Bringing Drama into a Virtual Stage

Isabel Machado
INESC and CBLU, University of Leeds
Rua Alves Redol, 9
1000 Lisboa, Portugal
+351 21 310030
isabel.machado@inesc.pt

Rui Prada and Ana Paiva
IST, Technical University of Lisbon and INESC
Rua Alves Redol, 9
1000 Lisboa, Portugal
+351 21 3100219
{rui.prada, ana.paiva}@gaiva.inesc.pt

ABSTRACT

This paper describes a collaborative virtual environment, *Teatrix*, developed with the aim of bringing drama activities into a virtual stage.

Drama activities and story telling play important roles in children development. Based on this premise and also on real classroom activities, we developed *Teatrix* as a collaborative virtual environment, where both drama and story creation are merged into a unique medium providing a form of collaborative make-believe for children.

In this paper we will focus on the design, architecture and preliminary results of *Teatrix*, as well as on the future steps of the research.

Keywords

Collaborative virtual environment, intelligent agents

INTRODUCTION

Drama activities and story telling play important roles in children development. 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 [4].

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.

The product of such research is a collaborative virtual environment for story creation, *Teatrix*, which aims to provide effective support for young children (7-9 years old) developing:

- their notions of narrative, through the dramatization of several situations;
- and, their ability to take a 2nd and 3rd person perspective across the experience of a wide range of situations.

Teatrix is an application developed under the NIMIS (**N**etworked **I**nteractive **M**edia **I**n **S**chools) project, which is an EU-funded project under the Experimental School Environments (ESE) program.

The goal of the research conducted in the NIMIS project is to explore and augment current classroom activities with the introduction of new technology. This new technology does not only comprise the development of software applications but also the establishment of a new classroom concept (CiC – **C**omputer **i**ntegrated **C**lassroom) by introducing also innovative hardware. The aim of the CiC concept is to integrate the innovative hardware in such a way that the usual and curricular activities are brought into the computational environment.

Therefore, in the development of *Teatrix*, we relied strongly on the educational and pedagogical approach taken in a Portuguese school (O Nosso Sonho[1]), because we didn't want to develop a research system detached from the educational reality and from the children needs and requirements.

In this paper, we present *Teatrix* a collaborative virtual environment, which provides the children with the means for collaboratively creating the story on a virtual stage. The children will create the stories using a set of pre-defined scenarios 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/his character's actions. So, their characters must act in a believable way, in order for the story creation

[1] "**O *Nosso Sonho***" is a school in the suburbs of Lisbon. The school's pedagogical approach, since it is not a curricular school, aims at providing the children with the possibility to choose, freely, the daily activities and though promoting the acquisition of mature decisions by the children.

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].

From this creation process a physical artifact, “*film*”-like object, is created to give to the children the possibility to be the *audience* of their own performances.

This paper is organized as follows: first, it is described the design issues that conducted to the current version of *Teatrix*, then the architecture of the collaborative virtual stage and its components are explained. Finally, the current achievements are discussed and the future steps delineated.

THE DESIGN OF *TEATRIX*

The design of *Teatrix,* as has been stated before, was grounded on a set of experiences run in the school *“O Nosso Sonho”*. During the experiences we observed children of several ages performing fairy tales in different settings: theatre and puppet scenarios. In this school, there is an educational approach that divides the types of activities in rooms, and therefore provides the children with the possibility of choosing by their own their daily activities. From these experiences we took four basic conclusions for the design and development of *Teatrix*:

1. *The performances always comprised a theatre alike ritual.*

   Whenever the children decided to perform a fairy tale, they first dressed-up and put some make-up to better “incarnate” the character. After having discussed the roles of every child the acting process began.

2. *Audience played a very active participation during the performance*

   The children that were not participating on the play constituted the audience. This audience had a very active participation and reaction to the performance and always made a lot of comments.

3. *Children (characters) interacted and explored both scenarios and props*

   In the theatre settings, children moved around the scenario and picked the props in order to better perform their roles in the story.

