. Just give them the tools and the opportunity. Opportunity means more than just 'access' to computers. It means an intellectual culture in which individual projects are encouraged and contact with powerful ideas is facilitated" (Papert et al. 1991, 8).

The Logo language evolved, in 1985, to the LogoWriter. It included a friendlier and more intuitive interface and a word processor and was translated to several different languages, encouraging international popularity and reach.

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<sup>3</sup> Solomon, Cynthia. 1987. Computer Environments for Children: A Reflection on Theories of Learning and Education . The Massachusetts Institute of Technology: 105.



Later, Mitchel Resnick, took advantage of *LEGO* bricks, sensors motors and lights to create *LEGO Logo*. It allowed Logo users to create and program robotic systems with the Logo Programming Language.

In the early 1990s a new version, *MicroWorlds*, was again released. Drawing tools, shape editors, music creators and the ability to use imported files were included. The last released version of *MicroWorlds* is *MicroWorlds EX*. Because this version allowed parallel processing, animations with several actors could now be created, making the program even more appealing as a learning and exploration tool.

Projects around Logo continued to evolve. Fred Martin created the Programmable Brick which had an integrated computer allowing programs to be downloaded to the brick. This feature became a part of *LEGO Mindstorms* and, afterwards, *Handy Cricket* and *PICO Cricket*, smaller variants of the initial brick.

With time Logo Blocks derived from these initial approaches. Using Logo Bricks one could write programs by assembling pieces similar to those of a jigsaw puzzle.

Later, in the 1990s, LEGO started including mechanical parts like gears and pulleys, in the construction kit. Children could use them to build robots and, while doing it, acquire and develop knowledge on robotics and its underlying concepts.

There are more than 250 projects derived from the original Logo. They can all be found in Pavel Boytchev's Logo Tree.

### 3.4. After Logo

Papert's incursions inspired many projects that are still used today.

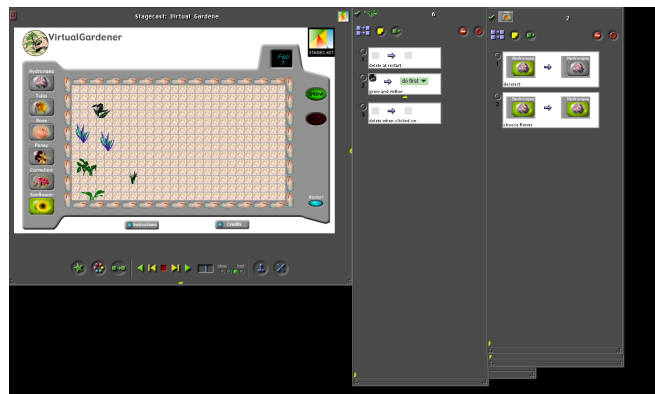
Here is a small introduction to some of the most relevant projects that try to empower children by giving them digital tools for self expression through the authoring of computer games.

Game creation tools for children are mostly developed for the context of a classroom but manage to escape it.

Stagecast, Scratch, Squeak EToys (originally created by apple in 1996 and last released in 2010), Alice, Microsoft's Kodu, all have become important learning tools chosen by teachers and parents (Lee et al. 2011).

#### Stagecast

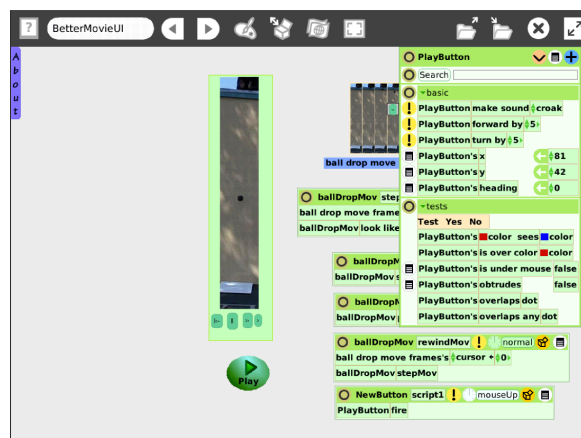
Is a visual programming language to allow children to program and design their own computer games. Programming is done by demonstrating with the mouse. The software records the programs in form of "if-then" rules.



15. Stagecast: Editing object behavior

#### Etoys

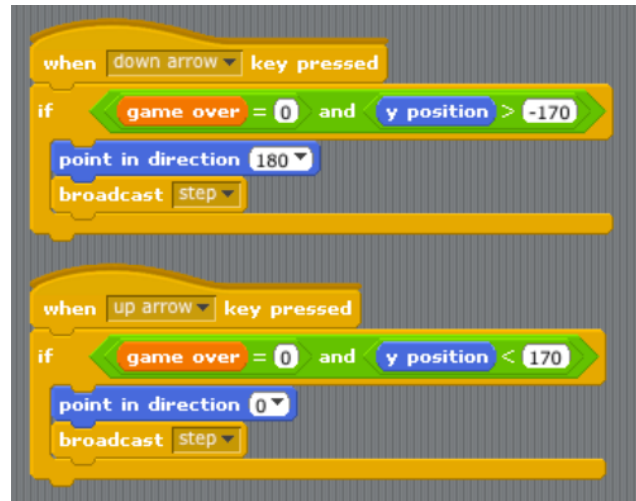
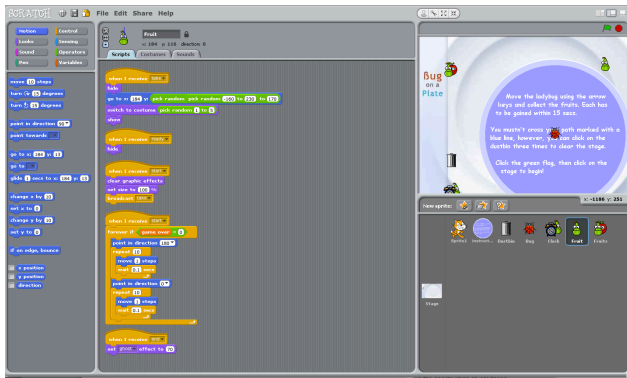
Etoys is a multimedia authoring tool for children. Built on top of the Squeak programming language, this was a pioneer project because it was the first to introduce a tile-scripting interface, taking advantage of drag-and-drop. Users can use the "tiles" to build scripts for objects.



16. Etoys: Editing object behavior

## Scratch

Scratch was developed at the MIT Media Lab by the Lifelong Kindergarten Group in 2004. It uses a building block logic that makes tasks very simple and accessible even to novice users. Launched in 2007, it has now over 2,600,000 projects shared on Scratch’s website. Like with building blocks, using Scratch teaches its young users “to think creatively, reason systematically, and work collaboratively (Resnick et al. 2009).

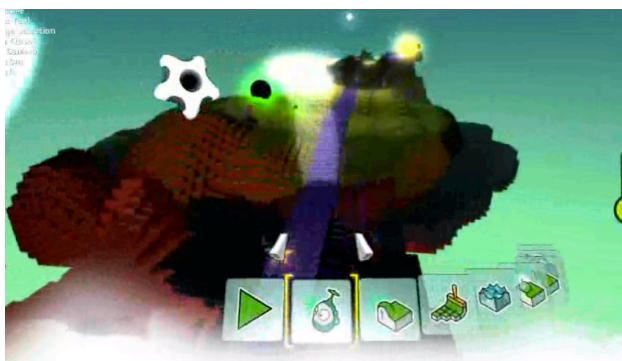


17 and 18. Scratch: The interface

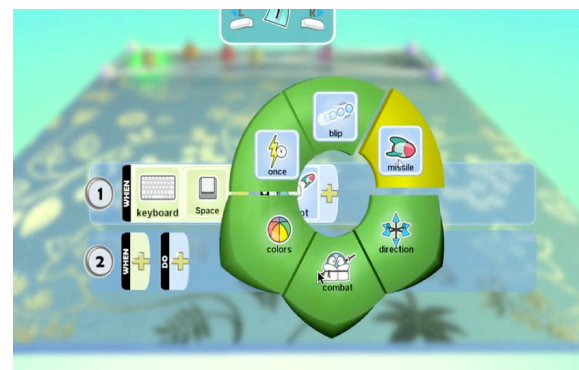
## Kodu

Kodu is a programming environment designed for children. It uses a visual programming language developed by Microsoft and is one of the best available examples of visual based toolkit for creating games. Because, like Scratch, It follows a building block logic and the interface is entirely composed of icons with almost no textual information, it is very easy to use.

Kodu’s grammar is a “high-level, visual, and interpreted language. In Kodu, users program characters, objects, and the way they interact, individually. This specific grammar was inspired by robotics and is event driven. The lines of program are in the form of conditions “a rule could read, when see apple red, do move toward quickly, where when see apple red is the conditional, and do move toward quickly is the action”. The words in Kodu are represented by tiles, the user writes the game by assembling them, thus creating the rules. It is available for computers running Windows and Xbox 360.



19. Kodu by Microsoft, editing game.



20. Kodu by Microsoft, editing actions.

### 3.5. Mobile Multi-Touch Devices As Toys

For the iPhone and the iPad there are also interesting tools for children to explore, learn and create. Because of Apple's iOS user interface guideline, most iPad applications for kids tend to be more carefully designed.

#### Suwappu

Suwappu<sup>4</sup> is the result of McGarry Bowen's project Haitsu.

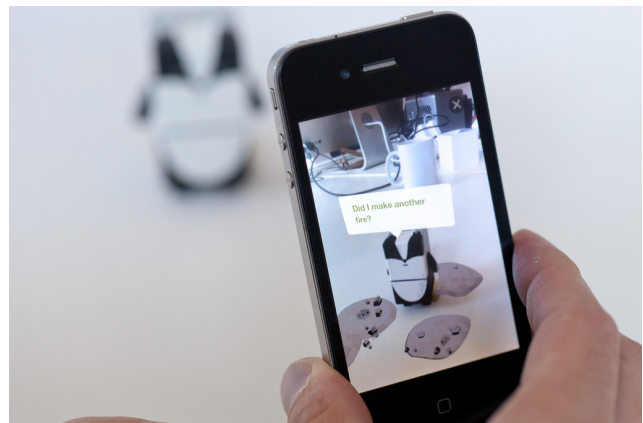
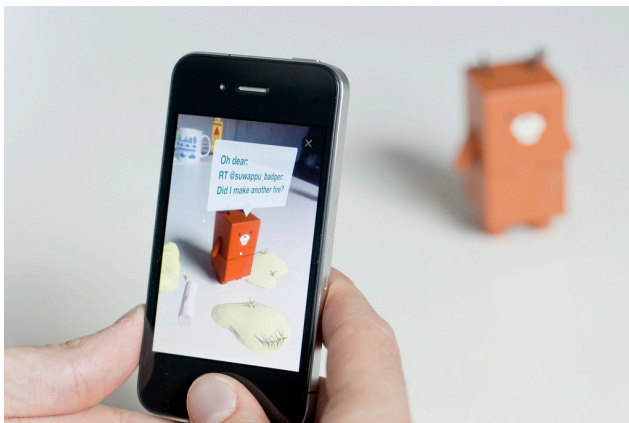
Haitsu is a made up word created "by combining the Japanese words for 'Hybrid — Haiburiddo — and Communication — Tsūshin.'" They call it "the art of hybrid communications, a made-up idea that we find useful".

Suwappu combines media and real toys to create a new concept.

The toys can be used independently but, when combined with an iPhone or iPad running the application while filming the character, the character's story unfolds in front of us.

There are eight Suwappu characters — the Beaver, the Fox, the Tuna, the Deer, etc. — with tops and bottoms that can be swapped allowing a wide range of possible combinations. The top, or the toy's head, "contains" information on its personality; the bottom, the toy's feet, information on the character's surrounding environment.

When the character is seen through the lenses of these mobile devices, using augmented reality, the content that corresponds to each of the toy's parts appears, letting the user experience the character in the chosen environment to tell its own story: "So Badger's head on Tuna's pants means Badger's personality in Tuna's world."



21 and 22. Suwappu: Augmenting the characters' world

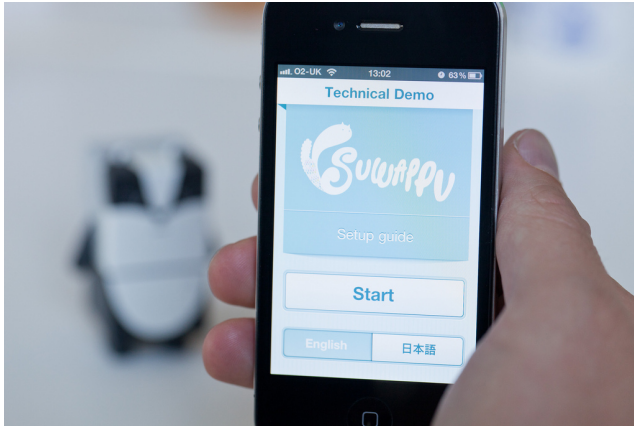
The application reads the toy's facial features, colors and forms.

Their creators intention is to have story episodes for each character released from time to time to be "experienced" through the actual toy that is, simultaneously, the main character of the story. "Writers for the characters," could then, "produce episodic content over time, and intertwining story lines referencing real world events, as well as the toys' physical experience they've had in the world that week, as they live with their owner."

<sup>4</sup> 2011. "Suwappu." Introducing Suwappu! MCGARRYBOWEN. (visited 30 July 2012). <<http://www.getsuwappu.com/>>.

The team is also studying ways to integrate social platforms, like Twitter, to expand the user's experience.

This application is currently only a prototype for the use of its creators and to display its potential.



23 and 24. Suwappu: The application and the characters.



25. The Suwappu Characters and its possible combinations

## Toca Boca

Toca Boca's team<sup>5</sup> actually manages to turn mobile multi-touch platforms into toys. The only extension they use is the real world and they do so in a very original way. This company's motto is "A New Way to Play".

They develop toy-like applications for mobile multitouch platforms.

