

## THE CONTRIBUTION OF 2D ANIMATION IN DIGITAL GAMES WITH A TANGIBLE INTERFACE

Ana Paula Macedo Caruso

*Orientadoras*

Professora Doutora Paula Tavares

Doutora Cristina Sylla

Projeto apresentado

ao Instituto Politécnico do Cávado e do Ave

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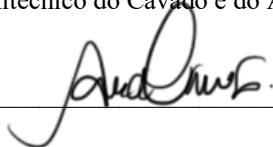
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# THE CONTRIBUTION OF 2D ANIMATION IN A DIGITAL GAME WITH A TANGIBLE INTERFACE

## ABSTRACT

When animating characters, the animator's role resembles the one of a puppeteer – by controlling the characters, s/he translates concepts into movements. Her/his work will give form to the characters' personalities and unfold the stories' atmosphere. Rhythm, timing, intensity, etc. rely on how the animation is done. That is true for linear animation. But in interactive animation – animation for interactive media such as video games – the role of puppeteer is granted to the player. The animator is responsible for creating the structure which ensures that the player is in control. Usually, such control comes through the use of joysticks or touchscreen interaction, but it can also take innovative forms.

That is the case of Mobeybou, a storytelling video game in which this work is based. In Mobeybou, we present the player with an unusual way to control the characters – a Tangible User Interface (TUI) – and increase the depth of the players' role by transforming them in storytellers. This also changes the way we animate the game, and adds new levels of complexity to design and development.

Our goal, with Mobeybou's animated content, is to offer the player enough creative freedom to compose narratives, but due to limitations of time and human resources we had to narrow the range of elements and possible actions with restricted action libraries. To evaluate the impact of the animated content in the creative process we have tested Mobeybou with children, ages 5 to 14, in classroom and summer school context.

**Keywords:** 2D animation, interactive animation, video games, Tangible User Interface, Storytelling.



# O CONTRIBUTO DA ANIMAÇÃO 2D NOS JOGOS DIGITAIS COM INTERFACE TANGÍVEL

## RESUMO

Ao animar personagens, o papel do animador se assemelha muito ao de um marionetista – ao controlar os personagens, ele / ela transforma ideias em movimentos. O trabalho do animador moldará o caráter dos personagens e revelará a atmosfera das histórias. Ritmo, tempo e intensidade, etc. estão sujeitos ao desenrolar da animação. Pelo menos em animação linear. Em animação interativa – animação para mídias interativas, como videogames – o papel de marionetista é concedido ao jogador. Aqui o animador será responsável por criar a estrutura que garantirá ao jogador estar no controle. Regra geral, esse controle ocorre através do uso de joysticks ou da interação em telas sensíveis ao toque, mas ele também pode assumir formas inovadoras.

É o caso do Mobeybou, videogame educativo para contar histórias no qual esse trabalho se baseia. Mobeybou, oferece ao jogador uma maneira incomum de controlar os personagens – uma interface tangível – e aprofunda o papel dos jogadores, ao transformá-los em contadores de histórias. Tudo isso também muda a maneira como as animações para o jogo são criadas e adiciona novos níveis de complexidade tanto ao design quanto ao desenvolvimento.

Nosso objetivo, com o conteúdo animado, é oferecer ao jogador liberdade criativa suficiente para compor narrativas, mas, devido às limitações de tempo e recursos humanos, o leque de elementos e interações foram restringidos através de bibliotecas de ação. Para avaliar o impacto deste conteúdo animado no processo criativo, testamos o Mobeybou com crianças de 5 a 14 anos, em contexto de sala de aula e atividades de tempo livre (ATL).

**Keywords:** animação 2D, animação interativa, videogame, interfaces tangíveis, narrativa.



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Although this was not a long journey, this year felt like a lot. The whole experience made me grow, in both personal and professional levels. It was an incredible ride, even if the road got bumpy sometimes... there moments when I felt overwhelmed and moments when I thought I would never make it. But every time things got too hard, there was always someone to help me get back up, reminding me of my strength. And I would not be able to get here without these very special people:

- My supervisors, who illuminated my pathway. Prof. Dr. Paula Tavares and Dr. Cristina Sylla, thank you for your patience, your availability and your commitment. Without your guidance and support this work would not be possible.
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*To my family.*  
*It was your love and support that brought me this far.*



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## 1. INTRODUCTION

*“Tell me a fact and I’ll learn.*

*Tell me the truth and I’ll believe.*

*But tell me a story and it will live in my heart forever.”*

*Indian Proverb (Fails et al., 2005, p. 49)*

The present work is been developed as part of a research project held at the Minho University in Braga, Portugal, financed by the Portuguese national funding agency for science, research and technology – FCT: “Mobeybou<sup>1</sup> – Moving beyond boundaries. Designing narrative learning in the digital era”.

The Mobeybou investigation team is developing a digital game for storytelling that uses a tangible interface to manipulate the digital content. Its main goal is to foster creativity and storytelling capacities while promoting digital literacy, within a multicultural framework, and it intends to do that by creating specifically designed animated content.

We have been working with video game animation for a few years now, and the idea of working with Mobeybou caught us from the start. From the moment we learned about the project it all made sense: a digital game, a creative tool for educational context, a wish to make the world more tolerant. All that enclosing the opportunity to work and study interactive animation.

Animating for video games can be challenging. Authors such as Bill Tomlinson (2005) point out the differences between interactive and linear animation, one of the key aspects been that in video games, the animator hands over to the player the control of the character. Once the character is coded in the game, we are not in charge anymore. Animating for Mobeybou adds another layer to challenge: instead of controlling a character through a more or less linear narrative (video games in general have a predefined plot), with Mobeybou the player will be using our animations to create its own narrative. Our job will be to provide the player with the raw material s/he needs to exercise her/his creativity. We will try to achieve that by creating animated repertoires that offer the players enough creative freedom.

Is important to stress that limitations of time and human resources available will require us to limit these repertoires to basic actions-reactions, generating what we are calling a “restricted action library”. This limitation forced us to ask: will the animations influence the players’ creative process? How these constraints affect the storytelling?

While conducting our bibliographic research on tangible interfaces for storytelling creation, we failed to find works that studied the use of restricted animated content and its effects on narratives.

Therefore, the present work emerges from the desire to explore the field of interactive animation and try to answer that question. To do that whilst promoting cross-cultural exchange amongst children is an appealing bonus.

<sup>1</sup> <http://mobeybou.com/>

## 1.1 OBJECTIVES

As mentioned in the introduction, the main objectives of the present work are: to develop animated content for Mobeybou's tangible user interface; to do that by creating restricted action libraries for the interactive characters; and to analyze how the animated content affects the decision-making process in the construction of narratives.

In a more specific context, our operational objectives are: to research ways to optimize the creation of animation libraries; with that optimization try to find ways to offer more creative freedom for the player; and to analyze – through the observation of focus groups in game context – if, and in which way, the animation affects the construction of narratives.

## 1.2 METHODOLOGY

The first part of the project consisted in creating the game elements (illustrator), setting the rules that will guide the characters' behaviors (whole team) and to animate each character according to the behavior tree (animator). To do so we conducted research about character design and animation, creating cycles for interactive animation, interactive storytelling and, more specifically, about the cultures that we are representing in the game. The work also required deepening our knowledge of the software used for animation.

The second part of this project presents the field studies, which consisted of a series of interventions carried out with Mobeybou to test<sup>2</sup> the system with children in early school ages (6 to 10-years-old) in order to get feedback from the players and observe the game in use, so we could improve, both the content [here we focus on the animated content] and the system.

Since this project follows a user-centered design, both parts were intertwined along the course of this work. Design Based Research encompasses a correlation between theory and practice, where the first informs and gets influenced by the later, in a process of designing – testing – and redesigning. According to Van den Akker *et al.* "one of the goals of Design Base Research is to support the development of prototypes that can be tested providing feedback for further development" (Van den Akker *apud* Sylla, 2014, p. 96).

## 1.3 NAVIGATION

This work is organized into five chapters. The first chapter introduces the project, motivation and goals. Chapter two gives a brief overview of the history of animation, the arise of video games and the confluence of both worlds. It also discusses the use of video games in educational contexts and lists some examples of

<sup>2</sup> In the initial planning of this work, it was our intention to submit the participant groups to two different types of tests, the first using a low-cost prototype (paper cards) and the second using the digital manipulative. After testing this format with 24 children (22 during the school year and 2 during a summer school) we realized that the data collected with the paper cards had little importance to the animation field, thus we decided to focus on testing with the digital prototype.

commercial games. Chapter three refers to the use of Tangible User Interfaces (TUIs) for storytelling in children's education, and presents some examples of TUIs for storytelling. The fourth chapter presents the project in more depth, from the development of the animated content to the user tests, along with observation notes and tests' results. Chapter five presents the conclusions drawn from this research along with thoughts about possible future work.



## 2. ANIMATION

### 2.1 THE ART OF MOVEMENTS THAT ARE DRAWN<sup>3</sup>

It is difficult to find a universal definition of animation, from an etymological perspective, animation comes from the Latin ‘*animationem*’, a noun derived from ‘*animare*’: ‘to give breath to’. From a technical perspective, animation can be defined as the illusion of movement through the combination of sequential static images (Wells, 2013). From this angle, we can say that mankind has been doing animation – or at least trying to – since the Paleolithic (Azéma & Rivère, 2012). But maybe animation is created by the subtleties in-between frames, as Norman McClaren says: “*what happens between each frame is more important than what happens on each frame*” (McClaren *apud* Wells, 2013, p. 10). Either way, we believe animation is an art and so, and agree with a poetic definition proposed by Bill Tomlinson in his work about interactive animation: “*animation is the art of breathing life into things*” (Tomlinson, 2005, p. 1).

In the next section we will address briefly the history of animation, the emergence of videogames and the birth of interactive media, its connection with animation, and the differences that exists between linear and interactive animation.

### 2.2 BRIEF HISTORY AND CONTEXTUALIZATION OF ANIMATION

#### 2.2.1 THE DAWN OF ANIMATION

When we think about animation, we most certainly think of cinema or television animated movies. Videogames will probably not come to mind as an example of animation. And that is expected, after all, animated movies have been a part of our lives since the beginning of the 1900s, while videogames only entered the world in the late 1970s.

As we mentioned above, if animation is a representation of movement through static images<sup>4</sup>, then we can say that its history dates to the dawn of mankind. Some researchers speculate that humans have been attempting to depict figures in motion by painting animals on cave walls’ with multiple pair of legs (Williams, 2002).

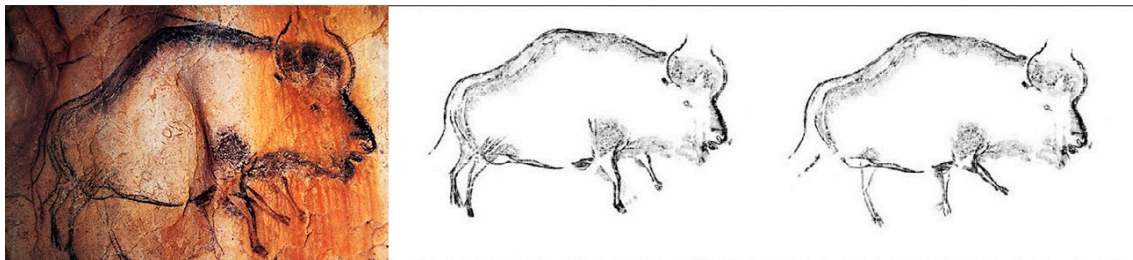
<sup>3</sup> Excerpt of a quote from Norman McClaren “Animation is not the art of drawings that move, but rather the art of movements that are drawn”

<sup>4</sup> In an interesting parallel, Teixeira (2013) quotes Rick Parent who differentiates “animating” from “to animate”, stating that the first means the act of moving something that cannot move by itself, while the latter means “to give life to” as we mentioned before.



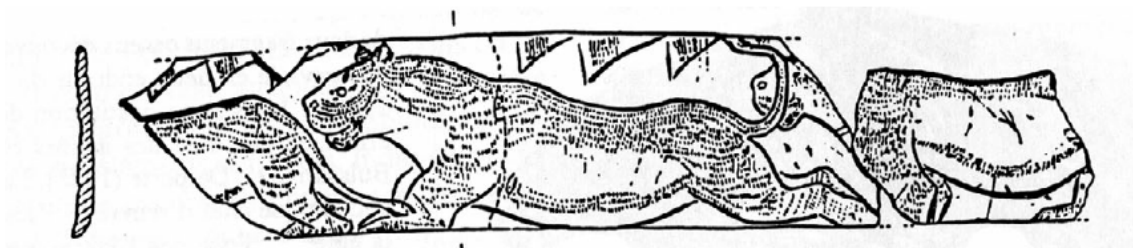
**Figure 1 - the 'Grand Panneau of the Salle du Fond'** (Photograph: J. Clottes, Chauvet Science Team) (Clottes *apud* Azéma & Rivère, 2012)

Azéma & Rivère (2012) advocate for this idea, saying that even if it is impossible to prove the real intentions of the Paleolithic artists “the experience we have today allows us to assert that this hypothesis is more and more likely” (Azéma & Rivère, 2012, p. 317). Wall paintings found on caves in France suggest this hypothesis, e.g. the ‘Grand Panneau of the Salle du Fond’ (Figure 1) and a drawing of an eight-legged bison (Figure 2), both at the ‘Chauvet Cave’.



**Figure 2 - Photography of the cave wall (left) and drawing separating the two superimposed images (right)**

According to their research in France, 53 figures in 12 caves represent movement using superimposition, with the drawing of successive images on top of each other, being Lascaux the cave with the greatest number of examples. Another attempt on depicting movement is thought to be the juxtaposition of successive images, in which the artist draws successive positions of the animal – those are more rarely found, but a bovine rib found in a cave called La Vache is considered to depict three consecutive images of a running cat or lion (Figures 3 and 4).



**Figure 3 - Reproduction of the fragmented rib. Drawing by: D. Buisson (Azéma & Rivère, 2012, p. 320)**



**Figure 4 - Photograph of the fragmented bone**

One of the most fascinating example of the paleolithic ‘animations’ are some stone plaques and discs that have slightly different images engraved on both sides and are perforated in such a way that researchers suggest the idea of a paleolithic *thaumatrope* (Azéma & Rivère, 2012) (Figure 5). This proposition is based on the examination of several similar objects. The objects were first thought to be decorated buttons or pendants, but researchers made successful tests with replicas of the discs showing that the hypothesis of the thaumatrope is plausible, although it is impossible to know for sure the artists’ intention with this engraved artifacts (Azéma & Rivère, 2012).



**Figure 5 - Reproduction of a bone disc found in *Laugerie-Basse*. Drawing: A. Roussot (Azéma & Rivère, 2012)**

We can also find examples of sequential images in temples and artifacts from ancient Egypt – Williams (2002) mentions a temple to the goddess Isis, where sequential images of the goddess were painted on the columns creating the illusion of movement when ride or walking along them – and in Greece where we can find pottery with painting of figures in successive stages of action (Figure 6) (Williams, 2002).



**Figure 6 - Greek amphora (left and middle) and drawing of sequential images [Photograph: The Metropolitan Museum of Art<sup>5</sup> / Drawing: Richard Williams (Williams, 2002)]**

But perhaps the oldest known example is a 5,200-year-old ceramic bowl found in Iran. In 2008, a documentary made by CHTHO – Iran’s Cultural Heritage and Tourism Organization – presented what seems to be the earliest record of a frame by frame animation, a ceramic bowl that depicts sequential images of a goat jumping to catch leaves from a tree (Figure 7). The bowl was excavated in the late 1970s, at an urban settlement called ‘Burnt City’ (Shahr-e Sukhteh), and only recently researchers figured out that the images were an early type of zoetrope: when the bowl is spanned you can the goat leap to catch a leaf from a tree (Ryan Ball, 2008).



**Figure 7 - Sequential images found in 5,200-year-old ‘Burnt City’ bowl (Ryan Ball, 2008)**

## 2.2.2 MODERN AGE MECHANISMS AND THE EVOLUTION OF ANIMATION

Throughout history, mankind has developed, several mechanisms that use sequential images to create movement, such as the *magic lantern*, which consists of a box with a curved mirror inside and a light source to project images painted on glass plates. Its invention is connected to the work of Athanasius Kircher (1602-1680) and Christiaan Huygens (1629-1695). But the first “animated projection” happened in 1736, with the work of Petrus Van Musschenbroek (1692-1761) who developed a mechanism with animated glass plates and a disc with sequential images that produced the illusion of movement (Teixeira, 2013). Later, in 1799, Étienne-Gaspard Robertson improved this mechanism and presented it to the world by the name of *fantascope* (Figure 8).

<sup>5</sup> Retrieved from: [http://www.metmuseum.org/toah/hd/argk/hd\\_argk.htm](http://www.metmuseum.org/toah/hd/argk/hd_argk.htm)

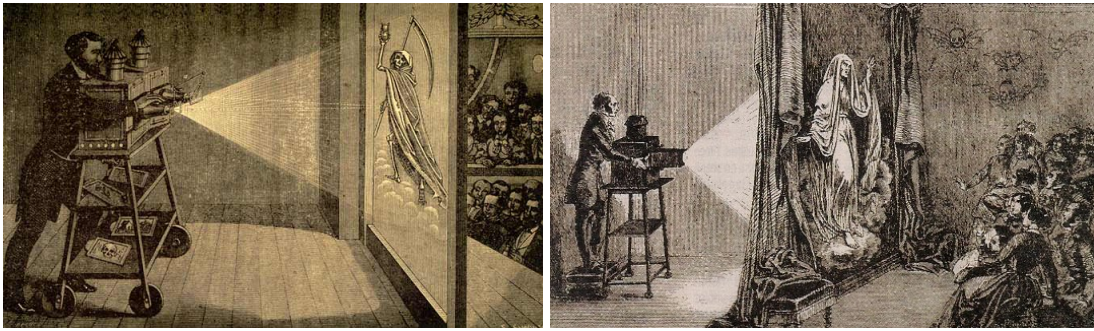


Figure 8 - Illustrations depicting Robertson *fantascope* in use.

In the beginning of the 19th century, Peter Mark Roget published a study called “Persistence of Vision with Regard to Moving Object” (1824), describing the phenomenon that is responsible for the human capacity of seeing a series of static images turn into the illusion of one image in motion. In 1829, inspired by Roget’s theory, Joseph Plateau created the *phenakistiscope* (Figure 9).



Figure 9 - The *phenakistiscope* (left), the *zoetrope* (middle) and the *praxinoscope* (right)

Plateau’s invention consisted on a series of slightly different images on a disc, vertically attached to a handle, when the disk was rotated in front of a mirror the viewer would see the animation. In 1834 William Horner developed the *zoetrope* (Figure 9 middle) [‘the wheel of life’ (Williams, 2002)]. The *zoetrope* served as inspiration for the *praxinoscope* (Figure 9 right), patented by Emile Reynaud in 1877, and in 1861 for the Coleman Seller’s *kinematoscope*, (Wells, 2013) (Figure 10 right). Together with the advance of photography, culminated in the development of cinematography in the 19th century. The *zoetrope* might have also served as inspiration to the creation of the *flipbook* (Teixeira, 2013). Wells (2013) says that they were found throughout Europe and often contained erotic drawings. The *flipbook* was patented in 1868 by John Barnes Linnett by the name of *kineograph* (see Figure 10 left).

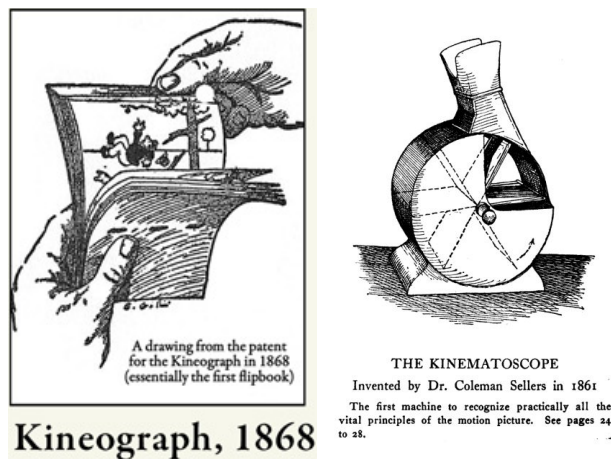


Figure 10 - Advertisement for the *kineograph* (left) and the *kinetoscope* (right)

### 2.2.3 ANIMATING WITH PERSONALITY

Despite all that, according to Williams (2002), animation as we know it, with characters that have some kind of anthropomorphic behavior, begun in 1914 with Winsor McCay's short animated film 'Gertie the Dinosaur'. In it, a playful dinosaur chases a mammoth into a lake (Figure 11). With Gertie McCay gives us the first animated "personality" and that is considered the beginning of the age of animated cartoon characters.

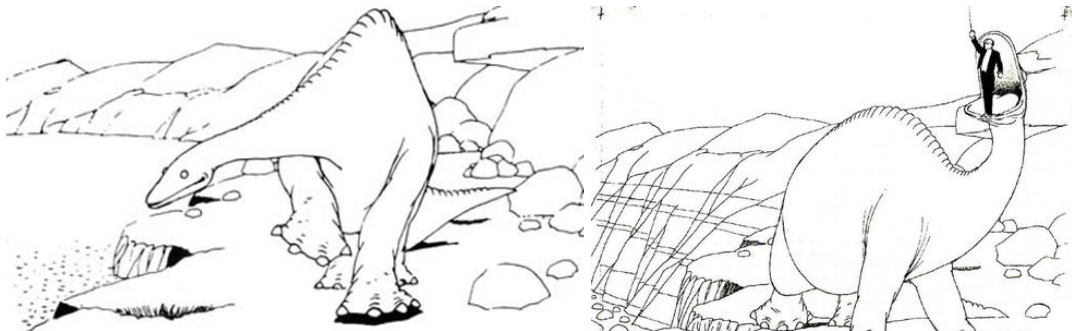


Figure 11 - Stills from McCay's animation *Gertie the Dinosaur*

Walt Disney improved the animation of cartoon characters with the creation of the iconic Mickey Mouse figure. Mickey was first presented to the public in 1928, in the cartoon "Steamboat Willy". Disney was a pioneer in animation. He released the first full color cartoon, "Flowers and Trees" (1932), and, according to Williams, the first cartoon with "*clearly defined and believable separate personalities*" – the "Three little pigs" (Williams, 2002, p. 19). The author claims that in this animation the characters were "*acting so convincingly that the audience could identify with and root for them*" (Williams, 2002, p. 19). A few years later, in 1937, the studio released another 'first' with "Snow White and the Seven Dwarfs", the world's first fully-animated feature-length film. With that, the Disney's Studio started what has been known as the 'Golden Age' of animation (Williams, 2002).



Figure 12 - Frame from the Disney's animation Snow White

The next remarkable moment in animation happened after the second world war, the arrival of television generated a new niche market, hungry for fast products. The rhythm of television production required a simpler work (Williams, 2002). Animation had to adapt to a high paced pipeline, with a limited number of frames. That fast process required that animators worried less with creating realistic and soft movements and gave origin to a new style: the limited animation.

#### 2.2.4 LIMITED ANIMATION



Figure 13 - Examples of early animated cartoons (Crusader Rabbit, left; a Terrytoon Cartoon, middle; and Winsome Witch, right. Winsome Witch is one of the first female characters of television cartoons)

Limited animation would become the basic style of animation for video and television. The advance of computers and its use as tool for animators speeded up the process and changed the way animation was created. Computers helped popularize animation, making it faster and even easier to create as technology evolves. But computers **don't** create animation, they are only a tool for the artist, and despite of the tool used, one thing remains as important to animators as it always was: more than making an object move from point A to point B, like McClaren suggests: animation is what happens between frames (McClaren *apud* Wells, 2013). Good

animation must convey personality and create relatable, believable characters. John Lasseter, Pixar's creative director, stresses the importance of knowing the basic principles of animation:

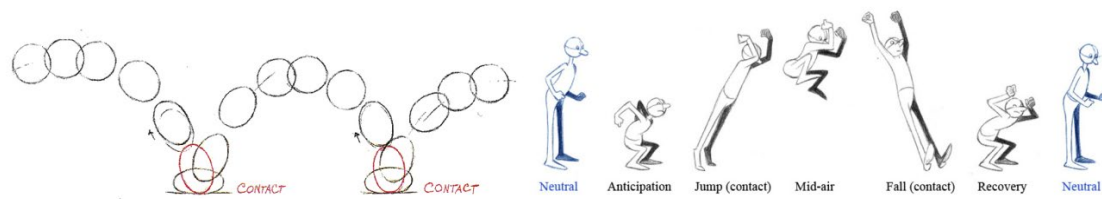
*"The computers don't create animation for the animator — the animator still needs knowledge of the principles of timing in order to make the computer animation come alive. With any type of animation, the goal is always to make a character look like it's thinking, that all of its movements are generated by its own thought processes. No software program is going to give you that." (Lasseter apud Teixeira, 2013, p. 47)*

The principles he refers to are the Twelve Principles of Animation<sup>6</sup>, described by Frank Thomas (1912; 2004) and Ollie Johnston (1912; 2008), two of Disney's lead animators in a book called *The Illusion of Life: Disney Animation* (1981). Below we list Thomas' and Johnston's principles along with a brief explanation of each one:

1. Squash and stretch – creates the illusion of weight and flexibility;
  2. Anticipation – prepares the viewer to the coming action and makes the movement more realistic;
  3. Staging – directs the audience attention to what is more important in a scene;
  4. Straight ahead action (creating all the animation poses from start to end) and pose to pose (creating the keyframes and adding the in-between after) – the first creates a more fluid movement and the latter is used to create dramatic and emotional scenes<sup>7</sup>.
  5. Follow through and overlapping action – creates the impression that the character is following the laws of physics thus making the movement more realistic;
  6. Slow in and slow out – by drawing more frames in the beginning and end of a sequence, and fewer in the middle, the animator gives emphasis to the fast bit of the action;
  7. Arc – to make the movements look more natural and fluid;
  8. Secondary action – the addition of secondary actions (flow of clothes, movement of hair) to emphasize the main animation;
  9. Timing – can transmit the character's mood or emotions and create the impression of weight, timing is crucial to create *reaction*;
  10. Exaggeration – to amplify the character actions giving it more expression;
  11. Solid drawing – *"the better you can draw, the easier it will be for you"* Marc Davis (quoted by Thomas & Johnston, 1981, p. 66). This principle stresses the importance of drawing characters with weight, depth and balance, and urge the animator to avoid drawing both sides of the figure mirrored, what they call *twins*;
  12. Appeal – the importance to make the character believable.
- (Thomas & Johnston, 1981, pp. 47–70)

<sup>6</sup> Some of these principles are also mentioned when we highlight Tomlinson (2005) main differences between linear and interactive animation.

<sup>7</sup> In computer animation the principle of pose to pose is more commonly used, the animator creates the keyframe and the computer fills in the gaps using interpolation and predetermined parameters (Victor *et al.*, 2009).



**Figure 14 - Illustrations explaining the principles of squash and stretch and anticipation**

Thomas and Johnston's principles are followed to this day by animators of all areas, be it in experimental or interactive cinema, though in interactive media it can be difficult, and in some situations even impossible to follow all those principles when animating a character. We will detail this in section 2.4.

Interactive animation was born along with video games, to which the invention of television and, of course, computers, was crucial. But it still took a couple of decades from the birth of television to the dawn of the videogame era. In the next section we discuss this further.

## 2.3 PRESS START TO PLAY - AN OVERVIEW ON VIDEO GAMES

Wolf (2008) defines video games as any type of game that runs on a hardware (e.g. computers, consoles, tablets etc.) that incorporates an element of interactivity and uses a display to show the result of the player's actions. Tomlinson (2005) points out *Spacewar!* as the first "real" computer game to be ever created (DeMaria and Wilson *apud* Tomlinson, 2005), although it was not a commercial game – personal computers did not exist at the time – it was an important breakthrough in the history of digital games.

The popularization of video games as we know them began a couple of decades later, with the release of "Pong" by Atari (1972). Pong, a digital table tennis simulator, was an immediate success<sup>8</sup>.

*"Pong allowed modern kids to do something their parents never fathomed: they could control and manipulate what they saw on television. This was the most revolutionary media event since the invention of television itself. And what remains profoundly striking is how that sentiment was simultaneously so obvious and so overlooked by just about everyone."* (Müller, 2010, p. 73)

Pong's gameplay was very simple, it consisted in a black screen with two moving white bars on each side of the screen, representing the players rackets, and a white dot that moved from side to side, to represent the ball. A gray dotted line divided the screen as a ping-pong net and two gray numbers on each side of the line displayed the score of each player (Figure 15).

<sup>8</sup> The console had only this one game hardcoded into it, but by the end of 1974, Atari had sold over 3 million dollars' worth of Pong and its sequels. (Lapetino, 2016)



Figure 15 - Pong's gameplay (left) and console (right)

The crude graphics from that time might not seem appealing to our current aesthetics, but due to the lack of graphic and rendering capacity, there was not much room to venture in graphics, so both the art and the animation were very basic. Also, at that point, the programmer was in charge of producing all the game assets, including the art.

As it is exemplified in the game *Pitfal* (Figure 16) the images were formed by simple colored squares that were written by the programmers in the game's code. At that time, when video game on-screen graphics were not much sophisticated, the art department focused on creating graphic design [packaging and advertising] capable of inspiring the imagination of the players. "The games were simple so you had to create as much of the context with reality as you could (...) We had to implant the visual image in the gamer's mind." (Steve Hendrix *apud* Lapetino, 2016, p. 22).

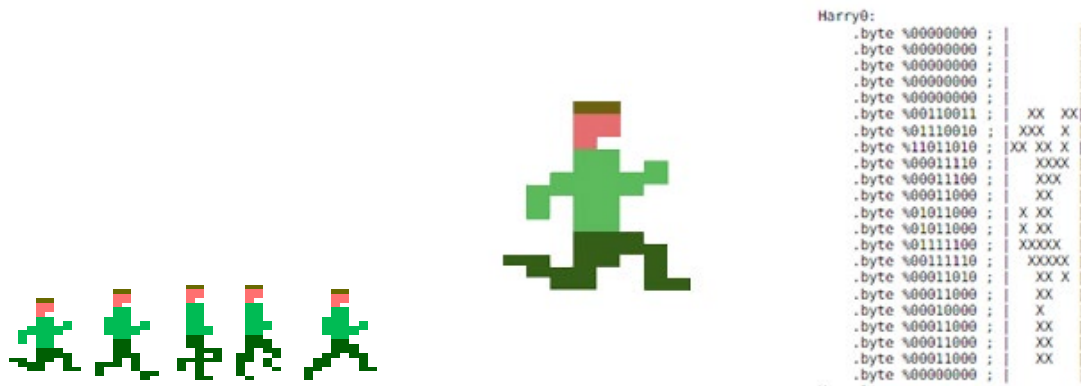


Figure 16 - Sprites of the character Harry from the game *Pitfal* (left) and excerpt of the code (right) for the position highlighted in the middle.

Lapetino (2016) calls that a bridge between reality and imagination. More than highlighting the game packages in the shelves, the art transformed the crude graphics into characters, narratives and sceneries. "Box artwork often served as a player's first exposure to a new title (...) Art and design brought this first generation of home video games to life, allowing players to see more than just the simple pixels on screen." (Lapetino, 2016, p. 22).

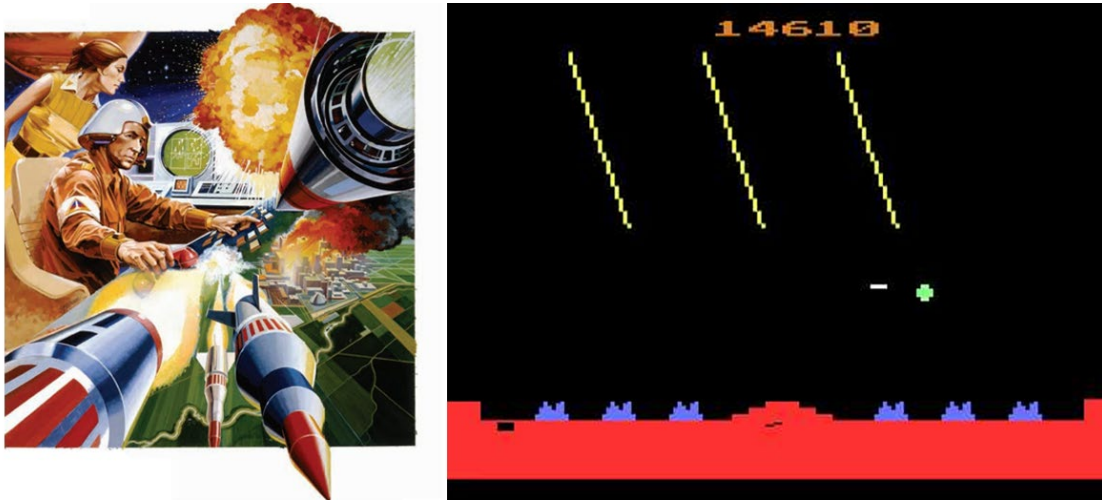


Figure 17 - Atari's game 'Missile Command' (cover art versus gameplay)

The graphics for the advertising campaign and for the packaging helped creating the magic universe of the game, transforming those pixelated blocky graphics into worlds and characters (Figure 17). Most of the art of a game is strictly linked to the player's imagination, and both players' engagement and enjoyment levels depend on how well the game is designed. In those early days, this was true maybe more than in any other time in video games. "Above all, graphics [marketing material] must attract the players and help them feel that every Atari game is an adventure" George Opperman, head of Atari art department (Lapetino, 2016, p. 32) (Figure 18).

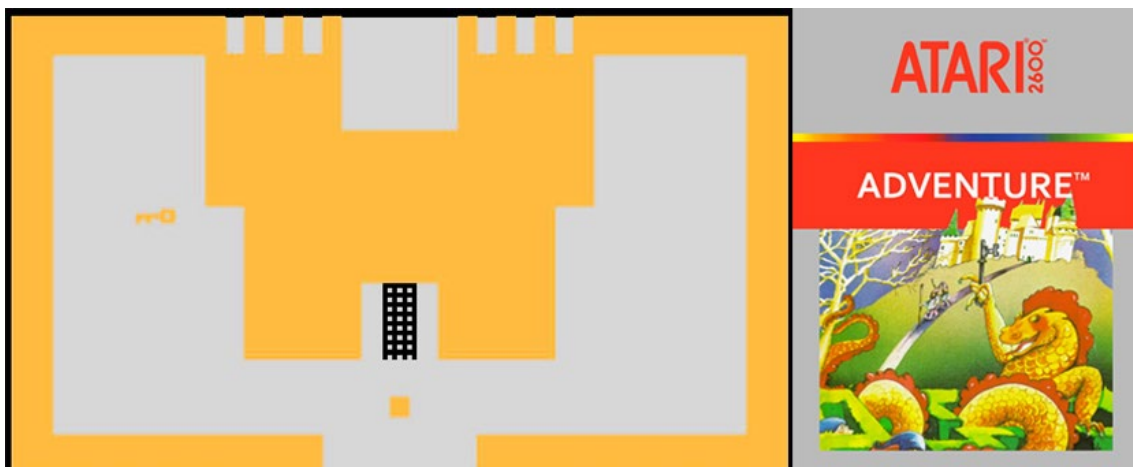


Figure 18 - Atari's Adventure: screenshot of the game (left) and the rendition of the game 'universe' that illustrated the package (right)

### 2.3.1 MORE GRAPHIC CAPACITY EQUALS HIGHER GRAPHIC QUALITY

In the following decade, traditional 2D animation was integrated into games, more precisely into an arcade game. In 1983, the company "AMS" along with "Bluth Studios" and "Cinematronics" released Dragon's Lair, (Figure 19) an arcade game that was made with 22 minutes of traditional animation. The game used laserdisc

technology which granted highly superior graphic quality, and Dragon's Lair was marketed as “the meeting point of video games and animated films”.

Created with traditional hand drawn animation, the gameplay consisted on a series of animated clips that played after the user made a choice. It became an immediate success amongst the critics, but as a game it had serious limitations, being described as an “interactive cartoon” where the player is allowed limited decisions through the story (Müller, 2010). Nonetheless, it marks the starting point from where video games get closer to the animated narratives used in cinema and video.



**Figure 19 - Dragon's Lair: Screenshot of the original game (left) and promotional art (right)**

The arise of the next generation of video game consoles (Nintendo Entertainment System standard), in the late 1980s, opened a market for illustrators and animators in the video game industry. With greater graphic and rendering capacity, these consoles were a huge improvement compared to the previous systems, with 256-color palette and a graphic resolution of 256x240 pixels. Now, the art department became fully responsible for the game's visual concept and graphical development, leaving programmers and engineers in charge of coding the game (Müller, 2010).

From there on the technology and the devices never stopped evolving, but the introduction of traditional animators to the video game industry would remain a milestone. Digital games transform the viewer (passive) into player (active) giving him, for the first-time, control over the elements that appear on the screen. It creates a new form of narrative and a new way of thinking animation. As such, animators must adapt their skills to thrive in this new world: interactive media.

## **2.4 WELCOME TO THE WORLD OF INTERACTIVE ANIMATION**

*“If drawn ‘classical’ animation is an extension of drawing, then computer animation can be seen as an extension of puppetry – high tech marionettes. Both share the same*

*problems of how to give a performance with movement, weight, time and empathy.”*

(Williams, 2002, p. 20)

As said before, video games introduced a new aspect to the universe of animated narrative: interaction. With video games and interactive media, the control over the narrative change hands, what once was completely in the care of the animator now has shifted to the player.

Teixeira & Marques, (2012) remind us that several digital games have linear animations as a part of their content – cutscenes introduce the player to important parts of the story, animated tutorials explain how to play the game etc. – but most of the time these linear animations play a second role in the game itself (Teixeira & Marques, 2012). But we are only interested in the interactive animation during gameplay, when the player controls the character through the narrative.

There are profound contrasts between linear and interactive animation, although both want to engage the viewer through the creation of interesting plots and relatable characters, and both share the same principles and techniques. The most significant difference is how the media deals with the characters, and it can be resumed to who holds control over the character's decisions.

Based on that, Tomlinson (2005) highlights five key differences between animating linear and interactive characters: location of intelligence, emotional expressiveness, navigation (or collision avoidance), transitions between actions and interaction between characters.