4. *The underlying narrative of the fairy tales provided the medium for the social interactions among the children*

   The children played their roles and stayed in character throughout the performance. And also, they had to interact with each other in order to perform their roles and to create and re-create the stories.

Based on these conclusions we designed *Teatrix*, in such a way that it follows a theatrical metaphor. So, the environment is divided in three steps strongly related with the theatrical performances.

The first one offers the children the possibility to prepare the scenario, props and characters for each story (in relation with what happens in *the backstage* of a theatre during the preparation of a play).

Figure 1 - *Teatrix*: Backstage Option

The second step provides the children with the possibility to initiate one story and to start the acting (*on stage* performance). The children act by means of their characters, which they command throughout the story creation process. Before starting the acting activity, each child has to choose a character to control. In this environment, there is also the possibility to have system-controlled characters, which means that they interact with the child-controlled characters. After having chosen the characters, children are ready to start their performances, and the performances take place in a collaborative 3D world. In this case virtual reality technology plays an important role in this phase, because it provides the children with the means to explore the scenarios during the story creation [12]. The story creation only evolves if the children work together to achieve a common goal: their story. From the story creation process a “*film”*-like object is created. This *“film”*-like object offers the children with a product, which they can analyze and even to reconstruct in future performances. Furthermore, the children get much more from an interaction or experience if in the end they will create a meaningful artifact, that they can exhibit as a proof of their personal or collaborative work [9].

Figure 2 - *Teatrix*: On Stage Option

The third option is based on the artifact produced from the story creation process. In this phase, children can be the audience of their own performances and watch their previous performances (as being the *audience or the public* in the theatre - Figure 3). In this option the children have also the possibility to write about the stories previously performed.

Figure 3 - ***Teatrix***: The Audience

ON STAGE: THE COLLABORATIVE DISTRIBUTED ARCHITECTURE

Teatrix's *on stage* option is a collaborative tool that allows several children to work on the same story at the same time. Each child acts in the story by means of a character, her/his adopted character. So, whenever a child-controlled character acts or does some action in the story is because its child controller directs it on that direction.

During the story creation process, each child sees the actions performed not only by her/his character but also by the characters in the same scenario. The children can talk to each other in order to establish collaboration activities or they can collaborate via their controlled characters by establishing a dialogue between their characters.

Based on collaborative and distribution premises, we had to devise a mechanism that would distribute the several components available in the virtual world. To accomplish such distributed architecture we use the *coupling* concept implemented the Java Match Maker (JMM) library. This coupling process links two objects in such a way, that each object replicates each other behavior [15].

The components that can be coupled in our system are the world of the story (the stage) and its characters (see Figure 4). In our architecture we have:

- a story server module: owned by the child who has started the story
- and several client modules: owned by all other children that have chosen to play the same story.

The server has have the following responsibilities in the system: it controls the system controlled characters, resolves conflicts for shared resources (e.g. two characters trying to get the same item) and has the system time clock. The story director is also running in the server (see Figure 4).

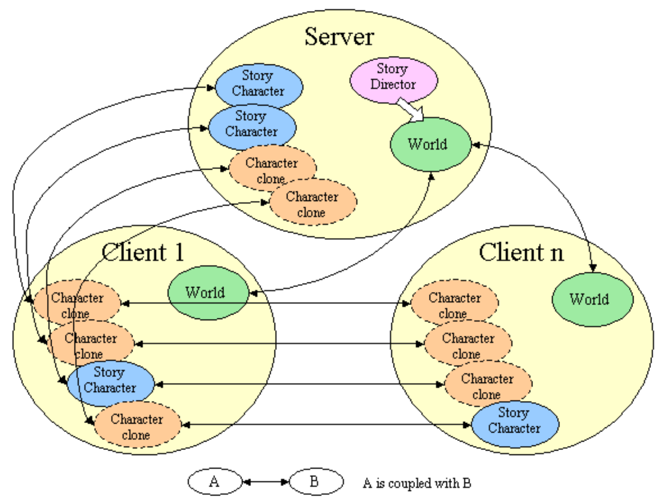

Figure 4 - ***Teatrix* Distributed Architecture**

Each module has whole information about the world, and a representation of each character in the play. Characters can have a full representation, with internal representation (reasoning and internal world state), or just an external representation and no reasoning capabilities. The last ones are called "clones" they just replicate the behavior of a full representation character.