Each application constitutes a different toy that can be used for a different type of play. For example "Toca Tea Party" is a table set for tea. Children can play around the iPad freely by serving cookies, tea, cakes almost like a real playtime with real toys. Similarly there is a "Toca Train", where kids drive a train through an imagined world of They also have applications which structure and logic is closer to that of a game. "Toca Doctor" is a game-like application where A a little boy has all sorts of pretend health problems and, by selecting them, children can cure him and see him smile back in appreciation.

"Helicopter Taxi" takes advantage of augmented reality and the iPhone. It transforms the mobile device into a toy helicopter. Kids pick-up passengers with specific purposes that give them directions to where they want to go. Augmented reality helps gives the users the feeling that the helicopter is actually in the room.

Their applications follow six guidelines:

1. "A balance between the different needs that kids have

Kids have many different emotional needs, and we believe that digital products should try to address a wider spectrum of these than just playing games or teaching ABC. Used correctly, digital products can be an amplifier or synthesizer of kids emotional development too.

2. We think it is important to play. But not just games

We believe we can make digital products that can be a part of, and facilitate, different types of play. On screen, and away from the screen too.

3. Products that allow you and your kids to play together

Far too often, digital products are used as pacifiers for kids. We believe there is a place for digital products that allow kids and their parents to play together. More fun for both of you!

4. A positive view on technology

We believe that the development of technology is something positive, and that it should be embraced and used for good.

5. A safe digital environment for your kids

We believe safety should come first when your kids are using our products. That's why we don't have banner advertising or in-app purchases for kids in our products.

6. You will like our products, but your kids will love them

We make products for kids, and our highest wish is to make them smile. When we develop products we test and co-create together with children to make sure that they like everything about them. No matter what the purpose of the product is, we believe that it should also start with a smile."

All of Toca Boca's applications have strong colors, big buttons or clear hit target areas. Their designs make use of simple animations so the child knows exactly where to press. There are no hidden menus or items and everything is wide opened to the user to manipulate.

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<sup>5</sup> 2012. "Toca Boca." A New Way to Play | Toca Boca. Toca Boca. (visited 30 July 2012).  
<<http://tocaboca.com/>>

Exploring the possibilities of direct manipulation, they create experiences for free play inside each application.

Their characters are friendly and have different and clear personalities. Their “emotional expressions” give the users direct feedback so they can tell if, for example, a specific monster from “Toca Kitchen Monster” does not like broccoli or a character from “Toca Hair Salon” does not enjoy their new look.



26. Toca Boca: Happy monster in Toca Kitchen Monster

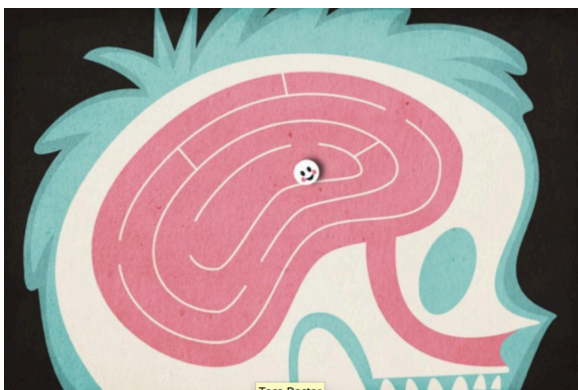


27. Toca Boca: Dropping a passenger in Toca Train

“Toca Train” is a good example of simple and uncomplicated controls. The train travels through an island landscape. The user stops in different train stations to collect passengers and cargo. To control the train’s speed, there is only a lever with four different speeds: zero, one, two and three. To manipulate it, they simply move it up and down accelerating and slowing down.

There are no written instructions, only the lever and big round buttons that correspond to the passengers, and their places in the train, or to the cargo that is being collected or dropped. To emphasize their functionalities, the application makes use of simple sounds and animations.

Applications that require navigation bar-like menus, use either simple and direct icons— so the user is never lost, and always knows how to come back — or contextual menus — for example, a fridge with food in “Toca Kitchen”. Everything works through pushing buttons or drag-and-drop.



28, 29. Toca Boca: Toca Doctor and Toca Tea Party.

## LaunchPad Toys

LaunchPad Toys<sup>6</sup> is one of the best achieved iPad projects available for children. They sell one main application “ToonTastic”. It is a free play, storytelling tool for kids.

Oriented to digital play and creativity for young children with large icons and buttons, the possibility of playing with either given characters or draw new ones in a paper-like approach and record voices while manipulating the objects directly.

First designed at Stanford’s School of Education by Andy Russell, the initial project focused on the creation of a storytelling network for children “designed to be used with custom-built multi-pen interactive displays for arts and technology museums” that could also be used online with a conventional mouse”.

It attempted to

- (a) Seamlessly integrate the creation process with the visual and narrative nature of play;
- (b) Scaffold the storytelling process by:
  1. Breaking it down into manageable steps aligned to fundamental storytelling principles;
  2. Providing story starters to jumpstart the imagination;
  3. Visually mapping emotion to perceptible outcomes;
- (c) Harness peer-collaboration to encourage outward creative expression, thereby transforming the child’s natural inner-monologue into collaborative dialogue and role-play.

By following Papert and Vygotsky ‘s constructionist and social development theories to create a tool to:

- (a) Empower young children to share their ideas and stories with friends and family by bridging the gap between formal writing and imaginative play.
- (b) Introduce and guide key storytelling principles like Character, Setting, Story Arc, and Emotion to help structure kids’ creative writing.
- (c) Promote cultural literacy through ToonTube: A Global Storytelling Network for Kids, by Kids.



30. ToonTastic, creating music.



31. ToonTastic, playing.

Kids are free to explore this application because its interface is very easy and intuitive,

<sup>6</sup> "Creativity at Play | Launchpad Toys." Creativity at Play | Launchpad Toys. LaunchPad Toys, n.d. (visited 28 July 2012). <<http://launchpadtoys.com/>>.



which enhances their experience as users.

In Toontastic, the child builds a story one scene at a time. He or she starts by selecting a scene type (Setup, Conflict, Challenge, Climax and Resolution) and then mixing and matching characters, settings, and actions to define the story event for that scene. The goal of this exercise is not to create a script *per se*, but to establish clear and succinct story events around which the emotive structure will turn. The story arc is then drawn by adjusting energy levels for each scene and by choosing appropriate emotional themes, thereby determining that scene's background music.

After creating their animations, children are free to share them using "ToonTube". The application's Youtube-like platform.

Another interesting LaunchPad Application is "Monkeygram". Using this application children (or parents) can create and send animated cartoon postcards to friends through text message, email and social networks.

The applications require parental authorization to be installed. Once downloaded and installed, an e-mail is sent to the registered owner of the device. Only after confirmation, can kids start playing with it.

Because this project started in an academic context it is well documented, which makes it a perfect case-study.

### Kapu Toys

Based in Finland, this company created an application for mobile devices that is constituted by ten different toys for toddlers<sup>7</sup>.

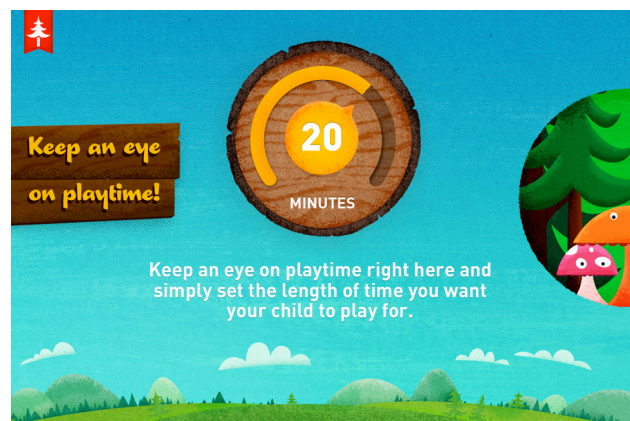
Simple virtual "toys" with simpler interactive possibilities.

The application is beautifully designed with vibrant colors and affable characters.

Its most interesting characteristic is the fact that it gives parents the possibility to monitor playtime and define how long the child can play with it, providing a solution for the most common critique made to applications that target kids.



32. Kapu: Manipulating objects on screen



33. Kapu: Parental Control for playtime.

<sup>7</sup> 2012. "Kapu Toys." Kapu Toys - The Digital Toy Box. Kapu Toys. (visited 30 July 2012).  
<<http://www.kaputoys.com/en/>>

## LEGO's Life of George

"Life of George"<sup>8</sup> brings lego bricks and the iPhone together.

The game is all about completing tasks, level by level. The faster and most accurately the lego model is built, photographed and recognized, the highest you rank.

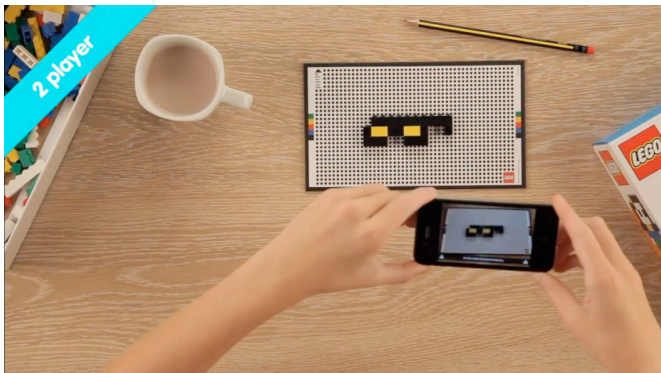
The package brings 144 *LEGO* pieces and a map, or board, called the "Playmat." This mat, enables the technology designed by *LEGO* (EyeCue) to recognize the built pattern when it is on it.

The game develops around George's life: "a software engineer by day, an adventurer by night," Because George has many hobbies, he keeps track of his things in a photo album. In each of the twelve levels the player has to build a total of ten models of George's items.

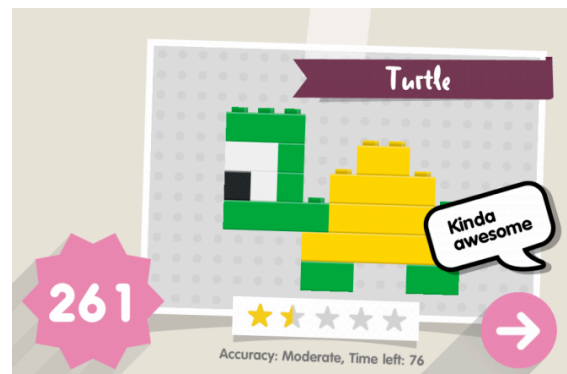
The game has different difficulty levels and can be played either alone or with another player. There is also a "Creation Mode" where the user is able to create and upload customized models and his own creations made with the *LEGO* bricks to create his own "iOS Scrapbook."

The toy is ranked "4+" on the AppStore.

The application that accompanies it is very well designed, with expressive colors, simple but beautiful graphic elements. The different options, game modes and scrapbooks found in the UI are represented by a desktop like environment where the user chooses the elements he intends to use. These elements are very realistic and contrast with the rest of the other user interface buttons and elements used to navigate inside the application's different modes and levels, which are geometric, bright colored and big.



34. Life of George: Using EyeCue



35. Life of George: Score

Having different difficulty levels the user can choose from, makes it easy for a young new user to start using the toy and learn how to master it at his own pace.

The other interesting characteristic of this toy is that anyone can enjoy it even though it was built for children.

## AppToys and WowWee Toys

WowWee Toys created what they call AppGear<sup>9</sup>. A subsection of the company that is fully dedicated to the integration of mobile multitouch devices in physical toys.

<sup>8</sup> 2011. "Life of George." LEGO.com George Products. LEGO. (visited 30 July 2012). <<http://george.lego.com/en-us/products/life-of-george/>>

<sup>9</sup> "Home." APPGEAR. WowWee Toys, n.d. (visited 27 July 2012). <<http://appgear.com/>>.

AppToys<sup>10</sup> also creates toys that use mobile multitouch devices to expand the play experience.

Both companies design toys for older children. The themes revolve around topics that would interest children above seven years of age, and most probably scare younger children: guns, aliens, war, airplanes, zombies, fast races, etc.

For smaller children AppToyz offers AppLingz. These characters are plush toys where the user can insert the mobile device to turn them into interactive characters. AppLingz themselves have personalities and need to be cared for and fed, but the toy can also be used as a simple protection for the device so parents can rest sure it is safe and won't hurt the child. With it, children can explore other applications other than the one designed for the pet toy.

The application also works without the toy and is fully downloadable for free. It is a fairly simple application. The pet's face occupies the whole screen and responds to the user's interactions with facial expressions and sounds. The user can feed the pet, care for it, play with it, and find out how it "feels" by browsing through the big icons.

For older children both companies have first person shooter games that combine real toy guns and mobile devices. The users insert the device in the toy and, through the device's screen, they can see the "enemies" integrated in their "reality."

AppGear's ZombieBurz also combines physical toys and the smart devices. It is a defense game, where small zombie action figures can be placed on the device running the application. The user has to defend himself — the zombie — from human attacks. It is played by controlling the "real" character with one hand (to move, turn, pick up items etc) and selecting actions with the other on the device (change weapon, shoot, deploy traps, etc). There are four different applications, one for every action figure in the game's package. Each application also corresponds to a different setting for the game: an avenue, a diner, a high school and services.

Because the game is designed to be played while holding the character with your left hand, and toggling options on the device with your right hand, there might be some issues for left-handed users who may find it harder to control and require extra time to adapt. Overall, the game's content and discourse is very appealing to older children and, despite the rich 2D graphics and sets, the controls are simple and easy to use.

### **Hasbro's Zapped Games**

Hasbro, creator of classical games like Monopoly, has released a new version of The Game of Life<sup>11</sup> that combines the game's board and an application for iPad that extends the game's experience.

In this version, all gaming decisions are made through the mobile device and the characters can be customized.

A similar version for Monopoly is to be released shortly.