In the following we present Tomlinson (2005, pp. 6–15) five main differences in more detail:

1. **Location of intelligence:** in linear animation, the character's behavior is created and controlled by the art team (from screenwriters to animators). It all happens before any presentation to the public. In interactive animation the character's behavior is generated by the computer in accordance to the inputs from the player. Tomlinson (2005, p. 6) says it's more or less like “taking an intuitive process (the way an animator or animation director decides to have a character act) and making it explicit (so that a computer program can make the same decisions on-the-fly).” To achieve that explicit process, the animators work together with the programmers when creating an interactive animation. They design a set of behaviors and rules creating the basic material for the character's behavior. When this is accurately done it creates a believable behavior and thus a believable character.
2. **Emotional Expressiveness:** as the name says, this refers to the characters' expressiveness. In linear animation, once more, the animator is in control through all the process, being able to adjust the animation if necessary. This is not possible in interactive animation due to the enormous array of possible interactions. Instead, the animator can create multiple animations for each action, these set of actions composes what we call the action library<sup>9</sup>. “Interactive characters are more likely to be broadly expressive, i.e., able to express simple emotions in a variety of appropriate contexts. Linear characters, on the other hand, are deeply expressive;” (2005, p. 10)

<sup>9</sup> There are ways of generating procedural modifiers and a lot of researchers have done that to control emotional expressiveness (Tomlinson, 2005), but we are not interested in computer generated animation, so we won't be looking into that.

3. **Navigation:** or collision avoidance is the ability to control when a character collides with something. In linear animation, as the animators are the ones in control, a character collision reflects a conscient choice. In interactive animation, as the control of the character lies with the player, it might collide with obstacles or other characters at any given point. Although navigation might seem like a difficult task, it offers an opportunity to design the character personality. “Navigation is one of the main forms of control that players can exert over an interactive character – steering it from place to place. As such, it provides an important opportunity to layer expressive content over user-directed actions.” (2005, p. 11)
4. **Transitions between actions:** in a linear animation, the animation can make the character transition from one action to the other in an expressive and fluid way. The transition can help the audience understand how the character feels and learn more about his/her personality through his/her behavior. In interactive animation this is not so easily done. Since the character’s actions are controlled by the player, the character needs to transition between animation cycles, and it is very difficult to predict which sequence of events might take place or the moment a transition will occur. There are ways to ensure that the transitions work as good as possible, most of them require a great effort from both the animation and the coding team. It is possible to work with short transitions or procedural interpolation, but it is necessary to deal with the possibility of lag between cycles or truncated animations. The animator can also create additional animations for each action, for example, walk cycles that end and start for both right and left leg so when the character transitions from a walking to an idle<sup>10</sup> cycle it does it in a smooth way. However, this decision can overwhelm both the animators and the programmers, since it requires more work, more storage space and more execution time. This is one of the challenges the development team has to face when producing interactive content, how to ensure the best possible quality and a viable final product without straining the production time.
5. **Interaction between characters:** as in every other of the previous differences, in linear animation the characters can be animated as needed, and most important, simultaneously. In interactive animation this is not possible, so it is the animator’s job to foresee how this is going to occur. Simultaneously, the programming has to be done precisely so that the independent animations of both characters are triggered at the exact same time. This is very hard to be done properly. One of the solutions to avoid most problems is to give the characters a limited number of actions and pair them with reactions from the other characters. Again, this requires that both, the animation and the programming team work closely together in order to ensure the best results. The animator needs to be very critical and see where the animation is not working, and try to understand the system in order to see how to fix it, as well as orienting the programmer when necessary.

We believe that understanding these differences is important to comprehend the challenges involved in animating for interactive media. According to the Tomlinson (2005), traditional animators tend to struggle

<sup>10</sup> “a ‘moving hold’ in which the character stands still, but shows a small amount of bodily motion so that it still looks alive”

when transitioning from linear to interactive media, and the key part is to understand how the media work. Once the animator understands how the character will be controlled and accepts that s/he is not in control anymore, then it can be an exciting process. In linear animation the animator is in charge of modeling the characters' behavior, s/he is the one that decides when and how it happens. This is not the case in video games, as Tomlinson (2005) states when explaining the main differences between this two media, this decision has to be made instantaneously by the computer as it "reads" the players' actions, turning control inputs into animated responses that are displayed on the screen. Tomlinson calls that taking an intuitive process and making it explicit, by transforming 'the way an animator or animation director decides to have a character act' into rules that a computer program can follow to make the same 'decisions on-the-fly' (Tomlinson, 2005). To make this intuitive-to-explicit process possible, the animation team and the character designers create a set of actions and behaviors for the characters – the action library – and the specific rules for the actions and reactions, that will later be coded into the game system by the programmers or engineers.

We could say that interactive animation weaves together both worlds: animation and digital games. The present work tries to weave together animation, digital games and tangible user interface devices, by animating for a storytelling platform, named Mobeybou. If creating animated content for video games can be challenging, animating for Mobeybou adds a new level of complexity. In Mobeybou, instead of controlling just the character's decisions, the player has creative control over the whole narrative. We will explore this topic in depth in chapters three and four when we talk about the technology used and the development of the game. But first, we will address the use of video games as an educational tool and list a few examples of digital games that focus on storytelling.

## **2.5 IS MOBEYBOU A VIDEO GAME?**

Esposito's defines video games as "a game which we play thanks to an audiovisual apparatus and which can be based on a story" (Esposito, 2005, p. 1). It is a broad perspective, but it comprises the key components of a digital game: play, a digital interface and a narrative. One might argue that Mobeybou does not specify conflicts or a quantifiable outcome (score), as Zimmerman suggests – "a game is a fictional interactive activity without obligation, with rules, a defined time and space and quantifiable outcomes" (Zimmerman *apud* Correia & Oliveira, 2011, p. 87) – and that Esposito mentions narrative only as an option, but he also reminds us that not all digital games have conflicts (e.g. puzzle-games) or quantifiable outcomes (The Sims, SimCity) and not all video games need a story (e.g. Tetris).

According to Rushkoff (2013) some key aspects of video games are "to engage with players in an open-ended way, to communicate through experience, and to invite players into the creative process" (Rushkoff, 2013). In addition, he brings to our attention the concept of finite versus infinite games, coined by the religious historian James Carse. Carse (1986) classifies games into two categories: finite games, which are "played for the purpose of winning" and infinite games, which are "played for the purpose of continuing the play" (Carse, 1986). The former has winners and losers, the latter is played just for the sake of play. Rushkoff (2013) sees in

Carse's definition of infinite games a reference to interactive narratives and open-ended games<sup>11</sup>, saying that what he proposes is "an approach that favors improvisation over fixed rules, internal sensibilities over imposed morals, and playfulness over seriousness" (Rushkoff, 2013).

*"While finite games are externally defined, infinite games are internally defined. The time of an infinite game is not world time, but time created within the play itself. Since each play of an infinite game eliminates boundaries, it opens to players a new horizon of time"*  
(Carse, 1986, p. 7).

The essence of video games is to give the players the power of choice and, with that, a sense of free will, Rushkoff stresses that even if *"the game writer may have an ending or final level he wants everyone to get to at some point, moving through this world is supposed to feel like free will. [...] Instead of watching a character make the only right choice in each scene, the player is the main character, confronted with a myriad of choices"* (Rushkoff, 2013, p. 38). In addition, he says that video games have a "participatory storytelling". Differently from a movie or book, where the narrative is linear and the choices have been already made, in a digital game the choices are made in real time and every step is open to new possibilities (Rushkoff, 2013).

Also, video games do not have to be devoid of meaning and values. Serious games are an example of that, they use what Rushkoff calls "communicate through experience", and give the player an opportunity to learn about important issues through playing – health, violence, ethics, etc.

With all that in mind, we believe that Mobeybou can be classified as both a video game and an infinite game: it has the digital component, it is open-ended, it favors participation while promoting collaboration over competition and playful exploration over winning, its essence is participatory storytelling and its goal is to promote acceptance and tolerance through cross-cultural exchange.

## 2.6 VIDEO GAMES AS AN EDUCATIONAL TOOL

Video games are universal. Nowadays most children grow up interacting with computers, smartphones, consoles and, of course, playing video games. No wonder Prensky calls this generation "digital natives" (Prensky *apud* Yu & Olinzock, 2011). Children are fluent in video game concepts and can easily navigate its' worlds.

Gaming and playing are considered to be key elements in children development, authors like Piaget (Piaget *apud* Correia & Oliveira, 2011) and Vygotsky (Vygotsky *apud* Correia & Oliveira, 2011) say that by playing children assimilate the world and extrapolate their role, acting "as if they are larger than they actually are" (Vygotsky *apud* Correia & Oliveira, 2011). Playing games stimulate collaboration, social interaction and creativity.

Research suggests that using video games as a tool can be helpful. Digital games help improve spatial skills, problem solving, language, abstract thoughts, etc. Correia & Oliveira (2011) state that the use of video games in educational contexts "encourages active, critical, autonomous and participated learning processes,

<sup>11</sup> E.g. role-playing games (RPGs)

[...] engaging players in non-passive forms of acquiring knowledge and skills” (Correia & Oliveira, 2011, p. 86). Their statement is based in the theory of authors such as Prensky and Gee who defend the use of digital games as learning tools. They point out that a crucial factor in learning is students’ engagement in the learning process, and as Correia & Oliveira said, video games offer students an active and participative role (Correia & Oliveira, 2011).

However, serious games have its limitations. Difficulty in finding games that include curricular contents, community’s acceptance (video games are not seen as a serious activity), and technical resources (Correia & Oliveira, 2011). Besides that, we believe it is important to mention that the process of developing a digital game might require a substantial amount of time as well as personal resources from different areas, and this can turn the task into a difficult endeavor. Mester *et al.* (2011) say that developing an educational game is a complex work, reminding that it is a multidisciplinary task and, as such, it “calls for the cooperation of various experts: video game designers, content experts, researchers in the field of didactics” etc. (Mester, Molcer, & Delic, 2011, p. 249)

## 2.7 EXAMPLES OF EDUCATIONAL GAMES

In the following, we list here some examples of commercial games, ranked as the best educational games for children according to internet reviews, considering the improvement of skills similar to the ones Mobeybou is focused on. The majority of best recommended serious games are world building games, also called “God games”, like Minecraft and Lego creator islands, and puzzle-solving games like Scribblenauts, Box Island and Thinkerolls 2.

**Minecraft** – is a 3D, open-ended, sandbox game that allows playing in several ways, e.g., exploring, resource gathering, crafting or combating (survival mode). The graphics of the game have a resemblance to the early 8-bit consoles, they are made in voxel art (3D pixel art) and everything in the game is made of blocks. According to the reviews, the game helps enhancing life skills, such as creativity (the player can create anything using the 3D blocks of the game), problem-solving (survival strategy) and collaboration (children can create a server and play together)<sup>12</sup>. The game has an educational version specifically customized for the classroom environment. According to an article in The Guardian, teachers use the game for lessons in architecture, physics, ecology, history etc. (Stuart, n.d.)<sup>13</sup>. The use of blocks as the construction material can be considered a constraint, but constraints can improve creativity (Stokes, 2006), forcing the player to find solutions to solve challenges of the gameplay.

<sup>12</sup> Reviewed by Vince Mattheus for iD Tech blog. Retrieved from: <https://www.idtech.com/blog/best-video-games-for-kids> and Keith Stuart (Stuart, n.d.) Date of access: 2019-10-22

<sup>13</sup> Retrieved from: <https://www.theguardian.com/technology/2016/jan/22/minecraft-education-edition-why-its-important-for-every-fan-of-the-game> in 2019-11-24.



Figure 20 - Minecraft: Education Edition (screenshots from the game)

**Toca Life** – With several different scenarios, games from the series ‘Toca Life’ are aimed at children age four and older. Like Minecraft, they are open-ended games where the player can explore worlds and create narratives. According to the company’s website “there are no rules, no boundaries and no ‘right’ or ‘wrong’ way to do anything”. The app uses 2D cutout animation with the characters in full front view and animations made with very simple movements and seems to value diversity, quantity of elements and characters over style and animation.



Figure 21 - Toca Life Hospital (screenshots from the game)

**Scribblenauts** – Are a series of puzzle-action games for the Nintendo DS console in which players can create objects from a huge database in order to solve puzzles and overcome obstacles in a free-roaming world. To do that, the player has to write down the name of an object, and add adjectives to it – like ‘*giant rideable bunny*’ – the representation of the object materializes on the screen, so the player can use it to move around the game and solve puzzles. The game art is 2D cutout animation.<sup>14</sup>

<sup>14</sup> Reviewed by *Giant Bomb*. Retrieved from: <https://www.giantbomb.com/scribblenauts/3025-1646/games/>. Date of access: 2019-10-22

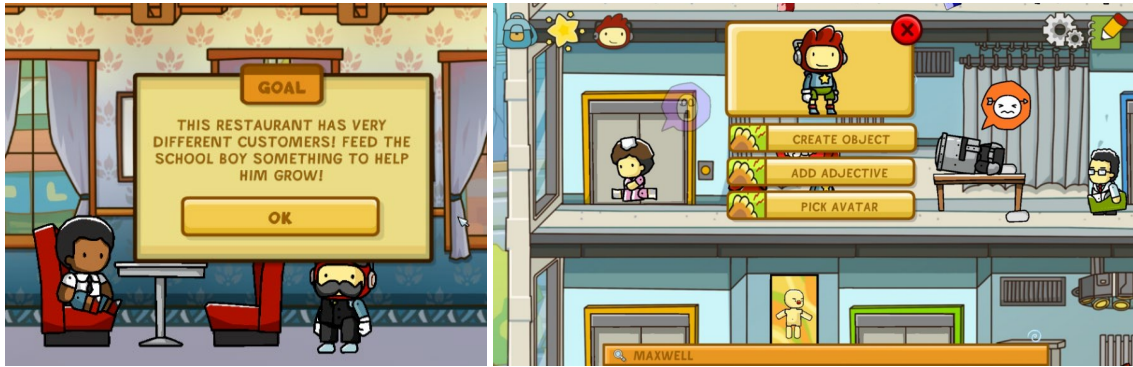


Figure 22 - Scribblenauts (screenshots from the game)

**Thinkrolls 2** – is a logic puzzle game for children ages three to five and five to nine. Its content is based on physics and aims to teach the children concepts such as gravity, buoyancy, electricity, acceleration, etc. According to the reviews it can also help children to improve their fine motor skills as they control the character and the environment by moving objects around to create pathways.<sup>15</sup>

**Box Island** – this 3D puzzle game aims at teaching computer coding to children. The player controls a character by using chunks of code that tells the game what the character shall do, for instance: turn left, move forward, repeat until tile. The game has a version designed specifically to be used in schools that includes a mode called “hour of code” with lessons, solutions and explanations of coding concepts and game design.<sup>16</sup>

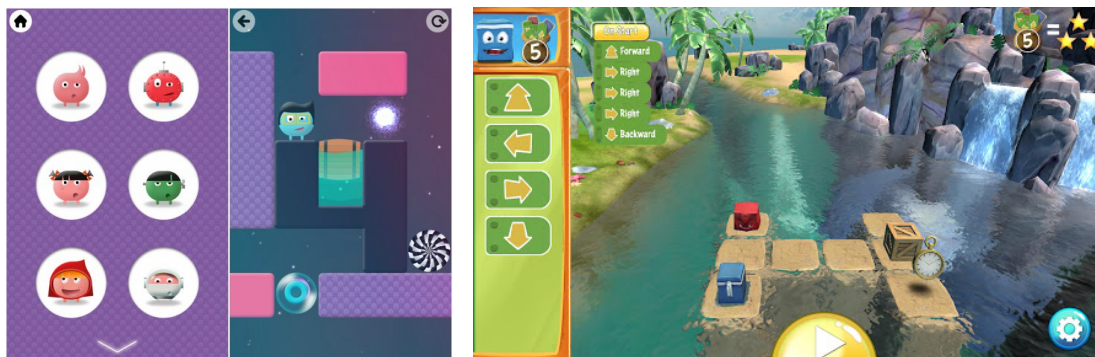


Figure 23 - Thinkeroll 2 (left) and Box Island (screenshots from the game)

<sup>15</sup> Reviewed by Dhvanesh Adhiya for *iGeek*. Retrieved from: <https://www.igeeksblog.com/best-iphone-ipad-kids-games/> Date of access: 2019-10-22

<sup>16</sup> Reviewed by Seth Guttenplan for the blog *Common Sense Education*. Retrieved from: <https://www.common sense.org/education/app/box-island-for-schools> Date of access: 2019-10-22



### 3. TANGIBLE USER INTERFACES

Overall, we can say that the main difference between creating linear and interactive animation lies on the shift of control from the animators to the player's hands. Usually, such control comes through the use of joysticks or touchscreen interaction, but it can also take innovative forms. That is the case of Mobeybou, the storytelling educational game in which we base this work.

In Mobeybou, we present the player with an unusual way to control the characters – a Tangible User Interface (TUI) – and increase the depth of the players' role by transforming them in storytellers. This also changes the way we animate the game, and adds new levels of complexity to designing and developing. In chapter four we will explain the process of creating Mobeybou's universe, focusing on the process of designing and animating the characters and the other game elements, but first we will briefly introduce the concept of tangible interfaces and present some examples of TUIs for storytelling.

#### 3.1 INTRODUCTION

Tangible User Interfaces (TUIs) are computationally-enhanced physical objects that can be used to manipulate digital content (Ullmer & Ishii, 2000). Differently from conventional tools, such as mice, keyboards and joysticks, TUIs are embedded with significance and representation. Although we find relevant studies about the use and development of TUIs for children's education, there is still a lot to cover in this field.

During our bibliographic research we failed to find works focused on the use of animation for tangible interfaces, the closest work being the development of a TUI for authoring 2D and 3D animation, the *Reactoon 2D and Reactoon 3D* (Alves *et al.*, 2010), *two* authoring tools for children to create animations without requiring any specific computer or software skills. Even though the *Reactoon* system relates to both animation and storytelling, we do not consider it to be of great relevance to our work, since in its 2D version the digital content is not animated, also, it is not clear how the resultant animations work. In its 3D version, although the characters have pre-made animation cycles, the interaction relies primarily on a graphical user interface (GUI) and is done by touch, which is not our focus.

In the next sections we briefly cover the use of tangible systems and its potential in children's learning, and present some relevant works that explore the use of TUIs for storytelling. We are prioritizing research that uses animated digital content, as those are more relevant to our work.

#### 3.2 CHILDREN ARE TACTILE LEARNERS

For the past decades, computers have become a part of our daily life. "Screen-based interactions" have become a natural and intuitive thing (Ullmer & Ishii, 2000), but most of the human-computer interaction happens through the manipulation of graphical interfaces (GUIs). The objects used to control it – mouse, keyboard, joystick etc. – have very little or no meaning at all to the manipulated content. Tangible User Interfaces (TUIs), as previously said, are embedded with relevance to the digital content. Ulmer and Ishii remind us that purely graphical-based interfaces lack to seize the diversity of the human senses, as they rely

only on audiovisual stimuli (Ullmer & Ishii, 2000). And most of the digital material we encounter, even when it uses Virtual Reality technology – which explores movement and space as a part of the digital experience – are mostly visual and limited to screen interaction.

Along with the vast number of research that aim to connect and analyze the links between physical representation and digital information, there are several prominent studies about the potential of using tangible interfaces in children's education (Sylla, Branco, Coutinho, & Coquet, 2012). That potential has to do with the way children interact with the world. Several studies show that children learn about the world and about themselves through play, exploration and physical manipulation (Spina-Caza, 2010). They develop cognitive and social skills by role-playing, imitating, interacting with other children and the world (Fails *et al.*, 2005).

There is several research connecting touch and learning. Montessori makes a link between children's hands and the brain, as children gather information and impressions about the world by exploring and manipulating things (Montessori *apud* Spina-Caza, 2010). Similarly, Piaget states that manipulating objects is crucial to children's cognitive development. According to him, a person's knowledge is based on the manipulation of objects that happens in the early years of childhood (Piaget *apud* Sylla, 2014). Jones *et al.* call the touch “an active discovery sense” saying that physical objects ‘feel’ more real than visual information (Jones *et al. apud* Spina-Caza, 2010, p. 299).

In the last decades, there has been an increase in the number of studies on educational TUIs for children, Price *et al.* analyzed the use of TUIs in promoting playful learning. Their work evaluated the level of interest, engagement and enjoyment of children playing a game with a tangible interface, and obtained positive results. According to these authors, playful learning happens when the limits between learning and having fun are blurred (Price, Rogers, Scaife, Stanton, & Neale, 2003). They consider following aspects to characterize playful learning: exploration through interaction; engagement; creativity and imagination; reflection and collaboration. In order to understand the main differences between GUIs and TUIs in children's learning, Fails *et al.* (2005) and Sylla *et al.* (2012) carried out comparative studies using graphic and tangible interfaces. However, despite the results suggesting advantages of TUIs over GUIs, like most research, they point out that, due to the size of researched sample, more studies are necessary to obtain an accurate response.

In the next section we list a few examples of educational games for storytelling that use tangible user interfaces.

### 3.3 TANGIBLE USER INTERFACES FOR STORYTELLING

*wIzQubes<sup>TM</sup>* – is a mixed reality system for storytelling. It is composed of a pair of physical cubes that are tracked by a computer's webcam. The player can choose between two preexistent narratives and use the cubes to navigate the story. The computer displays the animated scene in Augmented Reality accordingly. The system does not allow the player to create a story, only to advance in a linear story by making the correct combinations, however, the insights gathered by the research are interesting. They report that the children focused their attention on the animations and not on moving the tangibles, showing that content plays an important role in the experience, contributing to engagement and enjoyment, “They played with the cube when (1) the story

character asks for an item or (2) when the story advances to the next scene.” (Zhou, Cheok, Tedjokusumo, & Omer, 2008, p. 5).



**Figure 24 - User study in Singapore (left) (photograph: Zhou *et al.*, 2008) and picture showing the system in use (right) (Photo by MXR Corporation)**

*Make a Riddle* and *TeleStory* – are language-learning applications developed by Hunter *et. al.* that run on the Siftables platform. The *Siftables* are digital manipulatives that combine tangible and graphical interface in itself. *Make a Riddle* is targeted at children ages 4-7 years and its objective is “to teach spatial concepts and basic sentence-construction skills through creative play” (Hunter, Kalanithi, & Merrill, 2010, p. 207). It was design to work independently and it does not require an external display to show the digital content, the images and animations are viewed on the built-in display of the blocks. The application uses four blocks, three displaying words which the children could use to create riddles, and a fourth block that displays an image representing the combination, e.g. “mice on ice” shows the image of two mice ice-skating.



**Figure 25 - *Make a Riddle* (images: Hunter *et al.*, 2010)**

*TeleStory* “is designed to teach vocabulary and reading to children by enabling them to influence a story about a cat and dog” (Hunter *et al.*, 2010, p. 207). Contrary to *Make a Riddle*, where the digital content is entirely displayed on the *Siftables*, *TeleStory* uses a HD television to show the animated content that is triggered by the combination of the *blocks* (in this case the display on the *Siftables* shows a static image representing its content). The application has a set of animated sequences that appear on the screen when the children place the blocks next to each other, e.g. placing the tree-block next to the cat-block triggers an animation of the cat climbing the tree in the large scene, with subtitles and audio response “cats can climb trees!” (Hunter *et al.*, 2010, p. 208). The researchers observed that the use of a large screen increases the engagement of the children and so allows a more immersive experience, but creates a challenge regarding visual attention. They also pointed out that the sentences from *Make a Riddle* were more easily remembered by the children than the ones from *TeleStory* (Hunter *et al.*, 2010).



**Figure 26 - TeleStory (left), the Siftables (middle) and its resulting animation (right)** (images: Hunter *et al.*, 2010)

**Triangles** – is a system of physical triangular pieces that allow the users to interact with the digital content (Gorbet, Orth, & Ishii, 1998). The prototypes developed in the study – *Galapagos! – A World-Wide Web Story* – is particularly interesting to our work, focusing on storytelling. The interface is comprised of simple shaped pieces that work by combination which triggers a digital response in a nonlinear narrative. The triangular pieces connect by all sides through magnets that transmit electricity and digital information between the pieces and the computer. Gorbet (1998) mentions the advantage of using a generic shape, as this “enables them to be all about connections and relationships - a simple geometric shape has less semantic loading than familiar objects such as a digitally augmented set of dolls or books.” (Gorbet *et al.*, 1998, p. 3) (Figure 27). On the other hand, they say that the use of simple-shaped pieces poses a problem when it comes to create exclusive content, as their simplicity enables a huge number of possible combinations. Even with the limited number of pieces (the TUI offers only seven triangles) the researchers had to limit the number of appropriate combinations in order to develop a viable product.



**Figure 27 - Galapagos! Prototype developed with the Triangles interface (Photograph: Gorbet *et al.*, 1998, p. 3)**

**TOK** – is a Tangible Interface designed for storytelling. The system consisted on a set of blocks and an electronic board<sup>17</sup> that connects to a computer or tablet. Each block has a sticker representing a character or element based on traditional European stories and fairy tales. Placing the blocks on the board triggers animated digital representations on the screen that are accompanied by sound effects (Sylla, 2014). TOK was the building foundation for the Mobeybou, and its system is being used in the earlier stages of development to test art, animations, interaction between elements and backend code.

<sup>17</sup> Mobeybou first tests were conducted using the TOK system (electronic board and blocks) so we could test the content that is being developed.



Figure 28 - TOK, children using the device (Sylla, 2014)



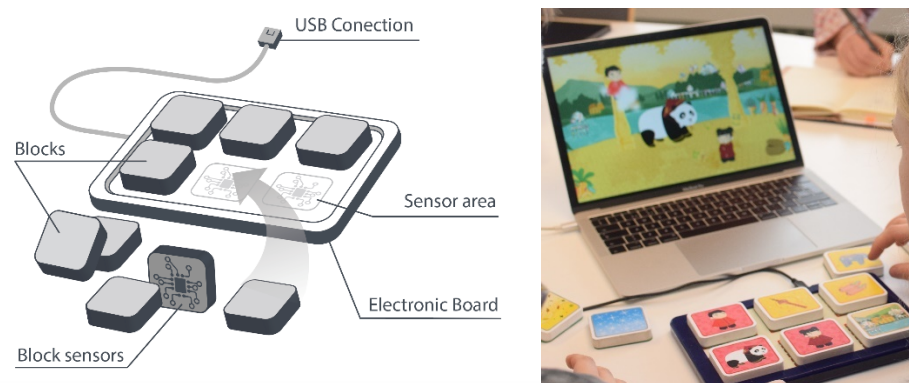
## 4. PRACTICAL PROJECT: ANIMATING FOR MOBEYBOU<sup>18</sup>

### 4.1 MOBEYBOU – MOVING BEYOND BOUNDARIES

Mobeybou is a tangible user interface for storytelling that uses physical blocks to manipulate digital content. It aims at fostering children's creativity and storytelling competences while promoting multicultural awareness, collaboration and integration (Sylla, Sá, *et al.*, 2019). In the next section we will explain how it proposes to do it, describe its components in detail and explain the process of creating and animating the interactive narrative elements.

### 4.2 THE TANGIBLE USER INTERFACE

Mobeybou is both an upgrade and an expansion of TOK (Sylla, 2014) that intends to extend its functionalities as well as changing the way the tangibles communicate with each other and with the computer/tablet. While this new system is still in development, the software is being tested using TOK's original device: a set of physical blocks that work with an electronic board connected via USB to a computer or a tablet (Caruso, Sylla, Sá, & Tavares, 2019). This electronic board has six slots (Figure 29, left) for placing the blocks, each block represents a narrative element. The placement of the blocks on the board triggers animated digital content that is displayed on the screen (Figure 29, right). The combination of different blocks results on different animations. Both the board and the blocks have magnets that help the connection and facilitate placement by snapping the blocks correctly into place.



**Figure 29 - Mobeybou model (left) and current prototype being used (right)**

This system allows testing the interactions and the animations implemented in the game, as well as testing the game itself with our target players. It is important to say that, so far, the use of the electronic board imposes a limitation on the number of active elements in the gameplay, as the player can only use six blocks simultaneously (Caruso *et al.*, 2019). Regarding the limited board, during the field studies, some pairs asked

<sup>18</sup> This chapter is based on two academic papers, one indexed in the 7<sup>th</sup> Confia - International Conference on Illustration and Animation and one presented at the 31<sup>st</sup> Conference of the Society for Animation Studies.

to have more slots in the board so they could use more blocks simultaneously. In section 4.7 we will we present the field studies in depth.

### 4.3 MULTICULTURALISM THROUGH STORYTELLING

Humans are storytellers by nature. From the paintings on the cave walls to the animated movies of cinema and television, we have been telling stories, as an expression of self, a teaching method, a way of honoring past generations, or just for mere entertainment.

For children, stories play an utterly important role. Stories are powerful mechanisms for both learning and teaching (Fails *et al.*, 2005). Children learn by social interaction and imitation of one another (Xie, Antle, & Motamedi, 2008) and stories and narrative exploration allow them to observe, copy and role play. Telling stories helps them to learn about life and the world, and, perhaps more important, stories are a compelling way to transmit cultural and social values. Therefore, stories and storytelling can be used to promote multiculturalism, helping to create more inclusive and tolerant societies (Sá, Sylla, Martins, Caruso, & Menegazzi, 2019).

As a storytelling tool, Mobeybou aims to be a part of this change, and tries to do so by offering the children a variety of narrative elements from different countries and cultures. Such elements are represented in Mobeybou's physical blocks. These are grouped into small kits of seven blocks each, representing landscapes, characters and objects that are characteristic of each country/culture (Figure 30). In a first moment we are trying to represent the most common cultures present in Portugal and Europe, but future work will extend the number of kits available in the game. We will describe the kits' elements in more detail in section 4.5.

The development of the game is intertwined with the development of support materials for the kits, the first of those materials is an interactive book that presents a story staged at India. The development of this book required the art and code team to stop working in the game, slowing down the implementation of some elements.

Up until now, we have illustrated and animated three<sup>19</sup> kits: India, China and Brazil, although the development of the additional interactive book has delayed the full implementation of the kits, for instance the kit representing Brazil was only partially implemented (protagonists and scenario<sup>20</sup>) when we tested Mobeybou in the schools.

<sup>19</sup> Along the writing of this project we started creating more kits, we have illustrated kits that represent Angola, Portugal and Germany and are in the process of animating their elements.

<sup>20</sup> The scenario presented some bugs when combined with the night-block so we decided to remove it from the last interventions.



Figure 30 - Example of blocks currently used in the game from the Chinese kit

#### 4.4 MODELING THE STORY WORLD

When we started discussing the design of the kits, we had to find a balance between the complexity of the project's goal – to provide the maximum creative freedom for the user – and the technical challenges. The structure should be as simple as possible while providing interesting and diverse narrative material. Since our goal was not to create a story but a framework for creating narratives, we adopted the classic narrative model proposed by Propp (Propp *apud* Sylla, 2014) as a basis to model the behavior of the narrative elements. According to this model, a narrative follows a sequence of events: an initial setup, a conflict, an attempt of solving this conflict, and its resolution. Tanenbaum *et al.* (2010) say that coherent narratives make use of reoccurring themes, characters, locations to create the structure for the story. The importance of repetition was recognized decades before by Vladimir Propp (1928/1968). In his work, after analyzing several Russian fairytales and folktales, Propp realized that they all had a common structure and a standard set of characters: the hero (or protagonist), the villain (or antagonist), the donor (who gives the hero a magical object), the dispatcher (who sends the hero on his journey), the false hero, the helper (gives support to the hero), the princess (or the reward) and the king (or who grants the hero its reward).

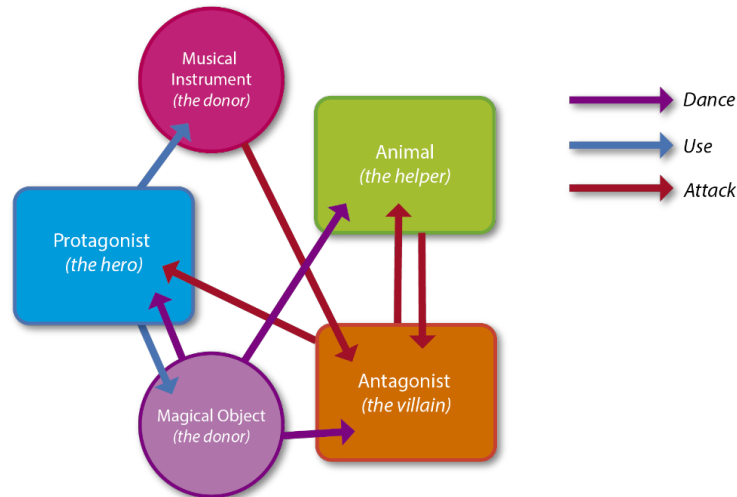
In Mobeybou we have three of those classes: the protagonist, the antagonist and the helper. We applied the function of the donor to the objects, which are magical objects (a local object embedded with magical powers) and a musical instrument representative of local culture (it holds the power of enchanting everyone that listen to its music). Those five elements constitute what we call major classes.

The organization of the elements in classes allow us to define how they relate to each other through behavior trees (BT) (Sylla, 2014) a concept used in video games to model how the characters behave, react and are controlled (Figure 31). The BTs will serve as base for the characters' animation libraries

The behavior trees define how the elements of the game will interact with each other and with the environment. Each class has a corresponding set of rules defining how it is supposed to act in each given situation. Besides facilitating the implementation of the elements in the game, this set of rules helps creating a

recognizable world for the player (Sylla, 2014). The chosen format sets the narrative's core in the interaction between the characters and makes it easier for the player to understand and relate with such characters (Louchart & Aylett, 2004).

**Figure 31 - Behavior tree of the major classes**

















To illustrate this, in the following we describe some relations and interactions between the classes:

- a) a protagonist by itself is always weaker than an antagonist;
- b) being weaker, the protagonist requires help from other elements to escape or win a conflict. This help can be provided by a helper-character (an animal) or a helper-object (a magical object or a musical instrument), or by the number of protagonists in the gameplay surpassing the number of antagonists by two or more (three protagonists are stronger than one antagonist);
- c) the animals and the antagonists are equally strong, so in case of conflict, if they are equal in number, the system randomly decides who wins the conflict;
- d) the musical instruments can only be used by the protagonists and when they enter the game, they stop all conflicts, making every active character dance;
- e) similarly, the magical objects can be used only by the protagonists and will grant them special powers over the antagonists, either to escape or to defeat them (Caruso *et al.*, 2019).





The quantity of blocks from a class present in the gameplay influences the resulting action. The same is true for the order of placement – in gameplays where there is more than one protagonist in scene, this rule defines which protagonist will get the objects or the musical instruments. In the following we present some possible scenarios that illustrate this influence (Table 1).

**Table 1 - Influence of blocks in conflict resolution**








		When only one character is active, its behavior varies between idle and walk cycles.
 		When more than one character of the same class is active, their behavior varies between idle and walk cycles, and laugh if they are protagonists.
  		Protagonists get afraid, the antagonist attacks, after 3 attacks, the protagonists faints (each one at a time).
   		The first protagonist gets the magical object and escapes, the antagonist attacks the second protagonist, after 3 attacks, the second protagonist faints.
   		The first protagonist plays the musical instrument and makes everyone dance. There are no fights.

Next, we illustrate the interaction between the characters, when there is one or two of each class active in the gameplay (Table 2). This table was first created in the early development of the game, when there were only two kits illustrated and animated, and was used as a reference to code the characters' behaviors. So far, because of the electronic board, we have a limited number of blocks active during gameplay: only six blocks can be used at the same time. This technicality influences the rules for interactions between characters as we have today. We are currently developing blocks that connect to each other via Bluetooth and to the computer via USB through a master block. That will remove the physical limitation imposed by the use of a board. Yet, some adjustments will be necessary if we decide that the game will no longer have a limited number of active characters in gameplay.

**Table 2 - Interactions between classes and resulting actions<sup>21</sup>**

	[empty]		 
[empty]		Idle	Idle
	Idle	1. Prot. Scare → Afraid / Ant. Walk 2. Ant. Attack → Prot. Flinch 3. Ant. Attack → Prot. Flinch 4. Ant. Attack → <b>Prot. Faint</b> 5. Ant. Idle	1. Prot. Scare → Afraid / Ant. + Ant. Walk 2. Ant. Attack → Prot. Flinch 3. Ant. Attack → Prot. Flinch 4. Ant. Attack → <b>Prot. Faint</b> 5. Ant. + Ant. Idle

<sup>21</sup> Complete interaction table in Appendix III

 	Idle	1. Prot. + Prot. Scare → Afraid / Ant. Walk 2. Ant. Attack Prot. → Prot. Flinch 3. Ant. Attack Prot. → Prot. Flinch 4. Ant. Attack Prot. → <b>Prot. Faint</b> 5. Ant. Attack Prot. → Prot. Flinch 6. Ant. Attack Prot. → Prot. Flinch 7. Ant. Attack Prot. → <b>Prot. Faint</b> 8. Ant. Idle	1. Prot. + Prot. Scare → Afraid / Ant. + Ant. Walk 3. Ant. Attack Prot. → Prot. Flinch 4. Ant. Attack Prot. → Prot. Flinch 5. Ant. Attack Prot. → <b>Prot. Faint</b> 6. Ant. Attack Prot. → Prot. Flinch 7. Ant. Attack Prot. → Prot. Flinch 8. Ant. Attack Prot. → <b>Prot. Faint</b> 9. Ant. + Ant. Idle
	Idle	1. ANIM. Menacing / ANT. Idle Randomly Chosen (RC)  If ANIM. Attacks: 2. ANIM. Attack → ANT. Flinch 3. ANIM. Attack → ANT. Flinch 4. ANIM. Attack → <b>ANT. Faint</b> 5. ANIM. Idle  If ANT. Attacks: 2. ANT. Attack → ANIM. Flinch 3. ANT. Attack → ANIM. Flinch 4. ANT. Attack → <b>ANIM. Faint</b> 5. ANT. Idle	1. ANIM. Scare → Afraid / ANT.+ANT. Walk 2. ANT. Attack → ANIM. Flinch 3. ANT. Attack → ANIM. Flinch 4. ANT. Attack → <b>ANIM. Faint</b> 5. ANT. + ANT. Idle
 	Idle	1. Anim. + Anim. Menacing / Ant. Scare → Afraid 2. Attack Anim. → Flinch 3. Attack Anim. → Flinch 4. Attack Anim. → <b>Faint</b> 5. Idle	1. Anim. + Anim. Menacing / Ant. + Ant. Idle (RC)  If Anim. + Anim. Attacks: 2. Anim. Attack Ant. → Ant. Flinch / Anim. Attack Ant. → Ant. Flinch 3. Anim. Attack Ant. → Ant. Flinch / Anim. Attack Ant. → Ant. Flinch 4. Anim. Attack Ant. → <b>Ant. Faint</b> / Anim. Attack Ant. → <b>Ant. Faint</b> 5. Anim. + Anim. Idle  If Ant. + Ant. Attacks: 2. Ant. Attack Anim. → Anim. Flinch / Ant. Attack Anim. → Anim. Flinch 3. Ant. Attack Anim. → Anim. Flinch / Ant. Attack Anim. → Anim. Flinch 4. Ant. Attack Anim. → <b>Anim. Faint</b> / Ant. Attack Anim. → <b>Anim. Faint</b> 5. Ant. + Ant. Idle
 	Idle / Idle	1. Anim. Scare → Menacing / Prot. Scare → Afraid / Ant. Idle 2. Attack Anim. → Ant. Flinch 3. Attack Anim. → Ant. Flinch 4. Attack Anim. → Ant. <b>Faint</b> 5. Anim. Idle / Prot. Idle	1. Anim. Scare → Afraid / Prot. Scare → Afraid / Ant. + Ant. Walk 3. Ant. Attack Anim. → Anim. Flinch / Ant. Attack Prot. → Prot. Flinch 4. Ant. Attack Anim. → Anim. Flinch / Ant. Attack Prot. → Prot. Flinch 5. Ant. Attack Anim. → <b>Anim. Faint</b> / Ant. Attack Prot. → <b>Prot. Faint</b> 6. Ant. + Ant. Idle

→ (Consequence); / (Simultaneous); Prot. (Protagonist); Ant. (Antagonist); Anim. (Animal).

