

# TEATRIX: Virtual Environment for Story Creation

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**Abstract.** This paper describes TEATRIX; a learning environment designed to help children, and their teachers, in the whole process of collaborative story creation. TEATRIX provides an environment where both drama and story creation are merged into one medium providing a form of collaborative make-believe for children. While creating a story TEATRIX allows the children to interact with each other in a distributed 3D environment, by means of their chosen characters. Each character is an intelligent software agent living in the world of the story: the theatre stage. Characters that are not controlled by children act autonomously according to the actions and goals set up by their role in the story. The roles in the story are based on the work by Vladimir Propp on folk tales and can be chosen from a set that includes a villain, a hero, a princess, a helper, etc. Children not only set up the scene for the development of the play and its characters, but also do the whole performance. TEATRIX is being evaluated in a Computer Integrated Classroom (CiC) environment which is part of an EU funded project (the NIMIS project).

## 1. Introduction

Drama is part of our lives since early childhood. Children as young as three engage in the art of make-believe exploring the boundaries of the real and the fantastic [13]. One of the most important aspects of drama is that it provides a type of activity where children engage in the play actively, with several senses. Aristotle refers to this as “enactment”: which means to act rather than to read. Enacted representations involve direct sensing as well as cognition [5].

However, due to its physical grounding, acting is often seen as activity done separately from the creation of stories and the writing process. Merging acting, reading and writing into one single environment, and supporting it, was one of the main goals of the research here presented. Such environment aimed at providing effective support for children developing: their notions of narrative, through the

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dramatization of several situations; and, their ability to take a 2<sup>nd</sup> and 3<sup>rd</sup> person perspective across the experience of a wide range of situations.

To achieve such pedagogical goals, we relied strongly on the experiences that a school (O Nosso Sonho<sup>2</sup>) has with their “*Dramatic room*”. The “*Dramatic room*” is a special room where children choose to go to play dramatic games. There, they dress up, choose their story, choose their characters and act.

Based on this experience and evaluations conducted in the school [8] we designed TEATRIX, which is like a game where children, collaboratively, create their own stories, by choosing the scenes, the characters, acting and writing. In TEATRIX children create the stories using a set of pre-defined scenes and a set of pre-defined characters. These characters may act on behalf of the children or autonomously. Each child will expect the story to evolve in reaction to her character’s actions. So, their characters must act in a believable way, in order for the story creation environment to engage the children in an entertaining experience, which can meet the child cognitive needs to interpret, understand and interact with the world in term of stories [1].

In this paper we will describe TEATRIX, its underlying architecture, and the role of the autonomous agents (as synthetic characters in the stories) and present some steps taken in the evaluation process.

This paper is organized as follows: first we will provide a description of what is TEATRIX, describing the several phases in the story creation process. Then, we will present the architecture used for the story creation environment and the agents there embedded. We show how such architecture fulfils the needs of TEATRIX story creation aims. Finally we will present the evaluation set up where TEATRIX is being used and tested.

## 2. Teatrix: General Description

TEATRIX is part of a large project NIMIS (Networked Interactive Media In Schools) [4], an ESE (Experimental Schools Environments) project in the i<sup>3</sup> (Intelligent Information Interfaces) area. The main goal of the NIMIS project is to develop a virtual classroom where the current activities, as well as new ones, can be carried out by children and teachers. TEATRIX is one of the applications within NIMIS. Others include “Today’s Talking Typewriter”[15] and “T’rrific Tales”. The first step in the development of TEATRIX was to experience and to gather information from collaborative story creation situations in real classrooms by children of target ages. The findings have shown that these activities are performed in well-defined phases [9]. In the first place the teacher together with his pupils chooses the story to be played, then each child chooses which character he wants to play. When everybody is happy with his role in the story, the stage set-up and the characterization of the young actors is made. The class is ready for the performance and the play begins.

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<sup>2</sup> O Nosso Sonho is a school in the suburbs of Lisbon situated in a deprived area. The school’s pedagogical approach, since it is not a curricular school, aims at promoting free choice and mature decisions by the children. So, everyday children have the freedom to choose which “room” to go, either, the drama room, the intellectual room or the studio room. The CiC environment is set up in one side of the intellectual room.

Aiming at the recreation and expansion of this activity in a virtual interactive learning environment. TEATRIX transposes the story creation process of a real classroom into a virtual classroom and merges the writing with the playing. We've recognized from the real world experience that the whole process can be divided into three different phases, for each we've defined a different module: story set-up, story creation and story writing.