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<sup>10</sup> 2011. "AppToyz." Apptoyz. Apptoyz International Ltd. Web. 30 July 2012. <<http://www.apptoyz.com/>>.

<sup>11</sup> "THE GAME OF LIFE: ZAPPED Edition." 2011. HASBRO - The Game of Life: ZAPPED Edition. Hasbro. (visited 27 July 2012). <[http://www.hasbro.com/games/en\\_US/shop/details.cfm?R=1BB09E0D-5056-900B-10A5-B2774C8FEA89:en\\_US](http://www.hasbro.com/games/en_US/shop/details.cfm?R=1BB09E0D-5056-900B-10A5-B2774C8FEA89:en_US)>

## Chris O'Shea's Couly Owl

Couly Owl<sup>12</sup> is one of Chris O'Shea's projects. Chris is an artist and designer from Britain that explores the applications of technology with a focus on child's entertainment and play. He has designed several interactive experiences for children and conducted many presentations and studies on the subject.

One of Cowly Owl's applications is Makego. Makego is a simple application for children to play and customize a variety of vehicles. It invites children to expand the play experience with a hands on approach. The little users can use actual toys and other appliances — LEGO bricks, paper, cloth, etc. — to design the settings and the cars they want to play with.

The project's release video shows children playing on race tracks, streets, ponds that they created with their own customized cars and canoes. It is to be in constant expansion with new vehicles to be released in future updates.

The interface is very simple: Large icons for starting menus, let children choose which vehicle to play with.

Once the vehicle is chosen, the menu is contextual and integrated in the set.

When playing with the racing car, the engine noises are motion activated, it runs out of gasoline, and has a speedometer. Kids can also change the color of the car.

With the ice-cream truck, kids have to serve the right ice-cream to their customers (which can be actual toys) and place the collected money in the cash register. When arriving close to potential costumers, play the jingle.

While playing with the canoe, children may start or stop the engine, feed ducks with loafs of bread and, because the boat sometimes gets damaged, fix the holes with the hammer.



36, 37 and 38. Makego vehicles: race car, ice-cream truck and canoe

This toy is a very good example of the integration of smart devices and open ended play, giving children enough options to choose from to define how and what they want to play,

<sup>12</sup> O'Shea, Chris. 2012. "Hello, We Are Cowly Owl." Cowly Owl. Cowly Owl. (visited 25 July 2012). <<http://www.cowlyowl.com/>>.

without imposing itself and its rules. The only limitation will be, of course, the device's battery and the user's imagination.

### 3.6. Screen Media Usage Concerns

Although there is some excitement around these new technologies and their possible roles as children's toys, there is also some criticism.

Concerns revolve mostly around the fact that technologies cannot replicate the real world and therefore cannot substitute interactions with the real world.

When children, or adults, experience flow, they may become so engaged that they will find it difficult to have a balanced usage of this media. Children may choose to spend less time playing outside and interacting with their peers, becoming isolated and sedentary.

Screen media is also stressful to children's eyes, spending too many hours using screen based media is not healthy and may lead to eyesight problems later in life.

Furthermore, because many technological projects for young children focus on intellectual stimulation and the acquisition of mathematical and language related concepts — are educational — many argue that, by focusing on adult-like activities, children's emotional and cognitive needs are ignored.

Another argument against these technologies is that children, in the computer or mobile device with internet access, are exposed to inappropriate content without parental supervision (Cordes et al. 2009).

Some criticism is valid and needs to be considered. Children are fragile beings that should be guaranteed quality playful experiences that do not harm their development.

One possible solution for duration of screen media usage, is giving the parents tools to limit their children's time using these technologies. One of the projects presented in the above section, Kapu Toys, provided one such solution. Parents can limit the time children play with Kapu Toys by defining a duration limit. When time is up, the application will stop. And, of course, there is always classical parental monitoring and the negotiation between parents and children on time spent pursuing different activities.

It is not up to technology to replace parents, but designers cannot ignore issues related to technology usage.

Projects and applications that focus on intellectual work for very young children, must be carefully built. Very young children should be free to play without suffering the stress of academic pursuit. Many child psychologists and experts are against teaching very young children how to read or count unless they demonstrate curiosity for these subjects (Resnick 2004, Montessori 1912).

Still, some of the criticism seems to be unfounded.

Children find original ways to integrate technology with play. In a report called "The technologisation of childhood? Young children and technology in the home" (Plowman, 2010), found that children's attitude toward technology in play varies according to availability, parental attitudes and individual disposition.

They also report cases where playing and technology were combined perfectly. They give the example of a boy that used internet access to download and print Lord of The Rings characters. He would then cut the characters out, glue them to cardboard and use them for role play with other toys.

Parents reported stimulating media usage so that children could master basic technological skills like navigating on the internet.

Many of the families interviewed for this report used technology to share pictures or videos of family moments (Plowman, 2010).

Another critique made to the digital realm and its forms of play is that, in many cases, giving the child tools for self expression or “choices” means decorating a flat or customizing a car. This is not an actual form of active participation and does not empower children in any way. Many times these are just options the player can choose from to make their already defined storyline more appealing (Lauwaert 2009).

### 3.7. Lessons From Literature

#### 3.7.1. The Montessorian and Frobelian Principles

As presented in the second chapter of this thesis, there are many software and mobile applications designed for children.

All the most influential software examples try to replicate construction toy-like mechanisms when building visual programming languages to serve as tools for self expression and learning.

They do this by using tiles, or programming blocks that fit to each other. Each tile corresponding to behavior that can be assigned to objects by dragging and dropping. Children can create their own characters, sprite sheets, sets and, by bringing it all together, computer games that can later be shared among peers.

Many of these programming tools were designed in an attempt to teach children programming logics. While children are building their own animations and games, without realizing it, they are learning abstract concepts and their implementation.

There is a goal beyond learning, there is what Papert called “hard fun”.

Fröbel and Montessori’s toys do exactly the same thing, but for younger children. While manipulating objects, children learn about concepts such as color, weight, shape, texture, numbers, quantities, etc.

Zuckerman (2010) gathered what he called “lessons from Fröbel and Montessori” to design digital objects for learning. His work is concerned with tangible digital objects rather than digital software.

Although when designing for mobile multi-touch devices one cannot explore many of the frobelian and montessorian ideas, there are still those we can.

Zuckerman defined the following frobelian and montessorian design principles:

- (d) Sensory interaction;
  - (e) Modularity;
  - (f) Simple aesthetics, appealing to children;
  - (g) The Developmental-appropriateness and continuity;
  - (h) Focus on conceptual manipulation (Montessori);
  - (i) Physical ‘puzzle-like’ aimed at specific configurations (Montessori);
  - (j) Physical language, aimed at many configurations (Fröbel);
- (Zuckerman 2010).

In mobile multi-touch devices sensory interaction is limited. Touch, for example, is limited to the flat screen and the device’s weight, smell, texture, shape and size can obviously not be altered.

For exploring sensory interaction one needs to rely on sound, and visual stimulations, exploring colors, shapes and sound textures. Interface aesthetics can, of course, incorporate the principles of simple aesthetics that are appealing to children.

Developmental-appropriateness can be assured by scaffolding complexity when it comes to the interface, interactions and the possibilities offered by those interactions. This ensures the user can learn to interact with the mobile application on his own and gradually start exploring more complex features and possibilities.

The last three principles defined by the two educators raise other types of issues. When Montessori talks about manipulation, she is talking about the manipulation of physical objects. One good example of this is the Montessorian method used to start



teaching writing to children. This method explores the repetition of certain movements and postures that we use to hold a pen or draw certain letters. This is actually a method that is still widely used in schools (Montessori 1912).

The same can be said about the last two principles, physical puzzle-like objects or physical languages cannot be replicated in mobile multi-touch devices. The only physical aspect about the device, is the device itself and its characteristics.

What one can still explore is the inherent logic of these design principles; in fact, many of the software and mobile applications discussed do exactly this. They replicate construction block-like logics to allow exploration, experimentation and multiple combinations of behaviors or elements. They did it so well that they became an extension of the popular construction toy in the world.

Some may allow for more configurations than others. Suwappu, for example, has limited configurations and, even though one can combine different character parts, when it comes to extending the experience with the mobile device, we are still limited to the content supplied by its makers. It is, for this reason, closer to montessorian principles.

Makego also explores specific configurations, but children can still be free to think of as many types of configurations as they can imagine. It better embodies an “open-ended” play logic, following frobelian principles.

These two examples, like Life of George, AppLingz or ZombieBurz, are perfect for another reason. They demonstrate ways to extend the physical experience of the device, to make it “tangible”.

ToonTastic explores some of these principles without expanding the device physically. By using ToonTastic, children explore narrative structures, exploring and manipulating related concepts like the conflict or the climax of a story. Its also designed with children’s developmental needs in mind and meticulously scaffolded for independent use.

In some ways these principles are also present in Ackerman’s recommended principles (Ackerman 2009) to design digital experiences for young children.

Granularity ensures developmental appropriateness and is also related to modularity, extensibility ensures an extended experience with different types of sensory interactions, linkage is also related to modularity and different possible configurations, recognizing that these may be different at different times and in different contexts and, finally, evolvability which is also related to modularity, developmental appropriateness and allowing different configurations and possibilities.

### 3.7.2. Design Guidelines

Assuring that young users have the best user experience possible, requires considering that we are working for users that may not know how to read, our end-users do not yet have their motor skills completely developed, our users are still growing and their interests and capabilities evolve and change quickly.

In this particular case, the purpose is to prototype features of an application that wants to behave as a tool to play with by creating and playing games.

As previously stated, toys cannot try to behave as static tools that impose rules. Toys must be prepared to be used for unexpected purposes, appropriated by their users in very different ways.

From her research with children for designing for mobile technologies, Druin talks about embracing the messy side of play:

“Don’t try to tidy up children’s lives. Consider clutterful design. Some design rhetoric presents technology in ways that either overlook messiness or see it as a means of tidying up the messiness of life. A more fruitful stance, particularly for mobile play innovation, might be to consider messy collections of technology and other resources” (Druin 2009, 119).

In evaluating the most important aspects to consider when trying to design an effective, efficient, emotionally satisfactory application for child’s play, audio instructions and prompts are essential. For younger children, that still do not know how to read or write, audio instructions need to behave as the guides of the application. Language used must be clear and not prone to misunderstandings.

ToonTastic makes this admirably well. The interface is structured so that children only have to focus on one activity at a time. Every time they choose one icon or label, entering contextual menus, audio explanations — that may be silenced or repeated — tell the child where she is and what she can do.

Audio prompts are the indications that confirm something is being done the right way or that something is not “allowed.”

These can work together for younger children and can be removed for older children.

Children are not the most patient users. When observing a child using a mobile device, one can see the child repeatedly selecting the same option or multiple options while the application is loading. This is why events should be programmed to happen on touch, longer contact of the finger on the device, and not on tap, as is common in most applications and all actions reversible. It also ensures that, if a group of children is using the device simultaneously, interaction will be less confusing and susceptible to mistakes. On touch, feedback that the specific icon has been selected must be immediate and clear. This gives the user the feeling of being in control and assures that the user does not lose confidence when exploring the application.

Because mobile devices are for short term use, interaction must be designed to be fast, easy and short (Druin 2009).

Multitouch gestures are not recommended and, if needed, should be used with caution. Children have difficulty coordinating their movements and find it very hard to perform fine motor gestures. This is also why interaction styles should be age-appropriate (interface type, menus, colors, etc.) and try to stimulate the development of these fine motor skills by involving the handling, manipulation and construction of objects on screen.

Icon labels must be placed on top of the icons. This is in reality, a recommendation for all applications that respond to touch, not only applications for children.

Placing icon labels on top, reduces the probability of the hand covering the label.

Druin also accentuates that applications that are planned for children need to consider other type of factors:

- (a) Parent-child relationships and group use should, not only be taken in consideration, but also stimulated;
- (b) Personal expression of ideas and appropriation should be seen as priorities;
- (c) Software and applications for children should try to find ways to “accompany” the user’s growth;
- (d) Efforts should be made to bridge the real and the digital world (Druin 2009).

## IV. Methodology

### 4.1. Introduction

If play is purpose-free, one needs to identify the key elements that could allow a child to face a context of an interface as a very organized “toy box.” Again, there is no point in trying to mimic the real world or real toys when what is being pursued here is a way for children to integrate logics of play and creativity into an application that can behave like a game.

These issues had to be talked over with children.

Most methods designed for working with children were developed in effort to develop educational software and applications (Druin 2009). Technology for educational content usually gets more attention from academic research as it is evident when we look at the amount and type of existing projects with this goal in mind.

From literature one can understand a lot about play mechanisms, but replicating some of these mechanisms in an application would be a useless attempt.

What technology can do, however, is give children tools to explore and play with in different ways. My goal was to create a simple tool that would let them take their creativity into the digital realm to create simple games to play and challenge others.

## 4.3 Applied Methodology

### 4.3.2 Initial Approach

In the process of definition and assessment of children's gaming content preferences and possible suggestions, I conducted a small study with a group of eight children (two boys and six girls) from ages six to ten in Escola da Várzea in Várzea, a small portuguese town close to the city of Leiria.

In my research I felt it was essential to listen to the children, not only to what they had to say, but also to how they responded to my approach to structuring the application's prototype.

This specific group of children was selected by the school teachers. In a few meetings I had the chance to explain the project and they suggested I'd leave the choice to their expertise and personal knowledge of the children.

My initial intent was to conduct careful cooperative inquire sessions by combining forces with a team of children designers.

Following Allison Druin's guidelines to have the group children work with and be the decision makers of everything related to content and, in the process, define the application's structure and main features.

I initiated contact with teachers in early January 2012.

Once contact was established with a teacher that was very interested in the study, I started preparing for the group sessions. Time was already short and, even though I had to work alone with the children, it would still give me the opportunity to follow most of Allison Druin's methods to lower both mine and children's social defenses so group work could start.