#### 4.5 CREATING THE GAME ELEMENTS

When we start creating the elements for the game, we were aware that it is impossible to represent an entire country or culture using seven elements, as “there will be many perspectives within a given group” (Isbister, 2006, p. 62). Such diversity cannot be homogenized and it is very easy to fall into stereotypes. As an alternative, we try to create narrative material as wide-ranging as possible to stimulate the children’s imagination and

curiosity, and entice them to learn more about the world. Isbister (2006) suggests that we test early and often with members of a targeted culture, getting a wider range of reactions in order to make sure the characters will have the proper appeal.

Regarding the acceptance of the characters' style, Hasegawa and Tsurumi, game designers from Sony Computer Entertainment Japan, in conversation with Isbister (2006) say that "children are very tolerant of variations of character design" (Tsurumi *apud* Isbister, 2006, p. 66) "perhaps when they see an image of a character, even if they don't feel fond of it at first, there are instances that they will like it when they see the character in action." (Hasegawa *apud* Isbister, 2006, p. 67).

Isbister (2006) suggests that we consider using non-human characters when creating foreign-culture-inspired characters, as they "travel well across national boundaries. (...) avoid activating ethnicity, and are forgiven for behaving in odd ways because they are so clearly not part of the usual human social structure." (Isbister, 2006, p. 60). However, in our case, ethnicity is a desirable trace. We want to promote multiculturalism, inclusion and acceptance, and we believe that Mobeybou's characters can be an effective way to offer foreign children a chance to place themselves as part of the narrative. We hope to create friendly, relatable characters, with whom the children can easily identify.

The process of designing the elements for each kit starts with an extensive research about the country, its culture and, when possible, consulting with locals, for an insider perspective of the culture in question. All the elements are representative of the targeted country, inspired by local folklore, traditions and mythology. As we mentioned previously, each kit is composed of: two protagonists (the heroes) – the initial configuration foresaw just one protagonist per kit instead of two; one antagonist (the villain); one animal (the helper); one landscape (which sets the stage for the narrative); one musical instrument; and one typical object (which is embedded with some magical property to help the protagonist) (Sylla, Sá, *et al.*, 2019).

The protagonists are stylized human children of similar age, inspired by native people of each country and portraying visual information that can help the player identifying the character's origin. The antagonists are created based on mythical creatures from local folklore. This intends to avoid any possible misrepresentation or prejudice that could come from having an evil or mischievous human as character (Sá *et al.*, 2019). The helper takes the form of an animal representative of the country's fauna. To create the antagonists and the animals we take under consideration how the character will behave when animated and how it will look in the group along with the other characters.

The protagonists are the only ones that can interact with all the other elements and will be affected by them. Only the protagonists can use the musical instruments and the objects. The animals and the antagonists will be affected by all blocks, but cannot use neither musical instruments nor objects.

We also developed a range of secondary blocks that represent weather conditions (snow, rain, wind, thunder, rainbow) and time (night). This range of blocks can be used within any configuration and have cumulative effects on the characters present in the gameplay – for instance, the snow-block has a visual effect that simulates freezing the computer screen and makes the characters shiver, stopping all other actions in place, and the rain-block, after being a few seconds in use, floods the screen (Figure 32) (Caruso *et al.*, 2019).



**Figure 32 - Cumulative effect of the snow-block (left) and the rain-block (right)**

The first elements we developed for Mobeybou consisted of one protagonist and one antagonist representing Japan. However, they were used only as a way to test the range of expressions and customization that a character could have, apart from experimenting with style, color and testing the coding of elements and animations. In the event of developing a Japanese kit, it will be necessary to review both the design and the animation for these two characters.

#### **4.6 ANIMATING THE MOBEYBOU ELEMENTS**

One major concern when designing the characters was the amount of work involved in animating them. The protagonists are the largest group of characters, and as we have mentioned before, they must be able to use all objects and musical instruments, be it from their original kit or not.

With that in mind, we decided to compromise on diversity and give them similar silhouettes and behaviors: therefore, they all share the same skeletal structure and have the same range of animations, being equally affected by the other blocks. We name this limited range of animations restricted action libraries. To make this decision we took under consideration our initial goal of having a large number of unique elements and the limitations of time and human resources – our team has one illustrator and one animator in charge of all the art content for the project (Caruso *et al.*, 2019).



**Figure 33 - Protagonists silhouettes and base body shape**

So, all protagonists share a similar basic shape, with similar height and features (Figure 33); they differ from each other through hair styles, thickness of the eyebrows, eye color and shape, clothes, patterns and colors (as showed in Figure 34). (Sá *et al.*, 2019) This process of using similar silhouettes is commonly used in mainstream animation and is subject to controversies, if on one hand we have more production in less time, on the other hand it can be argued that this creates a deprived repertoire of characters. On the good side, this

simplicity generates characters that are easily recognizable and have a neutral personality, and so, are easily transformable according to the player's desire and creativity. (Caruso *et al.*, 2019)



**Figure 34 - Protagonists representing India (left), China (middle) and Brazil (right)**

In contrast with the human characters, the animals and the antagonists have exclusive designs and, their uniqueness grants us more freedom to create their animations even while respecting the behavior tree delimitations. (Caruso *et al.*, 2019) For instance, all animals and antagonists have an attack animation, but every attack is exclusive of each character, e.g. in the China kit the panda bear attacks by turning itself into a ball and 'rolling' over its opponent while the *qilin* spits balls of fire (Figure 35). The process of animating these characters, which are unique, poses a higher level of difficulty but it is a lot more exciting. It is challenging to convey their personalities and the unusual behaviors that we design for them into the animation, but this is also the best part of working on them. In the following we list all the animals and antagonists' singular attacks.



**Figure 35 - Animals and antagonists' attacks**

The animation process starts by preparing the image file for rigging. This process is facilitated by rules set between the illustrator and the animator, which define how the elements are created (movable parts) and how the layers are named. But some minor adjustments might still be needed as the layers sometimes have a higher degree of details than necessary. Also, depending on the character and its actions, the layers can be merged or simplified. After making sure the file is ready, we run a built-in script (code) that the animation software provides. This script automatically creates a sprite from each layer and will not accept layers that have duplicated names, so we have to be certain that the layers are properly named, e.g. arms need to be labeled different for left and right, like arm\_L (left) and arm\_R (right) (Figure 36).



**Figure 36 - Example of layer hierarchy for the character's arm**

Once the file is exported, it can be opened in the animation software and rigged. The animation software used (*Spine 2D® by Esoteric Software*) allows us to create meshes over the 2D images. The meshes are constructed by creating polygons inside the image that turns it into a malleable surface. Manipulating the polygon vertices bends and deforms the image in a 3D-like movement, otherwise impossible to achieve with cutout animation (Figure 37). The meshes help to create subtle and softer movements. For example, in the idle animations, when the character is standing in place, he still needs to show some body movement, otherwise, it might seem that the game froze. By adding vertices to the character chest, we can create subtle movements that simulate breathing by expanding and contracting a portion of its chest. After all the bones are in place and the meshes are created, we can start animating. We usually start by creating all the bones and color-coding them before creating the meshes on the sprites that require it, like dresses, hair or fur.



**Figure 37 - Mesh created over the character sprite and the deformation resultant from manipulating the bones**

We have mentioned before that, when animating for interactive media, the animator has to grant control of the character's actions to the player. In Mobeybou the player is in control not only of the character, but of the whole narrative. Besides that, our main goal with this work is to offer the players a wide range of materials to create their narratives and this implies creating the largest possible number of blocks. Thus, it is critical to consider the progressive amount of animations and the restrictions that we face while creating them (Caruso *et al.*, 2019).

The first cultural kit to be fully developed was the Indian kit. As mentioned previously, it included only one human character as the protagonist. After discussing variety and gender representation, we decided to create both a boy and a girl for each kit. However, adding characters to each kit increased the volume of work necessary to animate them. Fortunately, we found a way to significantly reduce the amount of time required for the extra character animations: we asked the illustrator to create the second protagonist using the base of the first character (Figure 38 left). This way, we could duplicate the skeleton and its animations and so, having to do only minor adjustments to each animation e.g., to animate individually the movement of hair, clothes, etc. (Caruso *et al.*, 2019). This process was done for the male characters of both India and China (Figure 38 right).



**Figure 38 – China protagonists' (left) and detail of their middle portion (right), showing that the same shapes were used to create both characters**

Another issue we were dealing with was the interchangeable elements: mixing the elements from the different kits meant that every human character should share the use of objects and its respective animations. Each new character added to the game would inherit the magical objects, the musical instruments and its animations from previous characters, in the same way that the preexistent characters would need to inherit the new objects, musical instruments and animations. For every new character added, the number of bones and animations in all protagonists' skeletons would increase by at least two. It was vital to find a way to speed up this process and avoid redundant work, however at that time, our only option was to do this process manually, adding new bones and new images one by one.

Our first approach to creating a second protagonist for each kit was to duplicate the original animation file, rename it and replace its images (sprites) with the images from the new character. This allowed us to produce two animated characters in almost half the time. Designing the characters with the same basic shape, as shown in Figure 1Figure 38, also allowed us to share meshes between them (**Erro! Fonte de referência não encontrada.**) instead of creating a new one. Using the meshes to obtain softer movements was a style choice made in the beginning of the development based on the animator skills and in the resultant effect, but this process is quite time consuming. This loophole reduced considerably the amount of work required for creating the second protagonist (Caruso *et al.*, 2019).



**Figure 39 - Highlight of silhouettes of the two protagonists for the Indian kit, the girl was used as basis for the design of the boy**

And although this was a helpful shortcut, we still had to deal with the animations for all the other elements, and with the fact that different kits would have different pairs of protagonists and, even if they could share the structural shape between the two, different countries meant different clothes and behaviors and so, our shortcut proved to have a short life span, it was not going to suffice as we expanded the game elements.

The software used to animate allowed us to import animations from one skeleton to another, but crashed every time we tried to copy bones between two skeletons, forcing us to keep the process manual. However, given the increasing level of complexity, when we were preparing the characters for the third kit, we decided to resume the search for ways to simplify it. We expected to find some tutorial but fortunately, we were not the only ones struggling with this process. Improvements were made in the software by request of the user's community. Now the software allows copying bones and images from one skeleton to another by dragging the desired bone through the hierarchy tree, as long as we place both skeletons in the same project (**Erro! Fonte de referência não encontrada.**). This not only reduced the amount of work as also allowed us to improve both in quantity as well as quality.

Less time spent on preparing a skeleton gave us more time to refine the animations and make corrections whenever they were necessary. And when working in a project for over one year it is very important to find solutions to improve and fix details. For instance, the size and the resolution of images that compose the first characters needs to be reviewed, and we want to optimize the protagonists' animations and skeleton. Instead of having one skeleton per protagonist (male and female) we are considering having one protagonist skeleton per kit, and create the male/female versions as skins. This is something that needs to be further discussed with the engineer team, and needs to be tested internally before being implemented on the game. This can be an improvement on size and processing speed, but it can also happen that something does not work in this particular game.

Whereas it may seem that we are compromising originality by replicating animation cycles through the protagonists, nonetheless, every single animation is individually adjusted to better fit each character and give it a sense of personality, even if the structural basis is shared between all (Caruso *et al.*, 2019).

As mentioned before, the behavior trees were used as a basis for developing animation libraries for each class of characters. Bellow we list the libraries that are currently animated. Not all the animations have been implemented into the game and tested by players – which will happen in future tests – but the animations created take under consideration the feedback that we have received from the children in the various field studies. Those waiting to be coded are signed (\*).

#### **Characters' animation libraries:**

##### **Protagonists:**

- a) afraid (when an antagonist or more is present)
- b) asleep (after 5 seconds when the night-block is active)
- c) angry (if one antagonist and one animal are present)
- d) cold (after 5 seconds when the snow-block is active)
- e) dance (when another character is playing music)
- f) faint (after the antagonist attacks for the third time)
- g) flinch (when the antagonist attacks)
- h) idle (when no other action is happening / alternates between idle-walk-idle)
- i) knock out (cycle that follows the faint animation)

- j) laugh (when another friendly character is active)
- k) *play\_musical instrument*<sup>22</sup> (musical instrument is active - there will be one animation for each kit created, named accordingly, e.g. *play\_pipa* – Chinese kit)
- l) spooked (first action after placing an antagonist, is followed by afraid)
- m) *use\_magic object*<sup>23</sup> (object is active - there will be one animation for each kit created)
- n) walk (walk cycle, alternates with idle)
- o) zapped\* (randomly when the storm-block is active)

#### **Antagonists:**

- a) afraid [when is outnumbered by animals (2 or more) or protagonists (3 or more)]
- b) asleep (after 5 seconds when the night-block is active)
- c) attack (if an opponent is present)
- d) cold (after 5 seconds when the snow-block is active)
- e) dance (when a character is playing music)
- f) faint (after the antagonist attacks for the third time)
- g) flinch (when opponent attacks)
- h) idle (when no other action is happening / alternates between idle-walk-idle)
- i) knock out (cycle that follows the faint animation)
- j) walk (walk cycle, alternates with idle)
- k) zapped\* (randomly when the storm-block is active)

#### **Animals:**

- a) afraid [when is outnumbered by antagonists (2 or more)]
- b) asleep (after 5 seconds when the night-block is active)
- c) attack<sup>24</sup> (if an opponent is present)
- d) cold (after 5 seconds when the snow-block is active)
- e) dance (when a character is playing music)
- f) faint (after the antagonist attacks for the third time)
- g) flinch (when opponent attacks)
- h) idle (when no other action is happening / alternates between idle-walk-idle)
- i) knock out (cycle that follows the faint animation)
- j) menace (when an antagonist is active / before attack)
- k) walk (walk cycle, alternates with idle)
- l) zapped\* (randomly when the storm-block is active)

<sup>22</sup> At this moment, just the Chinese and Indian music instrument are coded in the game

<sup>23</sup> At the present moment, only the Indian object (a pair of magic shoes) is coded in the game

<sup>24</sup> The attack of the Chinese animal (Panda) still needs some fixing, as the programmer have not followed the animator's indications correctly – the panda should 'roll over' the opponent knocking it down as a bowling ball but right now it just rolls in the same spot.

Testing the game with children will help us determine how this decision affects the gameplay and the narratives created by them. In the next section we will describe the test sessions and report on the feedback gathered during children's gameplay with Mobeybou.

## **4.7 EXPLORATORY FIELD STUDIES**

### **4.7.1 RESEARCH METHODOLOGY**

This section addresses a series of tests carried out in five schools, located in Portugal and in Denmark. As we have mentioned in the beginning of this report, the development of Mobeybou follows a user-centered design, involving both the development team and the players at various stages of the process. For this reason, we started testing the idea with children in the very beginning of the development. Several trial sessions were carried out throughout the project. During this process, the use of prototypes that are fast and easy to create, help evaluating usability decisions and anticipate problems. An effective way to prototype tangible user interfaces is to use cardboard mock-ups. So, for the first user-tests, we created a low-cost prototype that consisted of paper cards with the initial drawings of the Mobeybou's elements. This study was held in the early stage of the system's development. We wanted to observe how the children would use (placement and interaction) the cards to tell a story and gather insights for the design of the digital system, as well as to see the level of engagement/acceptance and recognition of the imagery we were creating. The feedback we got from the children shaped the design of some character behaviors' as well as the usability of the blocks on the digital game.

The second user-test was carried out with TOK's original electronic board and the animated computer version of Mobeybou's physical blocks. In this version, we could observe how the children reacted to the animations and used them in their narratives. The feedback gathered in these tests will help us to understand how the restricted action library affects the children's creative process. In the following we explain the sessions in further detail.

### **4.7.2 FIRST PART – ANALOGIC PROTOTYPE**

#### **4.7.2.1 Participants**

The study took place at a public primary school in Braga (Portugal), with 22 children aged between 7 and 8 years (average = 7,5). We ask the teacher to divided the class into three large groups (two groups of seven, and one group of eight children), since the prototype allowed a broader activity. Each group had circa 20 minutes to interact with the prototype.

#### **4.7.2.2 Instruments and Data Collection**

The prototype consisted of 49 paper cards (Figure 40). To make them we printed the initial drawings created for the Mobeybou elements, and glued them to cardboard squares of 4,5 x 4,5cm (similar to the size of the blocks from the digital manipulative). The set of cards represented seven kits – scenery, protagonist<sup>25</sup>,

<sup>25</sup> At this point, each kit had just one protagonist

animal, mythical creature, object and music instrument; plus, seven secondary elements – weather and time phenomena. We portrayed cultures that we considered visually interesting amongst the prevalent ones in Portugal and Europe, in an attempt to observe how the children would perceive different nationalities and if they recognize them. We printed the images and glued them on 5x5cm cardboard cutouts, creating an object that would be resistant and easy to manipulate.

The data was collected through observation, written notes, audio/video recordings using a video camera on a tripod placed behind the children, and digital photographs.



Figure 40 - Sample of cards used in the analogic prototype

#### 4.7.2.3 Procedure

We displayed all the cards on a table, each group interact with them. We started by inviting the children to explore and play around with the cards. After a few minutes, we asked them to arrange the cards in groups, in order to see how they would interpret the visual symbols and if they would group the cards into the correct categories. We observed that most of the children could not identify the characters' nationality and, in some cases, could not identify the animal or object depicted on the card. In such cases, they would give the cards a familiar name. Despite of that, we observed that the children grouped the cards into the categories we had originally defined for them – e.g. they would group the mythical creatures and use them as “enemies”, the human characters would be gathered in another group and used as protagonists, and the animals in another group, used as friendly characters.



**Figure 41 - Children organizing and grouping the cards in categories (left, middle and right)**

In the third part of the intervention, we asked the students what they could do with the cards, to what they answered “tell stories”<sup>26</sup>. So, we invited them to create a story, in group using the cards. They divided the cards among themselves (each child would try to get as many cards as possible) and all worked on incorporate their set of cards in the narrative. Photographs displayed in figure 42 illustrate this.



**Figure 42 - Children telling stories in group (left, middle and right).**

After that exercise, we asked the children to tell a story using only the cards from one kit, first individually and after in pairs or trios.

#### **4.7.2.4 Observations**

The individual stories were far more intricate than the ones told by the groups. But the pairs of children working together were talking to each other, discussing what actions they should take, negotiating what cards to use, thus creating a dynamic group exercise. While one group was telling a story to the researchers, the rest of the children instead of watching and listening were engaged in their own experience, telling stories to each other in pairs.

The way in which they combined the cards, and the use given to the objects provided helpful insights for both coding and animation. For instance, the magic object from India, – a pair of embroidered shoes – got the ability to make the character, who wears it, fly. The shoes’ special power was later incorporated into the game.

<sup>26</sup> It is important to say that some of the students in this class had participated in the user-tests carried out with TOK, having previous knowledge of a storytelling tool. But even so, mediation from the researchers was required to help the narrative grow.



**Figure 43 - Cards as displayed at the end of one of the stories created by the children**

#### **4.7.3 SECOND PART – DIGITAL PROTOTYPE**

The studies with the digital prototype occurred in two different scenarios: the first ones during the school year and the last ones during summer school<sup>27</sup>. Consequently, both environment and context were different, and resulted in very different atmospheres.

In the summer school sessions, when we arrived, the children were oft in the school yard engaged in sports games and other ludic activities. These activities were briefly interrupted by the teacher, when she called a pair to take part in the tests. Usually, the first two pairs were chosen by the teacher, but after two or three pairs the children volunteered to participate. Often, a group of children that was not participating would gather around the table, watching the screen in a very engaged manner, making comments, cheering the characters, and asking the children that were playing to try out different combinations. Some of the children would be there waiting for their turn to play, some had played before and others would be just engaged spectators.

##### **4.7.3.1 Participants**

The tests were divided in six sessions that lasted from 3 to 4 hours each. The sessions took place at five different locations: two public schools in Braga (Portugal), one primary school in Aalborg (Denmark), one private study center in Maia (Portugal) and one private art school in Lisbon (Portugal). Our initial targeted audience was composed of children between the ages of 6 and 10 years with a proportional gender ratio. However, during the summer school tests, both the array of ages and gender ratio was diverse and different from our initial target, ranging from 5 to 14 years of age. In total 66 children participated in these studies, 26 boys and 40 girls, with an average age of 8,42 years.

<sup>27</sup> Delay caused by the development of support materials resulted on part of the tests being conducted at summer school.

In each of the sessions, we asked the teachers to group the children in pairs, even so, some of the children volunteered to participate interfering with the teachers' choice. All the sessions were held in the schools' facilities, in a separate room with one pair at a time. Each pair interacted with Mobeybou for a period of 15 to 17 minutes in average, although several of the pairs exceeded the limited interval, and / or complained when we said the session was over, sometimes asking if they could tell another story.

#### 4.7.3.2 Instruments and Data Collection

The digital version of the prototype consisted of twenty physical blocks: the complete Indian kit, the Chinese kit minus the magic object (it was not yet programmed in the game at the time), three blocks from the Brazilian kit (the scenery<sup>28</sup> and the two protagonists), three weather-blocks and the night-block, one electronic board with six slots and a computer (Figure 44 left).

The data was collected by the researchers present in each session via observations, written notes, audio and video recordings. The video camera was placed behind the participants, with fixed zoom and focused on the digital manipulative and the computer screen. Photographs of the children's interactions were taken in all sessions.



Figure 44 - Digital prototype - setting for the field studies (left) and children interacting with researcher (right).

#### 4.7.3.3 Procedure

As mentioned previously, the sessions were held in a separate room, where the children could interact freely with the tool without disturbing the ongoing activities. The rooms were equipped for the tests with a table and two chairs for the participants. The prototype was placed on the table, the blocks were randomly distributed beside the board (see Figure 44). The children came to the room one pair at a time. The researchers invited them to sit and freely explore the blocks and the animations. If necessary, the researchers would briefly explain how the system worked.

#### 4.7.3.4 Observations

At the beginning of the sessions, both in the classroom and in the summer school contexts, the children seemed a bit shy, either talking in a low voice or not talking at all, just experimenting with the blocks and

<sup>28</sup> Due to some bugs the landscape block from the Brazilian kit was not functioning correctly and was removed by the researcher in the last session (Lisbon).

watching the animations on the computer screen. They would kick each other with the elbow, and giggle mutually calling their attention to the behavior of the characters on the screen. After a few minutes of playful exploration, we asked each group if they understood how Mobeybou works and what they thought was its purpose. 21 of the 34 pairs said Mobeybou could be used to tell stories, and some pairs had more colorful and creative uses for the system (see Table 3). One of the participants, at first contact, said Mobeybou's purpose was *"to represent diversity"* but at the end of the experience, when asked how they would describe the tool, he said: *"This is basically a digital support for children to invent stories with their creativity"* (R. 14-years-old)

**Table 3 - Question: "What do you think we can use this tool for?"**

<i>"It's for theatre with pieces [...] we invent sceneries, stories, and happenings, I think."</i> Girl 7-years-old
<i>"to understand the ways of living"</i> – Girl 13-years-old
<i>"is to represent diversity"</i> – Boy* 14-years-old
<i>"A movie"</i> – Girl 6-years-old
<i>"A story, music... friendships, places"</i> – Girl 9-years-old

After answering our question, some of the pairs took initiative to tell a story without our intervention. However, most pairs required our invitation to start, with only 13 out of 34 pairs taking the initiative.



**Figure 45 - Children using Mobeybou's digital prototype**

### **Roles, learning and narrating by doing**

Along the experience we observed that the children would assume different roles. They would easily change between narrators, actors and spectators. Sylla (2019, p. 402) refers to that as *"narration by doing"*. Ackerman (2007) says that this is an intrinsic part of learning, *"people learn by switching roles from being producers to being critics, from being actors to being audiences, from holding the stage to moving into the background"* (Ackerman, 2007, p. 4).

Narrator was the commonest role assumed by the children. During most part of the narratives the pairs would conduct the plot, taking control of the narrative like a movie director or a puppeteer. As actors, they would embody the characters, putting themselves inside of the story and, in a certain degree, experiencing the situations as they were narrating. In some cases, they would use dialogues and direct speech. The excerpts on table 4 illustrate such situations:

**Table 4 - Use of dialogues and direct speech inside the stories**

<p><i>“one day the girl was alone. And it was night time. She could not see very well. ‘And then I found a thing... Aaaaaaah! A snake!’ So, she went to get her flute and played it to chase the snake away”</i> – Pair 24 (girl 9-years-old, boy 9-years-old).</p>
<p><i>“the elephant and the panda were outside Tiago and Nuno’s door and were making noises, but they had the flute near them and they played; Tiago asked: ‘Why are we here at night?’ and Nuno<sup>29</sup> answered ‘I don’t know either’”</i> – Pair 5 (boy 7-years-old, boy 8-years-old)</p>

As spectators, the children would take a step back, distancing themselves from the story and watching as the plot unfolds from the combination of the blocks. Often the children would stop the narrative to watch the conflicts between animals and antagonists, giving opinions about which one would win, cheering for their chosen character and demonstrating their frustration when the result was in favor of the opponent. We observed this behavior throughout the interventions. The next excerpt illustrates how they briefly interrupted the narration to watch the conflict, moving from narrator to observer: *“the girl was asleep [the protagonist had fainted from an attack but they omit that] and all the animals appeared [the animals and antagonists start to fight on the screen and both girls stop to watch it unroll and laugh]”* – and, rapidly reassuming the narrator’s role – *“but then the girl played the pipa to stop the animals from attacking each other<sup>30</sup>. The animals were talking. Then the elephant went home and the Chinese siblings appeared [...]”* – pair 4 (girl 7-years-old, girl 8-years-old).

Another pair named the conflicts “combats”, and used the rows of the electronic board to form ‘teams’ – *“the Chinese characters are on the panda’s team”*. According to their setup, the blocks in the top row were a team<sup>31</sup> (the Chinese protagonists and the panda) and the ones in the lower row were the opponent ‘team’ – Pair 30 (boy 7-years-old, girl 8-years-old).

In the same category (spectators) are the pairs that would not (verbally) narrate a story – eleven in total. In most cases they would agree when the researchers asked if they would like to tell a story, engage for a while if we kept talking and stimulating them but, for most of the time, they would remain immersed in the activity of changing the blocks and watching the animations that were triggered on the screen [they were not in complete silence for the whole time, they would make comments to each other, though they would not elaborate a narrative]. For example, pair 29 (two girls, 6 and 8 years old respectively) agreed to tell a story in the beginning of the session, and even asked to tell one more at the end, but in both moments, they would mostly play with the combinations of the elements and watch the animations. Remarkably, when we asked what they thought could be done with Mobeybou, the younger of the pair said *“a movie”*.

In another session, one of the participants of pair 18 (girl 1, 7-years-old) calls the attention of her partner (girl 2, 7-years-old) saying *“we are not supposed to ‘make’ the story this way”*. They discuss for a bit while

<sup>29</sup> They gave their names to the characters and each one would ‘play’ its role.

<sup>30</sup> We observed that the girls were, in general, less fond of the conflicts, some would even verbally indicate their frustration. In this situation, they would try to avoid conflicts by removing the antagonists’ blocks or adding a musical instrument to the gameplay.

<sup>31</sup> Animals and antagonists were the ‘fighters’ and the protagonists were the cheering supporters

playing with the blocks and girl 2 says that girl 1 is not telling a story. Quickly, girl 1 replies “*oh, you just put the things and that is it*” [referring to placing the blocks on the electronic board]. The first girl insists that she needs to “tell” (in the sense that they should just ‘read’ what is happening on the screen) a story and she starts narrating what she is seeing. Girl 2 interrupts with “*once upon a time, there was a girl...*” and girl 1 sharply cuts her off saying “*Not like this! You should just ‘tell’ the images... nothing else...*” [we just observe]. They come to an agreement and start telling a story like girl 2 wanted in the first place. Further testing and a more specific questionnaire might need to be applied in similar situations, in order to ascertain if the act of combining the blocks and watching the animations is indeed their idea of ‘telling’ a story. However, we found it relevant that Mobeybou triggered a discussion and negotiation between the girls.

Regardless of age, most of the observed pairs created narratives that followed the animated content, usually by describing what was happening on the screen. Twenty out of the thirty-four pairs based their narratives on the animations. But we also observed that the animated triggered new ideas and inspired the creative process, in various stories the children built on the actions they were seeing on the screen, for example: “*the elephant was mad with the snake because the snake had eaten its biscuits*” (pair 5 – two boys, 7 and 8-years-old).

Rowe (1998) divides play in three categories: constructive, exploratory and dramatic. Dramatic play is what happens when the children use make-believe and “role-playing to act out stories they invented” (Rowe *apud* Acevedo Aquino, 2015, p. 43). Aquino (2015) also points out that, when playing, children create and negotiate their own rules instead of following guidelines that were set for them (p.44). And although less common, we observed this behavior along the experience. Some of the pairs created stories that were unrelated to the animations displayed on the screen, telling what they wanted to happen rather than what was really triggered on the game. For example, pair 3 would tell what they want to happen instead of what was really happening with the characters: “*the children climbed on the elephant’s back*” (interaction that does not exist in the game) “[...] *they took a walk with their panda and a lion appeared and the lion bit the panda*” in the game, there was a musical instrument active and all the characters were dancing in the animation; “*it got dark [places the night-block] and the children went home; [they place the antagonists’ blocks] then an elephant appeared [placing the elephant block] and killed them!*” – in fact, the elephant lost the conflict, but the boy who was narrating ignored the scene on screen; “*then the snake killed the panda.*” [they remove the lion and place the panda] – again, the narration was different from what was seen on screen because the snake was the one who lost, but the boy who was narrating just laughed and kept on with his story. One thing that might be relevant here, at least with this particular pair, is that, from the start, they were visibly impatient<sup>32</sup>, changing the blocks in a frenetic way without waiting for the reaction to appear on the screen.

On the other hand, some of the children would stop in the middle of the description to watch the animation and adjust the plot accordingly. Table 5 illustrates these moments:

<sup>32</sup> Is important to say that in the first intervention, the system had a delay of a few seconds between the placement of the block in the platform and the animation popping on the screen, which can be responsible for aggravating the impatient behavior of some of the testers.

**Table 5 - The narrative is adjusted according to the animations**

<p><i>“Once upon a time there was a little girl that met another little girl, they are playing the flute, and all started dancing, [describing the animations that resulted from mixing the blocks] but suddenly it started raining, they had to run home. They began to play, suddenly a lion appeared and... [waiting to see the resulting animation: the lion trembles with fear] ...he was very scared and ran away.”</i> – pair 1 (boy 8-years-old, girl-7-years-old).</p>
<p><i>“And then, because we are in India, an elephant appears, with... flying shoes! (do you think it will work? Ok, it doesn't.) [changes the narrative] But the Chinese girl lost track of her elephant so she comes back from China to search for her elephant... [places the protagonist to use the object] ...and she flies on top of the elephant! But sees that she is too high and take the shoes off...”</i> [one more time, they adjust the narrative because the protagonist floats too far from the animal] – pair 31 (two girls, 12-years-old).</p>



**Figure 46 - Test sessions held in Maia, Braga and Lisbon (Portugal)**

### Constraints force you to think

Stokes (2006) says that constraints are tools that help develop creativity. She identifies a set of constraints that she considers important in early ages: domain, variability, task and later goal constraints. Here, we focus on the task constraints, which comprise “materials and conventions concerning their use” (Stokes, 2006, p. 123). Stokes suggests that “early exposure to task constraints has two special qualities. First, it’s playful. Second, all attempts, approximations or successes, are attended to and encouraged. Play and attention are rewards”. In Mobeybou, the constraints are the materials – the blocks, board, animations etc. – and the conventions – behavior trees, game rules, and limitations imposed by the system, such as blocks (elements) available and number of slots on the electronic board.

Dealing with the constraints made the children explore the game, think about the relation between the blocks and how their actions affected what was happening in the screen, thus promoting reflection and logical reasoning. We saw that after learning Mobeybou’s rules, the children often used them as a part of the stories. For instance, they would remove a block to make a character disappear, using the game’s constraint<sup>33</sup> in favor of the narrative: *“a snake appeared and ate the elephant [removes the block]”* Pair 4 (girl 7-years-old, girl 8-years-old). Some pairs realized how the order of placement changes which character gets the accessory. Pair

<sup>33</sup> The number of slots on the electronic platform limits to 6 the number blocks active in gameplay.

30 (boy 7-years-old, girl 8-years-old), after trying several combinations of the protagonists and the ‘magic shoes’, realizes that they can change who is wearing the shoes by changing the blocks. After that, they kept switching blocks until they got the desired reaction. This pair also transformed the absence of scenery on a location. They wanted to have all characters at the same time and so, there was no space for a landscape-block. Their solution was to make the characters go to what they called the “void”. They repeated the action again and again, laughing every time it happened: *[the researcher tells them it’s time to finish the story and since they seem reluctant to give it an end, asks them where the end will take place]* Girl: “In the void!” Boy: “In the void? No!” Girl *[laughing]*: “In the void! In... the... VOID!” Boy *[ignoring the ‘void’ and placing a landscape on the board]* “But they were very cold because they were at...” Girl *[removes the landscape and laughs]*: “in the void!” *[This continues for a while and the story goes on for another 5 minutes.]*

Pair 20 (boy and girl, 7-years-old) realizes that by removing the protagonist and placing it back on the board they make it appear in a different point of the screen and uses that as a trick to escape the attacks of antagonists. Pair 24 (boy and girl, 9-years-old) learned how the blocks related to each other and during the narrative, would hold up a specific block while enunciating the action, waiting to place it at the right moment to get the desired result.

Despite the creative solutions, pairs 15 (two boys, 7 and 9-years-old), 19 (two girls, 7 and 10-years-old), 27 (two girls, 8 and 10-years-old), 30 (boy 7-years-old, girl 8-years-old), 31 (two girls, 12-years-old) and 33 (two girls, 6-years-old) asked for a platform with more slots, so they could use more blocks simultaneously.

### **About engagement and enjoyment**

According to Price *et al.* tangible devices “have the potential to make learning playful and pleasurable through engaging children in exploratory and reflective activities” (Price *et al.*, 2003). Engagement plays a fundamental role in learning. Fails *et al.* (2005), quoting Dewey’s educational principles, place engagement, playfulness and interest in the heart of the process. Xie *et al.* (2008) state that engagement and enjoyment are “prerequisite aspects of children’s playful learning experiences” (p. 192). As for how to evaluate the levels of engagement in studies with children, Read *et al.* suggest observing the child for behaviors such as “smiles, laughing, concentration signs, excitable bouncing, positive vocalization” (Read *et al. apud* Xie *et al.*, 2008, p. 192). Collaboration, according to Xie *et al.* (2008), can enhance levels of engagement and enjoyment. They state that children are more engaged and motivated when working together and so, suggest using paired collaboration to enhance the experience for studies involving children.

Along with the behaviors previously listed the time spent in the interactions is also an indicative of engagement, enjoyment and immersion in the experience. From the observed pairs, we saw that the female pairs (G/G) had the longest time interactions, with an average of 18 minutes and 50 seconds, followed by the mixed gender pairs (B/G), with an average of 18 minutes and 32 seconds and the male pairs (B/B), with 14 minutes and 55 seconds interactions in average (see Table 6).

**Table 6 - Average interaction time per pair gender**

G/G pairs	Int. time	B/G pairs	Int. Time	B/B pairs	Int. Time
Pair 02	00:15:00	Pair 01	00:15:00	Pair 05	00:15:00
Pair 04	00:15:00	Pair 03	00:15:00	Pair 06	00:15:00
Pair 11	00:15:00	Pair 07	00:20:00	Pair 10	00:15:00
Pair 16	00:14:49	Pair 08	00:20:00	Pair 13 <sup>34</sup>	00:15:00
Pair 18	00:21:53	Pair 09	00:20:00	Pair 15	00:15:00
Pair 19	00:15:26	Pair 12	00:15:00	Pair 22	00:16:00
Pair 21	00:15:25	Pair 14	00:15:00	Pair 25	00:13:27
Pair 23	00:18:12	Pair 17	00:16:22		
Pair 26	00:19:17	Pair 20	00:21:00		
Pair 27	00:19:09	Pair 24	00:17:17		
Pair 29	00:23:28	Pair 28	00:15:17		
Pair 31	00:19:22	Pair 30	00:32:31		
Pair 32	00:17:07				
Pair 33	00:23:28				
Pair 34	00:29:56				
<b>Average:</b>	<b>00:18:50</b>	<b>Average:</b>	<b>00:18:32</b>	<b>Average:</b>	<b>00:14:55</b>

The last pairs in the summer school sessions had longer interaction intervals, but overall the pairs would extrapolate the allocated time despite of the context (school year or summer school).

Whenever the children had a chance to use Mobeybou for the second time, either telling a new story or retelling the previous narrative, the experience was livelier, with more intricate plots and signs of enjoyment like laughing, dancing and mimicking the animations. Pairs 4 (two girls, 7 and 8-years-old), 6 (two boys, 8-years-old), 29 (two girls, 6 and 8-years-old), 30 (boy 7-years-old, girl 8-years-old) and 34 (two girls, 5 and 8-years-old) told more than one story. This might be related with the amount of time – longer intervals allowed the children to get more at ease with the environment.

Three players of different pairs volunteered themselves to participate in a new session with other partners. This happened during the summer schools' sessions with pairs 15 (two boys, 7 and 9-years-old), 32 (two girls, 12-years-old) and 33 (two girls, 6-years-old).



**Figure 47 - The oldest participants (left) and the youngest participants (right)**

<sup>34</sup> This group had one extra 6-year-old boy, brought by his brother

In an informal conversation, the older participant of pair 25 (boy 13-years-old), associates the way of creating narratives to the players' age, in his opinion *"If it [Mobeybou] is used to create a story, I think it should be for older children, for the younger ones I think they should (re-)tell (verbally) what they see on the screen"*. According to our observations, younger children needed more support and engaged more if a teacher or a parent was present. For example, pair 23 (girl 1, 5-years-old, girl 2, 6-years-old) changed its attitude when Hugo, owner of the study center and father of girl 2, entered the room. Girl 2, clearly excited, exclaimed: "Dad! Look!" [pointing to the screen]. We use the opportunity to ask if they would like to tell a story [it was the first time we asked, they were not paying attention to us] and Hugo supports us "Yes, tell me a story, from the start". Girl 2. promptly agrees and starts. Older children were quicker to interact. They rapidly realized how the blocks worked<sup>35</sup>, how the elements related to each other (rules and behavior tree) and what the game was for. From what we observed, both level of engagement and style of narratives had more to do with personality than with age. Nonetheless, we believe that to work with younger children, 6 years-old or under, it is better to have a mediator present.