## 2.1 Phase 1: Story Set-up - Backstage

In this module a child can shape the story to be created by describing its main components: scenes, characters and items.

A scene is a spatial location where the characters can perform and interact; it has some décor objects that enrich its definition and has several exits, which allow the connection of different scenes. The characters can use these exits to move between scenes. For instance, in *Hansel and Gretel* possible scenes are: the house of the children, through the forest, a path in the forest, the wicked witch house, etc.



Fig. 1. Story set-up. On the left is the scenes set-up and on the right is the characters set-up.

Characters are defined by their name, their type, which defines their social stereotype (e.g. a little girl, an old lady, etc.), and their role in the story. A role, according to Barbara Hayes Roth [3], is the class of individuals, whose prototypical behaviours, relationships, and interactions are known both to the actors and to the audience. TEATRIX only allow six different roles for its characters: *villain*, *hero*, *helper*, *magician*, *beloved one* and *beloved relatives*. The choice of these roles is based on the seminal work done by the Propp [11] on folk and fairy tales. Our *Hansel and Gretel* example will have four actors: a boy, a girl, an old lady and a bird. The boy will be "Hansel" and he'll be a *hero*, the little girl will be "Gretel" and also a *hero*, the old lady will be a "wicked witch" and will be the *villain* and the bird will be the *helper*.

Throughout the play characters may need some items to support their performance. Items extend the base behaviour of a character as they give it new forms of interaction (e.g. with a magic wand a wicked witch can bewitch the little boy Hansel).

The story set-up is only completed when every character and item is placed on its starting scene (the place where they will first appear when the story creation starts)

and the desired connections between the scenes as established. Figure 1 shows two application snapshots of the backstage module.

Finally, the whole set-up is saved for future use or used immediately for a performance.

## 2.2. Phase 2: Story Creation - On stage

Once the initial set up is done, children can then play the prepared story. Note that one story set-up can be used for creating many different stories. The set-up only defines the initial situation (scenes, characters and items), and it is not difficult to see that from the same starting point several stories may emerge.

This story creation module is a multi-user module where several children can work together on the same story giving life to the characters. A child may have two roles in this phase: to be the owner of the story or just be one of its players. The owner is the one who took the initiative of the story creation. He chooses the story he wants to create from the set of stored set-ups and then waits for other children to join in. The owner sees every character that is chosen and has the power to initiate the story performance.

When everything is ready, the curtain is raised. The initial situation is narrated and a three-dimensional representation of the story world will appear (see figure 2 that shows a scene in a forest featuring a witch, a girl and a big cooking pot). Each child gets a view of the scene where his character was first placed. The child can control his character by choosing a specific action chosen from set of defined actions, which can change according to the character's type and role.

All characters that were not chosen by any child are system controlled and act in a goal oriented manner based on their type and role. For example, a villain will have the major goal to harm the hero.



**Fig. 2.** Creating a story. The central area show a 3D representation of the scene our controlled character is currently in, we can see other characters and items that are also there.

The children interact with each other and with the world, by means of their characters, being able to talk to the others, pick up and use items. The story emerges from this interaction. However, not all interactions lead to a coherent story. Thus, to support the achievement of a coherent structure in the performance, guaranteeing that the

characters perform according to their roles a director may be put in charge. We will discuss this element in more detail later in this paper.

When the story is considered finished, usually by the director (can also be finished by some children giving up), it will be stored for future replay or writing.

### **2.3 Phase 3: Story Writing - The audience**

In this module children can see the stories they've performed as a recorded movie and reflect upon the work done. The movie can be stopped at any time, rewound or forwarded as desired. A montage process can also be done on the original story. As a child watches the movie she can write about it or even criticize it. A child can write more than once about the same story. All written stories are stored to be read later or shared with other children.

## **3. The Agents in the Fantasy Worlds of TEATRIX**

When the play starts all characters in the story creation environment must act in order for a story to emerge. To achieve that, they were built as intelligent agents living in a synthetic 3D world. The use of intelligent agents as synthetic characters has had an increase of interest in the past few years. Works such as [2], [6], [12], [14] are good examples of how intelligent agents can improve the communication between learning environments and learners. Such agents can have life-like properties in order to help the learner, explain concepts, and demonstrate tasks. But the use of synthetic characters in learning situations does not necessarily fall into a tutor or a companion role. For example, recently a synthetic character was used as a learner avatar in a 3D world to teach microprocessor concepts [7]. In TEATRIX the intelligent agents will be the actors in a play.