Parent authorization was asked and only after all parents had approved of their children's participation could the study begin.

By the time the authorizations were signed, children had reached a point in their school year when classes are shared with other activities. For this reason, they could only spare one hour a day for four days. I had to structure my work with them for this time span and rethink my methodological approach.

As previously stated, cooperative inquire is a design process where the final users are design partners. There are three methods to work with children (Contextual Inquiry, Participatory Design and Technology Immersion), designed by Allison Druin and her team, that seem to be the best suited for the type of feedback designers need from children.

Left without feedback from the children for a very long time, I started working alone, trying to determine from literature what type of information I could test without having the designs or prototypes.

When the sessions started I had only structured the application and that was what I was going to test.

Another aspect that forced me to adapt previously defined investigation methods with children was the fact that I had to work alone. There could be no one else in the room as the teachers still had their classes to give to the remaining students.

In four days, it would be impossible to make the children understand the whole project and start work in the project. With this in mind, I decided to take what I already had to them.

Drawing from Alison Druin's cooperative inquiry methods, specifically participatory design methods, I adapted my approach to what I understood were the new constraints to the approach I had initially designed and prepared.

Taking into account that participatory design considers design as research and "attempts to examine the tacit, invisible aspects of human activity" and that in participatory design, the emergent design, constitutes the research I set out to adapt my methodology, there is more to participatory design than prototyping.

In literature we find examples of the implementation of participatory design methods (ethnographic observations, interviews, analysis of artifacts, protocol analysis), to design work arrangements or work environments. These examples were the basis of the participatory methods that today are used by teams with children (Druin 2009, 20).

In my case, what I could test and ask from the children was for them to experiment with my application's "play flow."

### 4.3.2 Preparing The Sessions

Explaining such a complex process to children is not an easy task.

From my meetings and conversations with the teachers, I learnt that my future work group colleagues didn't have that much access to new technology, which required preparing an introduction — I later found out this wasn't exactly the case nonetheless, before talking with the children, this was the information I had to start working from.

I was careful choosing what to dress. For this type of situations, informal clothing is the best choice. This helps reducing children's perspective of the adult as an educator and authority figure and feel less intimidated (Druin, 1999).

In the first session, I wanted us to get to know each other and become a little bit more comfortable with the new situation.

Following first introductions, I would present myself, explain them what we were going to do together, learn how much they knew about the technology what kind of games they liked and what they liked to play with. I also needed to stress that there would be no second names and that I wasn't a teacher, I was only "Filipa."

After this casual introduction, I hoped my partners would feel comfortable enough for us to start talking about video games and play so I could then set out to talk about game characters and their suggestions and what we needed to have to create a game.

The second session would start from the suggestions and ideas that the children had given me the previous day. These would have to be carefully printed and organized to strengthen the fact that I was really going to take their opinions into serious consideration. I hoped that this would make the children feel more confident and start assuming their role of partners.

We could then begin to do the most important part of these sessions: play with our new characters by customizing them through art supplies and making them ours.

Unfortunately, I knew I couldn't be a part of this part of the process. I needed them to work in groups, chosen by them. Being the only adult in the room meant I couldn't take "sides" or participate in any of the groups. It also meant that I was the only person in the room with them that could carefully observe and register this process. This was another great change to Allison Druin's guidelines, that clearly state that adults should work alongside with the children to form "Intergenerational Design Teams" (Druin, 1999).

Each group would draw by luck a number of papers where their suggestions were printed. This assured that no one would get to choose their favorite.

Once the play was over, we could talk about their choices and "processes".

Following our previously defined "elements of the game," we could then set out to repeat the same steps of the first day, with a different game aspect. It was important that this order made sense to me and my previously prepared structure, and to them and our conclusions from the first session. Fortunately, this turned out to be simpler than I had previously thought.

These steps would be repeated throughout the following session until we felt we could start playing a game.

That would be our goal for the last session. This way we all could have some sense of closure and of accomplished mission. Furthermore, it would give me a chance to see how they enacted what was supposed to be an electronic game in the real world: how they understood it, approached it and appropriated it.

### **4.3.3 Materials Used**

All the sessions were videotaped and analyzed afterwards.

Photographs, of the process and results were also taken, by both me and the children. The camera also proved to be a valuable tool to document the steps of the discussions. I would write children's opinions and suggestions on a big blackboard and photograph them afterwards, allowing the debate to continue with no need for interruptions.

Materials like plasticine, coloring pencils, glossy paper and child-safe scissors were also given to the children. These were to be used to assess their response to designing from their previously given suggestions, so that they could give shape to their own ideas.



#### 4.4 The Group Sessions

The school is a very typical small Portuguese town school. There are only two teachers for the four grades.

When arriving in the school for the first session, I already felt like a sensation among the kids. I had to go to each classroom to announce my arrival and children promptly rose up, even before the teachers called out their names.

The two teachers and the supervisor were extremely cooperative and had already prepared a room for us. All chairs and tables had been put beside the walls, leaving us with enough free space to work.

##### The First Session

I invited the children to sit on the floor and form a circle, while I set up the video camera.

Simultaneously, I started talking to them to make them feel more at ease.

I could see they looked at me with curiosity, but still felt a little intimidated by my presence. Slowly they started talking about themselves and making jokes. I had to wait until they decided it was my time to start.

Exercising control over the impulse to impose authority is very hard to do; but, if we don't want to be seen as authority figures, we cannot behave as such. Although I did manage to avoid this in many situations, there were also others in which that was not the case.

When they finally turned their attention to me I took the time to introduce myself and asked them if anyone had told them what we were going to do. The most extroverted children quickly answered "a game!".

In these group situations, children with more outgoing personalities — like adults — tend to take charge. This is another aspect of working with groups of children that adds some difficulty to the process. If we don't want the shyer children to feel alienated, we sometimes have to find ways to give them opportunities to speak up.

The group was composed of six girls and two boys. Ages varied between six and ten years of age. The majority was eight years old.

I then explained what we were going to do together. I presented the process like someone who is asking for a collaboration.

I asked them about their relationship with technologies. Most of them didn't know the term "multi-touch" but all had used or seen someone using a smart device with this technology and some of them had never played a video game.

While talking about video games, I took the opportunity, to ask them what they thought was needed to build a video game. I explained I wasn't talking about "computers," but the "pieces" that make up a video game.

With somewhat vague answers and examples we managed to reach one conclusion: we need characters that perform actions somewhere with a defined goal.

This is, of course, a simplified version that took some of my help and the capacity to interpret what they were trying to tell me.

As expected, older children tended to give me more structured answers, while smaller children had a tendency to take almost anything and turn it into "nonsense".

This particular situation was very interesting because I witnessed the older and the calmer children impose their authority over the younger or more irreverent children. Expressions like: "Oh! Stop talking nonsense, that's not what she wants," were heard in the room.

I then asked them about characters and what could a character be. They energetically gave me tens of suggestions until I had almost run out of space and was having difficulty keeping up with them. At a certain point, one of the older girls said: “I think that is enough,” in a very wise tone of voice and everyone seemed to accept that it was time to move on (see Appendix B).

After this first brainstorming session we discussed some group rules (see Appendix A). I sat back down with them and asked them what they thought about that. Again, to my surprise, the majority agreed.

All the rules were defined by the children. They defined a total of eight rules to which another one was added the following day.

These were actually very reasonable rules like, for example: “wipe your feet before you come in” or “respect the material”. The rules turned out to be very useful because every time things started getting out of hand, one of us would point at the rules and, because they were “our” rules, everyone calmed down.

### The Second Session

For our second session, I wanted to see how they responded to the fact that they would be working from their own ideas and materials. I brought, every idea they had proposed — including the rules — printed on paper.

I told them to organize into two work groups. These workgroups were needed so they could share the art supplies. They were asked to draw four pieces of paper, each corresponding to a different characteristic for a character. They responded very enthusiastically to the fact that they were invited to elaborate from their previous materials to create new ones.

My fear that they would completely ignore the context of those characters, was unfounded. They were very interested in the challenge.

Whether it was because of the challenge itself or because they were working from their own materials, I cannot say. The result were two very elaborate characters.



39. Children working together



40. Children working together

Group work turned out to be an issue. The older group elements took charge and ended up ignoring some of the suggestions younger elements brought.

### The Third Session

Session three was all about what a character can do and where could the action take place: the settings. Again, I found myself surrounded by a group of very enthusiastic designers.

A very diversified list of actions and possible “places” or worlds was the end-result. They insisted on creating these worlds and asked for art supplies to bring some of them to life. Again groups were formed and the results were rich illustrations built with plaster of Saturn and the North Pole (see Appendix C and D).

### The Fourth Session

The fourth, and last day, was about bringing everything together to enact the game. To each character, actions were assigned.

We also determined a very simple point system. Levels were drawn as maps with simple cut outs of the places defined in the previous day.

All the older group elements, the majority, could easily remember the defined rules and settings. Sometimes even having peaceful arguments about how certain situations could be resolved or which solution appeared to be the fairest.

This was the “messiest” session. They were very excited and assumed their roles with enthusiasm.

The two youngest members of the team, although very participative in oral discussions, seemed to prefer collaborating amongst themselves and play freely instead of cooperating with the group. They took great interest in working with art supplies but found greater difficulty in understanding the work process. The fact that the older group elements preferred to work amongst themselves, also didn’t help.

Shyer children grew more confident and participative from session to session. One of the biggest challenges was trying to keep them from calling me “Teacher Filipa.” This was more frequent with shy girls aged eight years old.

Generally, all team members were very cooperative and later reported to the teachers having enjoyed the experience.

## V. Discussion

### 5.1 Research With Children at Escola da Várzea

#### 5.1.1. Challenges of Working With Children

Working with children is a very rewarding but also challenging experience. Part of the difficulty comes from acquired habits we develop when establishing our relationships with children. There is a side to this relationship that involves inspiring authority and respect. This is also how children see adults in a first contact and they respond accordingly.

It is recommended that researchers, working with children, dress informally (Druin 1999). I tried to inspire sympathy by dressing as informally as I could and adding some humorous details to my clothing: pink sneakers and some pins. I hoped they would see me less as “the adult in the room” and more like the friendly girl that was going to work with them. The setting of the room also helped the process of establishing an informal relationship. We all sat on the floor and they immediately started talking with me about their lives.

In the process I soon realized that another challenge could be speech. If we want to be understood, discourse needs to be leveled. Evidently, we cannot expect children to do the same. This may sometimes cause situations to take more time than previously expected. We may need to make an effort to better understand what they are trying to tell us, and vice-versa.

While initiating a conversation about games, the discourse used was an issue and so were the contents. I resolved the situation by suggesting replacements until they agreed that a specific word would work for all of us. They used specific examples of games they knew as references and had difficulty in generalizing roles. For example, when asked about what they thought was necessary to build a video game, one of the girls started talking about the plants in a game, she was obviously talking about the obstacles.

Dealing with work groups was the most difficult task.

As reported by Vaajakallio et al., children with dominant personalities, more extroverted or, simply, older, tend to lead the group and make the decisions. Also, if there are two children of the same age in the group, they will tend to partner and work in pairs, ignoring suggestions given by their peers.

Younger children, if left alone in a group of older children, will seek isolation unless stimulated to participate.

Adding to this there are personal wills and moods that may be hard to manage. Children, feeling left aside by their colleagues, respond with aggressiveness and anger. There were no violent situations, but there were some hard feelings that had to be dealt with.

These situations cannot be given too much value, but they cannot be ignored either.

I tried changing the group’s balance by asking them to change work teams for the third session. The new groups worked better by joining the two older children of the group with the two youngest. The elements of the other group were all the same age, therefore, there were less conflicts.

When forming work teams with children, it is recommended that children are not younger than seven (Druin 1999). One of my group elements was six years old. A very sweet and shy little girl.

The other younger element of the group was a very lively boy aged seven.

The two children showed a tendency to isolate themselves from the group and engaging in solitary work. When they weren’t working alone, they would start playing with each other sometimes even installing chaos in the room.

Evaluating the results of these sessions is also not always simple. It is very important to continuously observe children as they work and participate in sessions and, from their expressions and reactions, what they understand and say, assess what is engaging to them. Results may not be clear or come in expected ways or from expected conducts.

### 5.1.2 Children's Preferences

When I started the group sessions, I had already defined some functionalities. It was with these functionalities in mind that I prepared for the sessions.

My initial approach was closer to a structured application that offered children the possibility to build simple games by following defined steps.

I wanted it to be a tool for self expression, but I needed the children's help to understand how.

In the first session we talked about characters and I collected their suggestions for what and how could a character be. Children's suggestions were clearly connected to their own personal preferences and contexts. Some of the answers illustrate this perfectly. They suggested, for example, that characters could be in mourning<sup>13</sup>, stylish, "Living-dead" or models.

The group was making so many suggestions and so energetically, I almost didn't participate in this process and found it very hard to write everything down for everyone to see.

The majority of the children's proposals were behavioral ones: evil, mean, good, fool, energetic, among many others, which can be applied to any type of character.

They also proposed many physical characteristics.

One of the interesting aspects about the children's proposals for the character's physical aspects, was that they never considered the character could be a car or an animal, even though we had previously talked about playing racing games.

It was only during the following session that they started working from their previously proposed characteristics.

Even though groups weren't exactly working (or playing) together, I could clearly see all the children were equally engaged in the task at hand: Happily talking, exchanging materials or having argumentations on how to best represent certain aspects of the characters. This was further evidenced when they decided they wanted to repeat the process for all the elements in the game and asked to bring their own mobile devices to photograph the results.

Children's proposals for actions demonstrated they had some notion of how a video game worked. Jumping, running, flying, falling apart, exploding, hitting, are all very typical actions one can perform when playing video games.

There were also more original proposals: Vomiting, hugging, becoming smarter or dumber, scaring, putting on make-up, were some of the most original ones.