Overall, the children gave very positive reviews over the game and the animated content. When asked on their thoughts about the experience all pairs said to have enjoyed it. They reported to be having 'a lot of fun', some were reluctant to finish the interaction and one child even mentioned desiring to own the game (see Table 7).

**Table 7 - Unexpected comments**

Pair 19, girl 10-years-old: <i>"I would like to have the game" [Researcher notes – when asked her what else she would like to have (in the game)].</i>
Pair 31, girl 12-years-old: <i>"I like this game" [random comment in the middle of the story].</i>

<sup>35</sup> Still some of them had trouble placing the blocks in the correct position.

## 5. CONCLUSIONS

The question that drove the present investigation may seem simple, but it is not an easy question to answer and, certainly, not trivial. Developing content that will be the fuel for children's creation has to be carefully considered, as we do not want to limit children's creativity, or fall into stereotypes and, most of all, we do not want to promote any sort of negative behaviors.

From the start of this work, we imagined that the animated content was bound to have some influence on the children's stories. But we had no idea of how and to what level.

And we can say now, that within the observed pairs, the animations have influenced the creative process. Sometimes as a facilitator to storytelling – like with the pairs that learned the relation between the blocks and created a story by using them – and others, as a trigger for imagination – like with the children that build on the animated content or the ones that did not even use it at all.

Regarding the effect of limitations created by the restricted action library, although we do not intend to have a definitive answer, within the focus groups it appeared to be positive or non-existent. The participant pairs either used the constraints in favor of the narrative, or create the narratives around them.

But still, we believe that further testing will enhance both the development of new content, as well as our understanding of its influence in storytelling. Children who had the opportunity of using Mobeybou for a second time showed improvement both in the depth of the narrative as in the levels of enjoyment – repetition made the children seem more comfortable with the whole experience. Thus, replication of the experience might give us interesting results.

### 5.1 FUTURE WORK

The Mobeybou project will continue with the development of new content for the main application (TUI) in the form of new kits representing cultures from around the world. At the moment we have three more cultures illustrated and ready for animation – Angola, Portugal and Germany – and have another two cultures researched and waiting for development – Russia and Turkey.

Alongside, the research team is developing support materials to accompany each culture. We have one interactive book already published, called “Mobeybou in India<sup>36</sup>”, which presents information about the culture in the form of an interactive story and incentives the reader to continue learning. The book has versions in Portuguese and English. We are studying a way to create a basic digital template to facilitate the creation of new similar content.

In an effort to improve the asset of the game, we are reviewing all the initial animations. We want to reduce the number of skeletons of the protagonists to one per kit, by transforming each version (boy and girl) into skins, thus reducing the size of the application and simplifying the addition of new characters to the code. We are also studying a way for the game to support customization of the characters without compromising our production capacity.

<sup>36</sup> The book is currently available at Google Play store:  
<https://play.google.com/store/apps/details?id=com.mobeybou.india>

We are currently working with the programming team in the adaptation of the existing content to Augmented Reality (AR), mixing the 2D animated character with low poly 3D models to create the AR experience.

## **5.2 PUBLISHED PAPERS**

### **CHI '19 Extended Abstracts, Glasgow, Scotland, UK**

**May 4<sup>th</sup> – 9<sup>th</sup>, 2019**

Sylla, C., Martins, V., Sá, G., Caruso, A. P., Amaro, B., Menegazzi, B., Sylla, F. (2019). Designing Narrative Learning in the Digital Era. In ACM International Conference on Human Factors in Computing Systems, CHI '19 Extended Abstracts, Glasgow, Scotland, UK, May 4-9. New York, USA, ACM Press.

Sylla, C., Martins, V., Sá, G., Caruso, A. P., Amaro, B., Menegazzi, B., Sylla, F. (2019). In ACM International Conference on Human Factors in Computing Systems, CHI '19 Video Showcase, Glasgow, Scotland, UK, May 4-9.

### **CONFIA – 7th International Conference on Illustration and Animation**

**June, 14<sup>th</sup> – 15<sup>th</sup>, 2019.**

Caruso, A. P., Sylla, C., Sá, G., Tavares, P. (2019). Animating for a Digital Manipulative: How to create restricted action libraries without restricting the players' creativity. p. 238-246. In CONFIA – 7th International Conference on Illustration and Animation, Viana do Castelo, Portugal, June 14-15.

Sá, G., Sylla, C., Menegazzi, D., Caruso, A. P. (2019). Visual Development Processes for a Multicultural Storytelling Tool. In CONFIA – 7th International Conference on Illustration and Animation, Viana do Castelo, Portugal, June 14-15.

### **31<sup>st</sup> Conference of the Society for Animation Studies, Lisbon, Portugal**

**June 17<sup>th</sup> – 21<sup>st</sup>, 2019.**

Caruso, A. P., Tavares, P., Sylla C. (2019). How 2D animation helps children learn to create stories using a Tangible User Interface. 31<sup>st</sup> Conference of the Society for Animation Studies, Lisbon, Portugal, June 17-21.

### **Creativity and Cognition '19, San Diego, CA, USA**

**June 23<sup>rd</sup> – 26<sup>th</sup>, 2019.**

Sylla, C., Pereira, I., Sá, G. (2019). Designing Manipulative Tools for Creative Multi and Cross-cultural Storytelling. In Creativity and Cognition '19, San Diego, CA, USA, June 23-26

Sá, G., Sylla, C., Menegazzi, D., Caruso, A. P. (2019). Multiculturalism and Creativity in Storytelling – Visual Development of a Digital Manipulative for Young Children. In Creativity & Cognition '19, San Diego, CA, USA, June 23-26.

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## **7. APPENDIX**

## APPENDIX I

Observation notes taken during the field studies.

**Analogic test – Low cost prototype (paper cards) / Observation notes**

**Visit to school EB1 S. Mamede, Braga (Portugal) | November, 10th 2018.**

**Researchers present: Ana Paula Caruso, Cristina Sylla, Douglas Menegazzi, Gabriela Sá**

**Participants: 22 children divided into three groups. (ages 7 to 8 years)**

**Average interaction time: 15 minutes**

### **Protocol:**

1- Children were divided in two groups of 7 and one group of 8 (groups were chosen by the teacher)

2 - We showed the children all the cards and asked if they knew the elements.

3 - We asked them to group the cards in different categories

4 - Children tried to identify the elements in the cards

5 - We asked what could be done with the cards

6 - We asked them to tell a story using the cards (in group, using all the cards)

7 - We asked them to tell a story using the cards from just one country (first individually, then in groups of two and one group of three)

### **Position of the cards:**

They always placed the cards touching each other, according to its function in the story: E.g. the rain was placed on top of the scenery or the character (on the row above)

They moved the cards (sometimes the same card) when they mentioned it again.

They never removed cards that they did not use again (when someone died/ change of scenery)

Objects were placed below the characters

They created rows for the elements: scenery on a row, wind on the row above (there were some exceptions where they grouped the cards in different forms)

### **Actions for the entities**

The Indian shoes were magical and could make entities float<sup>37</sup> / run / climb

Chinese fan creates a hurricane<sup>38</sup> / strong wind

The drums make the ground shake

<sup>37</sup> Effect was animated and coded to the game

<sup>38</sup> Effect was animated and coded to the game

The guitars make the entities dance<sup>39</sup>, turn the bad into good [the children would often turn the guitars into weapons and use them to “hit the enemies in the head”]

Indian lute enchanted the entities [similar to the dance effect]

The bracelets were magical and protect / they can also act as chokers / leashes for the enemies

The Manaia amulet is used for curing entities [New Zealand object]

The Peruvian poncho is used as an invisibility cloak [children also used it to protect entities from the cold]

The dragon [Niam, antagonist from the Chinese kit] spits fire and burns the entities [characters could appear with black faces like in comics]

Khodumodumo (green Kenyan monster) burps so loud and so strongly that makes the other characters fly off the screen.

Giant sable antelope (children called it ‘cabritinha’ a.k.a ‘little goat’) hits other characters with the horns (‘chifrada’).

Nian [Chinese antagonist] roars so loud that sends the characters to the moon [this is based on the narrative created by one of the participants: “o leão rugiu tanto que foram parar à lua”]

#### **General comments:**

They identify the clothes with the scenery (winter clothes with mountain)

They don’t know anything about geography, cannot name the elements [app with information]

Children couldn’t identify what was real and what was imaginary / make-believe (e.g. they couldn’t separate animals that exist in the real world from mythical creatures)

Children’ stories were a sequence of events, they just placed one card after the other saying “and then, and then”. Although there were monsters, they did not created conflicts, they would just say “and then a monster appeared, and then...,” the researchers tried to incentivize them by suggesting that they could use an object to help the characters

Repetition and observation improved the stories

Cards triggered collaboration and discussion about the story and how to proceed

Children used the night card as a landscape (e.g. in one of the stories, the characters traveled to the moon, as a physical place)

Mediation from the team was important to help the narrative grow more interesting

Children created the best stories when they had just one kit from one culture [with only one kit it was easier for them to identify the different classes of characters: e.g.

<sup>39</sup> Effect was chosen for all musical instruments, animated and coded to the game

children could easily identify the mythical creatures as antagonists, the human characters as heroes and animals as mascots/friends in their stories]

Children that were telling the stories in pairs didn't build narratives as interesting as those of the kids telling the stories by themselves [each child had a complete set with one human protagonist, one animal, a mythical creature, a landscape, a musical instrument and one object]. But the pairs of children were working together, talking to each other, discussing what actions they should take, negotiating what cards to use and so, creating a dynamic group exercise.

The group of three children that created a story together created teams of cards of the same category that acted together (humans in a group of protagonists, animals in another group as friendly mascots and mythical creatures in a third group as antagonists). While the trio was telling a story (to the researchers), the remaining groups on the table were also telling stories in pairs in a very engaging manner.

Children used familiar names to call the elements they didn't know [e.g. kiwi is a 'pintainho' (little chick), the Chinese pipa is either a violin or a guitar, the Indian pungi (flute) is a magic wand]

Girls tend to tell stories that are not violent.

Children tended to grab as much cards as possible. One child just picked cards with monsters.

*Questions that arouse from the experience:*

*[considering blocks that don't need a board to be read]*

*If we have different groups of blocks that are attached to each other how does the system know which one is active? If you have an unlimited number of blocks how do they interact in the screen? How does the system know that the game has started if you have just one element?*

*The square shape of the cards strongly influences the way the children positioned them on the table. How would they position cards that have different shapes (circle, hexagon, 3D figures)?*

### **Digital Test – Tangible User Interface prototype / Observation Notes**

**Visit to School EB1 S. Mamede, Braga (Portugal) | December 13<sup>th</sup>, 2018**

**Researchers present: Ana Paula Caruso, Cristina Sylla, Douglas Menegazzi, Gabriela Sá**

**Participants: 12 children divided in pairs. (6 boys and 6 girls, ages 7 to 8 years)**

**Average interaction time: 15 minutes**

*1<sup>st</sup> group - boy / girl*

They started slowly placing the blocks on the platform and experimenting, talking in a very low tone, shyly [the room was very quiet and the smallest sound would echo, which probably inhibited the children from playing more loudly and comfortably].

There were some difficulties with the fitting of the blocks on the platform [they didn't always know what side was up and sometimes they didn't even understand that the character wasn't shown on screen].

Researcher asks the children if they know what it (Mobeybou) is, one says **“this are cards to make stories [...] Placing these cards here”** (on the platform).

**R: “how do you know that?”** The boy says he remembers the platform from the year before, and said he liked it very much (nodding happily with his head).

Researcher intervenes and asks if they'd like to tell a story:

Story 1: [Created by both collaboratively] *“Once upon a time there was a little girl that met another little girl, they are playing the flute, and all started dancing, but suddenly it started raining, they had to go home [India landscape], they began playing. But suddenly a lion appeared... (watching the action on the screen – ‘lion’ trembles with fear) but he was very scared and run away. In the morning they started playing the flute and then they went away. They met a panda and they were all playing, then the panda went away and a snake appeared, she got very afraid. [once again, it looked like they were going to use the snake as an opponent but they saw the animation on screen and changed their initial idea] [...] then they all went to play hide and seek and they hide inside the house[...] and now only one friend was missing, he was hiding [...] and they were all happy. (this was inspired by the plot visible on the screen, which is based on the behavior trees of the characters). She went away, as she was very afraid [the plot generated by the BT inspires the children and they build on the actions that they see on the screen, apart from creating the narrative on their own, e.g. deciding which characters they use and what they are doing, etc.]. One friend had to go home but the rest of them played hide and seek [the children kept changing the landscapes as one of the protagonists was finding his hiding friends in different places], then they all went home.”*

They identified Xiao Li and Ju Long as being Chinese and after some incentive from Cristina they guessed Meera and Rajesh were from India.

Researcher asks whether the lion and the elephant are friends, the boy places both on screen to find out and concludes they are not friends **“it looks like they are not friends”** (both attack each other). Then he tries out different combinations of animals and concludes that the elephant and the snake are friends (he reconstructs a situation and analyses it to take conclusions). Interestingly is how he thinks, e.g. after observing that the lion and the snake are friends and the elephant and the lion are not friends, he creates the hypothesis that the elephant and the panda are friends, which is correct (the interactions stimulate logical thinking). Moreover, they say that the elephant and the panda are good and the other two not.

The boy explains how he came to this conclusion:

***“I experimented the snake with the panda and the result was bad, the panda with the lion also resulted badly, from there, there was only a possible conclusion: this two were friends (elephant and Panda) and these two were also friends (lion and snake). By looking at what they are doing I concluded that the panda and the elephant are friends because they help each other.” “With music they get calm”***

Researcher asks ***“do they all get calm when the pungi is playing?”*** They start placing the elements to check, and answer ***“yes”***. Researcher asks ***“what do you think about it?”*** Boy ***“It’s a good thing for not attacking”***. Researcher asks for other ideas to calm down the opponents, the boy says ***“when there is a party” “the music instruments make parties.”***

Researcher asks them what do they think the platform is,

**Boy: *“It’s for theatre with the pieces”***

**Girl: *“it’s also a game”***

**R: *“why do think that this is a theatre?”***

**B: *“we invent sceneries, stories, and happenings, I think”***

**R: *“and do you think this helps creating stories?”***

**B: nodding vigorously with head: *“it helps, it helps a lot”* (min. 6.50)**

**R: *“can you explain why?”***

**B: *“we have these pieces and when we place scenarios it helps us in the stories”***

**R: *“do you remember when we used paper cards to create stories, was it easier or more difficult than with this?”***

**B: *“for instance, when we used this block (Pipa) it did not play any music, and here we have the music notes”, and we have more ideas with these blocks”***

**R: *“what are your favorite blocks?”***

**B: *“this, this, this, this...”* [all of them he realized]**

Girl says the same, they have many favorite blocks.

*2<sup>nd</sup> group - girl / girl*

When we arrived, the platform was already full with blocks, one of the girls had placed them. Researcher asks if she wants to explain how the platform works, she agrees to do it. ***“You place it there and it appears there”*** (pointing to the pieces and the screen).

Children answer the researcher’s questions saying that Mobeybou is for telling stories.

Researcher asks the girls where are the characters from, they say from China and point to the Chinese boy and girl.

**R: *“where are the other’s from?”***

**G: *“from China and India”***

The girls were very shy and they took their time silently exploring the actions on the screen triggered by the placing of each block on the platform.

After this silent and shy exploration, Cristina asked them what were their thoughts on what was the purpose of this activity/platform: the answers were ***“It is for creating images”*** and ***“it can be used to tell stories”***.

Cristina asked them if they'd like to tell a story: without speaking, the girls put the India landscape block and the rain block on the platform; Ana Paula intervened and started narrating the events on screen which made them say out loud what they were placing on the platform; ***“a boy appeared and he played with the girls”***; once again, they stopped talking and just placed blocks on the platform, sometimes whispering descriptions of the reaction on screen: e.g. they put the wind block – ***“It stopped raining”***, the lion block – ***“the lion danced”***.

The girls, who were present during the first school visit, said they enjoyed playing with the digital platform better than simply using the paper cards, because they liked to: ***“see the blocks moving”***.

### *3<sup>rd</sup> group - boy/ girl*

*[All three groups had a tendency to fill in the platform with 6 blocks, hesitating to choose a block to take out when they wanted to put a new block in the story.*

*The child that was less actively in the process would engage with the blocks by arranging them in perfect rows and columns. It seems like the shape of the blocks incentivizes this kind of interaction.*

*Again, I noticed the children had difficulty putting the blocks in the right position on the platform. Sometimes it wasn't clear which side was up and they didn't always realize that the block wasn't being read by the platform. Sometimes they could feel the magnets weren't fitting well and they'd take the block and inspect underneath, as if looking for some indication of which was the right position.*

*It was also clear by this time that the kids are impatient with the reactions on screen. If there was a delay between the moment, they put the block on the platform and the reaction on screen, they would instinctively take the block out. This fast motion of putting in and taking out blocks sometimes 'froze' the Mobeybou program and made it obvious that the children needed an instant visual feedback that the block they chose to put on the platform was recognized and something should happen right away.]*

*They were asked to tell a story: “Once upon a time there was a boy and a girl and they had a snake and it was raining a lot and they went to the mountain and it was snowing in the mountain [the boy was narrating the story very quickly while they were placing the blocks on the platform, but there were a lot of errors occurring in the application that*

*interfered with the reactions on screen]; they took a walk with their panda and a lion appeared and the lion bit the panda [the narration didn't match the reactions on the screen at all: while the children were telling this storyline, we could see the lion, the panda and the two protagonists dancing on screen, because the punji block was on the platform];*

*[Note: the children seem to easily understand who should be the antagonists and who should be the friendly characters by looking at the drawing on the block, even though the reaction they get on screen isn't always what was expected (either because the Mobeybou application isn't working well or because there's an instrument on scene that prevents the antagonist from attacking)]*

*Continuation: "the kids climbed on the elephant's back [they put the elephant block on the platform and it appeared still on screen] and they all went to the desert and played a song; then a Chinese boy appeared [they specifically identified the protagonist Ju Long as being Chinese and were interrupted by Cristina who asked where was the girl (Meera) from to which they answered that she was from Brazil]; it got dark and the kids went home; [they placed the lion and the snake blocks] then an elephant appeared and killed them! [in fact, the elephant was the one who fainted on screen, but the boy who was narrating ignored the scene on screen and continued with his idea of what was going to happen]; then the snake killed the panda [again, the narration was different from what was seen on screen because the snake was the one who fainted after the panda attacked; the boy who was narrating looked as if he was guessing what would happen and when he got it wrong he laughed and kept on with his version of the story].*

Both participants said their favorite blocks were the landscapes and the animals and that they preferred the digital platform, instead of the paper cards.

**R: "what do you think is this for (platform)?"**

**G: "a story"**

At some point the boy starts telling a story [Researcher had asked what was going on (on the screen)]

Story 2: *"once upon a time there was a boy and a girl, the boy had a snake, and it was raining a lot in the place where they were, they went to a place to get shelter, and then it started snowing. [...] and then they went to another country [...] then it started to rain heavily and they went home and drank a hot tea. The elephant appeared, they climbed on it and went to the desert and then they played music. A Chinese appeared [Researcher: ah, so that boy is from China? And the other one? The girl does not know, the boy says: from India]. And then it started to snow and they went playing with the snow, and then a girl that was from Brazil appeared [referring to Meera]"*

Cristina says they may stop if they wish, but they ignore her and continue to explore Mobeybou

*“[...] then it became night and they went home, it started raining [...] and the story changed”*

**Researcher: why?**

**B: “because of the lion, and the elephant and the lion died, and then they were happy.”**

They liked more the sceneries and the animals, what they liked most was to place the blocks and see them appear on screen. Regarding the actions the boy liked most the weather blocks

The boy said at the beginning we would prefer the paper cards after the interaction he changed his mind and said that **“with the blocks it’s easier to imagine things”** [PROMOTION of CREATIVITY].

**Girl: “we use our creativity”**

**R: “how would you call this (platform)?”**

**G: “this is a storyteller”**

**R: “what would you like to add to the blocks?”**

**B: “there could be more weather, Thunder”**

**G: “and more landscapes”**

*GENERAL NOTES: this session at school validated the characters, as several children were able to identify them as from china and India, they also intuitively identified the opponents and the animal friends. Children also started to imagine characters from other countries [promotes multiculturality] e.g. the boy included a Brazilian character, expressly saying he was from Brazil. Several children referred that they liked the landscapes, this could be because they are new for them, different [representation of the other] [they set the stage]*

*This group moved the pieces on the platform, were they hoping to move the characters on the screen?*

*PROMOTION OF DIALOGUES: often the children look at the screen, observing what was going on, this provided an opportunity conversation (between the children themselves or between the children and teachers or parents) e.g. the children were observing the fight between the various animals and giving different opinions about which animal would win the fight. This role that children take as observers can act as a reflection moment [dive in but also dive out of the story, taking distance to reflect, as Ackerman says]. Such moments provide opportunities not only for changing ideas but also for learning from each other. [It’s like watching a movie authored by them]*

*INSPIRATION / DEVELOPMENT: building on that the children really liked to use the different weather conditions, incorporating them in their story, we decided to add some results/effects for the different weather conditions, e.g. in the current development when it rains the water level rises on the screen.*

*4<sup>th</sup> group - girl / girl*

They start saying the platform is for creating stories (they remember TOK from the year before)

**R: “how does it work?”**

**G: “we place a block here (platform) and we have to talk about that piece”**

**Girl 1 to girl 2: “do you want that I start?” (sic)**

When it started snowing the girls expressed their wonder “**AH!**” and delight, they also laughed about the interactions

*GENERAL NOTES: children were able to integrate the different countries in their stories; they did this on their own without any encouragement from the researchers.*

*STORY 3: “On a full moon night it was snowing a lot in India [they recognize the Indian landscape] a little girl was playing (looks at the researcher asking for the name of the instrument, R: this is a Pipa). She was playing pipa. And the girl had an elephant and there was a boy. It stopped snowing and the boy’s pet was an elephant, the girl stopped playing the Pipa and started [LEARNING OF NEW VOCABULARY, that she immediately used] playing flute (R: do you know the name of that flute? It’s Pungi). Suddenly there was a strong wind [G:” you removed the scenario!”] And then it became morning and they went eat. Behind the panda appeared a snake and ate the elephant [as the panda and the snake start to fight, the girl becomes very stressed saying oh no! And she looks for blocks to avoid the fight “Oh my god, poor panda!” (as he faints) [...] it stopped snowing and started to rain [...] the sister from the children [...] then a panda appeared and all the animals started to appear (all start to fight), but the girl wanted to play the pipa so that they did not attack [CHILDREN UNDERSTOOD HOW THE MUSIC INSTRUMENTS WORK] [...] then they started talking, that day there was very windy, really very windy, the elephant went home and the girls’ brother appeared”*

**R: “Where are these children from?”**

**G: “this one is Chinese (immediately recognized), the other is from India (toke some seconds to identify)”**

*“The boy went home [...] the girl played the pipa again, the wind stopped and it started raining, to stop the rain the girl started playing [she tries to remember the word and says pingi (instead of Pungi) but is visible the effort to learn the new words]”*

**R: “so, you think the instruments can be used to stop the rain and the snow? And what else?”**

**G: “to calm down people and the animals, make a party”**

**R: “what did you like most”**

**G: “to tell a story”**

**R: “what are your favorite pieces?”**

**G: “landscape India, snow, elephant, pipa”**

**R: “what else would you like to have?”**

**G: “other sceneries”**

**R: “what would you do with the other scenarios?”**

**G: “we would have other people from other places”**

**R: “which other countries would you like to have?”**

**G: “Spain, Brazil, Germany”**

**R: “what do you think this is?”**

**G: “this are images for us to try to create a story, to give us ideas for a story, and to help us create more creative stories”**

**R: “and do you think that this helps doing that?”**

**G: “yes!”**

**R: “do you prefer telling stories with this or with the paper cards?”**

**G: “with this, we get more ideas”**

**R: “how would you describe what you have done at home?”**

**G: “we did stories with pieces that give us a lot of ideas”**

**R: “do you think that this is a game?”**

**G: “it’s more than that, it helps us create a story, when we want to create a story, when the teacher tells us to create a story, we have more things in our head”**

*Note: talking to the teacher afterwards, she told me that one of the girls had a lot of difficulty reading and was one of the less accomplished students in her class; but during this activity, she was the one narrating most of the story, using connection expressions in her storytelling (like “numa noite de lua cheia, estava a nevar muito”; “de repente, começou um vento muito forte!”), asking questions about vocabulary and quickly applying what she learned (she asked the name of the instrument and only called it by its name afterwards; she verbalized the function of the musical instruments and she understood the behavior of the blocks on screen in a way she could say “the snake ate the elephant” while taking out the elephant block, because she knew it would disappear.*

*5<sup>th</sup> group - boy / boy*

*This pair needed some incentives to start playing with the platform, but they were the ones who stayed longer.*

*During the whole time, but specially in the experimentation phase, they were moving the blocks particularly fast, not paying any attention to the screen and not leaving the blocks long enough on the platform to watch the reaction on screen.*

*During their storytelling they would often mix up words and call the Indian landscape China and vice-versa.*

*Their story: “once upon a time in CHINA a lion and a boy... the lion attacked the boy (on screen, the protagonist fainted) and then he started playing (they added the pipa block, which appeared on the floor) but he was already dead (the protagonist was still fainted); a girl came and played and made the lion dance, then a snake came and it bites the lion (“deu uma picada no leão”) and everyone started at war and they fainted (they took out the instrument block and the girl also fainted); a girl came to wake them up and play (another protagonist was added with the pipa block) and they went home (they were still fainted on the screen); (they took out all blocks and restarted; there were also some technical difficulties) the elephant is the boy’s friend and he was furious at the snake because she ate his biscuits.”*

*Continuing: “[...] it started snowing and they got angry (“raivosos”) and in the meanwhile (“entretanto”) the panda fainted (at this point, they were narrating what was happening on the screen); they went home and the panda followed them and the snake appeared again and attacked the panda; four friends (the protagonists) started laughing and playing; it got late (night block) and they went home (they took out all the blocks); the elephant and the panda were outside Tiago and Nuno’s door and were making noises, but they had the flute near them and they played; Tiago asked: “Why are we here at night?” and Nuno answered “I don’t know either” (it was the first time someone gave their own names to the characters on screen and used direct speech and dialogues on their storytelling); the panda was the king of the forest and he gave the boys a souvenir that was the guitar; the boys played every day in their home; their mother (Xiao Li block) came to get them.”*

*This pair was the first to give their own names to the characters on screen and used direct speech and dialogues on their storytelling and to verbalize relationships that weren’t of equal statute (like friends, siblings; and instead they used the protagonists to express mother/son relationships). [Them placed themselves on the stage]*

*They also were the ones who showed more difficulties handling the blocks because they were often having trouble putting them in the right position on the platform and often times, they would give up on incorporating some blocks on their story because they wouldn’t see them pop up on screen.*

They were also doing something that we didn't see in other groups: they would hold a block in their hands and tell the story, incorporating the block in the narrative, and then putting it back down on the table without ever using it on the platform and make it pop up on screen. This could be linked to the frenetic and impatient way they were manipulating the blocks in general; or with the frustration of not always getting the block in the right position on the platform; or because of the rushed way they were getting through all blocks and the need/desire to use all of them at the same time, when only 6 fit on the platform.

*Notes: each boy narrates the actions "played" in the story by his friend, each one is a protagonist and the story is told by both telling the actions that the other is performing*

*Story 2: "Tiago went to China (his friend) and Nuno (himself) also went, there they saw a snake and the panda and they got very scared and started fighting, and then Tiago played guitar and the panda and the lion calmed down, then Tiago stopped playing and it started snowing and they (panda and lion) started to become mad, meanwhile the panda fainted and it started raining (removes snow block) and they went home (remove 2 blocks), and it started snowing again (place china scenario). The panda followed them (they collaborate, placing the cards, and building on each other's narrative) and then the snake attacked the panda, then 4 children started all laughing and one of them started playing guitar and then it got late they all went home (remove all the blocks). Then the elephant and the panda at Tiago's door made noise, and Tiago called a boy that had a flute and they played and the animals all started dancing. And then Tiago asked; "why are we here at night?" "I also don't know", and then it started raining and the lion got cold (he is trembling because he is afraid of the opponents). The elephant went away and the panda started fighting with the lion, and then the lion went away, and then it became morning and Tiago and Nuno left CHINA (china landscape block is placed) [children start thinking of the different countries], the king of the forest, the panda, gave them a souvenir that was a viola. Then they went to Portugal (India landscape) [the need to tell stories about their country?] and then the panda went away and Nuno and Tiago started playing at their home, and the snake also had a flute (does not work), she went away. Then the wind came and it pushed the lion away [until minute 6.36]"*

[the story goes on for remaining 17 min. From here I just write some relevant parts]

*"[...] and their mother (Chinese girl) was also in the china circle, because they were afraid of the snake, the elephant was angry because they had eaten his breakfast, and then as they had a viola at hand they started playing and dancing and the animals also started dancing."*

**Researcher: "is that the mother?"**

**Boy: "yes, they don't have a father"**

*“And then they returned to Portugal (India landscape), and then the snake was in the plane and Tiago gave her a kick and the snake run away. Then the wind came and took the elephant away (remove piece), a lion appeared and started dancing with them, but their mother gave the lion a spank and he didn’t like it. The cousin also came (9.0). The amazing thing (o espanto) is that she came on an elephant and they all started laughing, and they asked: “So, where did you get this elephant?” “it was in China” and then it started getting dark, and windy and she rode on her elephant [...] and then Tiago was playing hide and seek and he knocked a flower pot. Meanwhile it started raining [...] the panda appeared and the mother expelled the panda [...] the lion started trembling [as it was very cold].”*

**R. How would you call this (the tool)?**

**B: “puppet projector” (projeto de bonecos)**

**R. Do you like it?**

**B: yes, if we place them here, they appear there (on screen). They like to see the images on the screen.**

**R: what did you like most?**

**B: to place the pieces**

**R: which pieces did you like most?**

**B: the originals were these ones (the two boys, representing themselves)**

**R: what does that means**

**B: the originals are the raw material (as originais são a matéria prima – sic.)**

**R: do you remember using the paper cards?**

Children answer yes, but they prefer this version **“because they appear on the screen, and always appear the scenarios”**

**R: do you like the pieces or would you prefer a version where the elements are on the screen and you have to touch them?**

**B: I haven’t tried that, so I don’t know”**

**R: if we had different countries, would you like it?**

**B: yes, London, France, Spain, Space (moon)**

Ideas: the moon as a scenery, a spaceship.

6<sup>th</sup> group - boy / boy

*[The previous group explained to this group what they had to do (telling a story using the blocks placed on the platform and watch them appear on screen).*

*Once again, they manipulated the blocks very quickly without waiting for the reactions on the screen and they played with the blocks for a long time without adding a landscape block.]*

Story: *“Once upon a time, in a beautiful place, there lived a girl and a boy and they were very good friends; there was wind and rain [here they realized that only one of them would work]; it got dark and a snake appeared; the children got really scared [narrating what was happening on scree]) and the day came [meanwhile, in the screen, the two protagonists were being attacked by the snake and when both fainted the children laughed]; a lion appeared and they all went to the graveyard [removing the protagonists’ blocks]; the boy was going to play the flute [one of the participants held the pungi block in his hand but never placed it on the platform; after a little bit, Rajesh fainted]; “zombie boys” [they said as they put the protagonists back]; they had a lot of fun until it was night time. The end.”*

When asked ***“What do you think this is?”*** the participants answered ***“stories with blocks to put on the tray that appear on the computer”*** (*“histórias com peças de meter no tabuleiro que aparecem no computador” – sic.*)

When asked ***“What did you like best about this experience?”*** the said their favorite parts were the deaths and the attacks.

The researcher tries to speak with them, but the boys are just interested in further playing with the tool. Researcher asks them to stop the activity but they want to continue, the researcher agrees and they express the wish to create another story.

2<sup>nd</sup> Story: *“Once upon a time there was a place where a boy lived and a girl, but suddenly the boy saw the wind and a snake. The wind stopped but the snake attacked the girl [...] the boy woke up on a place and he didn’t know the way home, he met a panda, that was good, and told him the way home, and she went and found a girl and a boy [...]”*

Researcher has to intervene and ask them to finish the story as they continue over the time allocated for the group.

*“[...] and they lived happily ever after. They give an end to their stories.”*

**Aalborg, Denmark | March 14<sup>th</sup>, 2019**

**Researcher present: Cristina Sylla**

**Participants: 6 children divide in pairs (3 boys and 3 girls, ages between 8 and 9 years)**

**Average interaction time: 30 minutes**

*School visit to a primary school in Denmark. Interaction with 6 children from 2nd grade.*

*The interaction took place in a separate room with me, Eva and a pair at a time. All the pairs were composed by a boy and a girl. The teacher would come in two times during the interaction to take pictures of the children.*

*Each pair interacted for around 30 minutes with Mobeybou.*

*1<sup>st</sup> Pair (boy and girl)*

Talked a lot with each other while actively exploring the blocks, collaborate very well with each other. The blocks moved from the boy's side to the girl's side and vice-versa throughout the interaction.

Boy piles them up. Each of the child reaches over the other to get specific blocks that they wanted to use. They dance when they hear the pungi, making this Indian movements swirling the hands and the body. One time they even stood up to dance. The girl simulated that she was playing the pungi with her hands.

They laughed together with the characters mimicking them. Children looked at the screen from times to times observing the interactions. They referred that they liked the music most of all things.

*2<sup>nd</sup> Pair (boy and girl)*

The pair was a bit shy, they laughed at the entry video, when they heard the pungi, when the characters laughed, when the water filled the screen. They also liked it very much when the screen got frozen. They laughed when Meera was floating over the elephant, it looked like they were staying on top of HIM. When the girl placed the wind and the shoes she exclaimed "**Wow**".

Again, the number of blocks was always changing (on the side of each child), they were moved from one side to another (as if by magic, since this was done so naturally)

Again, each child reached over the other to grab a block. When one child placed the block the wrong way, the other would just move it to the right way without any comments. Both children did that.

Children looked at the screen from times to times observing the interactions.

The girl made different types of constructions with the blocks, the boy was more concentrated on using the board, sometimes he took blocks from her construction, she didn't mind. The girl liked most the Nian.

*3<sup>rd</sup> Pair (boy and girl)*

They were very careful at first, they observed and talked with each other. Both reached over the other to get blocks.

They laughed with water and with the characters.

The girl started to dance with her hands when she heard the pungi.

They often observe and point at the screen. Astrid told a story.

The boy likes how the panda attacks. Both are interested in how the system works, they ask about the sensors.

Astrid recreates a sequence of events (night, character, pungi) to understand how it works.

*At the end all the six children came together and started talking about and placing the blocks. They said, that they liked it more than learning from books, it's easier to understand as they can see the animations on the screen and recreate them. They would like to have more backgrounds and music instruments. A school background and a play background.*

*A snake coming out of the basket when they play the pungi (girl from group one makes movements like a snake moving up). They would like to have Portugal / Spain / a big city / Africa / savanna. Would like to have more countries.*

*Would like the kids to ride the elephant*

**Visit to School EB1 S. Pedro d'Este, Braga (Portugal) | July 9th, 2019.**

**Researchers present: Ana Paula Caruso, Cristina Sylla.**

**Participants: 10 children divided in pairs. (6 boys and 4 girls, ages 6 to 10 years)**

**Average interaction time: 15 minutes.**

*Tests started at 9h45*

*Kids are in "ATL" (free time activities), when we arrive most kids are playing football outside.*

*The teacher calls 2 boys to participate, they seem a bit reluctant since they were engaged in the game.*

*1<sup>st</sup> pair, Boy / Boy (Gonçalo, 10 years-old, Tomás, 8 years-old)*

*[We start the test by using only the blocks (no platform, no computer) to see how they use pieces and asked them to tell a story. They seem a bit confused on how to start, look at the blocks and G. says they are magnets (referring to the magnet that connects the piece to the board). Both seem a bit shy, G. asks if he can start, he keeps looking to the recorder (mobile phone used as a record device) and asking for permission to start telling the story. He starts with 2 protagonists blocks]*

*"Once upon a time there was 2 girls..." Then adds a landscape and follows with other pieces. He puts them on a line, [same behavior observed in the first tests with the paper cards]*

The blocks are aligned in line, one after the other, G. makes sure they all fit in the table [the physical space is a constraint] and once he reaches the maximum length, T. suggests he should continue in the bottom, adding a second row.

He uses all the blocks, forgetting the old ones and adding new until he uses all of them. T. looks really shy and just observes.

*We ask to take a picture of the story and set up the computer. We let them explore the pieces, and they look delighted when the placement of blocks triggers animations in the computer. They laugh and sigh with the sounds of the characters and musical instruments*

**G.: “you place the pieces here (points at the board) and they are connected to the story”**

Both starts dancing to the sound of the pipa. When asked if they want to tell another story they refuse, they only want to play with the blocks. G. starts to pile the blocks over the first slot – **“let’s see what happens if we put all like this”** – when nothing happens, he decides to use all the slots and tries to divide the blocks equal. When the piles don’t get the same number of blocks, he quickly counts how many they are and divides it by the 6 slots on the board – **“we have 20 pieces, it can’t be equally divided by 6”**.

Researcher asks what they like about the app, they say they liked the characters laughing [every time the protagonists laugh, they laugh together]

R. asks which way they like more, just the blocks or with the computer. They say **“Both”**

G. says with the computer is more fun cause the blocks **“feed”** the story.

**“the pieces are the raw material and the product is the story”** (as peças são a matéria-prima e o produto é a história sic.)

*[Teacher interrupts, it’s time for their morning snack]*

*2<sup>nd</sup> pair, Girl / Girl (Bárbara 7-years-old, Ariana 6-years-old)*

We let them explore the pieces as they will.

Both laugh and sigh at the sounds (music) and the weather effects, clearly enjoying the experience.

A. asks if they can tell a story. [the children took the initiative to tell a story without intervention of the researchers]

They start telling a story from the reactions triggered by the combination of blocks, using the animated interactions as trigger for the plot.

After they finish, we ask which blocks they like more, each chooses a girl (India and china female protagonists)

they say they really liked the snow-block **“because it makes them shiver”** and the night-block.

When asked about what else they would like to have, B. thinks a little bit and says **“Dresses”**

**Researcher: “for the girl? would you like to change her dress?”**

**B. “yes”**

**A. “and the shoes!” “I think the panda should have magic shoes and fly...!”**

and holds both blocks together, with the shoes underneath the panda.

