

A Digital Manipulative for Embodied “Stage-Narrative” Creation

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Abstract

This paper presents a study of the use of a digital manipulative developed to promote creative narrative construction and storytelling. The study was carried with 27 groups of preschoolers, of five years of age, who interacted with the digital manipulative during free-play time, during a period of six months. The study sought to access aspects of children’s embodiment of the narratives, and how they shaped the creation of stories. We observed that by using the digital manipulative, children’s narrative construction occurred in two levels, as children shared the stage, (controlling the characters, the location, the props, and the nature elements) and simultaneously performed on this stage. The sharing of the input devices (blocks) gave children equal control of the performance and orchestration of the story, while promoting and supporting peer collaboration. We conclude that the digital manipulative enables the performance of what we call embodied stage-narratives, promoting children’s imagination and creative thinking, as well as fostering early literacy skills and metalinguistic awareness.

Keywords: Storytelling; Narrative Performance; Stage-Narratives; Tangible Interfaces; Digital Manipulatives; Learning; Oral Expression, Emergent Literacy; Preschoolers.

1. Introduction

The development of the language is among the major challenges that young children face during the preschool years. Language develops primarily to communicate with others, and through the interaction with others, in a process that is essentially social and interactive (Snowling & Hulme, 2009:103), while at the same time mediating learning, and being a tool to organize the world (Bruner, 1966:6). Language empowers children to express themselves, to communicate with others and to participate actively in educational activities (Bruner, 1966; Van Scoter, 2001:8; Vygotsky, 1962).

Storytelling is an acknowledge dimension of linguistic development in childhood, and it is also considered a key dimension of cognitive and affective development (Bruner & Haste, 1988; Eagle, 2012). Moreover, storytelling provides opportunities for social interaction (Speaker, 2004) and innovative thinking, and offers children a “nourishing habitat for the growth of cognitive, narrative and social connectivity” (Paley, 2004:8). In this study we sought to access the kind of involvement that a digital manipulative, can offer for the construction of narratives, focusing on children’s embodiment of their narratives, as we assumed that embodiment is directly related with children’s involvement and immersion in the performed task.

2. Language Development through Narrative

Storytelling has the status of a privileged discourse format, however it is part of the “domain of language use, and narrative development is a subcomponent of language development” (Bamberg, 1997:65). From a constructivist and constructionist point of view, language provides “the building blocks” and narrative is the domain in which these blocks are assembled together creating new experience and knowledge (Bamberg, 1997: 86). Certainly, due to their linguistic structure, and

children's emotional bond with stories, stories are a privileged means for the development of language abilities.

Studies on children's early exposure to narratives have disclosed that hearing or telling stories has a major influence on the development of children's early literacy skills, being a creative and playful way of linguistic exploration (Collins, 1999; May, 1984; Paley, 2004; Speaker, 2000, 2004). At the same time stories offer a "memory framework", namely, the ability to remember and effortlessly analyse new stories, providing anticipation of information, which helps children to understand new stories and retell them (May, 1984), which in turn helps to construct meaning, and facilitates the creation of new stories (Morrow, 2005).

In fact, retelling or creating stories implies a mental reconstruction of the story events, which fosters the development of metanarrative consciousness (Brown, 1978), and the emergence of more advanced language skills, enhancing grammar, vocabulary, and sentence formation (Speaker, 2004). Confirming that vocabulary and syntactic complexity in oral language are more advanced in children who are frequently exposed to a variety of stories (Speaker, 2000).

Moreover, storytelling is a social activity (Britishch, 1992; Paley, 2004), which helps children to develop their ability to imagine alternative possibilities and work out their implications, while learning to handle contributions made by their peers, and responding to them adequately (Harris, 2000). Definitely, the importance of narratives goes beyond developing language abilities, encompassing other developmental dimensions. Unquestionably, stories help children to create their own identity, providing a gateway to the minds of others, their emotions and experiences, offering children a model and a mode to project, handle and ultimately helping them to solve own existing conflicts. As such, narratives help children to clarify their emotions, anxieties, fears and aspirations (Paley, 2004; Cooper, 1993; Engel 1999;

2005; Wright et al., 2008), offering a safe place to confront and explore their worries and insecurities.

2.1. Children's Creation of Narratives

At the level of the discourse, narratives are for children by far, more demanding than the discourse they use in daily life, presupposing the use of the past tense and a more elaborated and structured language, implying decontextualized use of the language, as the narrator always places himself at a distance from the related events (Dehn et al., 2014). As suggested by Van Scoter (2008:154) a good way of helping children to construct their stories is through the use of props; while it is common to use verbal props to foster the structured flow of a narrative, objects can also act as elements that foster creativity and learning. Van Scoter (2008:154) proposes using props for dramatic play, and Paley (1991, 2004) approaches children's language and thought development through the dramatic play of children's narratives.

2.2. Narrative Performance

The fictional nature of stories provides the ideal territory for exploration and experimentation, the use of the *magic words*, "Once upon a time..." or "A long time ago..." place stories in an imagined time and space. Similarly to a theatre performance (Burke, 1945), where agents act upon a stage, encompassing particular social interactions (Goffman, 1959), narrative performance (Langellier & Peterson, 2004; Langellier, 2003; Todorov, 1977), is essentially an act of embodied communication (Madison & Hamera, 2006; Peterson, 2009), constructed and negotiated with others (Bamberg, 2014), acting as social mediator, while helping to structure the self and understand the world (Bruner, 1966, 1991; Collins, 1999; Bamberg, 1997).