Settings were also very diversified and I could see that some of the older children were trying to give context to previous proposals.

They can be separated into: generic places, countries, outer space and fantasy worlds.

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<sup>13</sup> Black or dark clothes worn as a (conventional) sign of grief of sb's death.  
From "mourning." Hornby, A. S.; Cownie, A. D. (C. E.). 1993. Oxford Advanced Learners Dictionary. Oxford: Oxford University Press.

### 5.1.3. Conclusions

Even though time was limited, the solution and methodology found proved to be effective in answering some of my research questions.

From my team of young designers, I gathered very important information to work from. By the end of the four sessions I had my hands full with ideas and elements to work from and integrate into the prototype. I also had a different perspective of how I could structure my application to become closer to a tool for playing.

The group work sessions, gave me the opportunity to observe children play while following the structure inherent to the application.

By observing an enthusiastic group of children produce materials with art supplies to create a game, I started evaluating ways to integrate this possibility as one of the main features of the application. For this feature, prototype two different age adequate interface layouts and correspondent interactions.

The suggestions given by the children in our discussions also constitute a very reach collection of ideas I can integrate in the application to help my users bring their games to life.

Behavioral aspects for the characters can be designed to behave as elements they can use to finish their designs and add emotional expression to the characters.

The same is valid to actions. The sets may also be integrated as an option or as backgrounds for children to use freely and distribute obstacles and other game elements on.



## 5.2. The Prototype

### 5.2.1 Introduction

The prototype is still under development and will go through many changes and improvements until its final version. Its purpose is to carefully perfect the interface and defined interactions so a child, older than four, can work its way through it in the easiest and fastest way possible.

In the present moment, there are several sketches prepared to be tested in the running prototype.

There will be two versions of the prototype corresponding to the two different layouts: one for children aged between four and seven years old, and another for children older than seven.

The device chosen was a tablet, for children, a larger area of interaction, is always better. It is less prone to mistakes and leaves enough space for buttons and simultaneous use by multiple users.

It is also the most suitable mobile platform for “clutterful” design (Druin 2009). Children can manipulate objects on screen with more ease and build more complex things.

The tablet chosen was the Apple iPad, simply because we have access to one.

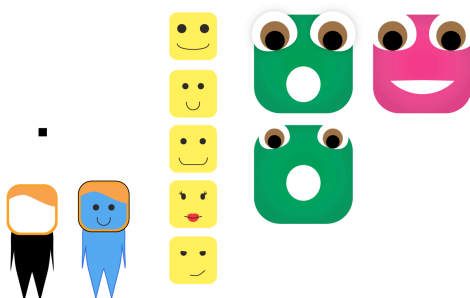
It will all be done in collaboration with a programmer since I do not have the knowledge to build it myself.

Literature calls for systems that enable children to integrate the real with the digital realm. The process of designing the prototype went through several stages to be where it is now. Initially, while gathering information from research sessions with the group from Escola da Várzea, the focus was turned to their suggestions. The goal, then, was to implement as many suggestions as possible into one working prototype.

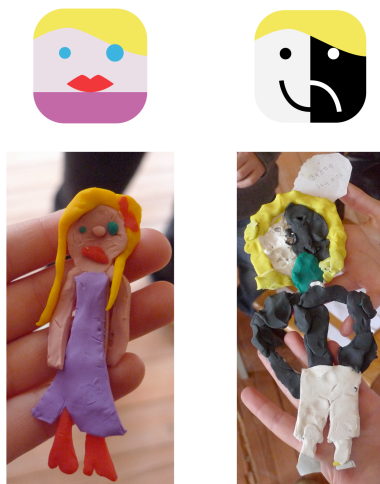
Finding ways one could make sense of so many different suggestions, turned out to be an obstacle. Given the children’s enthusiasm around character customization, the initial studies revolved around that feature by designing character shapes that could adapt and serve as many purposes as possible.

Deriving from the construction block logic, the intention was to create pieces that could be used to make whatever character the children wanted to play with in hope that, by starting to categorize the physical traits, other forms of categorization could be found for the other elements and children’s proposals.

The first sketches were “LEGO-like” characters that integrated the characters created by my young work group.



#### 41. First Character Sketches



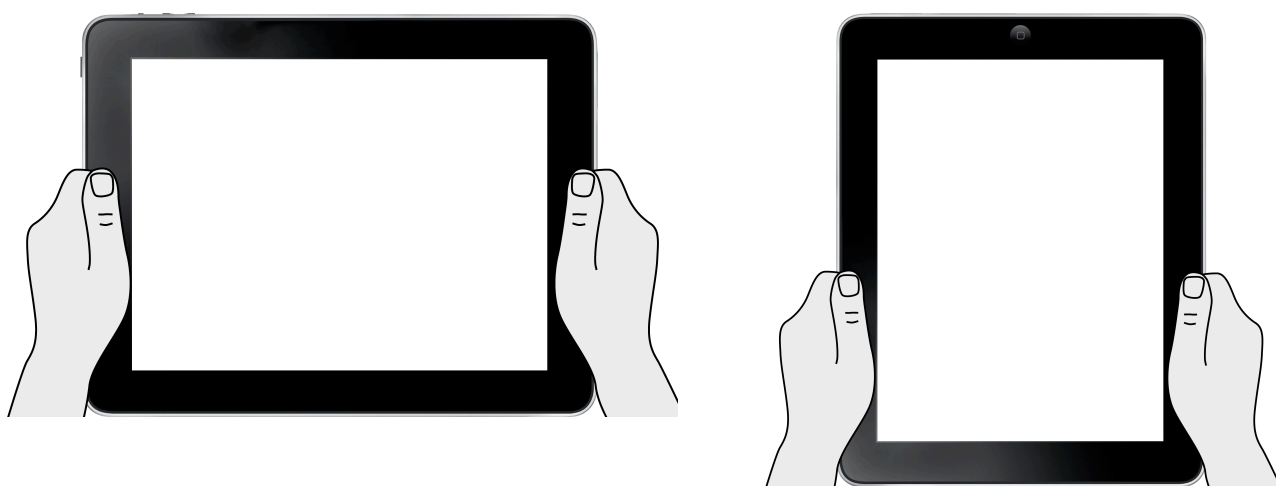
**42 and 43.** Character sketches derived from children's suggestions:  
a one-eyed stylish dwarf and a smart and thoughtful zombie

The problem of this approach is that, the initial aim — designing a digital toy — was lost. A second look at the sessions structure, revealed how engaged children were while preparing the game's elements, carefully building the characters and preparing the settings.

### 5.2.2. The Final Prototype

The focus shifted from the individual proposals, to the group's behaviour. By carefully dismantling the sessions, one could easily realize that it would be more relevant to think of ways to import and integrate children's creations, drawings or collages into the a game.

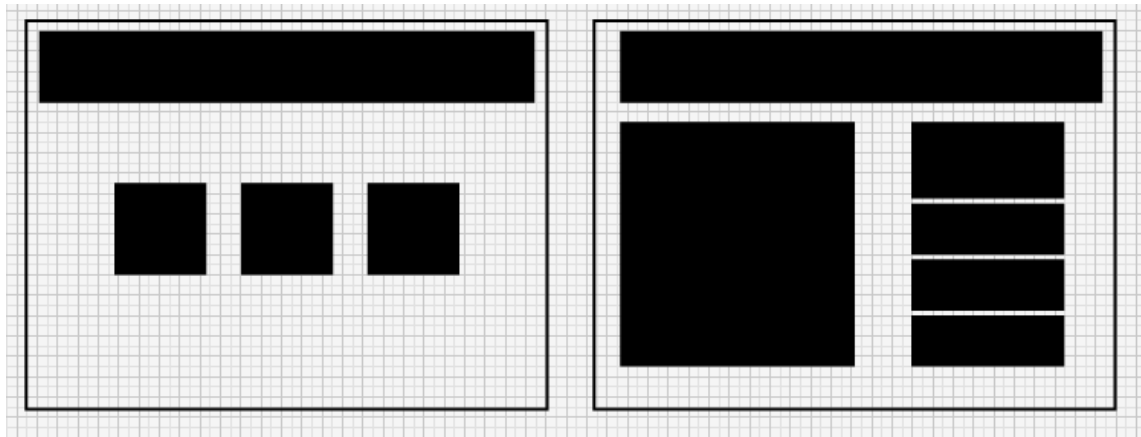
A five year old child's hand size varies between 7 and 10 cm<sup>14</sup> approximately. Using these measurements as reference, and observing children holding tablet devices, one may conclude that, for the children's small hands, the most stable position for the tablet, would be in landscape mode.



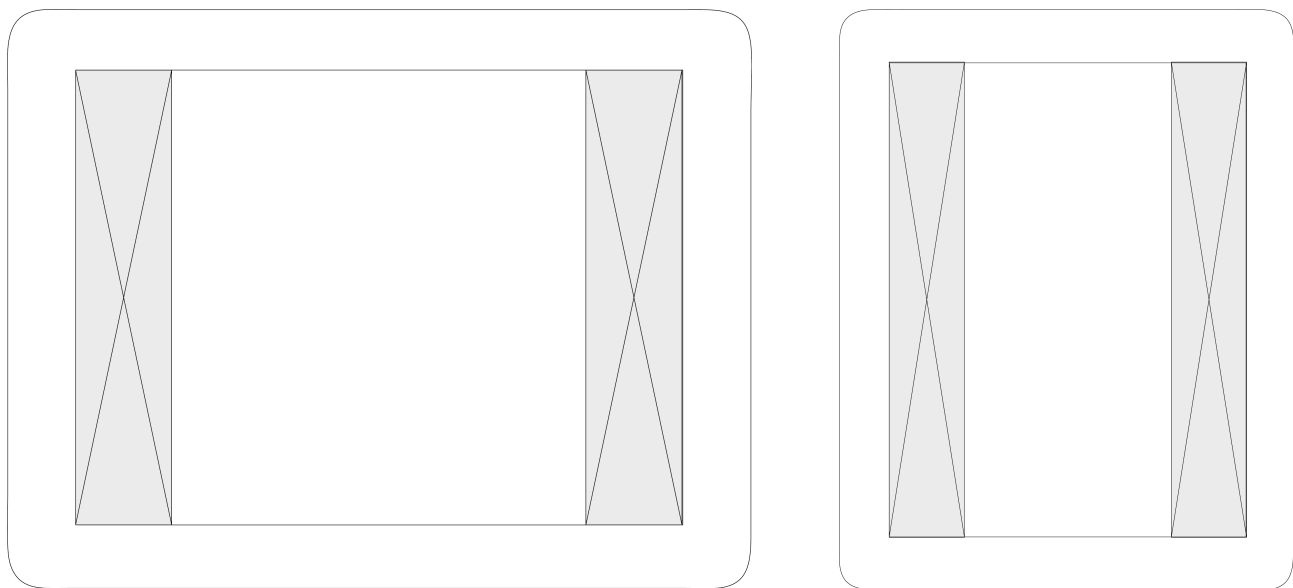
**44 and 45.** Comparison between child's hand size and tablet size.

<sup>14</sup> Snyder, Richard; Spencer, Martha; Owings, Clyde; Schneider, Lawrence. 1975. "Physical Characteristics of Children: As Related to Death and Injury for Consumer Product Design and Use Final Report Contract" in UM-HSRI-BI-75-5 Final Report Contract FDA-72-70 May 1975. (visited 27 July 2012) <[http://www.123rf.com/photo\\_12410133\\_childs-hand-with-index-finger-pointing.html](http://www.123rf.com/photo_12410133_childs-hand-with-index-finger-pointing.html)>

This second stage's sketches focus on designing the application's screens by asking where does the user start, where does he want to go, what does he want to do, etc. These second sketches were concerned with the general flow of the application, making sure the user wouldn't get lost in possibilities.



46. Touch Areas, First approach: Same application screen, different age span.



47 and 48. Preferred interaction areas for easier thumb reach.

This decision process brought the prototype's focus down to: scaffolded or layered design (Druin 2009, Gilutz 2010) and enabling the user to create and share content (Druin 2009). This specific prototype is only concerned in testing these two aspects. It revolves around assuring that the user is able to import his real life creations as game characters, and that there are, for this specific case, two different interfaces with the same functionality for different age groups.

The tables represented in figures 49 to 53, establish use case briefs and user goals. These briefs and goals are the result of different experimentations and different layouts. Here one can already find the data used to design the current version of the prototype.

### Screen 1 - Younger Users

Actors	Task-Level Goal	Priority	Briefs
Users	Take Picture	1	User takes picture.
Users	Exit	3	User exits screen, returning to previous menu (set).
Users	Next	2	User enters "Edit Character" Screen
Users	Previous/Back	2	User returns to previous menu.

### Screen 2 - Younger Users

Actors	Task-Level Goal	Priority	Briefs
Users	Confirm	1	User confirms that the automatic selection is correct.
Users	Retry/Undo/Cancel	1	User retries picture, returning to "Take Picture".
Users	Exit	3	User exits screen, returning to previous menu (set).
Users	Next	2	User enters "Edit Character" Screen
Users	Previous/Back	2	User returns to previous menu.

### Screen 1 - Older Users

Actors	Task-Level Goal	Priority	Briefs
Users	Take Picture	1	User takes picture.
Users	Exit	3	User exits screen, returning to previous menu (set).

### Screen 2 - Older Users

Actors	Task-Level Goal	Priority	Briefs
Users	Confirm	1	User confirms that the selection is correct.
Users	Retry/Undo/Cancel	1	User retries picture, returning to "Take Picture".
Users	Exit	3	User exits screen, returning to previous menu (set).
Users	Assign Character	2	User specifies that selection corresponds to character.
Users	Assign Obstacle	2	User specifies that selection corresponds to obstacle.
Users	Assign Set	2	User specifies that selection corresponds to set.