The worlds are coupled to each other, which allows the distribution of some events between them, this way all of them have the same state. The director only acts on the world of the server module and its actions are distributed to the other world representations by means of this coupling.

All worlds are synchronized via the central time clock also in the server. There is only one full representation of each character in the system. It is placed in the module of the child that had chosen to play that specific character, or in the server if no child has chosen it, all other modules only have a clone representation of it. Every character is coupled with all its clones, this way all character actions are replicated in every world.

In the following sections, it will be described in more detail the components: *story world*, *story characters* and the *story director* of this distributed architecture.

Story World

The world is the space were both agents and objects (inanimate entities) exist. Following the *theatre metaphor*, the world in *Teatrix* is the 3D stage where the story creation process evolves. This 3D stage consists of a set of linked-scenarios (*locales*). Each scenario defines the spatial localization of a character in a particular moment of the performance. Therefore, the actions of a particular character are only seen by the characters present in the same scenario.

These scenarios are linked between each other by special type of objects (*exits*). Each scenario can have several exits and therefore being linked with different scenarios. If a character wants to change the scenario where it is placed, it can just choose an exit and automatically will be transported to another scenario.

The entities available in the world are divided in two main classes: animated and inanimated. An animated entity is defined as having the capability to change the ***world state*** (for example, an agent). Inanimated entities are also subcategorized as:

- portable (can be carried around);
- non-portable;
- usable (it has a specific function and can be used by the agents);
- or décor entities (see **Figure 5**).

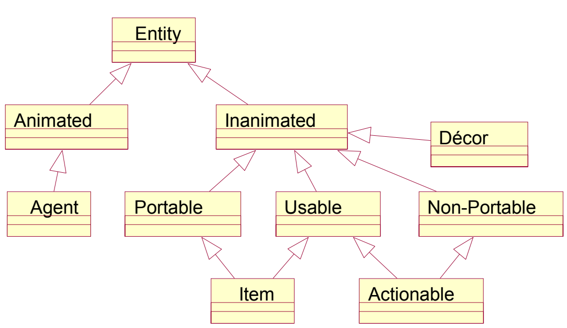

Figure 5 – Entity Classes

A usable entity will have a functional role associated and will determine the result of the *use* action performed by a character. For example, if a character uses a sword (*usable entity*) the result of the action will be to fight with or attack other character.

Story Characters

The development of synthetic characters as intelligent agents has had an increase of interest in the past few years. The research developed by Rickel and Johnson [11], Swan et al. [14], Frasson et. al [2] and Towns et. al. [16] 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. Nevertheless, 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 [6]. In *Teatrix*'s case the intelligent agents will be the story characters in a play. Such agents will be able to act both autonomously or controlled by the children.

This story characters will inhabit the 3D world were they can interact with each other and also with objects. In the following subsections, the world and story characters architecture will be described.

The Architecture of the Story Characters

The characters in the story are implemented as agents inhabiting and interacting in the 3D world. As have been said before, these characters can act autonomously or can be controlled by a child.

A story character in *Teatrix* is the conjunction of an actor and a role. An actor is the physical representation or appearance of a character. For example: a witch, a boy, or a girl. A role, according to Hayes-Roth [3], is the class of individuals, whose prototypical behaviors, relationships and interactions are known to both characters and audience. In *Teatrix*, the roles definition was based on the seminal work done by Propp [10] on one hundred Russian folktales (see [7] for more details on the characters definition). These roles define and establish the functional role of an agent, by means of the specification of the actions and roles for that agent.