2.3. Meaning Making through Embodiment

The extent to which embodiment shapes our understanding of the world has been extensively investigated by Embodied Cognition, which has highlighted that our bodily experiences are the basis of all cognition, and that even higher cognitive processes ground on embodiment (Johnson, 1987; Lakoff & Johnson, 1999). As (Barsalou, 1999; Barsalou et al., 2003) explain, the body is deeply involved and plays a central role in human cognition, and “all psychological processes are influenced by body morphology, sensory systems, motor systems, and emotions” (Glenberg, 2010: 586). In the field of tangible computing, embodiment refers to the kind of interaction used to manipulate digital content by using physical objects (Ainsworth, 1999). Indeed, instead of placing the emphasis on the tool itself, the interaction provided by tangible interfaces focus primarily on the manipulation of the objects (O’Malley & Fraser, 2005; Ishii & Ullmer, 1997; Ullmer & Ishii, 2001), facilitating understanding and meaning making.

Research in the field of Child Computer Interaction has investigated the connection between body and mind, how the bodily experience is involved in meaning making (Antle, 2009, 2013; Hornecker, 2005; Hornecker & Buur, 2006), and how body position, gaze and access to interaction shapes multimodal action flow (Price & Jewit 2013). According to Ackermann “Tools, media, and cultural artifacts are the tangible forms, or meditational means, through which we make sense of our world and negotiate meaning with others” (2004:15).

3. A Digital Manipulative for Creative Stage-Narrative Construction

3.1. Motivation

Discussions about the use of technology in the classroom have disclosed how technology often fails to exploit the affordances of the medium, by merely

transposing traditional learning materials to the corresponding electronic format (Plowmann et al., 2012:5,6). In fact, while it is widely recognized that technology can have significant impacts on learning in early education (Van Scoter, 2008:158; Voogt, 2008), there seems to be a lack of well-designed materials, as well of studies that investigate the role of digital media in early education (Plowmann et al., 2012:2). Moreover, studies involving children less than eight years of age are even more rare (Kamil & Intrator, 1998; Kamil et al., 2000; Lankshear & Knoebel, 2003; Yarosh et al., 2011).

Exposing children to rich contexts and situations stimulates their natural need for exploration and discovery (Van Scoter et al., 2001:8), offering an enormous opportunity for the development of pedagogical materials that target learning in the early years. Well-designed technology has the potential to create rich environments, providing challenge and adventure, while encouraging exploration and imagination (Van Scoter et al., 2001:12; Plowmann, 2012; Resnick et al., 2005). Indeed, technology has the potential to provide new experiences and interactions that go beyond what is possible in the real world (Van Scoter et al., 2001:9).

Aiming at contributing to a deeper understanding of the educational value provided by the use of digital manipulatives in preschool, we developed a digital manipulative for tangible narrative creation. The choice of narratives was motivated by the fact that narratives are a privileged mean for targeting personal and social development as well as the development of language and communication dimensions, which we together addressed in our study.

3.2. Design and Development

The design and development process of the interface extended for a period of three years, involving various classes of five years old pre-schoolers and their teachers (Sylla, 2013a, 2013b; Sylla et al., 2011). Although the teachers were always the same, the researchers worked every year with the children from the class attending the last preschool year, just before entering primary school the year after.

From the conception to the development of the final product, several design iterations were carried with the children, in which the research team tried to understand how to design an engaging and compelling tool, where children could play and experiment with story elements, creating their own narratives as “players rather than spectators” (Bruner, 1966:95).

During this period the design underwent multiple iterations, and the feedback provided by the children and the teachers was incorporated in the development of several prototypes, always following a cyclical process of developing, testing and redesigning (Barab & Squire, 2004; Cobb et al., 2003). The final interface elaborates on the feedback received during the various iterations. While it is beyond the scope of this article to give a detailed description of the development process, we will shortly present some relevant insights that informed the design of the final system. One of the prototypes used to access how children create narratives was an A4 paper cardboard and a set of cards with drawings representing characters, places and actions (fig.1). As we observed the children placing the cards in rows on the paper platform it was visible that they were concerned with the cards’ alignment, which suggested that a functional platform needed slots to place the cards, thus facilitating children’s task, while offloading extra cognitive processes, as children would not have to worry about alignment issues.



Figure 1- Children creating stories with the paper prototype.

Relatively to the size of the platform, we observed that some children felt compelled to fill the complete cardboard with the cards, clearly showing the need to reduce the size of the final interface.

As the children used the space differently - some began to place the cards on the top left side, others on the bottom right side, others placed the cards on the middle of the platform, and some used the space as a drawing (fig.1) - the system needed to identify: the content of each card, its location, and the order each card enters the system. So that users could randomly place the cards on the platform, jumping back and forth as they created their stories, without having to follow any determined order. Additionally the system needed to support connections between cards, or groupings of cards.

Building on the idea of using picture cards, we chose tangible blocks for defining and manipulating the story elements. Blocks are simple, intuitive objects, familiar to every child, easy to handle, manipulate and store, and a very natural mean to support complementary strategies (Antle et al., 2011; Kirsh, 1996). A complementary strategy is “any organizing activity, which recruits external elements to reduce cognitive loads” (Kirsh, 1995:212). Additionally, blocks allow multiple users to simultaneously manipulate the content, supporting peer collaboration, and “facilitating communication and “transparency” of interaction between multiple collocated users” (Ullmer & Ishii, 2001:12), providing “multiple access points” (Hornecker, 2005).