### Screen 3 - Older Users

Actors	Task-Level Goal	Priority	Briefs
Users	Cut	1	User selects areas of image to be imported.
Users	Exit	3	User exits screen, returning to previous menu (set).
Users	Assign Character	2	User specifies that selection corresponds to character.
Users	Assign Obstacle	2	User specifies that selection corresponds to obstacle.
Users	Assign Set	2	User specifies that selection corresponds to set.
Users	Cancel Character Selection	3	User cancels selection.
Users	Cancel Obstacle Selection	3	User cancels selection.
Users	Cancel Set Selection	3	User cancels selection.

49, 50, 51, 52 and 53. Actor Goals and Use Case Briefs.

The first prototype sketches were mostly concerned with the organization of information and layout distribution.

Having defined that the application would stay in landscape mode for smoother interaction and better assure the safe handling of the device, along with preferred interaction areas, the results can be found in figures 54, 55, 56 and 57.

Both versions have large icons and try to leave space for unexpected hand movements due to lack of fine motor skills.

In the presented versions the icons are the same size. The initial idea was to keep the application coherent but simply allowing more styles and types of interactions.

Although both versions feature importing the children's creations, they try to do so in different ways. Younger children are given less control. They will have to go through imposed steps to import different elements of the game into the application: characters, sets and obstacles.

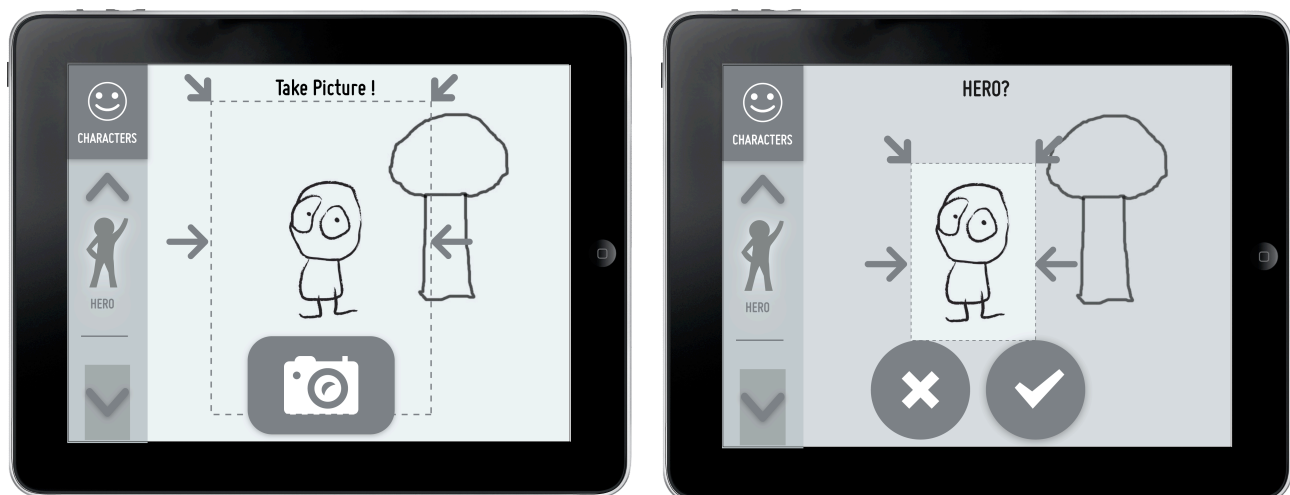
When photographing their drawings (these will have to be done in white pieces of paper), it is recommended by the application (through audio instructions) that children place it centered in the displayed rectangle. Once photographed, the rectangle adjusts to the shape's size. Once the child is happy with it, she can move on or try again.

Older children can import several elements simultaneously. They may draw the area corresponding to the objects and, afterwards, assign each element a job by dragging and dropping the correspondent icons.

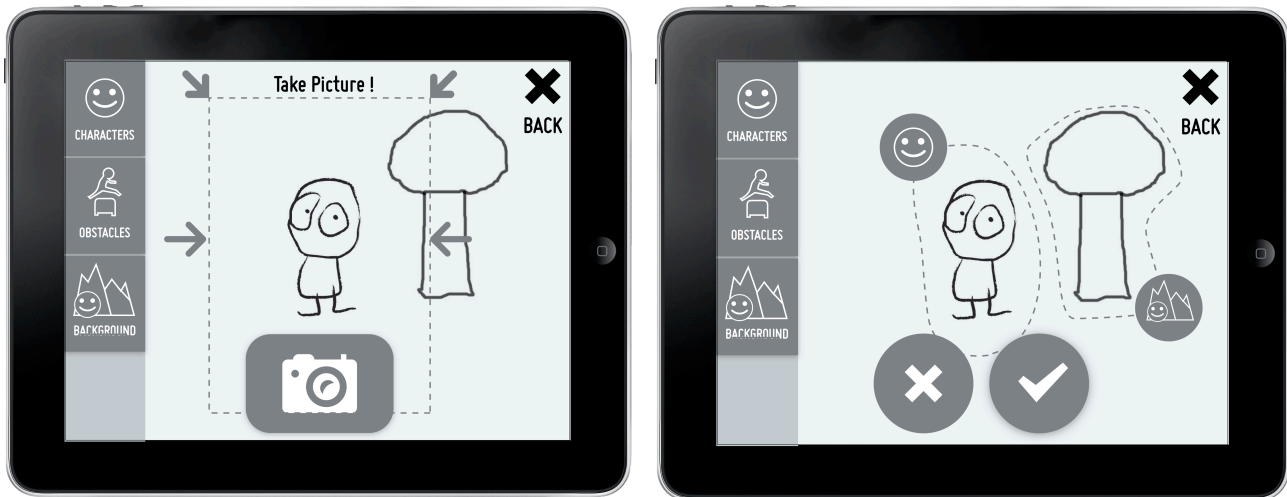
Visual feedback, although not represented here, will be given immediately.

The prototype, in this stage, will not have sound.

The most striking problem with these versions, is the placement of the camera button in both versions) because children have small hands. Icon size can also be gradually reduced from one version to another, this way older children can enjoy the application in more engaging ways because space won't be so problematic. It will also help them feel they are "growing up" because the overall aspect becomes less "childish".



**54 and 55.** Intermediate sketches for children younger than seven. Here, icons are still placed in the center.



56 and 57. Intermediate sketches for older children.

Text placement in these versions — and in figures 60 and 61 — is not ideal. As stated previously, text should be placed above the icons to ensure fingers do not cover relevant information.

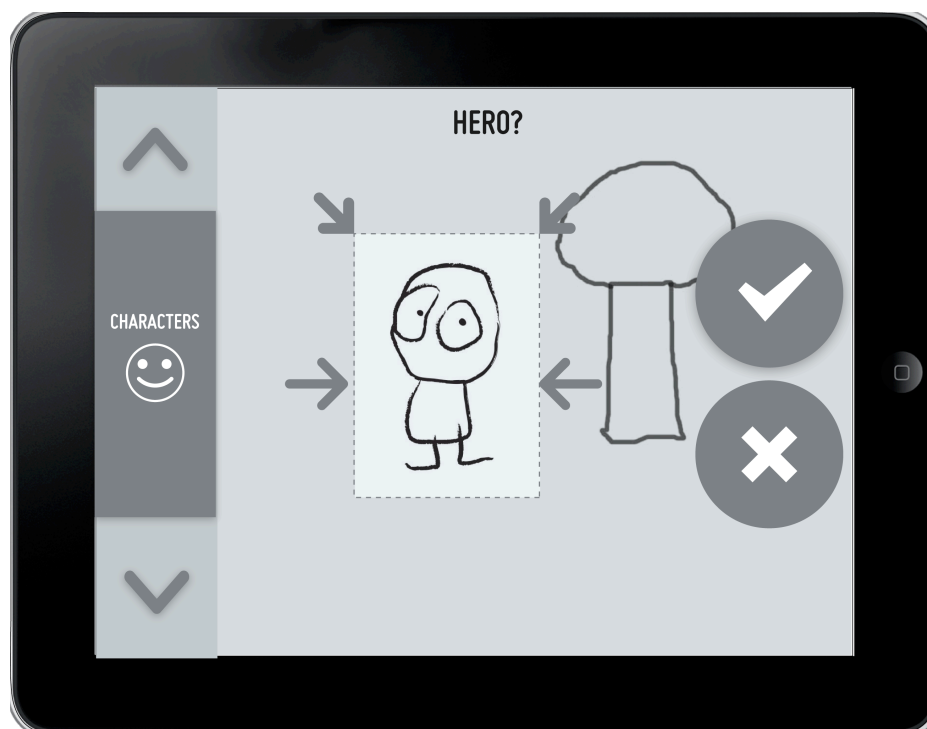
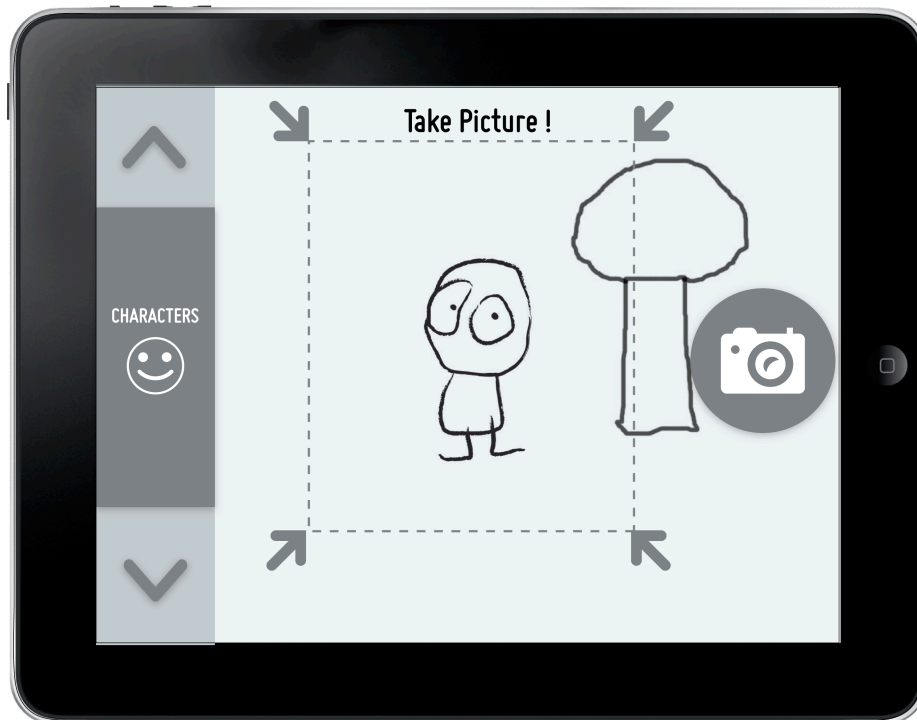
Interactions are still too complex.

For younger users, one should also simplify the applications's flow. It is always better to present one function at a time and avoid relying on visual hierarchies.

Older children, in this case, are expected to select the area to be cut and then select the corresponding game element. This could be simplified by allowing them to drag-and-drop the icons to the desired selection.

The current versions of the interface for young users can be found in figures 58 and 59.

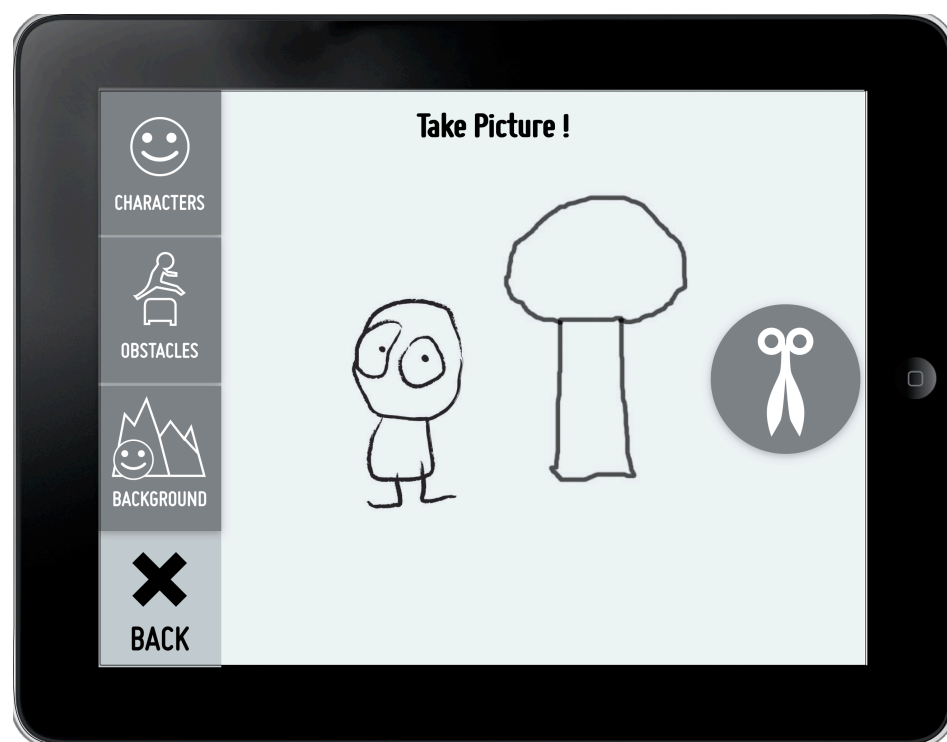
Differences are clear: icon placement has been changed to ease interaction while holding the device, the child is only expected to deal with one game element at a time and text is now placed on top of the icon.



58 and 59. Screens for younger users: Importing Characters

Designing for more complex interactions was obviously more challenging. The steps expected from the users to import game elements are represented in figures 60, 61 and 62. Not all aspects are resolved in this version because the concern, in this particular case, was resolving each problem at a time.

Icon placement has been reconsidered to leave more space for the child's creations, this way, the user is free to select the areas to be imported without so many constraints. Here, the user also has a way to cancel any desired selection to perfect it or try again.