From this distinction between actor and role a set of combinations can be achieved, and a wide variety of possibilities can happen and an extra factor of suspense is added to the story creation process. When starting the creation of a new story, each child is chooses which character s/he wants to control and what is the role of his/her character, but s/he does not know what roles are the other characters performing. So, besides having a goal to achieve during the story creation process the child has an extra motivation: discovering who are the bad characters and who are the ones that s/he can trust.

An agent is composed by five components (see **Figure 6**):

(1) the mind, responsible for the agent's behavior;

(2) the body, responsible for the representation of the agent in the world;

(3) the sensors, responsible for the information acquisition;

(4) the *effectors*, responsible for the execution the agent actions in the world; and,

(5) the inventory, which keeps track of objects that, the agent has in its possession.

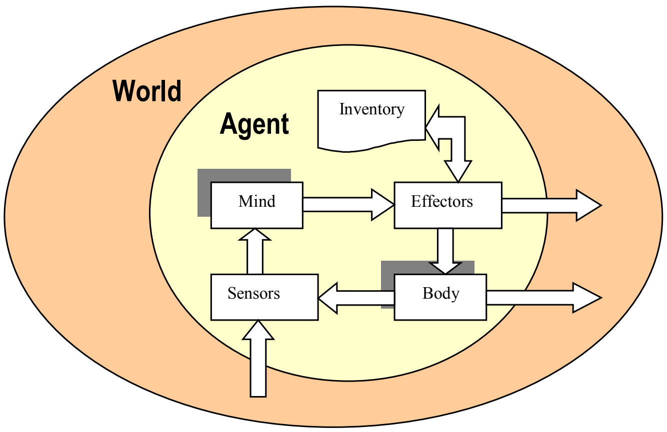

Figure 6 - Agent Architecture

An agent in *Teatrix* does not have to be constituted by all the five components. For example, the body and the inventory can be undefined, which means that the agent can not be placed in a *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). Nevertheless, the mind, sensors and *effectors* are essential, without any of them the agent is useless.

Mind

The mind keeps the agent's knowledge about the world (the world model) and about itself: the actions it can perform, their consequences, its goals and its emotional state (see **Figure 7**). 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 in accordance with its goals.

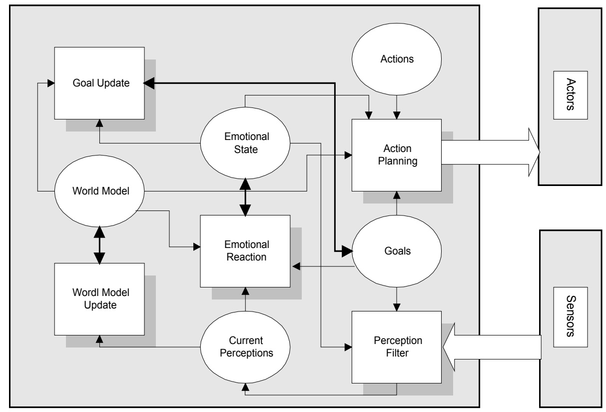

Figure 7 - The Architecture of the Mind

The components that manipulate the mind information are as follows:

- **Perception Filter** – determines if a perception received from a sensor is relevant to the agent at that particular moment. If so, the information is recorded in the Current Perceptions component. This process uses information of the current emotional state and goals (similarly to [8]).
- **World Model Update** – every time a new perception of a world occurs this component assures that the change is updated in the World Module.
- **Emotional Reaction** – a change in the world module or in the agents goals can cause a change in the emotional state, some perceptions can also do it.
- **Goal Update** – the goals can change when his vision of the world changes. The emotional state also influences the current goals.
- **Action Planning** – This component 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.

When the mind decides which action to perform it informs the corresponding *effector* to start the execution of that action. If a child controls a character agent, the mind of the agent has a passive role. The agent will not act by itself and thus the action planning will be inactive. However, all other components will still be active and the agent will continue to have an emotional state and it's own goals. For example, the child may force her/his character to do something against its current goals, and although it performs it, its emotional state will change into a more negative one.