*3<sup>rd</sup> pair, Boy / Girl (Andreia 10-years-old, Carlos 10-years-old)*

*[he remembers the researcher from previous tests for other devices]*

*[this pair asks if they can play, by now children are very curious gathering around the table and being led outside by the teacher]*

We say they can test the blocks and let them explore the interactions and animations.

They look surprised when the combination of character and shoes makes the character fly but don't make the connection between object and character immediately.

They say the character must be magic.

C. picks up two blocks [protagonists] and examine both on the bottom side, trying to see if there is any indication of how they work.

When asked by the researcher about why they think the girl was flying C. answers: **"Magic"**

**R. "where do you think the magic came from?"**

C. starts combining the blocks they had used to see if they can find out, placing sceneries, characters, music instruments... until he tries the shoes.

**"oh! the shoes are magic"**

They like to use the rain block, C. imagines that if he puts the shoes on the girl and she floats, she would float above the water (rain flood) and complains when the character just disappear.

*[During this session, there were a series of bugs, with the Brazil landscape, the rain block and the musical instruments, they seem to deal fine with the errors but notice them all, commenting on what is happening and trying to figure out why. ex. the musical instruments sometimes don't appear, (the music starts, the notes particles are triggered but the character is either in idle or in dance animation.)]*

They remove the block (sometimes the character, sometimes the instrument) and place it back getting the correct result **"oh, it was behind it"**

There's a bug with the rain that makes the fish swim backwards, they laugh and find it funny.

During the session they say what they like more in the device are the musical instruments and to see the snake dancing.

A. says she finds the magic shoes making them fly is a great idea. (**"é muito giro" sic**)

By this time there are a group of kids surrounding the table and asking for them to use specific blocks (use the elephant)

They keep combining the snake, the girl (Meera) and the musical instrument, sometimes placing it at the last possible moment, so the snake attacks before the girl starts to play.

They laugh as the snake dances and laugh seem to enjoy “killing” the girl.

They start placing more protagonists with the snake to see it “killing” them.

They have 3 protagonists in K.O. so they remove the snake and add other protagonists to see what happens. They comment on the protagonists walking “over” the dead ones and laughing.

We ask what they like more, A. says she likes the idea of shoes being magic, she likes it a lot, and C. says he likes to use the pungi and make the animals dance.

*\*they comment on the bug that makes the musical instrument play when the protagonist is dead*

*4<sup>th</sup> ‘pair’, three boys (Ivo 10-years-old, Diogo 8-years-old, Duarte 6-years-old)*

*(Diogo’s younger brother, and Diogo asks if he can play along)*

*(they were waiting around while the previous pair was playing, asking them to try specific blocks)*

They immediately start to try out all the blocks, Diogo controls the board and keeps saying “no, this block” and removing the blocks the other boys use. The younger boy is interested but doesn’t have a lot of “room to play”.

They want to use the shoes with the animals

They like the animal blocks and place them all together. [when all animals and antagonists are on gameplay the screen gets too crowded and the actions, attacks and fairs are really hard to comprehend.]

They comment on the panda attack [Panda attack needs to be fixed, this is a persistent error, animator and illustrator already commented on that, there was a video exemplifying the movement but it has not been fixed yet]

By observing the behavior of the animals and antagonists – they try different combinations of the four – they come to realize that the elephant and the panda are friends, as are the snake and the lion [since they don’t attack each other]

They start grouping the blocks by type, and end up separating them into their actual classes (except the objects and music instruments, those are grouped together). They arrange the blocks in vertical piles.

Diogo says he wants to tell a story. They all try to place the blocks at the same time, but Diogo is leading the trio. This group also creates a story based on the action on the screen. [animations]

They want to use two musical instruments together, as it's not possible at the moment they get a bit frustrated.

They want to pair the protagonists with animals and landscapes.

They call the Brazilian protagonists "índios" (as in indigenous, but meaning to call them Indians), according to Diogo Meera is Brazilian. They say both Indian characters are Brazilians, place the Chinese characters correctly, but are not sure about the landscapes [they call India Russia and Brazil Madeira or Açores (because of the banana trees in the image)].

They don't see the similar patterns on the stickers, and find difficult to group the kits.  
*[we need to review the Brazilian and Indian patterns, as both are yellow and very much alike, it's hard to distinguish between them]*

When asked about their favorite blocks, they say the animals (they used them a lot) and the magic shoes (all the groups said to like them). We ask if they think we should add something, they say we should create a jungle landscape, so they could tell a story about a boy and a girl who go on a jungle adventure.

*5<sup>th</sup> pair, Boy / Girl (Maria 7-years-old, Santiago 6-years-old)*

They sit at the table and Maria immediately starts grouping the blocks into piles of similar elements. She is clearly the leader in this pair.

They try out all the pieces but don't want to tell a story. When asked by their teacher what they are doing M. says those are pieces to tell a story.

They call the landscapes "worlds" and say that India is the prettier one.

They comment on the bugs with the musical instruments, wondering why it's not showing.

M. says her favorite block is the girl (not sure which one) and S. liked the "animals" (both antagonists and animals)

They say they would like to have more animals to play with.

*[The session is interrupted by the teacher, it's lunch time. (There were still a few kids waiting to play with the device, we say we will come back the next day)]*

***2<sup>nd</sup> Visit to School EB1. S. Pedro d'Este, Braga (Portugal) | July 10<sup>th</sup>, 2019***

***Researcher present: Ana Paula Caruso, Alline Bettin***

***Participants: 14 children divided in pairs. (4 boys and 10 girls, aged between 7 and 11 years).***

***Average interaction time: 17 minutes.***

*[We start the tests at 9h45. The children already knew what was about to happen and were asking to play, kids that had played in the previous test (day before) were asking if they could play*

again. We ended up having 7 pairs and some tests had the participation of extra kids. We ask the teacher to be with 2 children at the time, but soon there is a large group gathering around the table, watching and trying to participate.]

*1<sup>st</sup> Pair, Boy / Boy (Diogo\* 8-years-old, Lucas 7-years-old)*

D. had played in the day before; he is the leader and clearly controls how the “game” goes. He calls it a game. L. wants to tell a story and chooses the blocks he wants to use. They start a story using the Indian pieces and ask the researcher about the Chinese blocks: **“is this China?”** (showing the Chinese landscape)

**“he could be traveling through China!”** [exclaims as he shows the Brazilian protagonist]

we notice they don’t want to mix the blocks and we intervene to tell they can use and mix all blocks.

*[There is a bug with the pieces and they ask why the boy is not playing the musical instrument. They try to use both the pungi and the shoes and complain the blocks don’t work together.]*

The protagonist dies and the music plays and they comment on that *“what kind of error is this?”*

They realize that removing a block and placing it again can fix the error. They want to use the pungi.

**D: “There was a boy walking through China and he found a snake and to protect himself he had to build a musical instrument\* (pungi is playing in the background)”**

**L: “And a girl came, a Chinese, with magic shoes... to escape the snake. We finished!”**

They let me know they finish the story and we ask which block they liked more

Lucas: the lion, the girl (Chinese), the boy (Brazilian) and this and this (points to the musical instruments) (the other boy is organizing the blocks and don’t respond). We ask what they would like to have in the game, Lucas asks for more slots.

*2<sup>nd</sup> Pair, Girl / Girl (Beatriz 10-years-old, Joana 9-years-old)*

*[They start to try placing the blocks with a bit of shyness and talk in a very low voice. There is a girl waiting by their side, she had asked to play on the previous morning but there was no time. We had to restart the application three times due to errors. (error with: 2 protagonists + 2 musical instruments + night time) (characters remain in idle; we restart the app again and it works)]*

We ask them if they would like to tell a story using the blocks and they start talking between themselves in a very low tone. In the meantime, a group of 4 children gather around the pair, wanting to participate. Two of them played on the day before (Carlos and

Andreia), when we say we need to let other children try the game, they ask if they can stay and watch.

While this is happening [and perhaps because the focus is not on them] the two girls start to tell a story:

***Girl 1 “two boys went for a walk, bought musical instruments and then the night fell”***

***Girl 2 “They played the instruments and then it became night and they fell asleep”***

*[they tell a story based on what happened in the screen, referring to the blocks that were on the board]*

The girls seem a bit reluctant so we encourage them to try out the blocks and see what happens. They start to explore.

*The pair that had already played want to see the fishes swimming backwards.*

*Other children ask if they tried the lion and the snake together.*

*Extra boy 1 says the shoes make the characters fly*

*Extra boy 2 asks how does he knows that*

*Extra boy 1 tells him he saw it the day before*

The girls place the lion and the snake as suggested. Nothing happens. C. tells them they need to add a person or two. They watch and find it amusing when the snake “kills” the characters. Now they start combining the blocks to see what happens with antagonists, protagonists and animals. They try to save the protagonists by using the shoes, and the rain.

*(Other children start to intervene)*

***“do you think the snake will kill the fishes?”***

***“what if we put the lion that spits fire and the girl flying?”***

***“Look, have you tried the fiery lion with the flood?”***

***“Let’s see if the lion kills the fishes”***

***“No. He can’t fire”***

***D “I’m going to make a test. The lion that spits fire and the boy flying. we want to see if it spits fire”***

***C.: “he doesn’t lift up his head, he’s lazy”***

They want to have both instruments playing at the same time.

we ask what they liked about the game, Joana says she liked the shoes, Beatriz says she liked the musical instruments

we ask if there is anything missing on the game, they think a lot before saying we should have more musical instruments.

*3<sup>rd</sup> pair, Boy / Girl (Leonor 9-years-old, Diniz 9-years-old)*

*The pair sit down and start to try out the blocks, they were waiting by the side of the table as the previous pair played.*

*They place the lion, a landscape, the Indian boy with the pungi and Leonor laughs as they dance “he hypnotized the lion” as to which D. replies that the boy with the flute is a snake charmer*

**D: “He is a snake charmer!” “use the snake”**

**L: “where is the snake?”**

*They laugh as the characters dance to the sound of the pungi*

*Again, laughing to the dance*

**L: “let’s try the panda”**

**\*\*Andreia (in the background) “the panda is very cute.” “He doesn’t kill, the panda”**

*They laugh to the panda dancing*

*They start replacing blocks quickly in the board and tell it’s funny.*

*we ask if they think this can be used to tell a story, both said yes, removing the blocks from the board and organizing them before starting.*

**Both: “Once upon a time...”**

**D: “two boys. Or a boy and a girl” (while Leonor places one if the girls)**

**L: “two brothers”**

**D: “were playing a song”**

[Error and we have to restart the game]

**D.: Let’s choose a scenery already**

**L: Let’s choose. This one. Ok. Once upon a time there was a boy and a girl**

**D: place just a boy playing the guitar**

**L: no, let’s use the flute**

**D: they were playing the guitar until appears...**

**L: a snake! A snake appears.**

**D: They got scared and then**

**L: it snowed!**

**D: and then it starts to snow**

**\*\*Andreia comments in the background “they will die anyway, they will freeze”**

**D: and the boy died. It was a tragedy... the snake went away, but the girl was really sad**

**L: It stopped to “start” snowing (parou de começar a nevar. sic)**

**D: But she met a new friend**

*(the story goes on for a few minutes, they narrate what happens on the screen, clearly using the animations to create the plot)*

They place the elephant, the lion and 2 protagonists. The lion attacks and all scream in surprise when the elephant dies

**“Put the panda! put the panda!”**

**L: I’m afraid! Poor panda!**

They all cheer when the panda wins.

Now they try the panda and the snake

***D: But a new enemy appeared! The snake! That had killed the girl’s brother”***

They exclaim surprised and disappointed when the panda dies.

By now they understood the music stops the antagonists from attacking.

They keep trying combinations where the animals will fight to see who wins

They realize the panda and the elephant are “friends”

They put all the animals and the antagonists in the board and cheer when the animals win.

Every time the panda dies, they scream disappointed “oohhhh”

we ask them if they liked to which all (including the other kids) say they liked a lot.

D. says he liked the lion, the elephant, the panda and the snake

L. says she liked the elephant and the musical instruments

When we ask what they think is missing, Andreia says she thinks the shoes are too small and points out to the error that prevents the shoes from appearing on the protagonists when there is no antagonist in the scene. The pair never get to say if something is missing.

*4<sup>th</sup> pair, Girl / Girl (Matilde 7-years-old, Benedita 7-years-old)*

*(there is a 3rd girl sitting beside them, waiting for her turn to play)*

*[We invite them to try the blocks. They keep switching between the shoes and the punji. They seem disappointed the character doesn’t play music when its flying. They remain trying the combination of antagonist, shoes, music and protagonists.]*

They decide they want to tell a story

***B: “Let’s create a story”***

Can’t seem to agree on who will tell the story, which block they are going to use.

***M. “we are not supposed to ‘do’ the story this way”***

we tell them to create the story together but they can’t agree. M. says B. can tell her story first and B. says they should do it together. And keep arguing about the blocks chosen by the other.

we let them play, to see if they can figure it out.

Matilde says Benedita is not saying anything, and she answers ***you don’t need to say anything, just use the blocks.***

M. starts a story with *“once upon a time there was a girl”* and B. quickly intervene exclaiming she is not supposed to do it like this

**B. “you should just ‘tell’ the pieces and nothing else”**

**M: “no, it’s not true”**

**B: “ok, do as you like”**

**M. starts again: “once upon a time there was two boys”**

**B: “they were brothers”**

**M: “that were playing music”**

*(B: they can only play one instrument at the time)*

The story goes on, M. is the more talkative one, they keep on playing around with the landscapes and combining protagonists with the snake and the pungi.

One girl wants to see conflicts and fights, the other wants to put all the protagonists together, playing.

Error with the snow and wind, characters kept freezing with the wind.

They realize that the snake gets afraid when you have 4 or more protagonists on gameplay.

Matilde finishes the story with *“and they were all happy playing together”*

But they keep playing, despite the end of the story.

When we ask them to finish the story both exclaim *“no!”* so we invite them to create an end to the story.

Reluctantly, they accept. We ask them what they liked more about the exercise; B. says it’s when the boy has the shoes on (Raj). M. says *“we liked when all the kids were together and then the snake appeared and got afraid”*

When we ask if they would like to have more pieces, they say M: *“yes, we would like to have more animals, and more instruments (musical)”* and B: *“and more houses!”* *“like this”* (points to the landscapes) we ask if there is a specific place, M. exclaims: *“Paris!”*

*5<sup>th</sup> pair, Girl / Girl (Mara 10-years-old, Maria 7-years-old)*

*(Mara was patiently waiting on the side for her turn to play)*

*[They try out the blocks, talking between themselves to see which ones to use.]*

In a very low voice, they tell a story to one another.

By the way they chose the blocks we can see they have already thought of the pieces they want to use.

M. leads the story but Ma. keeps up and begin making combinations of blocks and participating in the narrative.

M. seems to avoid the combinations that cause conflict, they use music and every time Ma. removes the music block and the antagonist attacks, M. complains.

They finally decide to make the panda and the “lion” fight.

*[There’s an error with Iara (Brazilian protagonist) and the pungi (Indian flute) and we need to interrupt and restart the application. (this is clearly a break in the gameplay and although the children don’t seem to mind starting all over again, I believe it affects the experience)]*

We asked them what they liked more about the game, Ma. starts to pile up her favorite blocks – panda, the Chinese girl, the elephant and snow. When we ask her what else she would like to have (different blocks) **she says she would like to have the game.** And that she wanted to have more blocks.

M. says she likes the animals and the musical instruments.

They also say they would like the shoes to be bigger

*[other children complained about the shoes, about the size they appear on the screen - this was a change made by the developer in the last version, it wasn’t a group decision – and they also mentioned the shoes don’t work correctly all the time – this is a known bug and reported but not yet fixed]*

*[While the tests were happening, two boys, from the São Mamede school where we made the first field tests, approached the second researcher to say they had the same game in their school, and they had played, but the game was different and did not have the Brazilian character. One of the boys is Brazilian and was proud to have a character from his country, and asked for a “jacaré” (alligator), a jaguar and a “onça” (“although I know a onça is a jaguar” sic)]*

*6<sup>th</sup> pair, Boy / Girl (Davi 7-years-old, Francisca 7-years-old)*

*[randomly chosen by the teacher, unlike the others that asked to play]*

We let them explore the blocks. They switch the blocks rapidly making combinations.

They almost don’t talk. There is an error and we need to restart the game.

The girl arranging the blocks while the game is loading. (she is arranging the blocks in a line, pretty similar to the way the arrange the cards in the analogic version, it was the first time I observed this behavior during a digital test)

This pair is very shy. We ask if they think the blocks can be used to create a story and they rapidly agree, but when we ask if they would like to try telling a story they don’t say anything, and we can see they are embarrassed more than they are curious.

There is another error and we need to restart the app one more time.

F. is arranging the blocks in groups, separating them in animals and protagonists.

They work together, switching the blocks but they remain not talking. We can see they understand themselves from the way they fix each other blocks when they are not positioned right.

The researcher tries to stimulate them to talk, asking them to tell her what is happening on the screen.

**R2. “If I couldn’t see the screen could you tell me what was happening? Do you think you can help me? I can’t see the screen, what’s happening now?”** (turning the chair around)

They look a bit embarrassed but F. starts to describe the screen

**F. “A panda, a girl playing and a lion”**

**R1. “What are they doing?”**

**D. “They are dancing”**

**F. “Now there is a girl, a lion and a snake”**

**D. “She is flying”**

**R1. “Flying? How did you make her fly?”**

**D. “With these shoes”**

**R1. “These are magic shoes?”**

**D. and F. “Yes!”**

They want to use the music instrument but it doesn’t work so they remove the shoes.

**D. “Now she is back to normal”**

**R2. “And the lion didn’t ‘catch’ her?”**

**D. “No... Now it got her.”**

(The antagonist attacks the protagonist causing if to faint)

**R1. “What happens next?”**

**F. “Two more boys come”**

(They introduce 2 new protagonists at the scene)

They keep playing and swapping blocks without talking.

**R2: “And what is happening now?”**

**F. “Almost everyone is getting killed”**

They introduce a musical instrument; both are again in silence focused on the screen.

**D. “And came a panda... And it is fighting with the lion and the snake”**

(They swap the instrument for the panda and introduce the night block)

There are a few minutes of silent play

**R2: “this sound is different, what changed?”**

(after thinking for a couple of seconds and talking between themselves to see which pieces they would use)

**D. “It’s the night... And an elephant came. The girl is sleeping and the elephant too... The elephant disappeared. The girl disappeared.”**

**F. “I’m ‘doing it’ by groups”**

**R1 “That’s nice”**

***F. “So I have this one and this one and that one I can’t group”***

*[She points at two groups she divided by the color of the stickers, almost getting the kits perfectly correct. Here one problem is a design mistake, there has been some studies to the background pattern of the elements, to create some homogeneity between the kits but some colors are too close in the printed stickers so elements from the Brazil and the Indian kits look like they belong together. (F. groups the Chinese kit, and a mix of the Indian and Brazilian kits based on the yellow background, and the rest of the Indian Kit that uses a blue background, but can’t put the night, the snow and the rain in any group.)]*

Researcher asks if she thinks they could be in a group of their own but she doesn’t answer and D. gets back to the narrative.

***D. “Then a snake appeared”***

But gets interrupted by F.

***F. “Wait. This belongs in this group”***

***“This is a group, of yellows”***

***R1. “Very well”***

***F. “Let’s make another group”***

She chooses the similar blocks and places them at the board.

***R2 “what do you think is this group?”*** *(trying to see if they can recognize the country)*

***F. “This group with these ones. And these ones don’t have a pair so they can be in any group. This group is from this one. And these are from this one.”***

***R1: “Do you think this groups are from some specific place?”***

***F. “This one is also a group*** *(shows the Chinese group).*

***R1: “Yes, this is also a group”***

***F. “But is different. And now we are going to ‘make’ the last group”***

***“A place. This one. And this one”***

They keep swapping the blocks in silence.

We ask what they liked about the app. D says he liked the lion and the snake “because they are ferocious”

When we ask them what they would like to see in the game, D. asks for a shark. F. asks for a butterfly.

They also complain they cannot see the shoes (they are too small and not appearing properly on the characters)

We observed that F. while using the combination: landscape + Niam + protagonist, realizes that when she removes the protagonist block and place it down again, the protagonist appears in a different place in the screen and uses it to escape the attack.

7<sup>th</sup> pair, Girl / Girl (Leonor 11-years-old, Liana 10-years-old)

[they approach us when we are talking about finishing and ask if they can play]

From start they say “Let’s create a story” and start by using a scenery.

**Li “Is this at night?”**

**Le “You have to use...” (inaudible)**

**Li “There. Now who we’re going to put?”**

**Le “Let’s use this one, she is cute”**

**Li “Ok.”**

**Li “What we have to do for them to move?”**

**R1 “I think we have an error; they are supposed to move. Let’s restart the game”**

[There is an error, characters remain in idle animation, we need to restart the device. Error happened after combining the Brazil scenery, the night block and 2 protagonists. This type of error is happening a lot and we don’t know if is a problem with the code, with the images and animations or with the engine. We get new errors every time we introduce new elements to the game. Researcher reports this to Supervisor and recommends getting someone to review the code and help solve these problems.]

**R1: “Done. Now you can start.”**

**Le: “Do you think I start with this one?”**

**Li “With this one?”**

**Le “And we have to choose a scenery.”**

**“And this scenery?”**

**Li “Wow! How beautiful!”**

**Le: “How cute!” “Can we start?”**

They place one protagonist and adding a second one saying they want to make the protagonists laugh.

**Le “Now they will start laughing, the two”**

**Li. “Wait. It needs to be done in the right moment”**

She removes one character from the board and puts it back again.

**Li “Now he is going to walk”**

The characters walk towards each other and laugh when they meet in the middle.

**Li. “See?! I told you it had to be in the right moment”**

They combine both protagonists with musical instruments and want to see which one plays which instrument.

**Li “Put the flute. Let’s have them making music”**

**Le: “Right. ‘Do’ music yourself as well.” (Isso. Faz música tu também. sic)**

**Li “If we remove the boy, she gets the thing? Do you think so?”**

**“No.”**

**“It’s one at the time.”**

A Boy that is watching by the side of the table interferes: “yes, it only works one at the time”

*[Throughout the tests we noticed that the children wanted to have both musical instruments at the same time. This is not happening right now and has to be evaluated, we don't know for sure the implications it would have in the code and as a combination of sounds.]*

They want to use the Chinese blocks and call them “Japanese group”.

Le. points to the Chinese female protagonist and says it looks like “Pucca” (a Japanese manga character)

***Le “Doesn't this one looks like the ‘Pucca’? I think this is from Japan.”***

***Li “It's Japan, yes.***

***Le “Now let's use the background from Japan. This is the background from Japan”***

***Li “Yeah?”***

Li. pick up the Brazilian protagonist girl and says “***I think this one is from Brazil***”

They search for houses to use as a scenery

***Le.: “Is there no houses?”***

*[There is an error with the punji (the music plays and there is notes floating, but the character is playing the wrong animation)]*

They laugh with the error as the music seems to come from nowhere.

They place the rain block and when it floods the screen they exclaim “***Oh!***” in awe.

***Le: “how cute!” She exclaims as the fish enter the screen.***

Now they want to see what happens with the wind, expecting some funny reaction in the screen like with the rain or the snow. Le. says nothing is going to happen but Li. insists they need to wait. As nothing happens, they remove the block and move on.

Now they try a protagonist with both antagonists to see what happens.

Again, they call the Chinese girl “Pucca”

They want to try all the possible combinations and find weird that some blocks don't work together, like two musical instruments playing at the same time, or the shoes and a musical instrument (character floating and playing music)

*[This is an interesting observation and might be worth to add some combinations in these animations, like float and dance, float and play music]*

We ask which blocks they like more and they say it's the panda and the Chinese girl, Le. says that is because it looks like “Pucca”. We ask what they think is missing from the game and they say “Houses! More landscapes.”

***Li. “a beach”***

***Le. “a Japanese house”***

*Centro Educativo da Maia, Maia (Portugal) | July 22<sup>th</sup> 2019*

*Researchers present: Ana Paula Caruso e Gabriela Sá.*

*Participants: 10 children divided in pairs (5 boys and 5 girls, ages between 5 and 14 years).*

*Average interaction time: 16 minutes.*

*1<sup>st</sup> pair, Boy / Boy (Rafael 14-years-old, Tomás 13-years-old)*

We invite them to try the pieces, I think they misunderstood at first that they could place the pieces on the platform, their first action was to group the pieces by type.

We tell them they need to use a landscape in order to see the night, and ask them if they can identify the block's categories, if they can easily find which of the blocks in the set represent landscapes.

(For us this is so obvious that it is important to look at the set with fresh eyes and see if some image is not working)

They have trouble understanding how to use the night-block, they are not the first to have this difficulty, which gave us the idea to change the default background for the game. Right now, the game starts in a blank screen, and it requires the introduction of a landscape-block in order to see the night and to be visible (some of the weather effects are also hard to see due to the color of the particles used in the animation). We are discussing the possibility of creating a neutral background for the game like an empty theater stage or some other theatrical way to show the use of those blocks.

When asked by the researcher what they think the device is, R. says "it's to represent diversity"

We invite them to play and explore the game. At first, they don't understand they can place the blocks on the platform. Their first action is to group the blocks by category (humans, animals, accessories, weather).

R. comments on the magnetic part of the blocks.

We tell them they can try the blocks on the board. They start by placing the weather-blocks and the night-block. We tell them that these blocks require a landscape to be visible. We ask if they can spot the landscape blocks amongst the group of pieces.

One of the center's Teacher is watching (she was curious to see how the game worked) and she mediates the interaction a bit, suggesting how the blocks work.

They try to place both instruments at the same time. (almost all of the kids try this and then realize they can only be played at a time). They decide to group the blocks by category.

When asked by the researcher what they think the game was, R. says "is to represent diversity"

We ask if they think the game can be used to create a story.

**R. “yes, because it has sceneries and characters...”**

We ask if they would like to tell a story using the game and R. immediately starts

**R. “Tomás...” (using the other boy name) \*laughs**

T. reminds him they need to start with a scenery.

*They use the animated interactions of the blocks to create a story (most common way when using the game for the first time) [There is an error that causes the musical instrument to start playing when the protagonist is “down” and this makes them laugh and joke about it. And makes they wonder what happens if there is no human character on the game, only animals and musical instruments.]*

**T. “R. what happens to the instruments if there is no one? Do you think the snake will play?”**

They start trying combinations of characters to see the reactions. (Animals, antagonists and protagonists)

Hugo, the teacher enters the room.

**R. “Teacher, do you want to see a fight?”**

After a while, T. decides to try all the ‘yellow’ ones (sticker color)

We ask them if they understood how the game works and can explain the teacher what the game is for.

**R. “This is basically a digital support for children to invent stories with their creativity” (sic)**

We ask if they know which ones are good and which ones are bad (from the conflicts they watched) and R. says is “the elephant and the lion, because they were the one that lasted”

When the researcher asks why he choose the lion he says “no, clearly the elephant and the panda are the good ones”.

**Researcher: “if you could change anything, or add anything to the game, what would you do differently?”**

**R. “add more sceneries.”** And keeps going regarding the human characters:

**R. “by the way, I think this is diverse enough, all the races...” (“por acaso eu acho que tipo aqui ‘tá bem diversificado, as raças todas” sic)**

We ask if they recognize with countries/cultures are represented in the blocks, they say

**T. “China”**

**R. “the ‘yellow’ race, Asian. And Africa (looking at the Brazilian protagonists) and India, because of that dot (pointing to the ‘bindi’ in Meera’s forehead).**

**T. “from what I can see, each color is the ‘origin’ of a culture” (referring to the background of the stickers)**

R. says the game is missing European characters.

**R. “it would be cool if you put in our race”**

*2<sup>nd</sup> Pair, Girl / Girl (Leonor 5-years-old, Matilde 6-years-old)*

*(Matilde is the daughter of Hugo, the owner of the school, and he said they are used to tell stories to her at home)*

They try the blocks but are very shy and don’t talk while doing it.

They laugh to the music of the Pungi, and dance imitating the characters.

They also use the night-block without a scenery.

We let them play with the blocks for a few minutes, they talk amongst each other in a very low voice.

We tell them they should experiment a scenery with the weather-blocks in order to see it better.

Researcher asks if they understood how the blocks work and ask them to explain it.

**M. “Yes. When we put a piece, the things appear. The image of the pieces appears.”**

We ask if they think this is a game.

**L. “yes”**

**R. “and what do you think we can do with it?”**

**L. “we don’t know”**

**R. “what if I tell you this is to help creating stories? Do you think it works?”** *(they ignore the question and keep going)*

**L. “what do you want to do, M.?”** *(as M. organizes the blocks on her side of the table)*

**R. “I’m putting the pieces here to see the things we have”**

M. asks why the protagonist is laying down, we tell her is because he was attacked by the lion and she needs to remove his block and place it again for him to wake up. She seems to have learned it, for she would do that throughout the test with blocks that had ‘died’.

Hugo enters the room.

**M. “Dad, look!”**

We ask if they would like to tell him a story. (with some kids, having a familiar adult present helps to overcome their shyness)

**H. “Yes, tell me a story, from the start”**

**M. “ok”**

Hugo helps, saying they should start from the beginning “*Once upon a time...*”, M. starts in low voice but gets more confident as it goes.

L. says she thinks she saw “their movie” (pointing to the Chinese group, we believe she is referring to the panda/Kung Fu panda)

They don’t verbalize but keep on playing with the blocks and their interactions.

We ask which pieces they like most, M. shows the panda and the girls. L. shows the snow; they laugh as the characters shiver.

5 minutes to the end of the test L. says she is getting tired, from that on she stops paying attention to the game and starts talking about other things in the room. (and M. is the one that is clearly more engaged throughout the experience, maybe it has something to do with age?)

There’s an error and the music doesn’t play. M. “*there is no sound*”

We restart the game, but it doesn’t start. We reset the computer. (In the meantime, we ask them about the protagonists, and they can group the protagonists with the blocks from the background of the stickers)

They ask if there is a sun, when remove the night-block. When we ask if it’s not day already, they say it looks like it’s the afternoon.

In the end L. asks if they can go, and say they wanted to go away. M. say she didn’t want to leave, she would like to continue playing, so L. changes her answer “*Me too!*”

### *3<sup>rd</sup> pair, Boy / Girl (Yara 9-years-old, Rodrigo 9-years-old)*

We invite them to try out the blocks. Y. starts by grouping the weather-blocks. She places them all on the board. *[a common way of using the blocks, they don’t replace similar blocks, they just place one after the other, not paying attention to the fact that the previous ones are not working]*

They start the interaction without any conversation, we reassure them they can speak freely and that the recording is just for internal use. So, they start to talk a bit, the girl talks more. They appeared very shy in the beginning and were silently trying out the blocks on the board; but were quickly to feel at ease and Yara even got up from her chair and stayed that way while interacting with the blocks. This showed excitement and commitment towards the activity.

They quickly understood how to test each block effect on screen and the relationship between several blocks. It was easy for them to understand most part of the cultural groups and the categories (antagonist, protagonist, musical instrument, etc.). They separated the animals by two categories: the ones that made the protagonists happy and the ones that made them scared.

Again, they use the night-block without a scenery. The girl is very curious and works out that the magic shoes can help the protagonist escape the snake.

The game gets stuck after they place all the time/weather-blocks on the board. So, we need to reset the game.

This interaction has a lot of errors, we need to reset the game after using the night-block. While the game restarts they talk about which blocks they will try out.

**Y. "Let's put the snake and this one too, to see what happens."**

*[We need to restart the computer in order for the game to work. Meanwhile, the researcher asks if they know what is the objective of this game]*

**Y. "I think is to make people appear (referring to the board) and also to use weathers ('tempos' sic.) and landscapes, places"**

**R. "And about the characters, what have you discovered so far?"**

**Y. "these are Chinese. And they interact with the animals. If we place a panda, they will be happy, with the lion they will be scared."**

They recognize the Chinese and the Indian characters correctly, but they say the Brazilian ones are either Africans or Hawaiians, "because of the color and the clothes"

Y. wants to see what happens with the antagonist and the music.

R. wants to mix the sceneries but after trying it, understands that the last scenery block placed is the one that stays active.

We ask what they think they could do with the game. R. says they could create stories.

**R. "I think that is a good idea" "would you like to tell a story?"**

Both agree and Y. starts to name the sceneries.

**Y. "can this one be China?" "And this one? Netherlands?"**

**R. "No this one is Russia."**

**Y. "which one you want to use? Russia?" "So, we need to use these ones, unless you want to pretend these two are friends that are traveling" (she talks about mixing the sets. Most of the kids wants to use the 'correct' group of blocks instead of mixing the pieces)**

(India is Russia, Brazil is Africa. These two use the landscapes for the characters to travel.)

Yara was very active when telling the story and even did the dialogues. Exemple: **"Um dia, a menina estava sozinha. E estava de noite. Ela não conseguia ver bem... E daí encontrei uma coisa... 'Aaaaaah! Uma cobra!' Por isso, foi pegar na sua flauta e tocou para que a cobra se fosse embora."**

The little scream Yara made in character (as being Meera) sounded a lot like the little scream we hear when the characters are scared.

This was the first time someone created a love story between protagonists. The children usually apply the terms ‘friends’, ‘siblings/sister/brother’ or ‘cousins’

They use the blocks to show the story, they use the animations to tell the story but enunciate the actions before placing the blocks on the board.

This is the first story in which they create a dialogue. Y. makes voices for the protagonists.

We ask them to give the story an end, because of the time limit, they agree but keep adding new events.

Y. is the dominant one, and guides the story. She is very talkative, and she is the first child to use the protagonist pairs as romantic couples. ***“they are two best friends, but they are in love. But they don’t know because they never said anything”***. We ask if there is anything we could add or change in the game, but they just say they liked it like this.

*4<sup>th</sup> pair, Boy / Boy (Gustavo1, 13-years-old | Gustavo 2, 12-years-old)*

We invite them to experiment with the blocks, they group the pieces by color.

They ask if there is no ‘sun-block’ (they are the second pair to ask about the sun)

After they experiment all the blocks, we ask them if they understand how the game works and we ask them to explain to us what they think the game is for.

***G1. “to tell stories”***

***R. “would you like to try? To tell a story?”***

They agree and take all the pieces to start the story from zero.

The older kids usually understand the purpose of the game without our help, and agree to tell a story when we ask if they want to try it.

Before start they place blocks on the board in what seems to be a ‘rehearsal’ for the story. We tell them they can start whenever they like and G1. ask if they should be the characters, we tell them they can do as they like, the story can be anyway they want to. They create the story based on the animations, using them as guide but they don’t verbalize it a lot, almost as they were watching the story more than telling it.

***R. “Do you have any idea why the characters (human) are (look) like this?”***

***G2. “It has to do with region they are from. At Africa usually there are more snakes and animals”***

***G1. “And at China, Asia, they play more guitar.”***

***G2. “I think we should make stories about each region.” (referring to the color groups)***

When we ask what they would change or add to the game they say that they would slow down the rain because it floods the screen too fast, and that they would add a sun, but when asked how the sun would work (since all the sceneries are at daytime by default)

they don't know how to answer. They say that the default scenery looks like autumn, so they would add a sun to make it summer-like.

G1. say his favorite block is the guitar, and G2. say is the ice (snow-block)

We ask if they liked the game.

**G2. "It is a good idea."**

**G1. "But for what aged children is this for?"**

**R. "What do you guys think?"**

**G2. "It depends. If it is used to create a story, I think it should be for older children, for the younger ones I think they should (re-)tell (verbally) what they saw on the screen."**

*5<sup>th</sup> Pair, Girl / Girl (Beatriz 10-years-old, Ana Raquel 13-years-old)*

We invite them to explore the blocks, at first, they are very shy and don't seem very engaged.

Again, they test the weather-blocks and the night blocks on the blank screen.

*[There is a bug where the flute doesn't appear, only the music and the musical notes, they don't seem to mind it.]*

When asked what they think is the objective of this game, they say is "to understand the ways of living"

Their teacher (Hugo) asks them if they know where the human-characters are from. They say China, India and Angola (the Brazilian).

**R. "Why do you think those are from Angola?"**

**B. "because they are darker" (referring to the character's skin)**

**R. "And why do you think these are Chinese?"**

**B. "Because of the eyes."**

**R. "You said this worked to find out the other nationalities..."**

**A. "Ahn... for example, as these are various children from other places, there isn't a problem with races. They are all friends and they don't fight between them."**

**B. "Without the music they start to laugh"**

**R. "Do you think this can be used to tell a story?"**

**B. "Yes."**

**R. "Would you like to try?"**

**Both: "Yes"**

*They use the animations to create a story. They also use the different sceneries to make the characters travel. The characters on this story either run away or die, until one of the characters plays music and they all become enchanted. They use the music/absence of music to work with the conflicts. And the night/day to create passage of time.*

**R. “What would you add to the game or change?”**

**B. “A ball, for them to play with”**

**A. “Add more sceneries, like a children park”**

**B. “And a sun.”**

**R. “What would happen if we had a sun.”** (we are intrigued with this suggestion, as a lot of them ask for a sun but can’t create a proper use for it.)

**B. (thinks for a while) “But is already daytime”**

**R. “You can suggest what happens with the sun”**

**B. “The day would get brighter” “And a beach.” “And some Portuguese”**

**R. “How the Portuguese should look like?”**

**A. “fair-skinned.” B. “And with blue eyes.” A. “or green eyes” B. “because they all have brown eyes.”**

**A. “And it also could have other characters from other continents, or other countries.”**

**R. “And what do you think of the experience? Do you like it? Or it was boring?”**

**A. “É giro.”** (it’s cute)

**B. “Yes. It’s interesting.”**

**A. “It is interesting because it has this board that connects to the computer.”**

We ask if they think not having the board would make it better, they say it would be different, not better.

**A. “Trying different things can also be good.”** (‘Experimentar coisas diferentes também pode resultar’)

**Escola de Artes Pedro Serrenho, Lisbon (Portugal) | July 25<sup>th</sup> 2019**

**Researcher present: Ana Paula Caruso.**

**Participants: 14 children divided in pairs (12 girls and 2 boys, ages from 5 to 12 years).**

**Average interaction time: 20 minutes.**

[For this session, we removed the scenery-block from the Brazil kit, because the night-block is not implemented with this landscape and we saw it causes a bit of confusion with the kids as they place the blocks and nothing different happens. One other reason is the recurring errors after using the night-block. We thought it might be linked to this landscape, but it appears to happen with all 3.]

**1<sup>st</sup> pair, Girl / Girl (Leonor 10-years-old, Maria 8-years-old)**

We invite them to experiment with the game and see what happens when they use the blocks.

M. wants to use all the human characters to see what happens but doesn't want to remove the landscape.

They put one of the antagonists and when the character gets scared, they quickly remove the antagonist.