The design of the interaction followed three development principles: visibility, rapidity and reversibility of actions (Schneiderman & Plaisant, 2004). Following these principles, the tangible blocks make the interaction explicit and open (Hornecker, 2005; Ullmer & Ishii, 2001); give rapid feedback of the performed actions (placing a block on the platform immediately displays its digital content) and every performed action is reversible by simply removing the block from the platform, a feature particularly relevant for content exploration (Hourcade, 2008).

3.3. TOK- Touch, Organize, Create

The final interface (Sylla et al., 2013a), which we named TOK (Touch, Organize, Create), is a collaborative digital environment, which offers young children a playful and rich environment, for embodied collaborative language exploration, experimentation and tangible narrative creation. The system is composed by an electronic platform, and a set of 23 picture-blocks, which represent scenarios, characters and objects from familiar stories.

The surface of the electronic platform has slots for placing the picture-blocks. Both, the backside of the blocks and the electronic platform have magnets on their surface that correctly snap the blocks to the platform, making it easy to place the blocks, while simultaneously assuring a stable contact between the blocks and the platform (fig. 2).



Figure 2 - Children interacting with the system; block, front and backside (bottom right).

Each block has a sticker with a picture of what it represents on the upper side and a conductive pattern on the backside that is detected by capacitive sensors on the platform, providing the system its identification (fig. 2 bottom, right). Placing a block on the platform displays the corresponding digital content on the computer

screen, creating a direct mapping between input and output; the sequence of blocks placed on the platform unfolds a narrative.

Following suggestions from the teachers the blocks represent classical scenarios and actants from children's narratives (basically, heroes and opponents (Greimas, 1973, Propp 1928/1968), comprising characters, objects and nature elements (fig. 3). The familiarity of the characters allows recreating narratives, variations from the original stories, or simply to create completely new stories.



Figure 3 - Some of the characters and objects.

Five different scenarios (a castle landscape, a forest, a desert, the woods and a circus) allow locating the stories in different settings, and a block with the moon, allows transforming the day into night or the other way around (fig. 4 bottom right).





Figure 4 - Different scenarios to place the stories, and scenario placed together with the moon, which makes the night appear (bottom right).

The story world was modelled through behaviour trees (BTs¹), a concept well known in the field of computer games to model character behaviour, reactive decision-making and control of virtual characters. BTs describe general actions of entities, thus each entity interacts with the environment according to a set of predefined rules that define its behaviour. Since the behaviour triggered for each entity depends on the other entities that are also present in the scene, and the properties of those entities, for instance the level of health, there is a certain degree of unpredictability in the outcome of a given situation.

The principle followed in the design of the BTs was to model a world that would be understandable for young children, by creating a set of rules that they know from traditional story plots. There are four types of entities: scenarios, elements, objects and characters. Scenarios represent the background image where the action occurs; the elements (day, night and wind) interact with the objects and the characters bringing a dimension of change to the story.





The objects and characters are classified in good, bad or neutral; bad characters attack the good ones, good characters defend the neutral and help each other; both good and bad characters can join forces to defend themselves or attack their opponents. Specific objects like the caldron or the flowerpot can be used to

¹ <http://www.cg.cis.upenn.edu/hms/research/PAR/docs/refPAR/cavazza02interacting.pdf>

knock down bad characters. A bad object (poisoned apple) diminishes the health of a character, and a good object (carrot) increases it.

When the users place the blocks on the platform, the BT gets the inputs of the entities that are present (we will refer to the blocks placed on the platform as the state of the world). Regularly at a predefined time stamp the BT performs updates about the state of the world, and checks the defined priorities before triggering any actions. We will illustrate this with an example: a little pig is alone on the scene, where it is on idle behaviour; as soon as a second block is added to the system, the pig's BT detects the new entity and triggers the little pig's behaviour. If the second block represents a character classified as good or neutral both characters will interact, for instance, by playing together (table 1).




Table 1- Behaviour tree of a pig.

Entities (blocks placed on the platform)	Behaviour (result on screen)
	Idle
	Play together
	Pig tries to escape, runs
	Pig tries to hide inside the house

On the contrary, if the added block represents a bad character, for instance the wolf, the little pig will try to run away. On his turn, the wolf, as it detects a little pig, attacks. The result on the screen is an animation of a wolf chasing a little pig, which tries to escape. Now, suppose a block of a house is added to the platform, the little

pig's BT detects that there is a shelter, so the pig tries to reach the house to hide inside. Assuming the little pig manages to do it before the wolf catches him, the wolf will try to blow the house away (tables 1,2).

Table 2- Behaviour tree of the wolf.

Entities (blocks placed on the platform)	Behaviour (result on screen)
	Idle
	Attacks
	Attacks, if pig reaches the house wolf tries to blow the house away

As a result, there are no predefined stories, nor a linear narrative. The users create their own narratives according to the sequence of blocks and the order in which they place them on the platform.

3.4. Related Work

3.4.1. Digital Manipulatives for Storytelling

Approaches addressing the structure of the language and the construction of narratives have resulted in the development of various interfaces for storytelling. Some examples are StoryMat (Cassell & Ryokai, 2001; Cassell, 2004) a play mat with sewed objects where children can play using stuffed toys. The gestures and the story told by the child on the mat are recorded and then compared with stories from

children that have previously played on the StoryMat. The story with a similar pattern is then recalled and played, acting as inspiration for the creation of new stories.

TellTale (Ananny, 2001) resembles a worm with a body of five pieces and a head. Children can record audio into each part of the body, and hear it by pressing a button. The pieces are independent of each other, can be randomly sorted and rearranged, and a new story can be created at any time.