Body

The body represents the agent in the world. This representation is not only the agent's appearance to others, but also its "physical" state, which includes properties such as its height, weight, position in the world, etc. The important properties of the physical state are those who define the agent movement in the world, its position, velocity and acceleration.

Characters are represented in the world as "sprites", they don't have 3D representations but animated 2D representations. For every action there is an animated sequence of images that represent the agent in the world. The animations are linked to the actor definition.

The body just shows to the world how an action looks like without executing it; it is the assigned *effect* that performs the execution.

Sensors

Sensors gather information from the world changes and inform the mind about such changes. An agent knows the effects of its own actions by means of its 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 it is able to "see" it.

For the agents (characters in the *Teatrix* world) there are four kinds of sensors:

- **Action sensor** – this sensor allows the agent to perceive every occurring action his current locale, including their own.
- **Proximity sensor** – this sensor triggers every time an agent gets near a world object or leaves the proximity of a currently near one.
- **New entity sensor** – this sensor informs the agent of every entity that enters or leaves his current locale.
- **New locale sensor** – this sensor informs the agent he has entered a different locale. He is also informed of every recognizable entity that is in the new locale.

Effectors

An *effector* is the component that knows how to perform an action. Each action has a corresponding *Effector* that contains all the information about the execution of that action.

Each action has a three-phased execution. In the first phase the e*ffector* verifies if all preconditions are fulfilled. This verification is necessary because the world module 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 the performance of an action needs an item to be performed, the e*ffector* can use the Inventory contents to fulfill that requirement.

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.

Inventory

The inventory can be seen as a bag where the agent keeps all its objects. For the active object, it's used the metaphor *object in hand*. If an agent as an object *in hand* and decides to execute the action *use*, the result of that execution is directly defined by the type of the object *in hand*. When an agent picks up an item from a *world locale* the item is removed from the *locale* and placed in the agent's inventory, if he drops it the result it's the dual.

Story Director

The story director, also developed as an agent, is the one responsible for narrative guidance of the story. This agent has no "physical" representation in the *story world*, which implies that it has no *body* or *inventory*. However, he has some *God-like* privileges, in the way that it can sensor all *world locales*, insert some new items or characters in any *world locale* and is also able to know about every action occurring in the world.

Further, the director agent can talk to the other agents, giving them performance directives, and even control them if need (on behalf of the story coherence). The director agent is the one who decides when the story is over.

Since, we do not want to restrict children's creativity, we must have a special care when assigning such *god-privilege*s to the *story director*. Therefore, it must guide the children throughout the story creation process but it must not control their characters.

DISCUSSION

Our current results come from informal experiences run in "*O Nosso Sonho"* with children between 7-9 years old. The experiences were designed to:

1. *Test the usability of the interface, in particular in the setting up phase.*
2. *Test the capability of the children to control their characters.*

The results achieved revealed that the interface icons (for example for choosing the role of the characters) are appropriate. However, we found that children should be given more control of the characters, in particular of their state of mind (and not only actions). Such feature - the control of the agent's state of mind - will be incorporated in the next version that will be deployed to the school.

Since *Teatrix* is being deployed in a CiC environment, which integrates an interactive board and a set of networked computers enhanced with LCD tablets that are manipulated with a light pen, then the next evaluation will also consider the role of the hardware in the development of the stories and its link with the "real" performances. The children have demonstrated that they were very enthusiastic to that new medium of collaborative make-believe.

One should note that with *Teatrix* we do not want to claim this system will substitute the real classroom activities, but we think that it is possible to:

- improve children's way of performing and creating stories, in particular aspects such as "staying in character" and controlling the emotional state of the character;
- influence children's performances in the real world by what happens during the fantasy plays.
- promote the social relations between children, because they have to combine strategies in order to create a story and to conquer the goal and motive of the story.
- promote reflection on the role of the characters and the structure of the created stories, allowing children to critically evaluate their own created stories and performances.