**L. "Take it away. This is going to get bad. That was scary!"**

We ask them if they understand how the game works and what they think the game is for, they keep playing with the blocks without answering. When we ask if they think it can be used to tell a story, they agree. We ask if they understood how the conflicts work, if they can distinguish the bad and the good pieces. They group the animals, accessories, landscapes and protagonists as the good ones, and the antagonist and weather-blocks are bad. When we ask why they think the weather-blocks are bad, they say it is because the snow freezes them and the rain floods the screen and kills everyone *[this is not true, but as the water rises they cannot see the characters, so maybe it has to do with it, or with the idea that in reality a flood is a dangerous thing.]*

***L. "No, these are not good or bad, these are sceneries" "And this are 'tempos'"***

***[they call the weather blocks 'time']***

They start to group the blocks by type: animals, weather, sceneries, accessories, people, and keep the antagonists in a different category. She starts to place a group of blocks on the board and explains us that using these blocks *nothing* happens, ***"Because they are good"*** (referring to the absence of conflict). ***"But if we add this two..."*** (adds the lion and the snake and when the conflict arises, she quickly removes the block) ***No, it's better to take it away."***

They say the pair of characters are couples. The panda and the elephant are also a couple. *[this is the second time they use the concept of couples to describe the characters, instead of families (brother-sister; mother-daughter; cousins) of friends.]* In their story they give names to the protagonists (Manuel and Francisca, and Mariana and Miguel). They use the effects and animations to create the story.

***M. "The panda brought a girlfriend, a boyfriend... an elephant..."***

***L. "And one of them bought some shoes – because I don't know who will get the shoes (tries the block and sees who floats) – so, Mariana bought some flying shoes..."***

These pair incorporated the blank screen (when there is no scenery active) to their story: L. "In the morning they went to a land where there was nothing... and rained a lot... until they found two friends who manage to bring them home, and the rain stopped." *(adding scenery and removing the rain)*

When asked what they would add or change in the game, L. says ***"it could have less bad ones"***.

**R. “Less? But there are just two”**

**L. “Yes. But it’s too much”**

**M. “And could have more sceneries”**

**L. “And this could be bigger (points to the board), so we could put all the pieces.”**

They ask for a park and a beach. When asked if they know where the kids are from, they identify China, say the Indians are from Japan and the Brazilians are Mexicans (L. *“Because of the clothes”*)

They try to group all the blocks on the board, piling them up on the slots of the board, first by place and then by type – sceneries, accessories, ‘good animals’, ‘bad animals’ and people (they want to group them as pairs but there is not enough space, so they group the animals in one pile and separate the protagonists – boy + girl – in the 3 remaining slots).

*2<sup>nd</sup> Pair, Boy / Girl (Luca 10-years-old, Leonor 9-years-old)*

Nigh-block is the first one they try. *[this happens in most of the tests]*

They try to use blocks on top of each other in the board.

Try to use the musical instrument without any protagonist active.

They place the night-block, and when he wants to change it to day L1 asks if there is no day.

When place the protagonist they put all six at once. – L1. ***“Now let’s try to put all the characters”***

They have a bit of trouble placing the blocks (the ones that don’t have a visible ‘floor’)

*We ask them what they think we can do with the game:*

**L1. “A story!”**

**L2. “A story, music... friendships, places”**

**R. “Do you think there are good and bad characters?”**

**L1. “They are all good. When you use music, the bad ones turn good.”**

**R. “And would you like to create a story with this?”**

**L1. “Yes!” “but this will be recorded?”**

**R. “Do you want me to record your story?”**

**L1. “Yes.”**

*This is the first time we had this request, the game can record the screen but not the audio so far, so we use a smartphone to film the story. They ask to watch it when the story is over.*

**L1. “And when you’re recording, we can talk? Can we tell the story like a narrator?” “Do you want to be the narrator or should it be me?” (asks to the other child) “So I will be the narrator and you place the characters (blocks)”**

They are very spontaneous and creative telling the story, using an opening line and an end:

**L1. “The end! I hope you liked it and until next time.”** (*‘fim! Espero que tenham gostado e até a próxima.’*)

When asked what they would add to game:

**L1. “More sceneries, and a transport, like an airplane. Other scenery could be like a house or something.”** (*He also says he liked the laughs of the characters, and imitates their laugh*)

*3<sup>rd</sup> Pair, Girl / Girl (Matilde 6-years-old | Margarida 8-years-old)*

We invite them to experiment with the blocks. We have to reassure them they can use all the blocks, replace them... They seem to be very shy; they don’t verbalize and need a bit of interference from the researcher.

**M1. “Can we remove the pieces?”** [*she asks after we had told them they could use and move the blocks*]

They have some trouble with the placement of the blocks, and we need to intervene more than once.

We ask them to explain how the game works. L2 (the older girl) takes the lead:

**M2. “We put the characters [they call them ‘bonecos’ (dolls)], and then it appears here, the characters we put. And, for example, we put this violin and then we put a character and one of the characters starts to play it.”**

**R. “Nice. And what do you think we can do with it?”**

**Both: “A story?”**

**M1. “A movie”**

**R. “And would you like to tell a story?”**

They agree, but we need to restart the game, the character is dancing but the musical instrument is not recognized (scenery + protagonist + musical instrument).

[*In this session there is a lot of errors and we need to stop and reset the game a lot of times*]

They start the story with the night-block alone (“it was night-time”) and we need to interfere and tell them the night only works with a landscape.

They seem to be enjoying play but they act more like they are watching a movie then telling a story, they don’t verbalize the actions, but also don’t stop playing. [*maybe has something to do with the age? Older children are more like to create stories than the young ones*]

We ask if they would like to change or add anything to the game and both say **“Nothing. Nothing at all”**

Their teacher enters to see how they are doing and asks if they are having fun:

**M1. “A lot of fun!” (‘a divertir-me imenso!’)**

**M2. “I think it could have more sceneries. It could have a garden”**

The youngest asks to tell another story. (again, the “telling” is more “watching” the animations)

By the end of this session we need to restart the game another time, they want to use the ‘flute’ but there is no sound. As the game flows correctly, they dance to the sound of the *pungi*.

*4<sup>th</sup> Pair, Boy / Girl (Enzo 7-years-old, Carolina 8-years-old)*

They are a bit shy at the beginning and need some encouragement to start.

**E. “Look! If we put them here, they appear!”**

E. groups the blocks by color and wants to use only the groups at a time.

**E. “these people match”**

From their conversation and their reactions, we can see that they quickly understand what are the blocks.

**E. “Let’s create a weird map!”**

**C. “No, let’s take all off and try all different ones”**

E. calls the sceneries “maps” and is curious to see what happens if they use 2 maps. When he sees it can only be one landscape at a time, he asks which “map” C. wants to use.

They recognize the China landscape without any help, and before we ask anything. (he only wants to use the blocks that match as a group – “*este pertence aqui*”)

E. says that the characters are cold when they are shivering with fear.

They root for the panda and cheer when the panda defeats the “lion”.

E. wants to try “mixing the ‘weird’ groups”

We ask them if they understand how the game works and what they can do with the game.

**C. “A lot of fun stuff” (‘*muitas coisas giras*’ sic.)**

**R. “And you think we can use it to tell a story?”**

**Both.: “Yes!”**

**C. “Let’s tell a story!”**

**E. “Good idea!”**

Before creating a story, they start creating conflicts.

They clearly enjoy the conflicts and want to create “combats”, and they use each row of the board as a “team” – *‘the Chinese are on the panda’s team’*

Both cheer when ‘their’ character wins the conflict. They are so immersed on the play that they don’t respond any questions from the researcher.

After a few minutes experimenting with ‘combats’ they decide they should tell a story. They decided they need to choose a place – namely China – a ‘weather’, both musical instruments. They agree that C. should tell the story. It was curious to see that she uses the fisherman in the China landscape as an element of the story.

**C. “Once upon a time, there was a village where lived two kids and a fisherman...”**

She needs to point it out so E. can see it. *[she is the first child to use an element from the background on the narrative]*

They realize that changing the placement of the blocks, they can change which character is wearing the shoes.

This pair uses the animations in favor of their story, changing the placement of the blocks until they get the desired reaction.

The rain makes the characters “drown”.

They decide that the shoes can save a character from the flood, since it makes them float on top of the screen. As the shoes don’t work in the flooded screen, they remove the block from the board and blow in it, in a classic move used with videogame cartridges.

C. laughs when she removes the sceneries and the characters are on the blank screen. She calls it “the emptiness”.

We ask them to give the story and end, because of the time, but they don’t want to stop and keep on playing and laughing, clearly enjoying the experience.

*[These two seem to be really enjoying, and they explain some of the ‘weird’ things that happen saying they’re dreams. Their story lasts for X minutes, and has lots of turns and twists. We have to insist that they need to create an end to the story, and they keep going for more 5 minutes.]*

We ask them what they would add or change to the game.

**C. “A little less discussion.” (“um bocadinho de menos discussão” sic)**

We repeat the question, to see if we get E. to join the conversation.

**C. “I would put the kids to ride on top of the elephant.” (there is a moment of overlapping conversation) “This two would go here, (pointing to the India protagonists and the elephant) and this two, on the panda.” (points to the China protagonists).**

**E. “I would make this thing with more space.” “So, we could use more things at the same time.”**

*5<sup>th</sup> Pair, Girl / Girl (Beatriz 12-years-old, Madalena 12-years-old)*

B. notice the blocks have magnets and comments on the different height of some of the blocks.

They start using blocks from the same color-group. They separate the blocks by color (naming it 'yellows', 'reds' and 'textured')

They recognize India and China

They talk in a very low voice between the two, B. talks more than M. and interacts more.

We ask them if they understood how the game works and what they think we can do with it:

**B. "You can mix environments and temperatures and see what happens..."**

**R. "And what do you think we can do with this?"**

**B. "Perhaps... tell a story?"**

**R. "That's a good idea. Would you like to create a story?"**

**M. "Yes, ok."**

They start the story by telling what they're seeing in the screen, but they add new things to what is happening in the animations. B. is the one talking, she tells M. more than once to continue the story but as M. don't want to talk, she keeps going. By the end of the session M. is more comfortable and gets involved in the creation of the story.

They use the characters as father, mother and sons.

We need to restart the game and they keep talking between them about what is going to happen next in the story.

They avoid conflicts and remove the blocks before it happens.

**B. "I like this game"** (comments out of nowhere in the middle of the story)

We ask them what they would add or change to the game.

**B. "I would like to have an aquatic environment and more aquatic animals, because I liked that part of the rain a lot" "And I would like that you made this larger, and we had more places" "I'd liked the animals reactions with the characters and the temperature."**

M. doesn't know if she would add or change anything.

*6<sup>th</sup> Pair, Girl / Girl (Carolina 12-years-old, Beatriz\* 12-years-old)*

*(B. just finished her session, but comes happily saying she could 'play again' because her friend was alone. I think it might interfere with C.'s experience, but might be a good way to see how a second interaction occurs.)*

B. is playing for the second time, and she comes in excited telling C. what the blocks do.

We ask if she would like to show C. how the game works.

**B. "Yes! You put the blocks together and you can tell stories."**

C. say the characters will fall asleep with the night (could be from hearing the other kids or by mere guess)

B. clearly dominates the session.

Again, we need to reset the game several times due to errors. In the meantime, B. asks if C. wants to create a story. They rehearse the story and organize the blocks by type while we restart the game.

They notice when the characters are facing the wrong side. *(not looking at their opposites)*  
*[They want to make the snake and the 'dragon' fight, when they see it doesn't happen M. says that "the two friends brought the snake to fight the evil dragon, that killed their elephant and the 'dragon' turned the snake and they became friends."*

*We need to restart the game, so they decide to replay the same story and review it step by step. When the result of the fights is random, they get a bit confused but find a way to change the story on the fly.]*

**C. "The 'dragon' turned the snake evil."**

About their favorite blocks, each one chooses a set and defends their point of view.

B. likes the panda and all the China group; C. Likes the elephant and Indian group.

About changes they would make in the game, C. say we should add some pets, like bunnies, animals that the characters could 'pet' and care for.

They want animals that don't 'fight' and don't get frightened.

*7<sup>th</sup> Pair – Girl / Girl (Carolina 6-years-old, Matilde\* 6-years-old)*

*(this is the second session for M. she comes eagerly to 'play again')*

We ask if M. wants to explain C. how the game works;

**C. "I think we need to put the 'forms' here"** *(pointing to the board)*

**M. "Look here, C., you put a piece here and see what happens. Choose one you like"**

*(but when C. puts a protagonist and an antagonist, M. quickly takes the antagonist way*

**"No, she will get scared!"**

C. calls the attention of M. that a block is wrongly placed. **"I think this one is backwards, M."**

They keep playing with conflicts and the 'pungi' and laugh when the characters 'get scared'

Both dance to the 'pungi' song.

C. understands by herself that she can 'revive' a character by removing it and placing it again.

After the rain floods the screen and the fishes appear, C. wants to wait to see if a shark will appear, and starts cheering: **"Shark! Shark! Shark!"**

They are so engaged in the activity that they don't pay attention to our questions; we need to ask it more than once.

When we ask what they think should be different, C. say the board should be bigger:

**C. "what if this was bigger?"**

They wonder why the characters stopped playing (with the snow, when there are freezing) and ask why the protagonists sleep standing up.

**C. “Let’s put a bed”**

**M. “I would like them to have a house. A house, with all that the houses have.”** (and starts describing the color of the bathroom...)

C. wants to see what happens to the ‘lion’ in the rain

Still on the subject “what would you like to add in the game”: **C. “A rabbit and an anaconda.”**

*We say we need to finish, but the session only ends because C. has to go as her father arrives to pick her up.*

*8<sup>th</sup> Pair, Girl / Girl (Carolina 8-years-old, Sara 5-years-old)*

*[This two are sisters]*

We invite them to try out the blocks.

There is an error with the musical instruments, the ‘pungi’ doesn’t appear, and the ‘pipa’ plays by itself, but they don’t seem to mind and don’t remove them from the board. They speak in a very low voice between themselves.

About the protagonists they say they are from “Hawaii, India and China, or Japan.”

We ask if they would like to tell a story, they say yes and start playing but don’t verbalize.

They create their story using only one kit, the Chinese kit, they only mix up the musical instruments.

*[Their idea of creating a story (telling a story) is to combine the blocks and watch the animations, we saw that behavior in other groups, although our question was very clear (to us) maybe we need a different approach or some simple tutorial in the game to help them start.]*

We realize they are “telling” a story by the conversation they’re having while interchanging the blocks:

**C. “Let’s start another one” “About China”**

They whisper the story to each other.

When we ask what they would add or change in the game, they say more landscapes.

**C. “Instead of having two cities, two landscapes, it could have one more for this one.”**  
(referring to the Brazil protagonist)

**R. “Only one more? We could have more, don’t you think?”**

**C. “Yes, it could have a castle, a zoo, since it has animals, a temple...”**

**R. “A temple?”**

**C. “Yes a temple! Because Chinese like temples, besides that the dragons are part of the temples, the temples usually have dragons like this”**

*S. "At the door"*

*C. "You could also have a beach"*

*S. "It could have a sun"*

*R. "A sun? And how the sun would work?"*

*S. "If you have the moon, it gets dark."*

*C. "It become night" "And here is the sunset" (points to the sky of the Indian landscape)*

*S. "If you had a sun that would be brighter. Because this is the sunset"*

They keep suggesting things, more music, Portugal, tourists and adults. *C. "I think you could have some adults. At the temples you usually have guards. And the kids need to have their parents to enter the zoo." S. "In Portugal there are adults."*

After 20 minutes, we try to end the session, they thank us and politely ask if they can do another story. Since is the last session and they're waiting for their mother to pick them up, we let them keep playing. When we say they can do another story they get really excited and talkative, they are now talking loudly and dancing to the music of the 'pungi'. They seem to be very happy and engaged.

When the teacher and the mother arrive, they get excited and say they want to tell them a story, and enthusiastically start a new one. *[their teacher starts to explain the test to the mother but the girls quickly interrupt him, saying they're going to tell a story]*

It's interesting to see that their mother recognizes "Niam" and tells *"Oh, it's not a lion, it's a 'qilin'... it's a mythical character". [her husband, the girl's father, is Chinese]*

## APPENDIX II

Tabulation of the collected data – pairs description and relevant notes

## Pair's details and Observation Notes

S. Mamede (Braga)	Gender	Age	Gender	Age	Exp. Time	Initiative	Plot	Extra Observations	What the tool is for?
Pair 01	Girl	7	Boy	8	00:15:00	Requires invitation	Story follows animations	watches the animation and changes the initial plot	"It's for theatre with the pieces"
Pair 02	Girl	7	Girl	8	00:15:00	Requires invitation	Only play and watch	required intervention to verbalize the story	"It creates images" and "it can be used to tell a story"
Pair 03	Girl	7	Boy	8	00:15:00	Requires invitation	Story not based on animations		"a story" / "this is a storyteller"
Pair 04	Girl	7	Girl	8	00:15:00	Takes initiative	Story follows animations	tells more than one story	"this are images for us to try to create a story (...)"
Pair 05	Boy	7	Boy	8	00:15:00	Requires invitation	Story follows animations		"puppet projector. if we place them here, they appear there"
Pair 06	Boy	8	Boy	8	00:15:00	Knows what to do	Story follows animations	tells more than one story	"stories with blocks that appear on the computer"
Aalborg	Gender	Age	Gender	Age	Exp. Time	Initiative	Plot	Extra Observations	What the tool is for?
Pair 07	Girl	8	Boy	7	00:20:00	Requires invitation	Story follows animations		
Pair 08	Girl	8	Boy	7	00:20:00	Requires invitation	Story follows animations		
Pair 09	Girl	8	Boy	7	00:20:00	Requires invitation	Story follows animations		
S. Pedro (Braga)	Gender	Age	Gender	Age	Exp. Time	Initiative	Plot	Extra Observations	What the tool is for?
Pair 10	Boy	10	Boy	8	00:15:00	Requires invitation	Don't tell story / only plays	they refuse, only want to play with the blocks.	"the pieces are the raw material and the product is the story"
Pair 11	Girl	7	Girl	6	00:15:00	Takes initiative	Story follows animations		A. asks if they can tell a story.
Pair 12	Girl	10	Boy	10	00:15:00	Takes initiative	Don't tell story / only plays	They ask to play	--
Pair 13*	Boy	7	Boy	9	00:15:00	Takes initiative	Story follows animations	Previous knowledge by observation	--
Pair 14	Girl	7	Boy	6	00:15:00	Takes initiative	Don't tell story / only plays		those are pieces to tell a story
S. Pedro (Braga)	Gender	Age	Gender	Age	Exp. Time	Initiative	Plot	Extra Observations	What the tool is for?
Pair 15	Boy	**	Boy	7	00:15:00	Takes initiative	Story follows animations	Previous knowledge by use (+ space)	calls it a game and asks to tell a story
Pair 16	Girl	10	Girl	9	00:14:49	Requires invitation	Story follows animations		---
Pair 17	Girl	9	Boy	9	00:16:22	Requires invitation	Story follows animations	Previous knowledge by observation	tell a story
Pair 18	Girl	7	Girl	7	00:21:53	Takes initiative	Story follows animations*	*you should just describe the pieces	"Let's create a story"
Pair 19	Girl	10	Girl	7	00:15:26	Takes initiative	Story follows animations	Previous knowledge by observation (+ space)	---
Pair 20	Boy	7	Girl	7	00:21:00	Requires invitation	Don't tell story / only plays	Requires intervention / learns and uses game rules	to create a story
Pair 21	Girl	11	Girl	10	00:15:25	Takes initiative	Story follows animations	Previous knowledge/Asks to play	Let's create a story
Maia	Gender	Age	Gender	Age	Exp. Time	Initiative	Plot	Extra Observations	What the tool is for?
Pair 22	Boy	14	Boy	13	00:16:00	Requires invitation	Story follows animations	Requires intervention	"it's to represent diversity"
Pair 23	Girl	5	Girl	6	00:18:12	Requires invitation	Story follows animations	Requires intervention	"we don't know"
Pair 24	Girl	9	Boy	9	00:17:17	Requires invitation	Story follows animations	Uses dialogues (does voices)	create stories
Pair 25	Boy	12	Boy	13	00:13:27	Requires invitation	Story follows animations		"to tell stories"
Pair 26	Girl	10	Girl	13	00:19:17	Requires invitation	Story follows animations		"to understand the ways of living"
Lisboa	Gender	Age	Gender	Age	Exp. Time	Initiative	Plot	Extra Observations	What the tool is for?
Pair 27	Girl	10	Girl	8	00:19:09	Requires invitation	Story follows animations	(+ space)	don't answer, agree when asked if could be used to tell stories
Pair 28	Boy	10	Girl	9	00:15:17	Requires invitation	Story follows animations		"A story!"   "A story, music... friendships, places"
Pair 29	Girl	6	Girl	8	00:23:28	Requires invitation	Don't tell story / only plays	tells more than one story	"A story" / "A movie"
Pair 30	Boy	7	Girl	8	00:32:31	Takes initiative	Uses animations to fit the story	tells more than one story (+ space)	"A lot of fun stuff" ('muitas coisas giras.')
Pair 31	Girl	12	Girl	12	00:19:22	Requires invitation	Story follows animations	(+ space)	"Perhaps... tell a story?"
Pair 32	Girl	**	Girl	12	00:17:07	Takes initiative	Story follows animations	Previous knowledge by observation	You put the blocks together and you can tell stories."
Pair 33	Girl	**	Girl	6	00:23:28		Don't tell story / only plays	Previous knowledge by use (+ space)	Look here, C., you put a piece here and see what happens
Pair 34	Girl	8	Girl	5	00:29:56	Requires invitation	Story follows animations	Requires intervention / tells more than one story	agree when we ask directly if could be used to tell a story

\*Pair 13 – 3<sup>rd</sup> participant (extra) Boy 5-years-old

\*\* Participated two times

### APPENDIX III

#### Table of interactions (complete)

→ (Consequence); / (Simultaneous); P (Protagonist); A (Antagonist);  
N (Animal); X (Impossible)

		[empty]	<b>A1</b>	<b>A1+A2</b>
	[empty]		Idle	Idle
	<b>P1</b>	Idle	1. P1 Scare → Afraid / A1 Walk 2. A1 Attack → P1 Flinch 3. A1 Attack → P1 Flinch 4. A1 Attack → P1 Faint 5. A1 Idle	1. P1 Scare → Afraid / A1+A2 Walk 2. A1 Attack → P1 Flinch 3. A2 Attack → P1 Flinch 4. A1 Attack → P1 Faint 5. A1+A2 Idle
	<b>P1+P2</b>	Idle	1. P1+P2 Scare → Afraid / A1 Walk 2. A1 Attack P1 → P1 Flinch 3. A1 Attack P1 → P1 Flinch 4. A1 Attack P1 → P1 Faint 5. A1 Attack P2 → P2 Flinch 6. A1 Attack P2 → P2 Flinch 7. A1 Attack P2 → P2 Faint 8. A1 Idle	1. P1+P2 Scare → Afraid / A1+A2 Walk 3. A1 Attack P1 → P1 Flinch 4. A1 Attack P1 → P1 Flinch 5. A1 Attack P1 → P1 Faint 6. A2 Attack P2 → P2 Flinch 7. A2 Attack P2 → P2 Flinch 8. A2 Attack P2 → P2 Faint 9. A1+A2 Idle
	<b>P1+P2+P3</b>	Idle	1. P1+P2+P3 Angry / A1 Scare → Afraid	1. P1+P2+P3 Scare → Afraid / A1+A2 Walk 3. A1 Attack P1 → P1 Flinch / A2 Attack P2 → P2 Flinch 4. A1 Attack P1 → P1 Flinch / A2 Attack P2 → P2 Flinch 5. A1 Attack P1 → P1 Faint / A2 Attack P2 → P2 Faint 6. A1 Attack P3 → P3 Flinch 7. A2 Attack P3 → P3 Flinch 8. A1 Attack P3 → P3 Faint 9. A1+A2 Idle
	<b>N1</b>	Idle	1. N1 Menacing / A1 Idle (randomly chosen, a character attacks)	1. N1 Scare → Afraid / A1+A2 Walk

			<p>If N1 attacks:</p> <ol style="list-style-type: none"> <li>2. N1 Attack → A1 Flinch</li> <li>3. N1 Attack → A1 Flinch</li> <li>4. N1 Attack → A1 Faint</li> <li>5. N1 Idle</li> </ol> <p>If A1 attacks:</p> <ol style="list-style-type: none"> <li>2. A1 Attack → N1 Flinch</li> <li>3. A1 Attack → N1 Flinch</li> <li>4. A1 Attack → N1 Faint</li> <li>5. A1 Idle</li> </ol>	<ol style="list-style-type: none"> <li>2. A1 Attack → N1 Flinch</li> <li>3. A2 Attack → N1 Flinch</li> <li>4. A1 Attack → N1 Faint</li> <li>5. A1+A2 Idle</li> </ol>
	N1+N2	Idle	<ol style="list-style-type: none"> <li>1. N1+N2 Menacing / A1 Scare → Afraid</li> <li>2. Attack N1 → Flinch</li> <li>3. Attack N2 → Flinch</li> <li>4. Attack N1 → Faint</li> <li>5. Idle</li> </ol>	<ol style="list-style-type: none"> <li>1. N1+N2 Menacing / A1+A2 Idle (randomly chosen, one group of characters attacks)</li> <li>If N1+N2 attacks: <ol style="list-style-type: none"> <li>2. N1 Attack A1 → A1 Flinch / N2 Attack A2 → A2 Flinch</li> <li>3. N1 Attack A1 → A1 Flinch / N2 Attack A2 → A2 Flinch</li> <li>4. N1 Attack A1 → A1 Faint / N2 Attack A2 → A2 Faint</li> <li>5. N1+N2 Idle</li> </ol> </li> <li>If A1+A2 attacks: <ol style="list-style-type: none"> <li>2. A1 Attack N1 → N1 Flinch / A2 Attack N2 → N2 Flinch</li> <li>3. A1 Attack N1 → N1 Flinch / A2 Attack N2 → N2 Flinch</li> <li>4. A1 Attack N1 → N1 Faint / A2 Attack N2 → N2 Faint</li> <li>5. A1+A2 Idle</li> </ol> </li> </ol>
	N1+P1	Idle / Idle	<ol style="list-style-type: none"> <li>1. N1 Scare → Menacing / P1 Scare → Afraid / A1 Idle</li> <li>2. Attack N1 → A1 Flinch</li> <li>3. Attack N1 → A1 Flinch</li> <li>4. Attack N1 → A1 Faint</li> <li>5. N1 Idle / P1 Idle</li> </ol>	<ol style="list-style-type: none"> <li>1. N1 Scare → Afraid / P1 Scare → Afraid / A1+A2 Walk</li> <li>3. A1 Attack N1 → N1 Flinch / A2 Attack P1 → P1 Flinch</li> <li>4. A1 Attack N1 → N1 Flinch / A2 Attack P1 → P1 Flinch</li> </ol>

				5. <b>A1 Attack N1</b> → <b>N1 Faint</b> / <b>A2 Attack P1</b> → <b>P1 Faint</b> 6. <b>A1+A2 Idle</b>
	<b>N1+P1+P2</b>	Idle / Idle	1. <b>N1 Scare</b> → <b>Menacing</b> / <b>P1+P2 Scare</b> → <b>Afraid</b> / <b>A1 Idle</b> 2. <b>Attack N1</b> → <b>A1 Flinch</b> 3. <b>Attack N1</b> → <b>A1 Flinch</b> 4. <b>Attack N1</b> → <b>A1 Faint</b> 5. <b>N1 Idle</b> / <b>P1+P2 Idle</b>	1. <b>N1 Scare</b> → <b>Afraid</b> / <b>P1+P2 Scare</b> → <b>Afraid</b> / <b>A1+A2 Walk</b> 3. <b>A1 Attack N1</b> → <b>N1 Flinch</b> / <b>A2 Attack P1</b> → <b>P1 Flinch</b> 4. <b>A1 Attack N1</b> → <b>N1 Flinch</b> / <b>A2 Attack P1</b> → <b>P1 Flinch</b> 5. <b>A1 Attack N1</b> → <b>N1 Faint</b> / <b>A2 Attack P1</b> → <b>P1 Faint</b> 6. <b>A1 Attack P2</b> → <b>P2 Flinch</b> 7. <b>A2 Attack P2</b> → <b>P2 Flinch</b> 8. <b>A1 Attack P2</b> → <b>P2 Faint</b> 9. <b>A1+A2 Idle</b>
	<b>N1+P1+P2+P3</b>	Idle / Idle	1. <b>N1 Menacing</b> / <b>P1+P2+P3 Menacing</b> / <b>A1 Scare</b> → <b>Afraid</b> 2. <b>Attack N1</b> → <b>A1 Flinch</b> 3. <b>Attack N1</b> → <b>A1 Flinch</b> 4. <b>Attack N1</b> → <b>A1 Faint</b> 5. <b>N1 Idle</b> / <b>P1+P2+P3 Idle</b>	1. <b>N1 Menacing</b> / <b>P1+P2+P3 Menacing</b> / <b>A1+A2 Scare</b> → <b>Afraid</b> 2. <b>Attack N1</b> → <b>A1 Flinch</b> 3. <b>Attack N1</b> → <b>A1 Flinch</b> 4. <b>Attack N1</b> → <b>A1 Faint</b> 5. <b>Attack N1</b> → <b>A2 Flinch</b> 6. <b>Attack N1</b> → <b>A2 Flinch</b> 7. <b>Attack N1</b> → <b>A2 Faint</b> 8. <b>N1 Idle</b> / <b>P1+P2+P3 Idle</b>
	<b>N1+P1+P2+P3+P4</b>	Idle / Idle	1. <b>N1 Menacing</b> / <b>P1+P2+P3+P4 Menacing</b> / <b>A1 Scare</b> → <b>Afraid</b> 2. <b>Attack N1</b> → <b>A1 Flinch</b> 3. <b>Attack N1</b> → <b>A1 Flinch</b> 4. <b>Attack N1</b> → <b>A1 Faint</b> 5. <b>N1 Idle</b> / <b>P1+P2+P3+P4 Idle</b>	X
	<b>N1+N2+P1</b>	Idle / Idle	1. <b>N1+N2 Menacing</b> / <b>P1 Menacing</b> / <b>A1 Scare</b> → <b>Afraid</b> 2. <b>Attack N1</b> → <b>A1 Flinch</b> 3. <b>Attack N2</b> → <b>A1 Flinch</b>	1. <b>N1+N2 Menacing</b> / <b>P1 Scare</b> → <b>Afraid</b> / <b>A1+A2 Idle</b> (randomly chosen, one group of characters attacks)

			<p>4. Attack N1 → <b>A1 Faint</b></p> <p>5. N1+N2 Idle / P1 Idle</p>	<p>If N1+N2 attacks:</p> <p>2. N1 Attack A1 → A1 Flinch / N2 Attack A2 → A2 Flinch</p> <p>3. N1 Attack A1 → A1 Flinch / N2 Attack A2 → A2 Flinch</p> <p>4. N1 Attack A1 → <b>A1 Faint</b> / N2 Attack A2 → <b>A2 Faint</b></p> <p>5. N1+N2 Idle / P1 Idle</p> <p>If A1+A2 attacks:</p> <p>2. <b>A1</b> Attack N1 → N1 Flinch / <b>A2</b> Attack N2 → N2 Flinch</p> <p>3. <b>A1</b> Attack N1 → N1 Flinch / <b>A2</b> Attack N2 → N2 Flinch</p> <p>4. <b>A1</b> Attack N1 → <b>N1 Faint</b> / <b>A2</b> Attack N2 → <b>N2 Faint</b></p> <p>5. <b>A1</b> Attack P1 → P1 Flinch</p> <p>6. <b>A2</b> Attack P1 → P1 Flinch</p> <p>7. <b>A1</b> Attack P1 → <b>P1 Faint</b></p> <p>8. <b>A1+A2</b> Idle</p>
	N1+N2+P1+P2	Idle / Idle	<p>1. N1+N2 Menacing / P1+P2 Menacing / <b>A1 Scare</b> → <b>Afraid</b></p> <p>2. Attack N1 → A1 Flinch</p> <p>3. Attack N2 → A1 Flinch</p> <p>4. Attack N1 → <b>A1 Faint</b></p> <p>5. N1+N2 Idle / P1+P2 Idle</p>	<p>1. N1+N2 Menacing / P1+P2 Scare → <b>Afraid</b> / <b>A1+A2</b> Idle (randomly chosen, one group of characters attacks)</p> <p>If N1+N2 attacks:</p> <p>2. N1 Attack A1 → A1 Flinch / N2 Attack A2 → A2 Flinch</p> <p>3. N1 Attack A1 → A1 Flinch / N2 Attack A2 → A2 Flinch</p> <p>4. N1 Attack A1 → <b>A1 Faint</b> / N2 Attack A2 → <b>A2 Faint</b></p> <p>5. N1+N2 Idle / P1+P2 Idle</p> <p>If A1+A2 attacks:</p> <p>2. <b>A1</b> Attack N1 → N1 Flinch / <b>A2</b> Attack N2 → N2 Flinch</p> <p>3. <b>A1</b> Attack N1 → N1 Flinch / <b>A2</b> Attack N2 → N2 Flinch</p>

				<div>4. A1 Attack N1 → N1 Faint / A2 Attack N2 → N2 Faint 5. A1 Attack P1 → P1 Flinch / A2 Attack P2 → P2 Flinch 6. A1 Attack P1 → P1 Flinch / A2 Attack P2 → P2 Flinch 7. A1 Attack P1 → P1 Faint / A2 Attack P2 → P2 Faint 8. A1+A2 Idle</div>
	<div>N1+N2+ P1+P2+P3</div>	<div>Idle / Idle</div>	<div>1. N1+N2 Menacing / P1+P2+P3 Menacing / A1 Scare → Afraid 2. Attack N1 → A1 Flinch 3. Attack N2 → A1 Flinch 4. Attack N1 → A1 Faint 5. N1+N2 Idle / P1+P2+P3 Idle</div>	<div>X</div>

## APPENDIX IV

### **Designing Narrative Learning in the Digital Era**

Sylla, C., Martins, V., Sá, G., Caruso, A. P., Amaro, B., Menegazzi, B., Sylla, F. (2019). Designing Narrative Learning in the Digital Era. In ACM International Conference on Human Factors in Computing Systems, CHI '19 Extended Abstracts, Glasgow, Scotland, UK, May 4-9. New York, USA, ACM Press.

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# Designing Narrative Learning in the Digital Era

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**ABSTRACT**

This paper presents a first prototype of Mobeybou, a Digital Manipulative that uses physical blocks to interact with digital content. It intends to create an environment for promoting the development of language and narrative competences as well as digital literacy among pre and

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**KEYWORDS**

Digital Manipulatives; Tangible Interfaces;  
Storytelling; Oral expression;  
Multiculturalism; Collaboration.



**Figure 1: The physical blocks (top); Children interacting with a paper prototype (bottom).**

primary school children. Mobeybou offers a variety of characters, objects and landscapes from various cultures around the world and can be used for creating multicultural narratives. An interactive app developed for each country provides additional cultural and geographical information. A pilot study carried out with a group of 3rd graders showed that Mobeybou motivated and inspired them to actively and collaboratively create narratives integrating elements from the different cultures. This may indicate Mobeybou's potential to promote multiculturalism.

**1 INTRODUCTION**

Digital, discursive and multicultural competences are key dimensions in current international frameworks for early years' education [4], and an important part of educational curricula in various countries. As technology users, children have particular needs that have to be considered when developing technological products for them [7]. Digital Manipulatives (DMs), an interaction model that employs objects to manipulate digital content [8], are especially appropriate for young children. One of the major advantages of DMs is that they promote collaboration [5] and social interaction, which are driving forces for language development.

Storytelling has been one of the domains targeted in the development of such systems [3]. Besides playing a central role in children's lives, stories are a powerful way of transmitting cultural values, helping children to understand and to become part of the world [1, 2], and as such they provide the ideal territory to foster multiculturalism, contributing to build a more inclusive and tolerant world.

**2 MOBEYBOU – MOVING BEYOND BOUNDARIES**

Mobeybou builds and extends previous work [9], but while the former focused on traditional stories for children, Mobeybou provides elements for creating multicultural narratives, and at the same time, it empowers children with diverse cultural backgrounds to create and share their own stories. The manipulation of the digital content is done using physical blocks (see Figure 1 top), which supports and promotes collaboration and exchange of ideas [9]. Each physical block (4,5 x 4,5 x 1,5cm) has a visual representation on the top and a digital identification (ID) on its base. Placing a block on an electronic board triggers the corresponding virtual content on a device's screen. The visual narratives unfold according to the blocks that the children place on the board while they verbalize their stories.

An interactive app tailored for each culture presents a story and information about it, e.g. location, games involving local traditions, food or other elements that are representative for the culture (see Figure 10). We envision that Mobeybou can be used by young children in formal and informal educational contexts, individually, with peers or in group to promote the development of language and narrative competences as well as digital literacy and multiculturalism.

**2.1 Design and Development**

Mobeybou follows a user-centered design approach. Besides being shaped by research on the use of props to promote the creation of narratives [9, 10], studies on embodiment and tangible interaction [5, 10] its design is also informed by sessions carried out with the final users. In these sessions, we



Figure 2 – China's cultural set.



Figure 3 – India's cultural set.



Figure 4 – Brazil's cultural set.

use low-fidelity paper and functional prototypes (see Figure 1 bottom) to gather information on how the children use tangible elements to collaboratively create narratives. For the first design session we created different sets of paper cards representing elements from various cultures around the world. Each set of cards contained a protagonist, an animal, a mythical creature, a landscape, an object, and a musical instrument. There were also environment-cards, this is, cards representing rain, snow, wind and the night. The session took place at school in the classroom with a class of 3<sup>rd</sup> graders and their teacher. The children interacted with the prototype in groups of six. During the design session we talked with the children about the different elements represented on the paper cards and asked them if they would like to tell stories using the paper cards.

## 2.2 Observations

The children started using the paper cards like domino pieces, placing them together and creating rows. It was interesting to observe how the children used the paper cards and to talk with them about it. They identified the objects as magical, e.g., the Indian shoes could be used for floating; the Chinese fan could create a strong wind; the guitar would make the characters dance, and could be used to hit the antagonists on the head; the flute would enchant the characters, and the dragon would spit fire and burn the other characters.

## 2.3 Description of the System

The session at school informed the design of the interactions between the elements. There are various sets of blocks and each set represents a country. The design of each specific cultural set was based on a careful investigation in order to identify characteristic elements of the culture, which simultaneously have the potential to trigger the children's imagination and creativity. Presently we have completed sets for China, Brazil and India (see Figure 2, 3, 4). Each set comprises: one landscape, two protagonists (boy and girl), an animal, an antagonist, a musical instrument and a magical object (see Figure 5). The elements are divided into categories and behave according to a set of rules that define their actions in relation to the other active elements.