Cassel (2004) investigated the role of “story-listening systems” in supporting emergent literacy, focusing on the importance of emergent literacy attitudes, and the potential of technologies that encourage active instead of passive use. Among other interfaces she carried studies with TellTale and StoryMat.

Similar to TellTale, t-words (tangible words) (Sylla et al., 2012, 2013b; Chisik et al., 2014) (fig. 5 left) consists of a set of rectangular blocks, which can be used to playfully engage with sounds and words, mediating children’s oral expressions in novel ways (Ackermann, 2001).



Figure 5 - t-words (left), and Jabberstamp (right) reproduced from (Raffle et al., 2007).

The system has two functions, one enables users to record and store audio; the other enables them to play the recorded sounds, by snapping the recorded blocks together. Reordering the blocks changes the played audio sequence, allowing

exploring different sound and speech combinations and eventually fostering reflection over the language.

Jabberstamp (Raffle et al., 2007) allows children to enhance their narratives by adding sounds and voices to their drawings (fig. 5 right), by pressing a special rubber stamp on the paper sheet users are able to hear their recordings.

Make a Riddle and TeleStory (Hunter et al., 2010) are educational language-learning applications developed for the Siftables² platform. Make a Riddle teaches children spatial concepts and basic sentence-construction skills; TeleStory teaches vocabulary and reading through the manipulation and combination of story elements, such as a cat and dog, that live in a fanciful land.

Although each system addresses storytelling differently, they all have shown to positively influence and stimulate children's natural aptitude to involve in creative narrative construction. TOK differs from the above-presented systems, as the narrative unfolds according to the sequence of blocks placed on the platform. Indeed there are no predefined stories, and the narrative depends on the combinations of blocks placed on the platform, a characteristic that sets the interface apart from other tangible storytelling systems. The unpredictability of the story outcome creates a whole world with which children can interact trying out and exploring different situations and outcomes.

4. User Study

Following the development of the digital manipulative and in order to access its potential to engage children in the creation of narratives we carried a study with two pre-school classes.

² http://www.ted.com/talks/david_merrill_demos_siftables_the_smart_blocks.html

4.1. Context

The study allowed a natural and holistic approach (Miles & Huberman, 1994), as it took place within children's learning context. The preschool follows the High-Scope Curriculum, a constructivist model, developed in the 1960s (Schweinhart & Weikart, 1991), which is based on active participatory learning through hands-on experiences (Piaget, 1952; Piaget & Inhelder, 1969; Papert, 1993). The study was carried during children's free-playtime, involving 27 pairs of pre-schoolers aged five, during a period of six months. Free-playtime takes place everyday in the beginning of the afternoon and goes for around 45 minutes, during which children can freely play in four different "activity areas", (house, constructions, library and computer). The interface was set in the computer area, and according to the classroom rules the children could use the manipulative in pairs of two as long as they wanted (within the 45 minutes of the free-playtime period); when they finished, another pair could use the interface. Additionally a set of printed cards was created with the 23 pictures represented on the blocks, which was available in the library area that was adjacent to the computer area, where TOK was used. The children interacted with the system in groups of two on their own; there was no interference or suggestions given by the teacher or the researcher, who remained in the background. Two times a week on a regular basis the researcher visited the preschool and collected the data, using a video camera discretely placed behind the system. The children were so involved in the interaction with the interface and with each other that they seemed to forget the presence of the camera.

In order to avoid any bias caused by the novelty factor, we began the collection of the data some weeks after children started to use the interface.

4.2. Methods for Data Collection and Analyses

The collected data was analysed through content analysis techniques (Bos & Tarnai, 1999). In a second phase, as suggested by Bardin (1993), the counting of the scores obtained in each category was examined through descriptive and inferential

statistical analyses in order to find regularities and patterns in children's behaviours that could help to unravel the educational affordances of the system for storytelling. As before mentioned, we focused on the level of embodiment provided by the use of the interface, as we assumed that embodiment was directly related with children's involvement and immersion in the performed task.

The data collection process, followed mostly an observational approach, the instruments used were direct observation techniques, video recordings and transcriptions - that were later analysed and coded using content analyses - as well as peer tutoring, think aloud and talk aloud.

The categorization used in the study was based on the work of Wright (2007) that was adapted to our study taking into account the initial exploratory pre-analysis of the corpus of transcriptions. Thus, following categories were created considering three aspects or levels of embodiment:

- Speak with characters - children addressed the characters with direct speech, as if they were talking with them (example: "run, run, little pig, hide inside the house")
- Sing songs – children incorporated songs in their stories, inventing songs related to the created stories.
- Embody the characters - children became the characters themselves, like in a dramatic or theatre play (example: "Now you have killed me!" a boy that was creating a story with a piggy said to his friend, who was playing the wolf).

Further we considered the type of group and the interaction time in our analyses.

In accordance with Bardin (1993) the exploratory content analysis underwent three stages: i) pre-analysis, ii) exploration of the material and iii) processing of the results (inference and interpretation). In the pre-analysis the researchers established a

first approach to the content and captured the most recurrent interaction patterns. This first approach allowed obtaining a representational sample of the content.