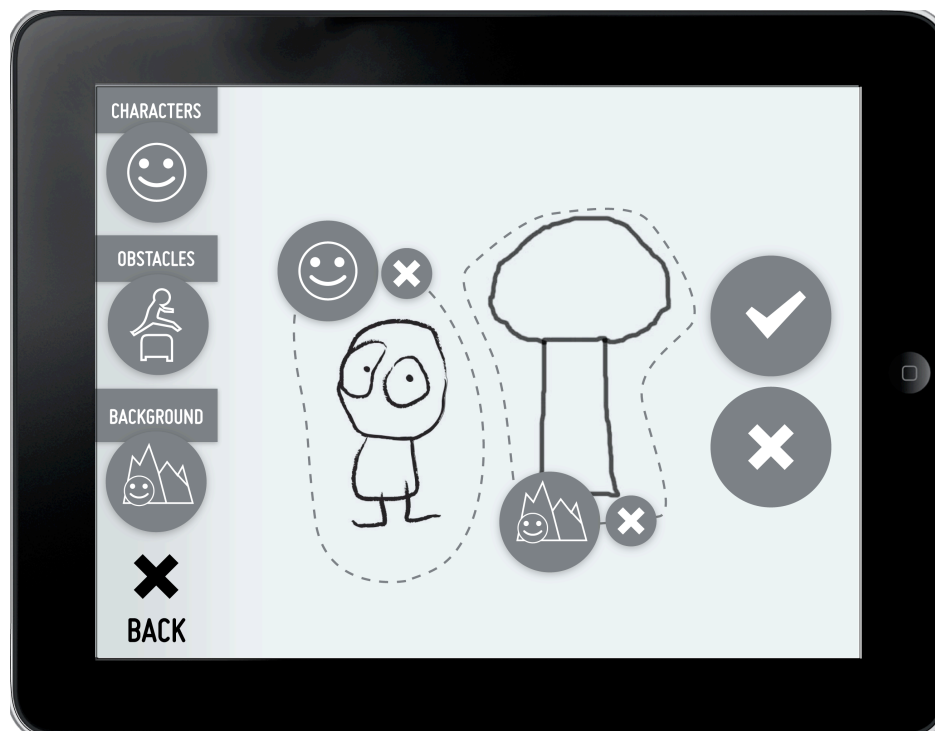


60 and 61. Screens for older users: Importing Characters.





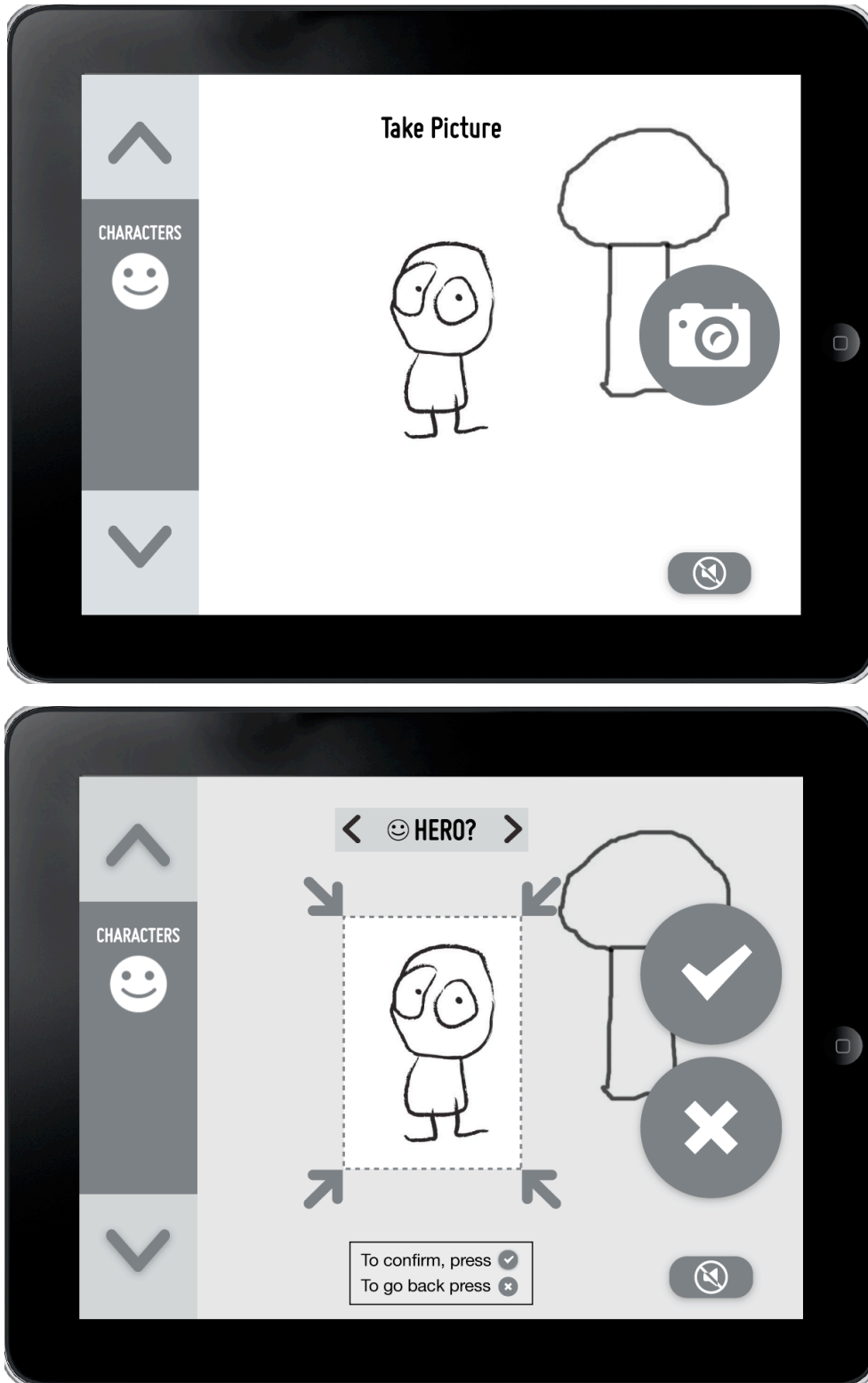
62. Screens for older users: Importing Characters.



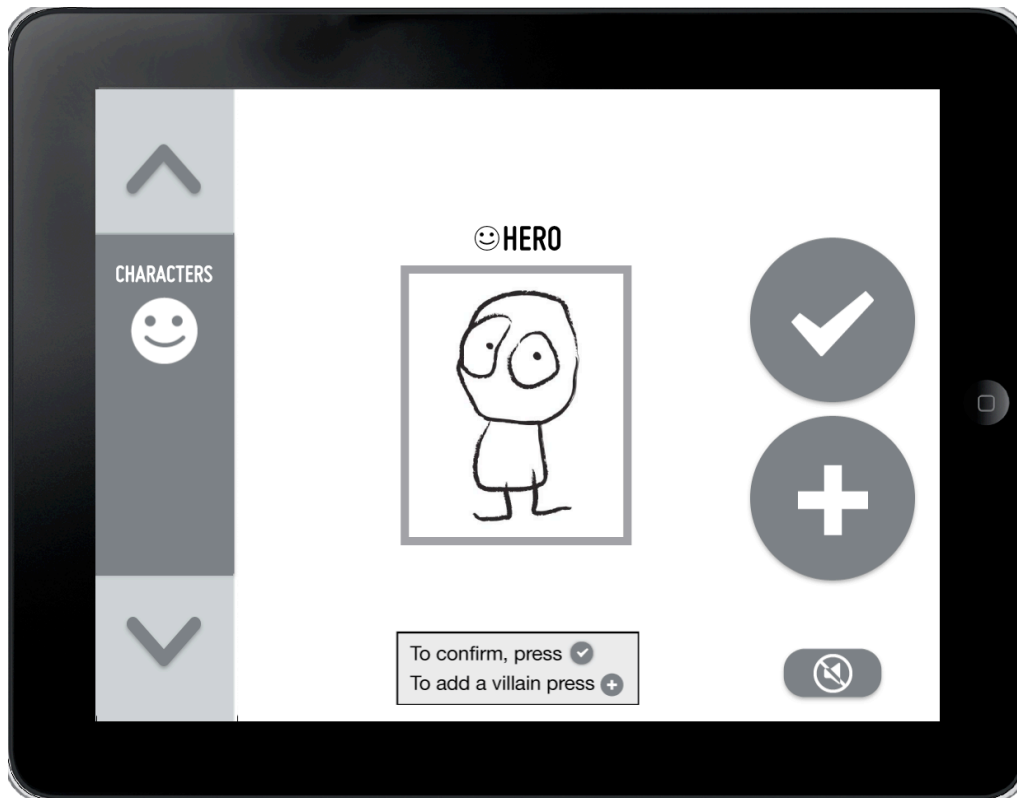
63. Screen for older users.

Figure 63 shows a more advanced version of the interface. Elements have been redesigned to help the user understand the different ways the user can interact to assign the game elements. Simplifying interactions requires making many attempts to reach a satisfying result.

The most recent versions of the interface can be found in figures 64 to 70. For younger users, the interface was slightly perfected. Icons are now larger, and the user may, after taking the picture, chose what type of character is being imported by selecting from new options above the bounding box that corresponds to the selected area.



64 and 65. First and second screens for younger users.

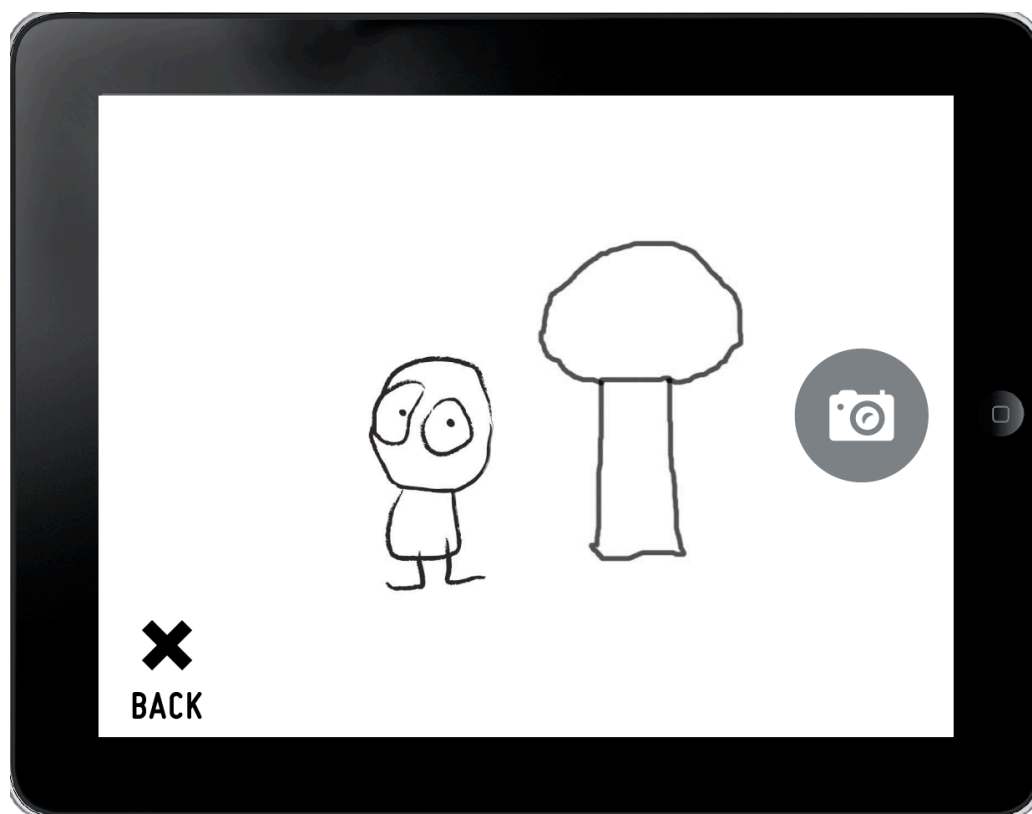


66. Third screen for younger users.

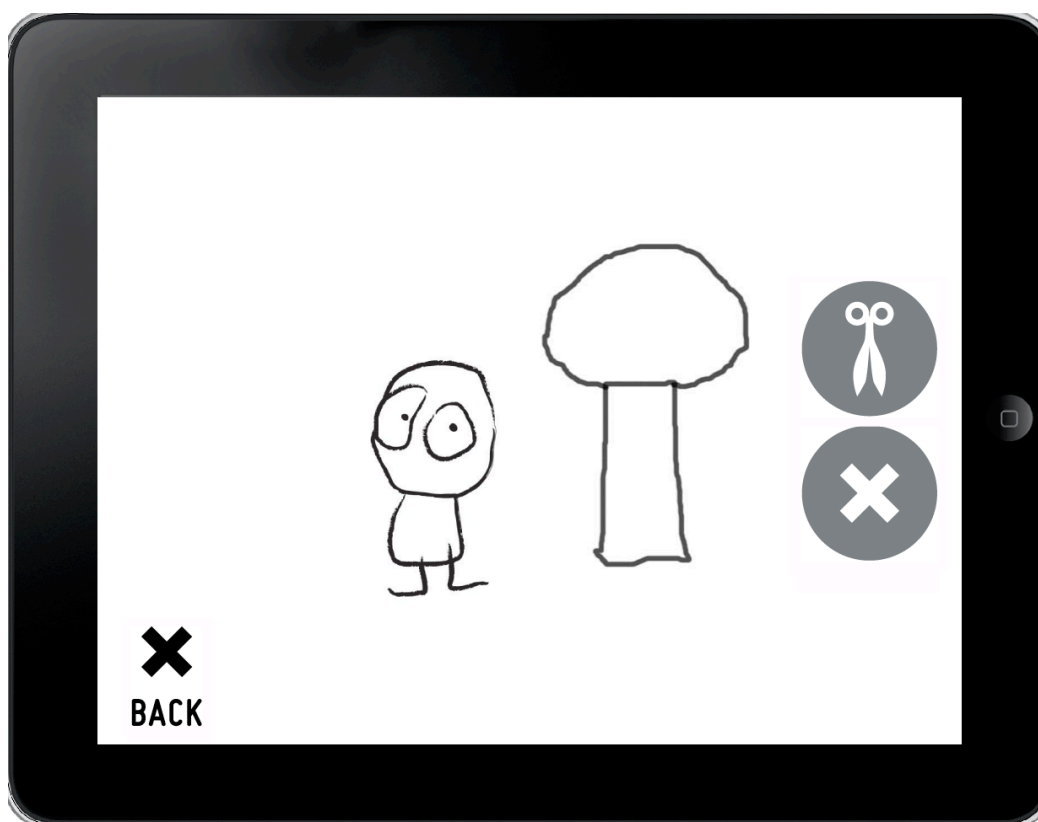
The version for older users went through more transformations. The initial screen was redesigned to include only the essential elements: the “back” and “take picture” buttons. This way we leave free space for the picture that is being taken.