The relations between the elements were developed following the traditional narrative model from Western cultures [6]. This is, the antagonists attack the protagonists; the animals defend the latter (see Figure 6, 7). The protagonists and the animals can join forces to defend themselves from the antagonists, who can also join forces to attack the former. The musical instruments can be used by the protagonists to make all the other "living" elements dance and become happy (see Figure 8). The magical objects can be used to help the protagonists escape or to beat the antagonists (see Figure 9). The environment-blocks (rain, snow, wind, rainbow, night) allow to further customize the stories (see Figure 8). All the elements from the different cultures can be mixed and matched to create narratives, potentially promoting multiculturalism (Figure 8).

The physicality of the blocks supports and promotes agency, collaboration, and exchange of ideas [8, 9, 10]. Based on the feedback from the teacher, we have integrated an audio recording function, which allows the children to record their stories, and can be used, among other functions, to assess the children's learning curve along time.



Figure 5– India, China and Brazil’s set.



Figure 6– Fight between *Hati*, the Indian animal and *Nagi* the Indian antagonist.



Figure 7– Outcome of a fight between *Gugu*, the Chinese animal and *Nian* the Chinese antagonist.

Inspired by the design session with the children, where they used the paper cards like domino pieces, we are developing a new hardware where the blocks connect to each other through magnets and communicate via I2C protocol. A master block receives the IDs of the connected blocks (clients), and sends them to the computer /tablet via Bluetooth, triggering the corresponding digital content on a device’s screen, always updating the elements present in the game. The master block has a battery to power all the blocks and a Bluetooth module to communicate with the device. The electronic circuit uses a peripheral interface controller (PIC) and magnets, which makes it possible to use small physical blocks.

## 2.4 The Story App

Ongoing and future work includes the development of a story app for each culture, which informs about the culture in a playful way, while simultaneously nourishing children’s creativity. The app presents a story and information about the culture, e.g. countries mostly associated with each culture and their location, games involving local traditions, food or other elements that belong and inform about each specific culture (see Figure 10).

## 3 PILOT STUDY

Following the first development of the software we carried out a pilot study at school with 12 children from the same class of 3rd graders, the intervention took place in a separate room (the gymnasium). The teacher divided the children in pairs, and one pair at a time came to the room to play with Mobeybou (for around 20 minutes). The group was gender balanced with the following composition: G 1 (boy/girl), G 2 (girl/girl), G 3 (boy/girl), G 4 (girl/girl), G 5 (boy/boy), G 6 (boy/boy). The researchers stood in the background, observing and taking notes, a video camera set up behind the children recorded the interactions. After each interaction, the researchers talked with each pair about their experience.

### 3.1 Observations

The children started by exploring the different blocks and the interactions among them, placing and removing the blocks from the board, experimenting different combinations. They often commented on what they were doing, talked about the blocks and the visualizations shown on the screen. The activity was collaborative, this seems to be also promoted by the blocks, which provided the children equal access to the input devices (blocks). The children easily identified the protagonists, the opponents and found out that the animals were the protagonists’ friends.

One boy told us how he came to this conclusion: “I experimented the snake with the panda and the result was bad, the panda with the lion also resulted badly. From there, *there was only a possible conclusion*: these two were friends [elephant & panda] and these two were also friends [lion & snake]. By looking at what they are doing *I concluded* that the panda and the elephant are friends because they help each other, and with music they calm down.”

Several children spontaneously identified the characters as being Chinese and Indian and explicitly included China and India in their narratives. Some groups used the musical instruments to calm down the antagonists and stop the fights. The following narrative quotations exemplify this:



Figure 8 – *Meera* (Indian protagonist) and *Gugu*, the Chinese animal, listen to *Xiao Li* (Chinese protagonist) playing the pipa, while snow is falling.



Figure 9 – *Ju Long*, a Chinese protagonist, uses the fan (magical object) to create a tornado that knocks-out *Nian*, the Chinese antagonist.



Figure 10 – Screen shot of the India App.

Pair N. 2 - “[...] The girl was asleep and all the animals appeared and they started to fight, but then the girl played the pipa (Indian flute) to stop the animals from attacking each other, and then the Chinese siblings appeared” [...].

Pair N. 5 - “Tiago went to China and Nuno also went, there they saw a snake and the panda and they got very scared and started fighting [the animals]”; “and then Tiago played the guitar and the panda and the lion calmed down [...]”. Interestingly, Pair 5 gave their own names to the protagonists, and each one embodied the character of the other, using direct and indirect speech as well as dialogues in their stories.

### 3.2 Informal Interviews with the Children

Following each group’s interaction, the researchers talked with the children about their experience. All the children identified Mobeybou as a tool for creating stories, some interesting descriptions were: [it is a] “Doll Projector”; “It is for making theatre with the pieces [...] we invent sceneries, stories, and happenings. It is also a game, we have these pieces and when we place scenarios it helps us in the stories... and we have more ideas with these blocks”. Another pair had the following conversation with the researchers. Pair: “We did stories with pieces that give us a lot of ideas”. Researcher: “Is it a game?” Pair: “it’s more than that, it helps us create a story, when we want to create a story... when the teacher tells us to create a story, we have more things in our head”. Another pair said that the board was a game to tell stories, saying that it was to: “make more creative stories”. We also asked each pair about their favorite blocks, surprisingly, a great number of the children expressed preference for the landscapes and the environment-blocks. The children also told us that they particularly liked to place the blocks on the platform and see the interaction on the screen.

### 3.3 Informal Interview with the Teacher

At the end of the intervention, we talked with the teacher, who was very positive about the potential of Mobeybou for promoting narrative competences, and knowledge of the world, by working across the different cultures. We talked also about the children participants and were surprised to hear that one of the children, who had enthusiastically created narratives with Mobeybou, was one of the less accomplished students in her class. However, during this activity, she used a rich vocabulary in her storytelling, used adjectives and linked the sentences with connectors e.g., “on a full moon night it was snowing heavily, suddenly a strong wind started to blow”. The child was curious and engaged, she asked questions about unknown vocabulary and quickly applied what she had learned, e.g., she asked the name of the instruments and only called them by their name afterwards.

## 4 CONCLUSION AND FUTURE WORK

The session with Mobeybou showed that it was easy to understand and use. The elements inspired the children to create narratives, and they showed interest for the represented cultures. The children mixed the different elements in their stories, inventing family relations between the protagonists. The use of the physical blocks and the corresponding visualizations on the screen promoted verbalizations, exchange of ideas and collaboration, which are driving forces for the development of

oral and narrative competencies. Future work includes the optimization of the new hardware, and the development of more sets for different countries. Following this, Mobeybo will be used in pre and primary school to investigate its potential for promoting language and narrative competences, as well as multiculturalism.

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## APPENDIX V

### **Mobeybou - A Digital Manipulative for Multicultural Narrative Creation – Video Showcase**

Sylla, C., Martins, V., Sá, G., Caruso, A. P., Amaro, B., Menegazzi, B., Sylla, F. (2019). In Proceedings of the ACM International Conference on Human Factors in Computing Systems, CHI '19 Video Showcase, Glasgow, Scotland, UK, May 4-9.

*Mobeybou, is a digital manipulative (DM) that uses physical blocks to interact with digital content. It intends to create an environment for promoting the development of language and narrative competences as well as digital literacy among pre and primary school children. It offers a variety of characters, objects and landscapes from various cultures around the world and can be used for creating multicultural narratives. An interactive app developed for each country provides additional cultural and geographical information about each represented culture.*

Watch it here:

[https://www.youtube.com/watch?v=E6C0iEZ0M\\_s](https://www.youtube.com/watch?v=E6C0iEZ0M_s)



## APPENDIX VI

### **Animating for a Digital Manipulative: How to create restricted action libraries without restricting the players' creativity**

Caruso, A. P., Sylla, C., Sá, G., Tavares, P. (2019). Animating for a Digital Manipulative: How to create restricted action libraries without restricting the players' creativity. p. 238-246. In Proceedings of the 7<sup>th</sup> CONFIA – International Conference on Illustration and Animation, Viana do Castelo, Portugal, June 14-15.



## Animating for a Digital Manipulative: how to create restricted action libraries without restricting the players' creativity

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[Animation and Technology / Animação e Tecnologia]

### Keywords

Animation, Digital  
Manipulative, Storytelling,  
Character Design, Action  
Library.

### Abstract

Animating for an interactive device requires a thorough planning and task division from the creative team, regarding character design and behaviors. This paper outlines the development of a set of characters and its animations for an interactive game with a digital manipulative (DM) that intends to foster children's creativity and storytelling competences while promoting multiculturalism. The DM consists of a set of physical blocks that represent characters, sceneries and objects from different cultures, and an electronic platform that connects to a computer or tablet, which displays animated responses triggered by the combination of blocks on the platform. We look into the process of creating the behavioral rules for the animated elements and the difficulties in aligning the volume of work with the available human resources and available time, reflecting on how this affects the creative process and how this process can be improved.

### 1. Introduction

This work reports on the development of 2D animations for a digital manipulative (DM). Digital manipulatives are devices composed of physical objects that mediate the user's interaction with digital content (e.g. graphics and audio content)<sup>5</sup> [1]. The DM presented here, aims at fostering children's creativity and storytelling competences while promoting multicultural awareness, offering the children a variety of characters, landscapes and objects from different cultures<sup>6</sup>. Those elements are divided in kits, consisting of a set of physical blocks that work together with an electronic board connected via USB to a computer or a tablet [2]. The platform has six slots for placing blocks. The placement of the blocks triggers animations that are displayed on the screen. The combination of different blocks results on different animations. Up until now, we have developed three kits, each of them representing a country – namely In-

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<sup>5</sup> Although commonly the digital devices (such as computers, video games consoles etc.) require a physical object (e.g. mouse, keyboard, joystick) to interact with the digital content, the role those have in representing the user interface excludes them from the notion of a DM, Ulmer and Ishii say that their physical form has little 'representative' significance [1].

<sup>6</sup> This study is part of a Masters final project and it is being developed in the context of a national research project that investigates the learning and socializing potential of digital manipulatives among young children [mobeybou.com]

dia, China and Brazil – all fully animated and implemented on the game for carrying out trials with various focus groups.

It is important to say that, so far, the use of the electronic board imposes a limitation on the number of active elements in the gameplay, as the player can only use six blocks simultaneously. This system is based on a previous device developed on the TOK project [3], and it has been used to test the interaction between the characters and the animations implemented in the game. Presently, we are exploring new hardware possibilities, by developing blocks that will connect to each other and to the computer via Bluetooth, giving the users the possibility of combining more elements simultaneously. The game elements are identified by an illustrated sticker on top of each physical block with the representation of its content (see Fig. 1). We are also studying the use of certain visual cues to make the placement of the blocks more intuitive.

The development of the DM aims at giving the children freedom to play with the blocks using them as the foundation for building creative narratives. Regarding the animation, this means creating a range of virtual interactions as wide-ranging and simple as possible, given that the interactions between the characters are triggered by the combination of the physical pieces. In the following, we will explain how the kits were created, and describe the development process of the animations of the first cultural kits, as well as the challenges of building a restricted yet functional “action library” for animating the characters.



**Fig. 1.** Example of physical blocks used in the DM.

## 2. Animating for a Digital Manipulative

### 2.1. Cultural Kits – Creating the Basic Materials

The DM is composed of various kits, each representing one culture/country. Each cultural kit is composed of seven elements: a scenery<sup>7</sup>; two characters (a boy and a girl), one animal, one mythical creature, one magical object and one musical instrument. There is a range of secondary blocks which affect the whole environment when they are used, such as weather phenomena: a ‘rain-block’, that floods the set, when it is placed on the board; a ‘snow-block’ that makes the characters shiver and “freezes” the screen; a ‘thunderstorm-block’, randomly hits the characters with lightning. There are also blocks that represent time phenomena: a ‘night-block’ changes the color and the light of the scene when it is placed on the board, and makes the characters fall asleep as long as there is no musical instrument active, or a conflict taking place.

In order to be able to define the interactions between the different game elements and to create a great number of animations as required, as well as to optimize the development process of the animations, we decided

<sup>7</sup> The sceneries do not have any effect on the other elements but can be affected by some of the blocks (such as rain and snow).

**Fig. 2 and 3.** China kit: conflict between protagonist and antagonist, with the help of the kits' magical object.



to group the elements into classes and to set a limited number of actions and reactions that would be generated by their possible combinations<sup>8</sup>. Each class acts in a certain way and every action will trigger a reaction accordingly. The behaviors of the elements are affected by the combination of blocks and by the number of blocks from each class present in the gameplay.

The major classes are: Protagonists, Antagonists, Animals, Magical

Objects and Musical Instruments. This division is based on the structure of classical narratives, which by tradition relays in a dual opposition: good versus bad, protagonists versus antagonists, heroes versus enemies [3]. This structure grants the emergence of a conflict and its resolution. To achieve this, we have created following rules: a) a protagonist by itself is always weaker than an antagonist, so when an antagonist attacks a protagonist, the latter will always be defeated by the former; b) the protagonist will always require help of other elements to escape or win a conflict; c) the animals and the antagonists are equally strong, so in case of conflict, if they are equal in number, the system randomly decides who wins the conflict; d) the musical instruments can only be used by the protagonists and when they enter the game, they stop all conflicts (all characters in the game will look happy and start to dance<sup>9</sup>); e) similarly, the magical objects can be used only by the protagonists and

will grant them special powers over the antagonists, either to escape (the magical shoes will make the protagonist float in the air) or to defeat them (a fan will create a typhoon and blow the opponent away) (see Fig. 2 and 3).

## 2.2. Characters: Designing and Animating

In the following we will focus on the description of the human characters' process of animation and the development of what we will call a shared restricted action library. Regarding the animation and the design of the game elements, all the human characters have a similar silhouette and behaviors: they all share the same skeletal structure and have the same range of animations, being all equally affected by the other elements.

This limitation was chosen in order to optimize the art team's work. Trying to convey our goal to have a large number of unique blocks with the limitations of time and human resources<sup>10</sup>, we decided to compromise on the variety of the characters to achieve an optimal development pipeline. To accomplish this, we designed the protagonists, which are the larger

<sup>8</sup> We will call this set of actions for each character a limited "action library".

<sup>9</sup> This reaction was inspired in the children's use of the Musical Instrument cards during the first interaction with the game, although some children would use the instrument as a weapon, most said the music would calm down the enemy, thus ending the conflict.

<sup>10</sup> The project art team is composed by an illustrator and an animator.

group of characters and who share the same nature – all protagonists are based on human children of similar age – with a similar basic shape, and similar height and features, however they differentiate from each other through hair styles, clothes and color. These characters also share the use of objects, such as the musical instruments and their animations. This process is commonly found in mainstream animation, and is subject to controversies, if on one hand we have more production in less time, on the other hand it can be argued that this creates a deprived repertoire of characters. [4] On a more positive note, this simplicity generates characters that are easily recognizable, that have a neutral personality, this way, being easily transformable according to the player desire and creativity.

In contrast with the human characters, the animals and the antagonists have exclusive designs and, their uniqueness grants us more freedom to create their animations even while respecting the behavioral tree delimitations. For instance, all animals and antagonists have an attack animation, but every attack is exclusive of each antagonist, e.g. the panda bear (China kit) turns into a ball and ‘rolls’ over its opponent, while the elephant (India kit) blows flowers from its trunk (see Fig. 4). The process of animating these characters, which are unique and therefore pose a higher level of difficulty, is a lot more exciting. It is challenging to convey their personalities and the unusual behaviors that we design for them into the animation, but this is also the highlight of working on them.

Analyzing the creation of these elements from the perspective of character design, the non-human characters “travel well across national boundaries. These characters avoid activating ethnicity, and they are forgiven for behaving in odd ways because they are so clearly not part of the usual human social structure” [5:60].



**Fig. 4.** Both characters have the same design with different patterns and details unique to each.

### 2.3. Creating Restricted Action Libraries

The need to simplify the creation process required a careful planning of the game elements’ behaviors. For that we designed a complex table of interactions, specifying how the combination of blocks would interfere with each other, according to the order of placement and the number of blocks in action. Table 1, presents a simplified overview of the interactions between the elements according to the number present in the gameplay:

*P	*A	*N	*MO	*MI	Conflict Result
1	1	0	0	0	Antagonist attacks and wins
1	1	1	0	0	Animal attacks and Antagonist loses
1	1	0	1	0	Protagonist uses Magical Object to win
1	1	0	0	1	Protagonist plays Musical Instrument and everyone dances
1	1	1	0	1	Protagonist plays Musical Instrument and everyone dances
1	1	1	1	0	Protagonist uses Magical Object to win

**Table. 1.** Simplified Table of Interactions

\*P: Protagonist,  
 \*A: Antagonist;  
 \*N: Animal;  
 MO: Magical Object;  
 \*MI: Musical Instrument.

In interactive animations, the animator has to bear in mind that the player will hold control over the characters' actions. In the work presented here, the player has not only control over the characters but also over the narrative, through the combination of the blocks during the gameplay. In a linear animation, like an animated movie, the animator is responsible for modeling the characters' behavior, and s/he is the one that decides when and how it happens. However, in a video game, this decision has to be made instantaneously by the computer, as it 'reads' the players' actions, turning control inputs into animated responses that are displayed on the screen. Tomlinson refers to that as "taking an intuitive process (the way an animator or animation director decides to have a character act) and making it explicit (so that a computer program can make the same decisions on-the-fly)" [6:6]. To make this intuitive-to-explicit process possible, the animation team and the character designers will create a suit of actions and behaviors for the characters – the action library – and specify the rules for the actions and reactions, these will later be coded in the game system by the programmers or engineers.

As mentioned in the introduction, the main goal of this work is to offer the players a wide range of materials to create their narratives. This implies creating the largest possible number of cultural kits<sup>11</sup>, so it is critical to consider the progressive amount of required animations and the restrictions that we face when creating them.

To find the best way to address the challenge of working with limited time and limited human resources, and to optimize not only the process but also the product (DM), the present work follows a Design-Based Approach, wherein practice and theoretical studies are intertwined, the theory instructs the design and the design itself improves the theory. Sylla stresses that "Design Based Research is practice driven, pragmatic, flexible and iterative", being a cyclical process of design, test and redesign from the users' responses after each iteration. [3:96] Every time a new kit is created, animated and implemented in the DM, it requires testing to verify if it is working properly (debugging) and usability tests, which provide feedback on how and where to improve the digital manipulative, e.g. during the first trials, while observing the groups experimenting with the DM, we noticed the users looked for an immediate response from the active blocks, rapidly swapping the blocks on the board.

When we started working on the animations, the team was still deciding on the composition of the cultural kits. The classes and the interaction between them were not yet defined. At first, we animated one single character mainly as a way to test which range of expressions and customization a character could have. This first character has not yet been integrated into the game and will probably require to be completely remade in order to be incorporated into the game universe.

The first cultural kit that was fully developed was the Indian kit. The first animated set comprised only one human character, a young girl named Meera, as the protagonist. While testing the interactions between

<sup>11</sup> In a first moment we are trying to represent the most common cultures present in Europe, but future work will extend the number of available kits in the game.

the characters we were confronted with the issue of gender representation and decided to create both a boy and a girl for each cultural kit. However, adding characters to each kit increased

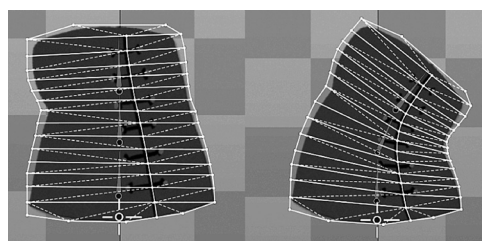
the volume of work necessary to animate them. Fortunately, we found a way to significantly reduce the amount of time required for the extra character animations: by using the same base for both character (see Fig. 5), we could duplicate the skeleton and its animations, therefore having to do only minor adjustments to each animation e.g. to animate individually the movement of hair, clothes, etc.

Another issue we were confronted with was the use of interchangeable elements: in order to give the players more freedom for constructing narratives and to promote multiculturalism, it was established that they should be able to mix the elements from the different kits. This meant that every human character should share elements and animations. The new character would inherit the magical objects, the musical instruments and its animations from previous characters, and the previous characters would inherit the additional objects, musical instruments and animations. For every new character added, the number of bones and animations in each skeleton would increase by at least two. This presented us with the challenge of how to speed up this process and avoid redundant work. The ideal process would involve not having to add all the new bones and images manually, as the development of new kits would affect and be affected by all previous work. On our first approach, sharing skeletons and animations between the human characters of each kit was done by duplicating the original file, renaming it and replacing its images. This allowed us to produce two animated characters in almost half the time. Designing the characters with the same basic shape, as shown in figure 2, also allowed us to share meshes between them. The meshes are constructed on top of the 2D image, by attributing a series of triangles that will allow the image to simulate a 3D movement otherwise impossible to achieve in this type of animation. By manipulating the mesh, we can bend the image simulating a malleable surface, adding a fluid feel to the movement (see Fig. 6).

Although this was a valid and helpful shortcut, we still had to deal with the animations for all the other elements. During the first months of work, the software used to animate allowed us to import animations from one skeleton to another, but crashed when we tried to copy bones and images between two skeletons, forcing us to add new elements and bones one by one. When preparing the third



**Fig. 5.** Both characters have the same design with different patterns and details unique to each.



**Fig. 6.** Mesh created over the character body sprite and its deformation.



**Fig. 7.** The Bones and the attachments can be copied from one skeleton to the other.

project (See Fig. 7) This software improvement significantly reduced the amount of work, improving its quality and quantity.

Every animation is individually adjusted to better fit the characters this way giving them a sense of individuality, but the structural basis on which it is created is shared between all. This allows us to give the characters some personality and to consequently increase interest from the players, while optimizing our production capacity.

### 2.3. Does a limited action repertoire affects the player experience?

So far, we have only tested the digital manipulative in a Portuguese school with a class of 2nd graders. The first trial was made with sets of paper cards representing the initial illustrations for each kit, in a simulation of the DM, and the second trial was made with the digital manipulative. Even so, during the first field trials, it was possible to infer some important aspects regarding the players' experience when comparing the use of an analogic version of the game and the DM itself. In the analogic version trials, we presented the children with seven complete kits and seven secondary cards to play with, and asked them to use the cards to tell a story. The children tried to use all the available cards, often creating stories that consisted of a series of "and then" events. In the second trial test, with the digital device, we offered them only two Cultural Kits (namely India and China) and four secondary blocks to play with (rain, wind, snow and night time). After exploring the blocks and learning their interactions, the children produced more creative stories, sometimes embodying the main characters. In the next section we highlight some excerpts of the informal interviews done with the children during the second field trial.

### 2.4. Field trial with 2<sup>nd</sup> graders and informal interview

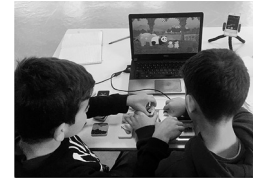
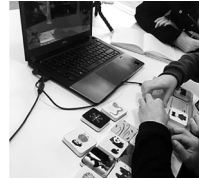
The first series of field trials resulted in some interesting feedback from the users. In the trials with the digital manipulative we started by letting the children interact with the interface without giving them any guidelines, just asking them to play with it and observing how they would manipulate the blocks and behave (see Fig. 7 and 8). They would intuitively place the blocks and wait for the animations to appear on the computer screen<sup>13</sup>.

<sup>12</sup> We started with eight animations per protagonist in the first version of the game. In the last version, which comprises three kits each human character had 19 animations and 28 bones.

<sup>13</sup> This first interaction showed the importance of immediate response from the blocks, if the animation took more than a couple of seconds to be triggered by the use of a block, they would remove it and place a different block on the board.

kit, given the increasing level of complexity<sup>12</sup>, we started researching for a way to simplify this process. Fortunately, thanks to improvements made in the software during that period, we could now also copy the bones and images from one skeleton to another as long as they were in the same

After a few minutes getting used to the interface, they were invited by the researcher to tell a story using the DM, which was followed by an informal interview as mentioned previously. We compiled below some highlights from the interviews:



**Fig. 8 and 9.** Field trial  
- Children interacting with the digital manipulative.

[group 1, boy and girl]

They started slowly placing the blocks on the platform and experimenting, talking in a very low tone, shyly. There were some difficulties with the fitting of the blocks on the platform [this observation leads us to work on visual signals to make the placement more intuitive as previously mentioned.] After the children get used to the interface, the researcher asks them what do they think the platform is.

Both: "It's for theatre with the pieces", "it's also a game"

Researcher: "why do think that this is a theatre?"

Boy: "we invent sceneries, stories, and happenings, I think"

R: and do you think this helps creating stories?"

B: nodding vigorously with head: "it helps, it helps a lot"

R: "can you explain why?"

B: "we have these pieces and when we place scenarios it helps us in the stories"

[group 4, two girls]

They start the interaction by saying the platform is for creating stories (they remember tok from the year before) Researcher asks: "how does it work?"

Girl 1: we place a block here (platform) and we have to talk about that piece

Girl 1 to Girl 2: "do you want me to start?"

[When it started snowing both girls said "AH!", delighted by the reaction of the block, they also laughed about the interactions.]

Researcher: do you prefer telling stories with this or with the paper cards [researcher referring to the first field trial]?

Girl 1: "with this, we get more ideas"

R: how would you describe what you have done at home?

G 1: "we did stories with pieces that give us a lot of ideas"

R: do you think that this is a game?

Girl 2: "it's more than that, it helps us create a story, when we want to create a story, when the teacher tells us to create a story, we have more things in our head (gives ideas)"

[group 6, two boys]

Researcher: How would you call this [the tool]?

Boy 1: "puppet projector interesting the idea of projecting the figures that they have on the hand"

R. Do you like it?

B 1: “yes, if we place them here, they appear there [on screen]. They like to see the images on the screen.”

R: do you remember using the paper cards?

Children answer yes, but they prefer this version “because they appear on the screen, and always appear the scenarios.”

Note: This pair was the first to give their own names to the characters on screen and use direct speech and dialogues on their storytelling. They were also the first to verbalize relationships that weren't of equal statute instead they using the protagonists to express mother/son relationships.

### 3. Conclusion and Future Work

Animating interactive characters is always a challenging task. This work forces us to reflect on the process of designing and animating the characters and on what is more important to offer: a wider range of characters or characters that are more unique. During the initial tests, the restricted action libraries did not seem to constrain the players.

Presently, we are planning new trial sessions that will allow us to test with a larger focus group and gather feedback from the players. This will allow us to keep on refining our work method and final product. This paper presents a work in progress, which will be improved on. We'll continue the research on animating for digital manipulatives in the context of this project, allowing the possibility of applying this research's methods to similar projects in the future.

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## APPENDIX VII

### **Visual Development Processes for a Multicultural Storytelling Tool**

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# Visual Development Processes for a Multicultural Storytelling Tool

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**Abstract.** This paper presents the evolution of the visual development process for Mobeybou, a digital manipulative that aims at promoting multicultural awareness through creative storytelling. It presents children with a variety of characters, objects and landscapes from various cultures around the world. Here, we reflect on three different approaches of the visual development, and on how to effectively create visual elements that represent a given culture, which have the potential to foster the children's imagination and creativity. The first approach was carried out by a single illustrator and was mainly informed by research on the web. It was time efficient and resulted in the creation of visual elements that may have been too obvious. The second one took longer, had more input from other team members and often resorted to pop culture as reference; the resulting visual elements were easily identified by the children, probably because they depicted somewhat stereotyped representations. The third approach was a collaborative process from the start, that relied heavily on the opinions and insight of people who were born and raised in the country being represented. It resulted in a more complex relationship between the visuals and the culture they portrayed, which was potentially enriching for the viewer but may hamper the immediate identification of the culture.

**Keywords:** Visual Development, Multiculturalism, Representation.

## 1 Introduction

This paper presents the evolution of the visual development process for Mobeybou, a digital manipulative, that targets pre and primary school children and aims to foster the development of language and narrative competences, while promoting multicultural awareness, through creative storytelling. Digital manipulatives are objects with embedded computational properties that enable the manipulation of digital content (Resnick 1998). Mobeybou, uses physical blocks to interact with the digital content. The tool presents children with a variety of characters, objects and landscapes from various cultures around the world. Consequently, it fosters the creation of multicultural narratives and empowers children with diverse cultural backgrounds to create and share their own stories [1].

Mobeybou is composed of an electronic board that connects to a computer via USB, and a set of physical blocks, which can be placed on the board to trigger the respective visualization on the device's screen. The narratives unfold according to the combination

of blocks that are placed on the board. So far, we have developed three sets of blocks, representing the cultures of India, China and Brazil. Each set is composed of seven elements: two protagonists (a boy and a girl), an animal, a mythical creature (who serves as the antagonist in the narrative), a landscape, a musical instrument and a magical object. These elements are representative of native components of the country or are inspired by the folklore, traditions and mythology of the culture. There is also a separate group of blocks that represent atmospheric conditions (night, snow, storm, rainbow, wind and rain), which affect the environment of the story (e.g. the rain block triggers a rain effect on the device's screen). The children can mix and match the various elements from the different cultures to create unique stories of their own. The experience of intertwined cultural elements potentially promotes multiculturalism, as children visualize how rich – both visual and content-wise – the intercultural experience can be.

At the same time, we are developing a complementary app about each country and its culture, so that the children can learn more about the elements present in the digital manipulative. The app presents a story and small games for each country, that reference the meaning behind the characters and the objects present in the storytelling tool; thus, adding value to the whole of the multicultural experience.

The present work is a reflection on three different approaches to the process of visual development, i.e. the creation of all visual elements that constitute the digital component of the tool. Here, we reflect upon the development process in order to understand how can we represent and honor a country and its culture, with such a limited number of elements, on a limited time frame, considering animation restrictions, without resorting to stereotypes and clichés.

## 2 Different Approaches to the Visual Development Process

### 2.1 The Development of the Indian Visual Elements

The Indian set was the first to be created (see Fig. 1), its development process represents the first design approach, which was carried out in a short period of time by a single illustrator. The creation of the set began with an online research of the Indian country, which included the search for traditional tales, customs and food, main religions, geographical information and common cultural practices that were unique to India; all accompanied by abundant visual references<sup>1</sup>. A selection process took place to decide which information could be used to compose the final group of seven elements. There were very few initial sketches and the final design was achieved quickly. The final versions were then presented to the team; up until this moment, the illustrator worked virtually alone. The team decided on a few small alterations and all the elements were optimized for the animation process. The Indian set helped to establish a look that would guide the creation of the next sets.

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<sup>1</sup> This is common practice for the visual development phase, as is described, for example in *The Art of Brave* [2] — the artists carried out research trips to Scotland to gather information and visual references for their story — and in *The Art of Tangled* [3] — the artists gathered information and visual references of medieval Europe and were inspired by other artworks that referred to their theme.

This first approach was quick and effective, relying solely on the research made by an individual, whose choices were inevitably influenced by biases and predetermined ideas about the country and its culture. This resulted in visuals that have a strong connection to the traditional – and perhaps stereotyped – aspects of India.

The Indian animal, whom we named Hati, is an elephant whose design was inspired by the decorated animals of the Elephant Festival in Jaipur [4]. Elephants have long been revered in India; Ganesha, the Hindu god with an elephant head, is one of the most known and worshiped deities across Asia; kings appeared mounted on adorned elephants to dazzle their subjects and affirm their power [4]. However, painting and parading elephants has also been associated with ethical questions about the mistreatment of these animals [4, 5].

The Indian antagonist Nagi (meaning the female *naga*) was based on the legend of *nagas* – semi divine beings of Indian mythology that can shapeshift between human and serpent form [6]. These mythical creatures are potentially dangerous, but often beneficial to humans, and appear frequently as door guardians of temples. Nagi's design depicts a colorful cobra, who does not transform itself, that looks both, menacing and fun.



**Fig. 1.** India's group of elements and the pattern that we have created and associated with it.

The first idea for the Indian musical instrument was a sitar<sup>2</sup>, but due to animation constraints, it was decided that we would use a *pungi* instead, since it is smaller and easier to equip on the characters. A *pungi* is an Indian flute made from a gourd that is mainly associated with snake charmers. This is considered an ancient practice that involved housing a snake in a basket and playing the *pungi*, making it look like the snake was transfixed on the instrument. However, as it is done today, snake charming may involve animal cruelty and has been targeted by laws prohibiting the possession of snakes [7].

The Indian object is a pair of *jutti* – shoes crafted in leather with extensive embroidery work, made with gold and silver thread [8]. When equipped on a character, the *juttis* make him/her float. This effect is not directly related to the history of the object; in fact, the idea came from preliminary studies that were done with a group of 3<sup>rd</sup> graders [1], who suggested this particular interaction.

Meera, the Indian female protagonist, has a long black braid, wears a red *bindi* on her forehead and a *shalwar kameez* – a garment consisting of a tunic and loose trousers that narrow at the ankle. Traditionally, women would also wear a *dupatta* – a light fabric scarf; however, it was not included in the design. Rajesh, the male protagonist, also has black hair and wears the same *shalwar* (loose trousers) with a *kurta* (a collarless shirt). In order to

<sup>2</sup> A sitar is a long-plucked string instrument that is played sitting on the floor.

optimize the animation process, the two characters' garments have the exact same silhouette. Although the top garments should realistically have different lengths, their current design allowed the animator to create a single animation that was applied to both.

The Indian landscape was inspired by photographs of Indian palaces, with ornamented columns and tiled floors. Some of the landscape elements are decorated with a pattern that are depicted on Rajesh's tunic, similar to the decorations on the *pungi* and on Hati's back.

## 2.2 The Development of the Chinese Visual Elements

The second set we created was the Chinese (see Fig. 2), which took longer and had more input from the other team members. The initial research was done, as explained before, resorting to children's books and movies as inspiration. Although most final designs were achieved quickly, there was a more extensive exploration of visual options than before.

The design of the Chinese animal – Gugu, a giant panda – was the element that took the longest to be completed. We tried out several initial sketches, representing different possibilities of shape and size, and the final design emerged out of a collaborative process. The giant panda is a Chinese native animal, whose conservation status is currently vulnerable; meaning pandas remain scattered and low-numbered in the wild [9]. Gugu's presence in the story world will potentially create an even stronger empathy towards this world-wide loved animal and allow children to learn more about the species, through the interactive app. The only embellishments on Gugu's body are discreet yellow lines around its paws. However, next to the other characters' in the group it did not stand out, so we added a red conical hat, with yellow details. This type of hat is present all over Asia, being a useful tool to keep laboring people in rice paddies protected from the sun and rain [10]. The conical hat has been used in film and other media to imply an ethnic type, connoting a vague representation of people of Asian origins, but often associated with Vietnam and the laboring peasant class. It is an element present in animation movies like the *Kung Fu Panda* trilogy [11, 12, 13] (Po, Crane and half the panda village use them); but also, in live-action movies, like *Big Trouble in Little China* [14].

It was decided that all the protagonists would have the same general design, as a way to make production more efficient and to allow the children who use the tool to immediately identify them. This accelerated and facilitated the process of designing Xiao Li (the Chinese female character) and Ju Long (the Chinese male character), who besides having a similar design to their Indian counterparts, have the exact same silhouette as one another. They both have black straight hair and pale white skin. Xiao Li has her hair in two buns, a hairstyle commonly called ox horns. This hairstyle was widely popularized by pop culture characters like Chun Li (from *Street Fighter* [16]).

The characters' attire was inspired by traditional clothing items like the *cheongsam* – a fitting dress worn by women – and the *changshan* – a dress or tunic worn by men. The combination of a straight-cut loosed-sleeve tunic with dark pants and shoes was inspired by the garments of famous Bruce Lee movie characters [17, 18]. We chose shades of red for the protagonists' clothing since it was a color that appeared frequently in our research; often connected to Chinese New Year's traditions.

The Chinese antagonist is Nian, a fire-spitting red creature, that resembles the flat-faced lion statues guarding Chinese Buddhist temples, as well as the papier-mâché costumes of the traditional lion dance, usually performed by a pair of acrobatic Kung Fu students [19:114]. The legend that inspired the creation of our character tells the story of a creature

who would come down from the mountains, every year, to devour people from the village and damage their crops. There are different accounts of the legend: some say the monster was lion-like and was scared away with loud noises, fire and the color red [20, 21]; others say the villagers created a lion costume with paper and bamboo that was used to scare the creature away [19:114]. These legends explain the beginning of Chinese New Year's traditions, like the fireworks and the use of red garments – referenced in our character through its fiery nature and look.



**Fig. 2.** China's group of elements and some of Xiao Li's outfit iterations.

The Chinese musical instrument we chose is a *pipa*, a short-necked Chinese lute. The *pipa*'s size and shape make it a good option to overcome animation restrictions. Its design was kept simple; the only addition being the scale pattern on its wooden body. This pattern is repeated in Xiao Li's tunic, in Nian's body, in Gugu's hat and in some elements of the landscape. The pattern repetition creates a visual cue that helps to identify which elements are from the same culture.

The Chinese object is the hand fan; it is still used today in dance, martial art performances and as a decorative item. Through time, hand fans evolved from simple accessory to artwork, and were used as canvases for poems, calligraphy, painting and embroidery [22]. They have also been popularized as martial arts accessories and weapons, by characters such as Kitana (from *Mortal Kombat* [15]). In the story world, the fan is used to protect the protagonists, similarly to a weapon, by creating a hurricane that knocks out the antagonists. The idea for this effect also came from the preliminary studies with children. The design of the fan is simple: red with a yellow dragon; in the same color palette as the other Chinese elements. We chose to depict a dragon because it is an inseparable symbol of the Chinese culture: from the zodiac sign to the dragon dance, it is a symbol of auspiciousness and prosperity present in Chinese legends, festivals and art throughout the world [23, 24].

This group's landscape was inspired by Chinese paintings, as the ones done by landscape artists such as Zhan Ziqian, Fan Kuan and Qi Baishi, whose works often depict top-rounded tall mountains near lakes or rivers – much like the landscapes one would find at Yangshuo County, another one of our visual references. We decorated the landscape with houses, red paper lanterns and common Chinese plants, like bamboo and *pilea peperomioides* – also known as Chinese money plant.

### 2.3 The Development of the Brazilian Visual Elements

The third and most recent set we have worked on was the Brazilian (see Fig.3). The approach to the development of the Brazilian elements was different from the two previously mentioned, as two members of the team were born and lived in Brazil, which made this approach to the visual development a collaborative process from the start. There was a period of individual research, but the design choices relied heavily on the Brazilian members' opinions and insight. Most elements of the set went through dozens of iterations and the team gathered every day to discuss them. This made the process much slower than the previous approaches and led the illustrator to create a much greater volume of work.

When creating the design of this group's protagonists, we considered the fact that, despite the great ethnic and racial variety in Brazil, the majority of the population (54.9% out of approximately 205 million people [25]) identify themselves as being *pardo*<sup>3</sup> or "black". This prompted us to use a darker skin color for the human characters. However, to further highlight Brazil's ethnic diversity, we chose a different skin tone for each protagonist, and so Kauê (the Brazilian male protagonist) is darker-skinned than Iara (his female counterpart); both their names derive from indigenous traditions. They both have curly hair, since this is a common phenotype in Brazil.



Fig. 3. Brazil's group of elements and initial iterations of Tatá.