In order to assure the reliability of the coding process two independent coders discussed the content of each category analysing and discussing video samples in order to attain the maximum consensus (Coutinho, 2013). Afterwards, each coder codified the videos independently. The inter-coder coefficient of agreement was calculated using Cohen's kappa formula (Cohen, 1960; Coutinho, 2013). The number of occurrences obtained in each category was registered in a table. In order to analyse the data, which was done using descriptive and inferential statistical techniques, each coded category of embodiment was assigned an additive number, as such *Speak with characters* was given number 1, *Sing songs* number 2, and *Embody the characters* number 3. We presumed that the level of embodiment was progressive, and so if a pair of children, during the interaction, spoke with the characters (category *Speak with characters*), it was assigned 1 point; in case the group in addition also sang songs (category *Sing songs*), then the group was assigned 3 points (1 point for *Speak with characters* and 2 points for *Sing Songs*); finally if the group, besides attaining the above levels of embodiment, would embody a character (category *Embody the Characters*) then the pair of children would attain a level of 6 points (1+2+3). This way we could quantify values for embodiment that varied from a minimum of 0 and a maximum of 6.

4.3. Orchestrating a Play with Peers

To better illustrate how children embodied their narratives in the following section we present three examples of groups interacting with the digital manipulative, which are representative for the way children used the digital manipulative to create their narratives.

Interaction 1: Luis³ and Gil's begin to use the interface. Luis begins by placing the *scenery*, the *wolf*, a house and a *pig*; Gil joins a little later (fig. 6).

- 1 Gil: What's going on?
2 Luis: It's the bad wolf blowing, because the little industrious piggy
3 hides inside the house, and the wolf is trying to catch him....
4 Now, this is for him to learn, the house will not fly away because it
5 is made of bricks. These two [shows the blocks of the straw and
6 wooden house] would fly away. Now help me Gil, it's more
7 funny"! [They remove the *wolf* and place the *houses*].
8 Gil: ... but they are not hiding!
9 Luis: No, only when the wolf appears [places the *wolf*], you see?
10 Gil: oh, he is going to eat the piggies! [Stands up anxious]
11 Luis: No, no, piggy, hide in the house! Now I will teach the wolf a
12 lesson, he'll see. Now take this wolf! You are not going to destroy
13 this house wolf, this house is very strong!
14 Let's try the night, now. "Piggy, hide yourself, hide yourself, run,
15 run" [they weave their arms, and stand up anxiously]
16 Luis: Now the wolf will learn a lesson [places the *cloud*, which
17 blows the wolf away from the screen].
18 Gil: Look; only these two houses were blown away, not this one
19 Luis: Yes, because it is made of bricks [mimics with his arms that
20 the house is very strong].
21 Luis: Now we are going to do something very funny! Hide little
22 piggy, hide yourself!
23 Gil: "Now you are dead Luis!"
24 Researcher: Oh! Was Luis a piggy?

³ The names of the children have been changed for anonymity.

25 Gil: Yes he was, and I was the wolf!
26 Luis: Now you'll have it wolf! [Places the *wind* that blows the wolf
27 away. Ana (a girl that was observing their peers' interaction)
28 addressing the researcher: Can I tell you something? - She takes
29 the blocks with the houses in her hands – Look, this straw house is
30 easy to blow away, this wooden house is more difficult, but this
31 brick house is impossible to be blown away!
32 Eva [who was curious and joined them: My house wouldn't also fly
33 away if a wolf came, and would try to blow it away, neither yours.
[She laughs and looks with complicity at the researcher].

Interaction 2: Ana and Samuel begin by sharing the blocks among them: each one gets a pig and the corresponding house (they say that each pig has his own specific house and do not want to separate the pigs from their houses). They personalize the pigs, decide which one is the oldest, the middle one, and the youngest, assigning them character traits, e.g. one is more courageous than the others another one is very diligent. Then taking turns each child places a block and tells a part of the story.

1 Ana: I want to be the yellow piggy
2 Samuel: I want to be the diligent piggy.
3 Samuel: Oh, that's my house, good, good [his *house* displays on the
screen, he claps hands; as the platform only comprises six slots for
placing the blocks and as all six are occupied, they discuss which
block to remove, in order to place the wolf].
4 Samuel: let's take one piggy!
5 Ana: We just take one of the houses!
6 Samuel: No, if we do that we lose!
7 Eva, joining them: It's better you take the wooden house away;
8 it is not strong enough!

9 Samuel: You can hide in my house [*brick house*]. They clap hands
10 when they defeat the wolf.
11 Let's start again
12 Ana: I have the forest, so it's me who starts. [They place the *pigs*
13 and a *house*, but she also wants to place the *wind*].
14 Samuel: No, please, please don't do that. My piggy will be blown
15 away! If you want to place the wind, we have to place this house
16 [*brick house*], so that it doesn't fly away!
17 Ana: Run, run, piggy, run", quick, quick piggy, hide inside the
18 house! [she bounces in her chair, anxious] Oh my piggy hides inside
19 your house! [She claps hands delighted] (fig. 6).



Figure 6 - Luis explaining his peer what is happening (top left), children standing up anxiously hoping that the piggy reaches the house on time, escaping the wolf.