Furthermore, we would like to prove that the use of virtual environments would enhance classroom and curricular activities in such a way that it would be not only a motivational factor but also an engaging way of promoting and conveying learning.

FURTHER WORK

Teatrix is still an ongoing research project and the future steps will mainly focus on two different approaches:

- the establishment of narrative mechanism that will guide the story creation process and;
- the definition of a qualitative assessment method for establishing a parallel between the stories produced with the *Teatrix* and with the performances done in the real settings.

ACKNOWLEDGMENTS

We would like to thank the members of the NIMIS project for their contributions during several discussions about the system and also for the development of the distributed infrastructure developed within the project.

REFERENCES

1. Dautenhahn, K.: "Story-Telling in Virtual Environments*". Working Notes Intelligent Virtual Environments,* Workshop at the 13th biennial European Conference on Artificial Intelligence, Brighton, UK, 1998.
2. Frasson, C., Mengelle, T. and Aimeur, E. "Using pedagogical agents in a multi-strategic intelligent tutoring system", *in Proceedings of the AI-ED workshop on Pedagogical Agents*, Kobe, 1997.
3. Hayes-Roth, B.: "Acting in Character", *in Creating Personalities for Synthetic Actors*, Eds R. Trappl and P. Petta, Springer, 1997
4. Laurel, B. *Computers as Theatre*, Addison-Wesley, 1993.
5. Lester, J., Converse, S., Kahler, S., Barlow, S., Stone, B. and Bhoga, R.: The Persona effect: Affective Impact of Animated Pedagogical Agents. In *CHI'97* Electronic Publications, 1997
6. Lester, J. Zettlemoyer, L, Gregoire, J. & Bares, W. "Explanatory Lifelike Avatars: Performing User Centered Tasks in 3D Learning Environments, in *Autonomous Agents'99*, ACM Press, 1999
7. Machado, I. & Paiva A. (1999) "Heroes Villains, Magicians,…:Believable Characters in a Story Creation Environment". In *Proceeding of the AIED workshop on Life-like Pedagogical Agents*, Le Mans 1999.
8. Martinho, C. & Paiva, A. "Pathematic Agents: Rapid development of Believable Emotional Agents in Intelligent Virtual Environments", in *Autonomous Agents'99*, ACM Press, 1999.
9. Paper, S.: Situating Constructionism. *Constructionism*, eds. Harel, I. & Paper, S., 1991.
10. Propp V., *Morphology of the folktale*. Austin: University of Texas Press, 1968.
11. Rickel, J. & Johnson, L.: Integrating Pedagogical Capabilities in a Virtual Environment Agent. In W.L. Johnson & B. Hayes-Roth (ed.): *Autonomous Agents´97*, ACM Press, 1997.
12. Roussos, M., Johnson, A., Leigh, J., Vasilakis, C., Moher, T.: Constructing Collaborative Stories Within Virtual Learning Landscapes. In *Proceedings of European conference on A.I. in Education,* Lisbon, Portugal, 1996.
13. Singer, D. & Singer, J. *The House of Make-Believe*, Harvard University Press, 1990
14. Swan, E., Johnson, L. & Ganesham, R.: Pedagogical Agents on the Web. In *Autonomous Agents'99*, ACM Press, 1999.
15. Tewissen, F: Java MatchMaker Online Documentation.

http://collide.informatik.uni-duisburg.de/Software/Docs/JavaMatchMaker/, Dept. of Computer Science and Education, University of Duisburg, 1998.

16. Towns, S., FitzGerald, P., & Lester, J. (1998). Visual Emotive Communication in Lifelike Pedagogical Agents. *In Proceedings of Intelligent Tutoring Systems 98 Conference,* Eds. Goettl, B., Halff, H., Redfield, C. & Shute V., Springer-Verlag, 1998.