To support the development of these agents we've elaborated an architecture with two main concepts: the world and the agents.

### **3.1 The World**

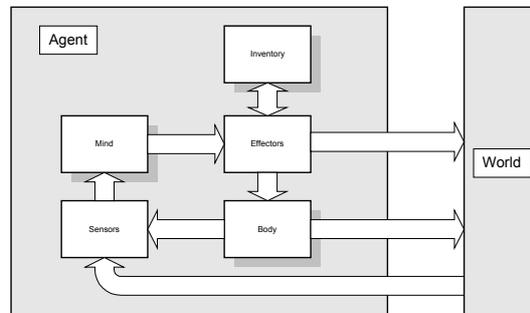
The world is the space where objects and agents exist. In TEATRIX the world is a three-dimensional stage divided into several locales (the scenes referred in section 2.1). The world objects are classed according to an ontology that divides the world entities into animated, that can change the world (e.g. agents), and inanimated. The inanimated entities can be portable and/or usable. The usable entities that are portable are items. Each different story will have a different ontology, based on the previous definition, depending on the world objects it may have. E.g. a story that takes place in a forest scene and has a magic wand on it needs a magic wand class and other classes that describe the décor objects in a forest (e.g. a tree class) in the ontology.

### 3.2 The Agents

The characters in the story are implemented as agents “living” in the world of the story, its stage.

The agent architecture has five components (see figure 3): (1) the mind, responsible for the agent’s behaviour; (2) the body, responsible for the representation of the agent in the world; (3) the effectors, responsible for the execution the agent actions in the world; (4) the sensors, responsible for the information acquisition; and (5) the inventory which keeps track of the agent’s possessions.

Not every component is needed in a TEATRIX agent. For example, the body and the inventory can be undefined, which means that the agent can not be placed in a world locale, because it’s “physical” representation is defined in his body, and cannot pick up items from the world (since it does not have a way of keeping them). The mind, sensors and effectors are essential.

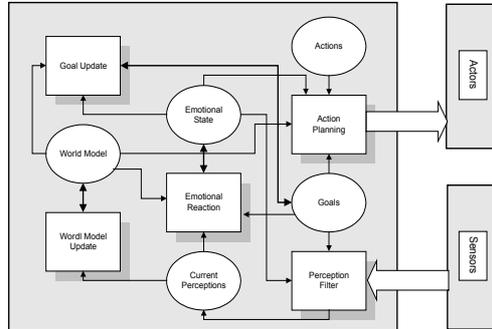


**Fig. 3.** Agent Components.

Next, we present a more detailed description of each agent component.

**Mind.** The mind keeps the agent’s knowledge about the world (the world model) and about himself: the actions he can perform, their consequences, his goals and his emotional state. The decision-making process is based on this knowledge. The agent can react to a perception or just act because it wants to change the world to according to its goals. Figure 4 shows the mind components and the links between them.

Five components manipulate the mind information: (1) the Perception Filter determines if a perception received from a sensor is relevant to the agent at that particular moment (similarly to [10]); (2) the World Model Update assures that the internal World Model is coherent with the perceptions received; (3) the Emotional Reaction change the Emotional State as the World Model or agent Goals change; (4) the Goal Update revise the agent Goals as his World Model or Emotional State change; (5) the Action Planning is responsible for the planning of the agents’ actions. Planning takes into account the current Goals, World State, the Actions that can be performed and the Emotional State. The Emotional State allows the agent to have preferences between Actions in certain circumstances.



**Fig. 4.** Mind Components. Boxes represent mind processes and ellipses mind knowledge.

When the mind decides which action to perform it informs the corresponding effector to start the execution of that action. However, the agent's behaviour is conditioned by its type and role. Two agents of the same type act differently if they have different roles and two agents with different types perform differently the same role. The character role defines some goals for the agent. For instance a "hero" has a predefined goal that is defeating the "villain" [9].

When a child controls a character, the mind of such agent has a passive role. The agent will not act by itself and therefore the action planning will be inactive. However, all other components will still be active as the agent will continue to have an emotional state and its own goals. For example, the child may force her character to do something against its current goals, and although it performs such behaviour, its emotional state will change into a more negative one.