We did not design the Brazilian protagonists wearing traditional folkloric costumes because the Brazilian members of our team thought it would be unrepresentative of their culture, since traditions vary widely across the country (this argument could be applied to the other two countries, India and China, with the latter being even bigger than Brazil, but we did not have the knowledge or insight to pursue this question further when we designed the elements for the previous groups). We also rejected the idea of dressing them as natives from the Amazonian forest; either option would narrow the rich multicultural diversity of Brazil, according to the members of our team, who were forceful in defending a less segregated or stereotyped view of Brazilian culture. They then suggested that we should dress the protagonists in contemporary summer clothes, like t-shirt, shorts, dress and flip-flop sandals, in bright colorful patterns. The patterns we created depict some of the

<sup>3</sup> *Pardo* is an adjective used to describe something of undefined color, between yellow and brown shades, often used as a synonym of *mulato* – someone with brown skin, descent of parents of different ethnicities, e.g. Caucasian mother and black father, or vice-versa.

country's most well-known tropical fruits, like *guaraná*, pineapple, banana and papaya. These design choices are aligned with the motto of one of the country's most famous brand, *Havaianas*, for it embodies "Brazil's fun, vibrant & spontaneous way of life" [26].

Following the line of thought that led us to create summer wear for the protagonists, we created a beach landscape, an inevitable association made with Brazil. However, after some team discussions and by suggestion of the Brazilian team members, we developed a second option that represented a Northern Brazilian scenario, near the Amazon forest. It depicts the rain forest, a river, a boat and *palafitas*. These are "floating houses" made of wood-suspended frames, that stand on flooded soils or rivers; therefore, common in the regions of the Amazon basin [27].

The antagonist of this group is a *boi-de-mamão*, a character from oral Brazilian traditions, that is known across the country by different names, like *bumba-meu-boi* or *boi-bumbá*. This creature, who resembles an ox, gives the name to a Brazilian folkloric dance, influenced by African, Indigenous and European traditions [28]. The dance is associated with several religious festivals that take place in June, where people build a colorful *boi-de-mamão* costume with papier-mâché and pieces of fabric, which is used by a dancer in theatrical and dance representations of this folkloric tradition. There are different legends about this character that vary from region to region; nonetheless, the ox is often depicted as a figure who dies and is later reborn. Our design of the *boi-de-mamão* is very colorful, with an air of madness, to make it fun. There are no legs visible under the cloth that constitutes the body of the character, so it looks like it floats. However, when it is hit by a lightning strike in the interactive platform<sup>4</sup>, it shows the skeletons of people underneath the costume; referencing the origin of the character.

The Brazilian musical instrument is a *berimbau*, a "musical bow" consisting of a long piece of wood, a single string of steel and a small gourd; it is played with an additional small rock or coin and a thin wooden stick [29]. Despite its African origin, the *berimbau* is typically associated with the state of Bahia and the practice of *capoeira*, a Brazilian cultural expression as ancient as slavery, that is simultaneously a dance, a fight and a game, involving music [30].

*Bambolê* – a hula hoop – is the object chosen for the Brazilian group. Variations of the hula hoop have been around for centuries – going back to Ancient Greece and Roman Empire; however, the hula hoop, as we know it today, was trademarked and popularized by Wham-O, an American toy company, in the late 1950's [31]. Because this is not an object typically associated with Brazil or of any traditional value to the Brazilian culture, other options were suggested by the team, like a *peteca*<sup>5</sup> or a Carnival mask, which were more obvious associations. However, the Brazilian members of the team were adamant in including the *bambolê*. They argued it was still a very popular toy in their country and it expressed playfulness, as well as the importance of dance in Brazilian culture. When the *bambolê* is used in the tool, a protagonist twirls it around their waist and it releases confetti; a reference to the celebrations of Carnival in Brazil.

Tatá is the name of the animal of this group – a giant anteater<sup>6</sup> – native to Central and South America and one of the species living in the protected area of Pantanal, a wetland region that extends from Brazil to Bolivia and Paraguay. This choice was made based on

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<sup>4</sup> The storm block of the tool triggers a lightning storm on the screen. Characters present on the screen will be randomly hit by lightning strikes, which shows their skeletons for brief seconds.

<sup>5</sup> The name of the shuttlecock used in a traditional indigenous Brazilian sport, of the same name.

<sup>6</sup> In Portuguese, it is called *tamanduá-de-bandeira*; we shortened it to Tatá.

its uncommon look and exoticness. Tatá's design had the biggest number of iterations. It was a challenge to work with its original dark browns and grays, because the other elements had such vibrant colors. We finally decided to create a colorful mane and tail; adding an anklet – a summery accessory, often sold near beaches.

## 2.4 Arguments for and Against each Design Approach

The process of developing the Indian visual elements was fast; but because it didn't originate from a collaborative work and the illustrator based the designs on information gathered online, the designs reflect a somewhat stereotyped representation of India. The choice of elements was perhaps too obvious, fruit of a shallow and distant research: due to the ignorance on our side, we could only rely on accounts found online and our own interpretation of them. Designing these elements posed a challenge because of the moral issues some of them provoked, related to ancient practices that are now being abolished and rethought by the Indian government, in a pursuit for contemporaneity and development. Despite this overall negative self-assessment, the children who experimented with the tool (and whose knowledge of geography is almost inexistent) enjoyed the characters and some could even identify the culture by looking at the them [1].

The process of developing the Chinese elements was slower and involved more collaborative work, which resulted in more thoughtful decisions; however, the final designs still represent clichés. We believe this is mainly due to the influence of Chinese representations in pop culture and visual media that we accessed. These stereotypical representations leave an indelible mark on our collective brain, making it difficult to disassociate certain symbols from the culture and looking further for better and deeper representation. The influence of Kung Fu movies and East Asian games and animation references are visible in our designs. The truth is that the Chinese group was quickly and easily identified by the 3<sup>rd</sup> graders in the preliminary studies [1].

The process of developing the Brazilian elements was much slower than the previous two and involved a much more collaborative approach, as explained above. The insights given by the Brazilian team members changed our perspective on designing the elements: it was no longer about tradition and stereotypes already seen in pop culture; it was about authenticity, contemporaneity and diversity. The visual elements have a more complex relationship with the country they are representing, making the connection less obvious. This may make it more difficult for children to identify the culture being represented; as there is no direct link between these elements and what we would usually see as representing Brazil on mass media – like football, *favelas* or Carnival parades.

## 3 Conclusion and Future Work

The research question formulated in the beginning of this paper brought forward answers that are not definitive nor are they rules easily applied to similar projects. This opportunity for reflection made clear that representing a culture is a delicate endeavor, that will almost certainly leave out important aspects of its identity. We bear in mind that any process of representation of identities, which inevitably simplifies and homogenizes a culture – since

cultures are never unitary in themselves – happens through an alienation of the complexities of the culture [32]. However, it is not within the scope of our project to show an extensive and comprehensive representation of each country's individuality. We aim instead to create story elements that will entice children's imagination and captivate their attention and curiosity, so that they can start a dialogue, and later learn more about the world.

Our research team progressively adopted a creative process based on exploration, collaboration and iteration. This analysis showed that collaborative work is of the utmost importance to achieve satisfactory results. The individualistic approach led to shallow and stereotyped representations, that were achieved in a short period of time and that were easily identified by the children; while collaboration led to discussions and deeper research to support claims, taking longer to achieve the final designs. Still, it was not enough to achieve non-stereotyped representations, because of the natural distance we had between us and those foreign countries. It can be difficult to empathize with the perspectives of individuals from a culture beyond our first-hand experience [33], which can hamper the process of designing for an international target-audience, as well as the process of representing the culture of others.

The key factor, we believe, to creating visuals that are more interesting and connect to their context at other levels is to work with people born and raised in that culture. Research will lead us through traditional and folkloric representations, while people who have a close relationship with the culture will show us different aspects of the country's identity. It results in a more complex representation that asks more of its viewer. However, we have to be aware of a generalization problem, that can happen if we regard a small group of people as being representative of the majority within a culture [33]. To prevent this, we could consult with bigger groups of people from a given culture, to get a wider scope of perspectives and opinions.

Given the purpose of our work – which is to foster the improvement of language and narrative competences, while promoting multicultural awareness through creative storytelling – we need to balance the stereotypical and the new forms of representation. It is important that the children can identify the culture being depicted, while at the same time, being confronted with new knowledge that will entice their curiosity and show them different aspects of that culture. We will continue to strive to attain a model of workflow that allows us to accomplish this goal, repeatedly, with each culture we incorporate in the digital manipulative.

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## APPENDIX VIII

Presentation that accompanied the talk at the 31<sup>st</sup> Conference of the Society for Animation Studies

### Proposal:

#### **How 2D animation helps children learn to create stories using a Tangible User Interface**

##### **Abstract**

This research is part of a Masters' project that consists of developing animations for a Tangible User Interface (TUI) for playful exploration and story creation. The main objective of this work is to analyse if the introduction of animated elements has an impact in the way children use the TUI and how they create stories.

In interactive animations the character is controlled by the player, so the animator's role is to create a behavioral repertoire and the rules that will establish the occurrence of each behavior. Programming these complex behavioral patterns is difficult, and requires that the interactive characters have a limited behavioral repertoire. So, one of the first tasks was to create an interaction tree to define the behaviors for the different elements and the relations between them. From this, we defined the basic animations. Additionally, this research aims at investigating if the limitation of those repertoires affects the creation of narratives, and if so, in which way.

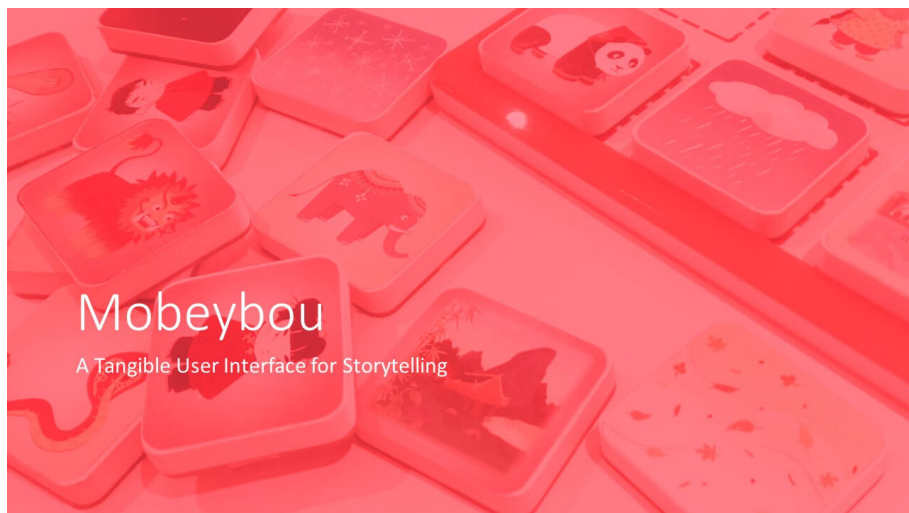
The project follows a user-centered design approach involving several iterations with different focus groups. The first tests were carried out with a paper prototype. A second session took place with an animated version with the basic animation and interaction repertoire. This research is a work in progress and the data collected in the tests indicate that animation is a resource that helps children to create different stories and engage with the Tangible User Interface.

**Keywords:** animation, digital manipulatives, videogames, interaction, narratives.

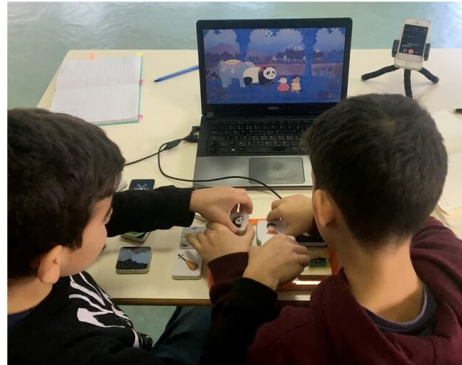
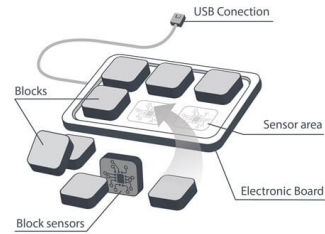


How 2D animation helps children learn to create stories using a TUI

This research is part of a Masters' project that consists of developing animations for a Tangible User Interface (TUI) for playful exploration and story creation. The main objective of this work is to analyze if the introduction of animated elements has an impact in the way children use the TUI and how they create stories.



- set of physical blocks that connect to a computer /tablet and trigger animated responses.



**Mobeybou follows a user-centered design undergoing several iterations.**

Video

Multiculturalism and  
integration through  
storytelling







### • Classic Narrative Model (Propp, 1928/1968)

- binary oppositions

Good vs Evil

Light vs Dark

Hero vs Villain

Initial  
setup



Arise of  
conflict



Attempt  
to solve it



Resolution

- Characters divided in classes
  - a. Relation between classes:
    - Strength
    - Number present
- Protagonist < Antagonist +2
- Prot. + Anim. > Antagonist
- Prot. + Magic Obj. > Antagonist
- Prot. + Musical Inst. > Antagonist
- Animal = Antagonist

Protagonists

Animals

Antagonists



## Conflict | Resolution

- Gameplay setup:
- 1 protagonist x 1 antagonist = antagonist wins



## Conflict | Resolution

- Gameplay setup:
- 1 protagonist + 1 animal x 1 antagonist = antagonist loses



## Conflict | Resolution

- Gameplay setup:
- 1 antagonist x 1 animal = random



# Restricted Action Libraries

Optimizing production pipeline

## Action Libraries | Protagonists

- Optimize production flow
- Protagonists with similar body shapes
- Shared images, meshes and animations



## Action Libraries | Animals and Antagonists

- Unique designs = Unique animations



## Field Studies | Constraints versus creativity

- Does the limited action library affects the way children create stories?
- Does animation has any effects on the use of the digital manipulative?



## Field Studies | First test

- Usability
- Image perception
- Linear construction
- Linear narrative



## Field Studies | Second test

- Interaction time
- Interest
- Engagement
- Embodiment





Video

Conclusion

- Increased engagement
- Increased interest
- Longer interaction time
- Creative stories



# Thank you!

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## APPENDIX IX

### **Multiculturalism and Creativity in Storytelling – Visual Development of a Digital Manipulative for Young Children**

Sá, G., Sylla, C., Menegazzi, D., Caruso, A. P. (2019). Multiculturalism and Creativity in Storytelling – Visual Development of a Digital Manipulative for Young Children. In Proceedings of the Creativity & Cognition '19, San Diego, CA, USA, June 23-26.

# Multiculturalism and Creativity in Storytelling

## Visual Development of a Digital Manipulative for Young Children

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### ABSTRACT

Here, we present the visual development of a digital manipulative that promotes creative storytelling among young children. The tool addresses multiculturalism, by presenting children with story elements from different cultures. We reflected on how to create visual elements that both represent a given culture and foster the children's imagination and creativity. It is key to create eye-catching and imagination-inducing visuals, that can be achieved through an exploratory and iterative process. It is crucial to undertake extensive research to learn about and understand the history and meanings behind each culture, to avoid stereotypes and other representation clichés. Whenever

possible, it is important to involve people raised in each culture in the design process, since their contribution is grounded in real life experience and will translate into valuable insights.

### Authors Keywords

Visual Development, Multiculturalism, Creative Storytelling, Digital Manipulative.

### INTRODUCTION

This paper presents the visual development of Mobeybou, a digital manipulative that uses physical blocks to manipulate digital content and aims to promote creative multi and cross-cultural storytelling among young children.

Digital manipulatives [1], often also named Tangible User Interfaces [2] are physical representations, materials or objects with embedded computational properties that allow interacting with and manipulating digital content. These tools are especially adequate for young children as they provide opportunities for exploratory physical embodiment (through manipulation) [3], collaboration, verbalization, exchange of ideas and negotiation [4].

The design of Mobeybou is framed by theories of embodied and distributed cognition [5, 6]. The role of sensorimotor action in cognition is well established. E.g., Glenberg

explains that “all psychological processes are influenced by body morphology, sensory systems, motor systems, and emotions” [7:586]. Research has also shown that besides the body, cognition is configured by the use of resources (tools, artefacts, materials) and by our interactions with others. These are external to the individuals but they are connected to their thinking [5, 6]. In the field of education, the role of tools, artefacts or objects can be traced back to visionary pedagogues like Friedrich Fröbel [8] and Maria Montessori [9]. Further, the intimate relation between tools, materials and human cognitive processes is undeniable, as detailed by [10:ix]: “Creativity is a practical as well as a conceptual process: how and what we create has much to do with the tools and materials we have available, and what we make of and with them”.

### STORYTELLING

Storytelling is one of the most powerful tools for children to communicate their creativity, providing opportunities for creative thinking [11], socio emotional development and social interaction [12]. Stories offer children a “nourishing habitat for the growth of cognitive, narrative and social connectivity” [11:8], having the potential to promote children's curiosity about the world as well as their acknowledgement and acceptance of diversity and empathy as they are introduced to unknown characters, to their lives

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and inner motives and feelings [11]. By providing a gateway to the minds of others, their emotions and experiences, stories help children to create their own identity [11]. “storytelling brings to the listeners heightened awareness – a sense of wonder, of mystery, of reverence for life” [13:17].

With Mobeybou children become narrators by doing. The use of blocks implies a natural use of the body, as the children use their hands, but also their eyes and ears, to grasp, sort, divide, arrange and place the physical input devices (blocks), while manipulating the digital content and collaboratively forging new ideas. The story creation combines moving images, sounds and music with verbal language. The manipulation of the blocks stimulates children to explore different possibilities, encouraging them “to try out multiple alternatives, shift directions in the middle of the process, to take things apart and create new versions” [14].

#### DESIGNING A TOOL THAT ADDRESSES THE DEVELOPMENT OF THE NEW 21ST CENTURY SKILLS

In recent years, there has been a strong claim for a change in educational policy and curricula in order to prepare young citizens for the demands of the 21st century society. Creativity, communication and collaboration skills have been identified as fundamental competences for overcoming cultural, geographical and language boundaries in the superdiverse society [15]. Creativity has been considered one of the most important skills to overcome difficult situations and problems. [10:ix] defines imagination as the ability to bring to

mind things that are not present to our senses, differentiating between creativity and imagination. “Creativity is a step beyond imagination: it is putting your imagination to work” [10:ix]. Far from being a special gift, creativity is collaborative, as “creative thinking almost always builds on other people’s ideas” [10:ix]

Mobeybou aims at stimulating children’s imagination and creativity in their storytelling. The collaborative handling of the story elements, which is potentiated and supported through the manipulation of the physical blocks (input devices), provides opportunities for starting a dialogue with peers, teachers and family, and to learn about other countries and their cultures, while practicing oral and narrative competences, as well as negotiation and cooperation skills. Moreover, the digital manipulative provides a collaborative storytelling environment where children are exposed to new concepts, which they can later explore beyond the experience provided by the tool.

#### CULTURE AND CULTURAL REPRESENTATION ON MEDIA FOR CHILDREN

Culture has been defined as including “the thoughts, behaviors, languages, customs of a society as well as the things it produces and the methods used to produce them” [16:2]. Media targeting children, such as television, books, video games or apps are privileged channels to communicate cultural knowledge [16, 17]. Through a careful selection of stories, children can be exposed to a range of ideas, customs, and beliefs which are new to them and different from their own. Stories and storytelling can be



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#### A - India and China

Top: the India group is composed of Meera and Rajesh, Hati - the elephant, Nagi - the dangerous snake, a pungi (instrument) and a pair of jutti shoes (object).

Bottom: the China group is composed of Ju Long and Xiao Li, Gugu - the giant-panda, Nian - the fiery lion, a pipa (instrument) and a fan (object).



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**B - Brazil**

Exploratory sketches and iterations of Kauê and Iara's characters.

The Brazil group is composed of Kauê and Iara, Tatá - the giant anteater, Mumu - the crazy boi-de-mamão, a berimbau (instrument) and a bambolê (object).



powerful means to teach children to accept difference and view it as a natural way of being in the world [18]. Besides, due to the today's superdiverse society [15], there is a demand for an "increased sensitivity to cultural differences, openness to new and different ideas" [19:7]. Therefore, multiculturalism is of the utmost importance in today's education.

### DESIGNING FOR MULTI AND CROSS-CULTURAL ACCEPTANCE

When designing visual elements that are representative of a given country and its culture, it is important to be aware of and avoid stereotypes, as these representations have the potential to strongly influence viewers [20]; so being mindful of the culture and understanding what is being represented is paramount to ensure proper cultural representations. However, it can be difficult to empathize with the perspectives of individuals from a culture beyond our first-hand experience [21]. Any process of representation of identities, which inevitably simplifies and homogenizes a culture – since cultures are never unitary in themselves – happens through an alienation of the complexities of the culture [22]. We acknowledge it is beyond the scope of this work to create a comprehensive portrait of a given country/culture. Instead, in our development, we focus on creating story elements that have the potential to entice children's imagination and captivate their attention and curiosity, so that they can start a dialogue, and later learn more about the world.

### DESIGN OF THE TOOL

Mobeybou follows an iterative and participatory design methodology, involving children and teachers along its development. It aims at scaffolding young children's ideas to create digital stories by manipulating physical representations of story elements. The digital manipulative intends to move beyond creativity processes based on individual, mental imaginary [23], transforming storytelling into a multimodal (visual and auditory) embodied (through manipulation) collaborative process.

Up until now, we have developed three sets of blocks, representing the cultures of India [A], China [A] and Brazil [B]. Each set is composed of seven elements: two protagonists (a boy and a girl), an animal, a mythical creature, a landscape, a musical instrument and a magical object. All elements are representative of native components of the country or are inspired by the folklore, traditions or mythology of the culture. There are also general elements that represent atmospheric conditions (rain, snow, thunder, wind), which help set the mood for the story and also trigger little comedic moments, meant to be surprising and entertaining for the users [1]. The children can mix and match the various elements from the different cultures to create unique stories of their own. The experience of intertwined cultural elements potentially promotes multiculturalism, as children visualize how rich – both visual and content-wise – the intercultural experience can be. In the following section we provide a detailed description of the tool.

### MOBEYBOU'S FUNCTIONING

Mobeybou promotes the development of a familiar relationship with visual elements of other cultures that might be unknown to the children. It also allows children from different cultures and backgrounds to create and share their own stories, thus creating a visual window to their world, which facilitates communication, develops social competences and increases the awareness of multiculturalism.

Presently, Mobeybou is composed of an electronic board and various sets of physical blocks that act as an interface for manipulating the digital content. The board connects to a computer or tablet via USB or Bluetooth. Each block (4,5x4,5x1cm) has the respective visual representation on the upper face. Placing a block on the board triggers its digital representation on the device's screen. When a block is removed from the board it disappears from the screen. (See the next page for a summary of these interactions and interface components.)

All the elements have specific animations that display different actions. Additionally, there are ambient and background sounds. The visual narratives unfold according to the combination of blocks that the users place on the board while they verbalize their stories. A recording button allows recording/playing children's creations.

Except for the landscapes [J], (which set the stage for the narrative) and the atmospheric-blocks [I] (rain, snow, wind, rainbow, thunder, night), all the elements behave according to a set of rules and constraints that define their actions and the relations to the other active elements (elements on the board). In their story creation with Mobeybou, the children

are incentivized to find creative solutions for the situations that unfold by attending to these rules and constraints, which they therefore need to infer and understand. The underlying constraints are given by the following rules: the antagonists attack the protagonists and the animals [C]; the animals can fight the antagonists back; the musical instruments and the magical objects have magical properties that help to resolve conflicts and can only be used by the protagonists; when an active element is defeated, the physical block needs to be lifted and placed again on the board, in order to bring it back to life. (See the next page for a summary of these interactions and interface components.)



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### C - Interactions between characters

Animals and antagonists have special attacks: Nian spits fire, Nagi strikes and bites, Mumu charges like a bull, Hati shoots flowers from his trunk, Gugu rolls up in a ball and hits, Tatá sticks out his tongue to attack.

## Character Interaction

## Idle state

Among characters of the same category



or of friendly categories (animals and protagonists)



## Protagonist vs Antagonist

Number of Protagonists < Number of Antagonists + 2  
Antagonists attack and win



Number of Protagonists ≥ Number of Antagonists + 2  
Protagonists scare the antagonists



## Protagonist with Instrument or Object

The object's effect neutralizes any conflict on screen, independently of which or how many characters are present



The protagonist makes everyone dance by playing an instrument, therefore neutralizing any conflict



## Animal vs Antagonist

Number of Animals = Number of Antagonists  
Randomly, one of them attacks and wins



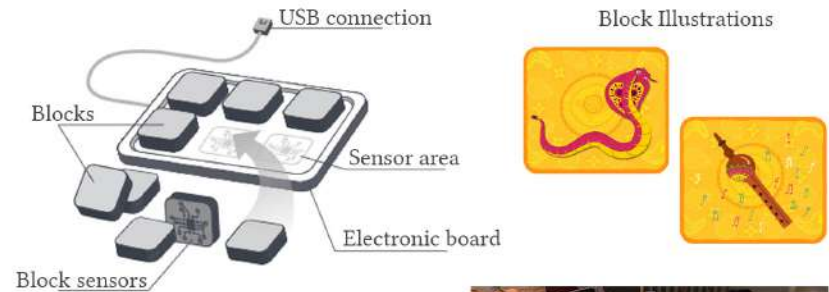
Number of Animals > Number of Antagonists  
Animals attack and win



Number of Animals < Number of Antagonists  
Antagonists attack and win



## Interface Components



This photo, taken by teacher Michael Skøtt Jensen, during a user test session in his class, in a primary school in Denmark (March, 2019) shows the USB-connected electronic board, the Mobeybou blocks and the image they triggered on the computer.



The combination of blocks on the left will cause the interaction depicted below to appear on the screen - with the Chinese landscape as background, Ju Long uses the shān zi to scare off Nian.



### THE VISUAL DEVELOPMENT PROCESS

One of Mobeybou's major goals is to stimulate children's imagination and creativity in their storytelling. Always being careful about cultural representation, we thoughtfully created interesting visual elements, which were animated to interact with each other according to predefined rules. These visual elements open the door to intriguing worlds, potentially immersing the users in the story world. To achieve a high level of immersion, the visual narrative elements should feel familiar (so that children can easily empathize with them), yet intriguing and reminiscent of a fantasy world. Additionally, the content should be tailored to young children, as they are our target audience.

The development of each group started with an extensive research about the country and its culture. Prior to the development of each cultural element, the illustrator carried out a comprehensive investigation assessing various materials and sources. She gathered cultural background information as well as visual information, which served as a basis for the design of each element (See the next page for an example of a Moodboard with photo references). As we moved further along the development of the story elements, we progressively adopted an explorative and iterative design methodology. Outgoing from her research, the illustrator started by creating a series of sketches that she then presented to the design team. Together, they narrowed down the options until a final design was reached. The team mostly discussed small details, like color variance, different hairstyles or pattern choices based on the aesthetic appeal of each image and its degree of representation of the given culture. This iterative design process resulted in a considerable number of sketches (a single element can go through

dozens of iterations before it reaches its final form) but allowed to make conscious decisions based on several options. The process of developing the first group of elements – the Indian visual elements [A] – was relatively fast; the illustrator worked alone and based the designs on visual and cultural information that she gathered through online research [24]. The second cultural group to be developed was China. We are aware that the visuals of China [A, D] may still represent clichés, mainly due to the influence of Chinese representations in pop culture and visual media that we accessed. These stereotypical representations leave an indelible mark on our collective brain, making it difficult to disassociate certain symbols from the culture [24].

The development process of the Brazilian elements [B, G] – the last and third group – took considerably more time than the previous two. The presence of two Brazilian team members informed the design of those elements. Therefore, the visual Brazilian elements have a more complex relationship with the country that they are representing, however, this may create a less obvious connection between the characters and the country/culture that they represent [24]. In order to provide the children with elements that activate their imagination and creativity, we opted for a visual style that is not too realistic but that will be recognized by children that are familiar with mainstream animated content. The users can easily identify the visual language of simple shapes and bright colors of our digital art as being reminiscent and in accordance to mainstream hits like Dora the Explorer [25] and other similar cartoons. Stepping away from realism intends to invite the children to a world of play and of make believe.

However, we avoided over-stylization, as it is important to leave enough detail, so that

the cultural identification is not confined to a single flat symbol intended to represent an entire culture.

To help guide the user through the story elements, there are visual cues that unify

all the elements from a given culture. The repetition of patterns and a consistent color scheme helps the user identify each group (culture) as a whole, without constraining the mixing of elements from the different groups.



D - Gugu design iterations

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E - Moodboard and photo references

## CHARACTER DESIGN

In the following section, we present the rationale behind the visual development of the story elements.

## THE PROTAGONISTS

The protagonists are humans with friendly features, which allows children to easily identify with them. Their design is cartoonish in proportion – their head is almost half their height [B, F] – and there is a prevalence of round features, which are more appealing to audiences and generally make the characters be perceived as being friendly; in opposition to angular shapes, which are usually associated with wicked, evil or mischievous characters. These associations come from nature, where rounded shapes tend to be safe (flowers, fruits) and angular shapes (thorns, fangs) require caution. The instinctive reaction that the audiences have to these visual shapes is based on the sense of touch and, while this sense is not present in visual art, the viewers tend to apply their real-life experiences onto similar shapes [26].

## ANIMALS

The animals are portrayed as friendly creatures that will help the protagonists in case of danger. Their general shape and proportions are very close to that of a real animal, but they are all embellished with elements from the culture to which they belong. Elephants have long been revered in India and so we chose to include them in the story world. Hati [F], the Indian animal, is an elephant whose design was inspired by the decorated animals of the Elephant Festival in Jaipur. For the Chinese animal, we considered several options, such as the golden snub-nosed monkey, the binturong and the tiger; however, our final choice was the panda [D]. This decision was

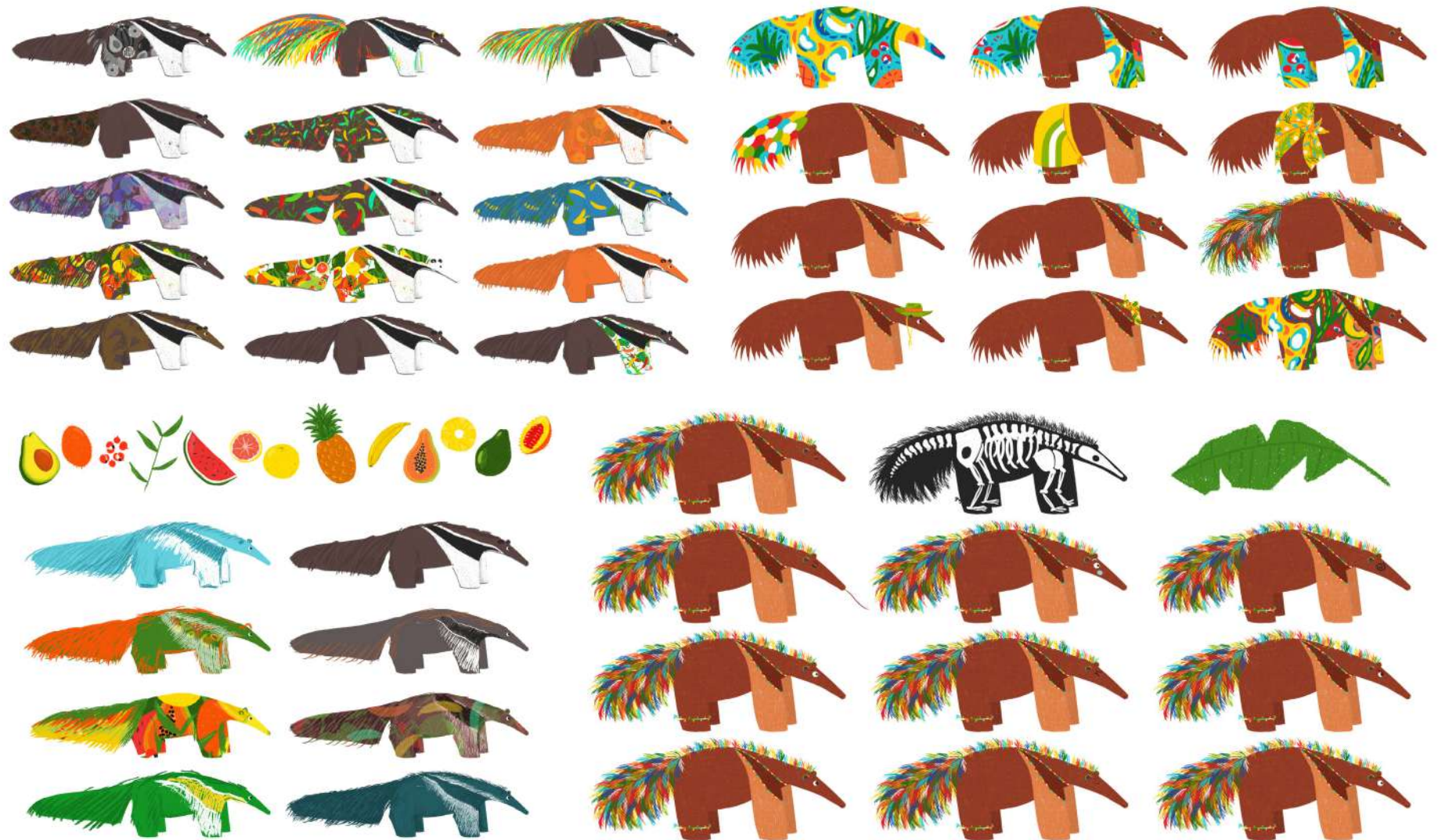
motivated by various reasons: the panda is a native Chinese animal, exclusive to this country (except for the pandas living in captivity in international zoos); it is loved and known world-wide; its conservation status is vulnerable at the moment, and so awareness for its preservation is important for its survival in the wild; it is easily and quickly associated with the Chinese country and culture by audiences everywhere due to mainstream hits like, for example, the Kung Fu Panda trilogy [27, 28, 29]. Finally, pandas' round physiognomy and four-legged stance facilitated the animation process, also allowing to create interesting and funny reactions, e.g. it transforms into a ball when attacking an opponent. Tatá [G], the animal of the Brazilian group – a giant anteater native to Central and South America and one of the species living in the protected area of Pantanal, a wetland region that extends from Brazil to Bolivia and Paraguay – was chosen due to its uncommon look and exoticness.



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F - Character design exploration





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## G - Tatá

Exploratory sketches and iterations of Tatá's character, the Brazilian giant anteater.

### ANTAGONISTS

The design of the antagonists [H] was inspired by the mythical – and often scary – creatures of each culture's folklore, traditions and myths. Their design has to convey an air of menace, but still be visually appealing to children. The Chinese antagonist is Nian, a fire-spitting red creature, that resembles the flat-faced lion statues guarding Chinese Buddhist temples, as well as the papier-mâché costumes of the traditional lion dance. Nian's development was inspired by a legend that explains the beginning of Chinese New Year traditions. This choice was later validated with a group of researchers from the Confucius Institute at the University of Aalborg (after seeing the character design, they immediately identified it as Nian, the legendary Chinese figure). The Indian antagonist Nagi was based on the legend of nagas, who are semi-divine beings of Indian mythology that can shapeshift between human and serpent form. The Brazilian antagonist is Mumu, the boi-de-mamão – an ox character from oral Brazilian traditions, who dies and is reborn. In our colorful design, there are no legs visible under the cloth that constitutes the body of the



### H- Antagonists

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Exploratory sketches and final designs of Mumu. Some of Nian and Nagi's poses and expressions.

character, so it looks like it floats. However, when it is hit by a lightning strike (when users place the thunder-block), it shows the skeletons of people underneath the costume; referencing the origin of the character as a papier-mâché costume used by dancers in several religious festivals.

### OBJECTS AND MUSICAL INSTRUMENTS

The objects and the musical instruments have magical properties, and can be used by the protagonists to resolve conflicts. These elements are depicted fairly realistically, but when placed on the board, the user sees their magic unfolding on the screen – the Indian shoes (juttis) make the characters float; the Chinese fan (shānzi) creates a tornado; the Brazilian hula-hoop (bambolê) fires confetti [1]. These magical effects can also inspire the children to create a story around them.

### THE LANDSCAPES AND THE ATMOSPHERIC-BLOCKS

The landscapes [J] aim at setting the stage for the narratives, and open the door to a magical world, transporting the children to distant places. Similar to the design of the other elements, in our visual development of the landscapes we avoid representing clichés that depict the most famous monument or landmarks. The landscapes themselves invite to the process of storytelling, hinting at cultural artifacts or native landscapes of the country they represent. This can potentially engage the users in a deeper way, triggering their imagination about stories that can unfold in such environments. The atmospheric-blocks [I] (rain, snow, wind, rainbow, night, thunder) allow to further enrich the setting. However, their use may generate unexpected visual reactions, for instance, after being active for a while, the rain-block will cause a flood, the snow block will freeze the screen after a while and the thunder-block will randomly hit the characters present on the scene.

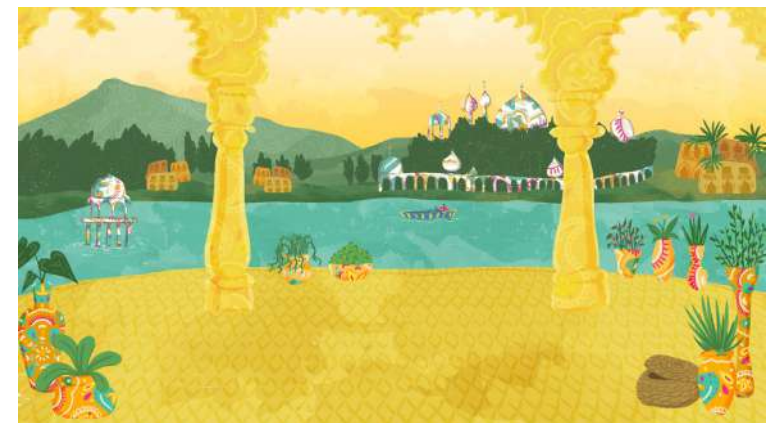


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### I - Effects

First column: snow; flood; lightning; bambolê firing confetti.

Second column: Mobeybou blocks; frost; children trying out the interface.



## SUMMARY

In this paper, we have presented the visual design process of a digital manipulative that aims at promoting children's collaborative multi and cross-cultural story creation. We reflected upon the question of how to create interesting visual elements, that justly represent a given culture, while fostering the users' imagination and creativity in their storytelling. Along the design process, we became aware that representing a culture is a delicate endeavor, that will almost certainly leave out important aspects of its identity. However, careful consideration, comprehensive research and collaborative creative processes can contribute to developing appealing visuals that may trigger children's imagination and creativity for their storytelling. If a story is also able to promote diversity, acceptance of others and curiosity about the world, it truly becomes a powerful way to understand and share life.

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## J - Landscapes

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Above: exploratory beach landscape for Brazil.

Right: final design for the Brazilian landscape, depicting the Amazonian forest and typical palafitas - the wooden houses on the river; China landscape; India landscape.

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