Interaction 3: The two girls start by dividing the blocks, Joana begins to speak

1 Joana: Once upon a time there was a castle and there lived a
2 princess, and it was a castle from a princess' kingdom, and in the
3 forest lived witches; there lived a fairy that protected the entire
4 kingdom. And the fairy protected the princess day and night;
5 she walked back and forth, back and forth and never got tired [when
6 there is no danger, the fairy always walk from one side to the other].
7 Maria: But suddenly a witch appeared [the intonation of her voice
8 raises creating suspense], and then a knight appeared and a caldron.
9 [Platform is full] Maria: But then the witch disappeared and she
10 promised to never come again [Joana removes the *witch*]
11 Joana: and the princess died [removes the *princess*], everyone was
12 very sad, but another beautiful princess appeared.
13 Maria: She was the most elegant in the palace
14 Joana: And the princess was sad, because there was nobody to
15 play, the fairy always had to work, always went back and forth, and
16 then by that time a piggy that had a straw house lived there [she tries
17 to place one of the *pigs*].
18 Maria: No not that one, that one is for the beach, you see he has a
19 towel [Joana agrees and places another pig. The platform is now
20 full] Joana: but suddenly in that town everything disappeared
21 [removes all the blocks, places the *forest*]
22 Maria: and a forest appeared and there lived a little fairy, the fairy
23 from the woods, that little fairy was in all the places, because she
24 was the only who protected the things, and everyone wanted one like
25 that, therefor she walked always from here to there, from there to
26 here [she bounces her head to the right and to the left, as many
27 times as she repeats that sentence] and then she went to another
28 place and did the same she went from here to there [begins to
29 sing]...

30 Joana: And in that forest appeared a flower [places block with
31 *flower*], but at that time... [Maria holds the block with the witch
32 looking at Joana, but Joana shakes her head and places the *princess*]
33 Joana: But in that forest there was a princess, it was the forest
34 protected by the fairy and from the princess Motabuela. And at that
35 time, but only at that time a knight lived there...
36 Maria: it's me now; he protected the princess together with the
37 fairy, because there were many witches there, and wolfs and many
38 wicked faces....
39 Maria: And there everything was very quite [lowers her voice and
40 gives a slowly intonation to her voice, extending the sound of each,
41 word] so the little fairy went to another place, she took the princess
42 with her and the knight
43 Joana: you have to place another place (a block with a scenario)
44 Maria: because they were all friends. And after they had gone from
45 one place to another, one place to another [she bounces her head to
46 the right and to the left, as many times as she repeats that sentence]
47 a forest appeared [places the *woods*], it was very frightening, with
48 noises [she whispers]. Suddenly the witch of that forest appeared,
49 she was the strongest, but the fairy was trying to kill the witch.
50 Who is going to win? [Whispers, and makes a voice of suspense].
51 [Joana lets the caldron fall over the witch]
52 Joana: and the caldron felt on the witch. [Both look at the
53 screen and watch what is happening].
54 Maria: You have won, little fairy from the woods! [Raises her voice,
55 happily], that's why you walk from place to place, because you are
56 the strongest. [They go on in which is already a new story].
57 Joana: a princess appeared, but then all them disappeared and at

58 that time the prince appeared and all died [removes all the blocks],
59 [Maria whispers to her: No, everybody disappeared]
60 Joana: But at that time a kingdom, kingdom, kingdom appeared,
61 there lived a wolf, a caldron and a witch...

They go on for more 25 minutes telling stories, one following the previous, and so on (fig. 7).



Figure 7 - Children talking about how to continue the narrative.

4.3.1. Creating Stories with Picture Cards

As previously referred a set of picture cards with the 23 pictures represented on the blocks was available in the library area, we observed that some children used them to create stories. Most of the time children created one or two stories, rarely spending more than some minutes in the task (fig. 8). The children used the cards to create and illustrate their narratives without showing the above-described levels of embodiment.



Figure 8 - Children creating stories with the picture cards.

5. Analyses of the Data

These three interactions described in section 4.3. disclose how children used the interface to create their stories; in the following we will present the analyses of the collected data, highlighting aspects of embodied narrative construction (table 3). As before mentioned, the children interacted with the digital manipulative in groups of two, the sample was composed by eight groups of boys, seven groups of girls and twelve mixed groups, in a total of 27 groups.

The groups were chosen by the children themselves, or assigned by the teacher as always several children wanted to play with TOK. The mean interaction time of each group was of 19 minutes. The groups of girls interacted the longest time with a mean value of 21 minutes, the group of boys with a mean of 19 minutes, and the mixed groups with a mean value of 18 minutes. Aspects of embodiment were present in four groups of boys five groups of girls and seven mixed groups, in a total of 16 groups. The analysis of the values for each of the three coded categories revealed that the first category (*Speak with characters*) was present in four groups of boys, three groups of girls and four mixed groups, in a total of eleven groups. Relatively to the second category (*Sing songs*), the results showed that it was not present in any of the boys' groups, and that three of the groups of girls as well as three of the mixed groups incorporated songs in their narratives, in a total of six groups. The third category (*Embody the characters*) was present in one group of

boys; five groups of girls and in four mixed groups, in a total of 10 groups (table 4).

Table 3- Embodiment scores of all groups.

Group (B-boy, G-Girl)	Interaction Time (min)	Speak with characters	Incorporate Songs	Embody characters	Total
BG	17	1			1
GG	45	1	2	3	6
BB	14	1		3	4
GB	12				0
BB	17	1			1
GG	6				0
GB	12				0
GB	11	1			1
GB	9		2		2
BB	21				0
GB	17			3	3
GB	37				0
GG	33	1	2	3	6
BB	12				0
BB	9				0
GG	9				0
GB	40	1	2	3	6
BB	25	1			1
GB	10				
GG	17			3	3
GB	21			3	3
GG	5			3	3
GB	4				
GB	25	1	2	3	6
BB	30	1		3	4
GG	35	1	2	3	6
BB	26				0

Table 4 - embodiment and type of group.