**Body.** The body represents the agent in the world. Such representation is not only the agent's appearance to others, but also its "physical" state, which includes properties such as height, weight, position in the world, etc.

Characters are represented in the world as "sprites" which means they don't have 3D representations but animated 2D representations. For every action there is an animated sequence of images that represents it in the world. The character type reflects its "physical" appearance so the animations vary according to a character type. The emotional state also changes the way the actions are represented.

**Effectors.** An effector is the component that contains all the information of how to perform an action. The performance is divided in three phases. In the first phase the effector verifies if all preconditions are fulfilled. This verification is necessary because the world model of the agent can be different from the real world, and thus, although the agent believes he can perform an action, that may not be possible in the real world. After such verification the action execution starts. Each step in the execution has a partial effect in the world and must be represented; this representation is achieved through the body. When the execution ends, the effector makes sure the action is finalized, performing the correct changes on the world. When an action needs an item to be performed the effector can use the inventory contents for that. In TEATRIX there are some basic actions that are common for all agents: walk, get

item, drop item, use item, activate item, interact and talk. The agent can have some specific type and role actions that will enrich this basic set.

**Sensors.** Sensors are the information translators that gather information from the world changes and inform the mind about such changes. An agent knows the effects of his own actions by means of his sensors. A sensor can filter a world event and not deliver it to the mind. This process simulates the “physical” limitations of the agent. This is different from the perception filtering process of the mind, in that case the process verifies if the agent is interested in the event and not if he is able to “see” it.

**Inventory.** The inventory can be seen as a backpack where the agent keeps all its possessions. The agent may also have an item in his hand, and it can switch that item with any other in his backpack, only that item (in the hand) can be used.

### 3.3 Director Agent

The director agent is the one responsible for narrative control of the story. Having no “physical” representation in the world, he has no body or inventory. However, he has some God-like privileges, this means, he can sensor in all world locales, insert some new items or characters in any world locale and is able to know about every action occurring in the world. Further, the director agent can talk to the other agents, giving them performance directives, even control them if need (in behalf of the story coherence). It is the director agent who decides when the story is over. A child can also control this agent and thus becomes the director of the play.

### 3.4 Distributed Architecture

Since TEATRIX is a co-operative environment we needed to distribute the architecture defined above. As we’ve mentioned before there is one child who takes the initiative of creating the story. This child will have specific competencies that the other ones don’t. The module associated with that child is named the story server.

In each story creation process there will be a story server and zero or more others client modules. The server module is responsible for resolving synchronization conflicts for shared resources (e.g. two characters try to get the same item) and for controlling the system time. The server also controls the director agent and all character agents that were not chosen by any child (system controlled).

The other modules, as well as the server, have complete information about the world and its locales. Each module controls the agent chosen by its child user, but only has clones of the other characters in the world. These clones don’t have capability of reasoning (e.g. don’t have a mind) and thus only repeat the actions that the agents they clone perform.

The director agent can not be cloned and only acts in the server world. Its actions are then transferred from world to world.

## 4. Evaluation

To ground the development of TEATRIX we've performed some studies on how stories arise and are developed in the *dramatic room* of the school "O Nosso Sonho". These results will, in the future, be used for the evaluation that is being carried out at the different schools within the project. The NIMIS classroom [15] (see Figures 5) is already in use in three different schools: one in Duisburg, Germany, one in the Leeds, UK, and one in Lisbon, Portugal. A first prototype of TEATRIX is installed in the Portuguese school and has started to be used by the children and the teachers.

Our plans for evaluation include the study of the conditions where the NIMIS classroom and its applications lead to the improvement of literacy, narrative skills and the ease of collaboration between children.



**Fig. 5.** NIMIS Classroom. Photos taken in the German school during a lesson where the NIMIS software was in use.

## 5. Conclusions

In this paper we have described TEATRIX a learning environment designed to help children, and their teachers, in the whole process of collaborative story creation. TEATRIX provides an environment where both drama and story creation are merged into one medium providing a form of collaborative make-believe for children. We've described the underlying architecture of TEATRIX focusing on the role of the autonomous agents (as synthetic characters in the stories). We've discussed the diverse elements that form part of the agent's architecture showing how these elements are combined to achieve the behaviour of the characters playing roles in the story.

TEATRIX is already in use in the school integrated in a Computer Integrated Classroom Scenario (CiC) developed within the NIMIS project. The next step is to evaluate its use and find out how the system is helping the students and the teachers in their learning activity, in particular in literacy.

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