Once the picture is taken, the user may choose to crop it or to try again, by pressing the “cross” button. If the user chooses to crop the picture, he can make several selections and then assign them a game element by dragging and dropping the corresponding icon. Once the icon is dropped on the selected area, a button appears allowing the user to cancel and either assign a different game element or discard it.

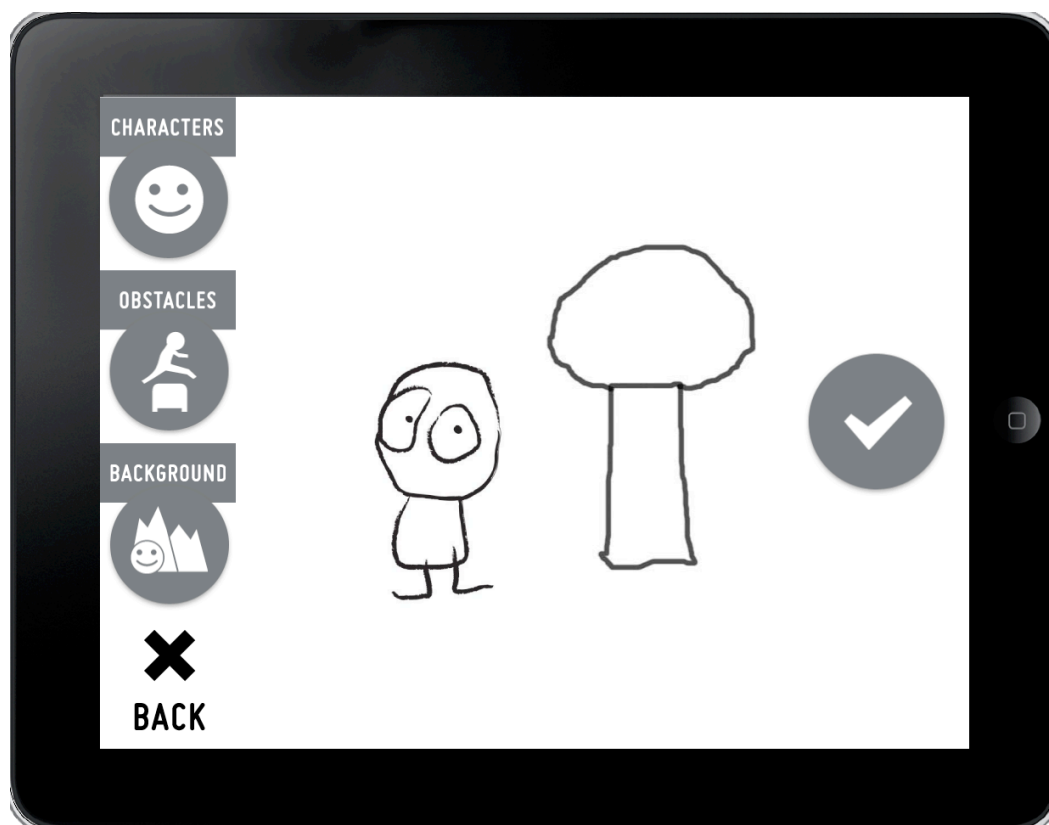
This process has already allowed us to perfect the interface considerably. As it is now, it will allow us to further refine and test it.



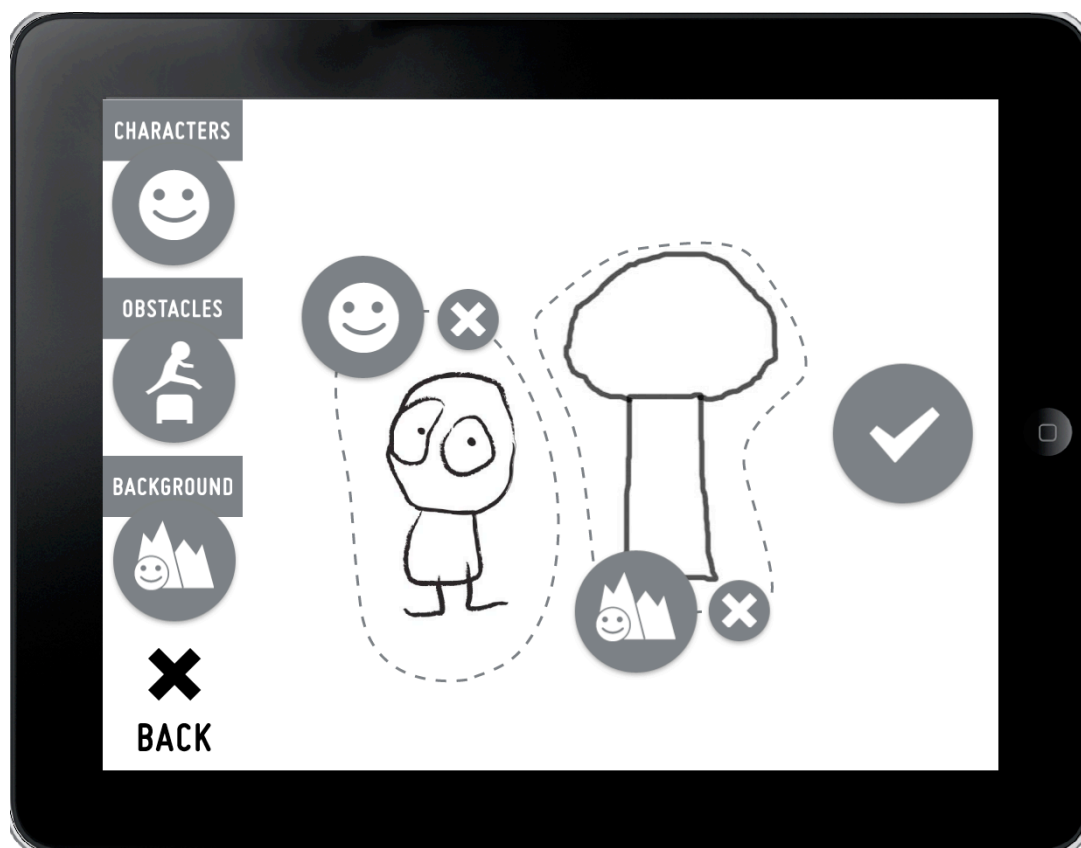
67. Initial screen for older users.



68. Second screen for older users



69. Cropping.



70. Assigning game elements.

## VI. Conclusion

Research on play and technology is anything but new. It is only because of the rising popularity enjoyed by mobile multi-touch devices, that this topic acquired a different relevance.

Either because it was expensive and not widely available, or because it was used primarily in schools, most of the technology previously available didn't enter children's homes so easily, but because mobile devices were already a part of people's daily lives, they seem to have changed this. The type of technology they carry and the precision they are designed with has forced designers and programmers to adapt and find new ways to think about interaction and content.

Well designed and structured applications are, nowadays, becoming the norm. These devices brought what I will risk calling a type of democracy to the software applications world. This "democracy" brought new and interesting — sometimes even experimental — interactive experiences to the end-user.

Applications extend the mobile experience. Suddenly, mobile phones and tablets acquired new functions that went beyond messaging and calling, they became tools that serve very distinct functions, there is an appropriation much like the one that is made with toys (Lauwaert, 2009).

The process of designing for play is a very fragile one. It is very easy to get caught in details and forget that most toys, are very simple tools that offer a large number of possibilities. Fröbel's Gifts and construction toys like *LEGO* teach us just that.

Working with children requires preparation and time, even when our goal is to design a tool to play. Lowering authority is not easy and although short periods of work were, in my case, productive, there wasn't enough involvement of the children in the process. We needed more time to establish a work relationship.

Teams are not composed of elements that don't work together.

Surprising rewards come from sharing work processes with children.

In my case, the documentation of these sessions was essential to the development of the prototype. Documented sessions allow the researchers to go back to that space and reevaluate, let it become part of the iteration process.

Much has been done recently and many different and original ideas have found their way into children's lives. This demonstrates that there is definitely space for the inclusion of mobile devices into play.

The efforts of researchers — like Alison Druin or Mitchell Resnick — to create good technology, that takes children's developmental needs seriously, without taking play away, is slowly making its way to the industry.

Still, few existing applications or projects that transform toys into mobile devices do so without the need to acquire extensions. From all the ones presented and evaluated in this thesis only two managed to do this: *Toca Boca* and *Makego*.

Digital toys, or digital devices that can be appropriated as toys, help children expand their play experience. For designers, bridging the two worlds, means that it is very easy to get lost in the complexity of constraints and forget about the original goal.

The best toys are always the simplest, because they are the ones that can better be transformed through appropriation.

The prototype originated from this research, represents only a part of a more ambitious project. It only approaches some specific features that proved to be relevant for a project

of this nature to ensure a future rich and engaging experience that bridges the real and the digital worlds while fostering self-expression (Druin, 2009).

Evaluating this project according to the montessorian and froebelian design principles established by Zuckerman (2010), reveals that it is in the right track:

- (a) It attempts to ensure sensory interaction by giving the children the ability to import their own “real world” creations;
- (b) Its structure follows a construction logic where the modules are the game elements;
- (c) The evolving interface and interactions ensure developmental-appropriateness;
- (d) Allows for many different configurations.

## 6.1 Future Work

Even though the prototype is still being developed, there will only be the opportunity to further experiment and refine the two features selected to work from.

Having a working prototype will help us assess how “effectively” this feature can expand the play experience, and the play experience contribute to this feature.

Since I decided to concentrate on specific features of a much bigger project, there is still much room to expand.

There is still much work ahead if this project is to become a full working reality.

Further research with the children is needed, not only to ensure a great user experience, but also to further analyze how they appropriate the tool.

Creating a logical framework of rules children can play with to create games and assuring the complexity of the application doesn't interfere with the simplicity of play, would probably be the biggest challenges. This would have to be tested intensively for granularity, extensibility, linkage and evolvability, Ackerman's principles to design good digital experiences for children.

For younger children, there should be simple audio prompts and instructions to help them use the application on their own without the help of an adult.

From the sessions conducted with the children, there is still a lot material to explore and prepare that can, and should be included in a more advanced stage of the development. The group's contributions would ensure an enjoyable and emotionally engaging experience.

Being an application for small children, audio would have to be carefully designed along with graphics and sympathy inspiring characters and interface responses to ensure a rich sensory interaction. What Montessori and Fröebel teach us is that a simple toy is enough, perfecting a toy to become simple requires knowledge and experimentation.



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## VIII. Appendices

### Appendix A - Established Rules

1	Do not run;
2	Do not interrupt your colleagues;
3	Put your hand in the air when you want to speak;
4	Respect your colleagues;
5	Do not harm others;
6	Don't feel embarrassed to speak;
7	Look after the material;
8	Obey the rules;
9	Clean your feet.

## Appendix B - Character Characteristics

- One Eyed;
- Blind;
- Mute;
- Paralytic;
- Deaf;
- Drunk;
- Alcoholic;
- Dwarf;
- Handicapped;
- Athletic;
- Obese;
- Fat;
- Thin;
- Polite;
- Stingy;
- Idiot;
- Rich;
- Poor;
- Resistant;
- Responsible;
- Irresponsible;
- Lazy;
- Energetic;
- Grumpy;
- Sleepy;
- Toothless;
- Vain;
- Noseless;
- Short;
- Intelligent;
- Dumb;
- Drugged;
- Friend;
- Enemy;
- Living-dead;
- Evil;
- Bad;
- Good;
- Goofy;
- Fool;
- Stylish Model;
- Thinker;
- Annoying;
- Talker/Chatterbox;
- Kisser;
- Boyfriend/Girlfriend;
- Physical Characteristics: Brunette, Blond, Bald, Red haired,, etc.
- Professions: King, Policeman, Cook.

## Appendix C - Actions

- Help;
- Brake the shoe heel;
- Walk;
- Date;
- Scare;
- Introduce;
- Film;
- Run;
- Boss;
- Jumo;
- Fly;
- Break apart;
- Break into little pieces;
- Explode;
- Fall;
- Put on make-up;
- Mourn;
- Enrich;
- Tidy Up;
- Hug;
- Dirty;
- Vomit;
- Impoverish;
- Enrich;
- Sneak;
- Become Dumber;
- Become Smarter;
- Get drunk;
- Drug;
- Rob;
- Hit;
- Attack.

## Appendix D - Settings

- North Pole;
- Bedroom;
- Kitchen;
- Prison;
- Sewer;
- Hospital;
- Court;
- Street;
- Jupiter;
- Moon;
- Mars;
- Black Hole;
- Stars;
- Space;
- Air;
- Sun;
- Garbage;
- Castle;
- Jungle;
- Forest;
- Woods;
- Zoo;
- Museum;
- Beach;
- Country;
- Cat Walk;
- Plaster World;
- Escola da Várzea;
- Ocean;
- Countries: Brazil, Italy, United Kingdom, Russia.