Type of group	Speak with characters	Sings songs	Embody the character
BB	4	0	1
GG	3	3	5
BG	4	3	4
Total	11	6	10

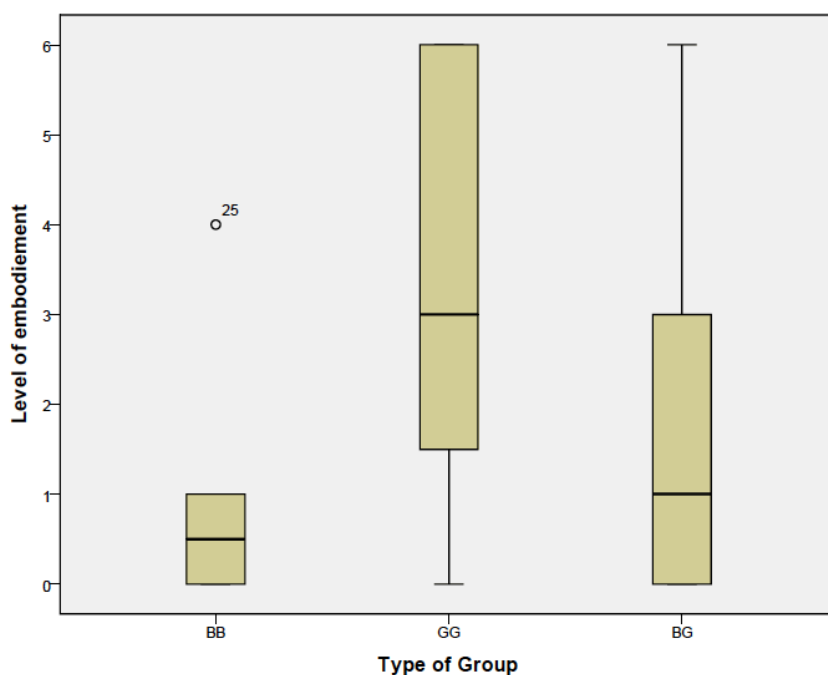
Pursuing the analysis and considering that the level of embodiment was in interval scale, we obtained following values of children's levels of embodiment through the descriptive statistical analyses (table 5).

Table 5 - Level of embodiment per group.

Type of group	Minimum	Maximum	Mean	Median	Std. Deviation
BB	0	4	0,88	0,50	1,356
GG	0	6	3,43	3,00	2,699
BG	0	6	1,083	1,00	2,250

As the results presented on table 5 show the mean embodiment value for the groups of girls was the highest with 3,43 followed by the mixed groups with 1,083, whereas the groups of boys scored 0,88. Indeed, the results show that the groups of girls have a higher level of embodiment followed by the mixed groups, while the groups of boys scored the lowest value.

Chart 1 - Children's level of embodiment.



The application of the Anova test on the data to access the significance of the differences on the level of embodiment between the different type of group showed a $p= 0.092$; although this value is not significant at the level of less than 5% value (the standard value of reference to reject the null hypothesis in educational sciences) nonetheless it is a value that is significant at the level of less than 10%, which confirms the differences that arise in the visualization of the boxplot chart (chart 1).

To finalize our analyses, and as the direct and indirect observation of the interactions led us to assume that the variables, interaction time of all the groups, and level of embodiment could be related to one another, a Pearson correlation was applied to the data. The obtained value (0,0665) showed a significant correlation between the interaction time and the level of embodiment, even for the level of less than 0,001.

In summary we can say that according to our analyses a great part of the groups integrated aspects of embodiment in their narratives, and it seems that the interaction time is positively related to the level of embodiment, as the correlation

between these two dimensions have shown.

5.1. Reflections on the Interaction

The results showed that embodiment was an important factor in the creation of children's narratives, contributing to their involvement and immersion in the flow of the narrative. Indeed, as illustrated in the transcribed examples, children's interaction with the digital manipulative took place in two distinct levels, in one level children acted as the directors of a play, orchestrating the action (Hermans, 1997; Wright 2007), like in a theatre play. On the other level children embodied the characters and become the actors of their own play. Indeed, as directors of the "stage-narrative" children planned their story in advance preparing the stage for the performance, which they clearly preferred to do with their peers, saying that it was more fun (Interaction 1: lines 6,7,21). Children ascribed attributes to their characters and houses. As directors of the play children guided the actors, speaking with them (category *Speak with characters*: interaction 1: 11-15, 21-22, 26: interaction 2: 17; interaction 3: lines 54,55) urging them to hide from the wolf, or telling the wolf they were going to give him a lesson. Together they discussed the best strategy to orchestrate their play when the slots on the platform were full.

As actors, children embodied the characters; clearly stating which character they were (category *Embody the characters* interaction 1: lines 25; interaction 2: lines 1-3) and offering their actor friends refuge in their homes (interaction 2: lines 9). They sang songs (category *Sing songs*: Interaction 3: line 29) Moreover, through their body movements and expression children conveyed their emotions, such as anxiety (interaction 1: lines 10,15; Interaction 2: 18), happiness (interaction 2: lines 3,9,19), or they illustrated and reinforced what they wanted to say (interaction 1: line 18). The performing of the story generated a sense of unity and belonging among the children; in fact, when embodying their pig characters children faced a common peril, and they held together offering each others house as shelter. Collaboration and

peer interaction was a strong motivational factor, driving the children to engage in creative narrative construction. Interaction 1 is a good example of peer tutoring, where one of the boys, helped the other to understand what was happening on the screen. Or as shown in interaction 3 one of the girls instructed the other that it was necessary to place a new scenery when that was mentioned in the story (line 43), or instructed her that the pig she wanted to place was not the correct one (lines 18,19), as we have referred before in interaction 2 the children had very precise conceptions about each of the characters. Also Maria suggests her friend to say that the characters disappeared, instead of saying that they had died (lines 59).

The variety of narrative approaches was also visible in the presented examples, indeed while in interaction one and two children created different variations of the story of the “Three Little Pigs” concentrating in trying to escape the wolf and saving the little pigs; the girls that performed interaction three preferred mixing characters from different traditional stories, creating different narratives. Like the two other groups the two girls embodied and dramatized the story, creating moments of tension, which they emphasised through the intonation of their voices raising (lines 7), lowering (lines 39), or whispering (lines 48, 50, 59) indeed, creating moments of tension, expectation and happiness according to the development of the plot.

The girls directed their stage-narrative in a very collaborative and tuned way, always building on each other’s narrative and extending it further. Sometimes they made suggestions explicitly, or merely implicitly, communicating through their bodies without needing to use words (lines 31, 32), just by simply gesturing, gazing or nodding.

5.2. The Emergence of Narrative

At the end of the interaction Maria turned to the researcher, saying: “TOK tells stories very well”! That may give a clue on how children view and understood the system. As a space where imagination could flew, which was reflected in the

fluidity of their narratives. Most children used different scenarios to place their stories. During the flow of the narratives a lurking conflict arose (a dangerous wolf, a wicked witch), that later outbreak (the wolf attacked the little pigs, the witch attacked the princess), which was solved at the end of the stories (the pigs were able to escape the wolf, the fairy defeated the enemy).

Also we were informed about the characters within the story plot, one little pig was industrious, the other was diligent, the fairy was there to protect the princess and the kingdom, the witch was a bad enemy representing a danger for all. In the course of the narrative the wolf attacks the little pigs, and the witch tries to kill the princess (conflict). The Little pigs seek refuge in the houses, and the fairy and also later a knight try to defend the princess, but she ultimately dies (interaction 3: line 11). Children solve the situation by removing the “dead” princess from the platform and place the block again, deciding that a new princess appeared, who was even more beautiful than the previous one (interaction 3: line 13).

All the three groups had to find strategies and solutions to further develop the story, when the platform was full. Along the story development the girls in interaction 3 create different atmospheres by describing the settings as calm and “quiet” (Interaction 3: line 39) and “frightening and with noises” (Interaction 3: line 47, 48), where eminent dangers were lurking, as “*there were many witches there, and wolfs and many wicked faces...*” (Interaction 3: lines 37, 38). They invented a name for the princess, calling her princess “Matabuela” (Interaction 3: line 34).

6. Discussion and Conclusions

We can refer to the interface, as a digital environment that supports what we call embodied stage-narratives, integrating visuals, voice, emotions, and sensory modalities. The creation of the stories was indeed an embodied performance, which involved sorting the elements, ordering, rearranging them, looking for specific

blocks, and placing and removing the block from the platform. The physical actions on the blocks seem to support the structuring and organizing of the story. As suggested by Antle et al. (2009:87) the direct handling of objects supports children to mentally solve the task through exploratory iterations. We can refer to TOK as a virtual stage where children create and act out their narratives. The interaction occurs in two levels, as children share the stage, (controlling the characters, the location, the props, and the nature elements) and simultaneously perform on this stage. The sharing of the input devices (blocks) gives children equal control of the performance and *orchestration* of the story. Simultaneously, freeing them to embody their narratives, externalizing feelings of apprehension, anxiety, enthusiasm or joy. As Wright points out “embodiment seems to be deeply imbedded in the children’s act of meaning-making itself” (Wright, 2007:17).

Like in a theatre play (Burke, 1945, Rifkin, 2009, Goffman, 1959), children perform the narrative acting out different roles, embodying the characters. Moreover, children’s identification with their narratives was also visible in the parallels that they created between the story and their personal lives (interaction 1: lines 28-33). We subscribe Wright, when she says: “Such open-ended, personal forms of knowing, expressing and communicating unleash and reveal children’s deep meaning, multiple perspective-taking and fluidity of thought.” (Wright, 2007:24).

Further, by acting as directors of the play, children may develop metanarrative awareness, planning and discussing the course of the narrative, and taking decisions. Peer collaboration was strongly promoted through the handling of the physical devices, which empowered each child to have an active role in the creation of the narrative. Relatively to this, we subscribe Fischer & Shipman when they say: “Environments that support the interaction of different skilled participants, encouraging “all voices to be heard” and combining different perspectives are a potential source for learning (Fischer & Shipman, 2011, cited in Eagle, 2012:48). Eagle adds to this, that the extent to which the artefact is capable of promoting social interactions, and an active, engaged, participation with the learning subject is

decisive (Eagle, 2012).

As a suggestion for educational practitioners, and according to the results of our study, mixed groups seem to work very well in collaborative narrative construction.

Relatively to the design of the system, the integration of a plot- and character-based approach supported and promoted the creation of a great variety of narratives. The unpredictability generated by the different combinations of story elements added a new exploratory and creative dimension, stimulating children's imagination, and triggering new ideas for the creation and development of narratives. Children liked to place their stories in different settings, as well as to change the day into night. They were delighted to use the wind to blow unwanted characters and objects away from the screen, and loved to knock down bad characters using the flowerpot and the caldron. In fact, while orchestrating their stories, besides adding elements to the platform, children recurrently applied different creative strategies, to influence the unfolding of the plot, such as removing certain elements from the platform to help others, or to escape danger, or lifting and placing characters to bring them to live, indeed taking full advantage of the possibilities offered by the system and even subverting its rules.

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