FaTe2: Storytelling Edutainment Experiences in 2D and 3D Collaborative Spaces

Franca Garzotto and Matteo Forfori
HOC-Hypermedia Open Center
Department of Electronics and Information, Politecnico of Milano
P.zza Leonardo da Vinci, 32 – 20133 Milano – Italy
[garzotto, forfori]@elet.polimi.it

ABSTRACT
Storytelling, edutainment, and collaborative interaction are all powerful paradigms to promote learning in young kids. The FaTe2 project offers a combination of these paradigms by providing a web based, multi-user, two and three dimensions virtual space where children (aged 7-11) can meet, chat, explore, play, and perform storytelling activities in collaboration. The paper describes the background of FaTe2, its educational motivations, its design solutions, and its implementation approach.

Keywords
Storytelling, Edutainment, Collaborative Learning, 3D Virtual Space, Story Grammar

ACM Classification Keywords
K3.1 [**Computers and Education**]: Computers Use in Education – *Collaborative Learning;* H.5.3 [**Information Interfaces and Presentation**] Group and Organization Interfaces – *Web Based Interaction*

BACKGROUND
The FaTe2 project exploits a "child-centered" design approach, which was informed by field studies on traditional and computer based kids' storytelling and on 3D web cooperation performed in the previous projects *FaTe* and *WebTalk*. *FaTe* (*Fa*iry Tales and *Te*chnology) created four interactive multimedia fairy tales integrated with educational games, for 5-10 year old kids. In 2004-05, we carried on an extensive ethnographic study [8] to understand the storytelling methods adopted in schools, the behavior of young kids with interactive stories, and children process of cooperative storytelling, thus identifying the core user requirements for FaTe2. The study involved eight teachers and 105 children (aged 6-9) of four classes at an Italian elementary school.

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It comprised three focus groups with teachers and twelve observation sessions with kids, who were observed in the computer laboratory (while using FaTe products in small groups) and in the classroom (while creating stories together using traditional "tangible" tools). The *WebTalk* project [2] built a powerful software framework to implement multi-user interaction and communication in *web based 3D worlds*. Using WebTalk, our team developed four 3D cooperative edutainment experiences (on Leonardo da Vinci's machines at the Museum of Science and Technology in Milan, on the Dead-Sea Scrolls at National Museum of Israel, on European History, and on Italian History) [6]. Their educational effectiveness was evaluated in massive field tests that involved over 1500 high-school students in Italy, Israel, and twelve European countries. Although targeted to an older audience than FaTe2, WebTalk activities helped us to understand some general paradigms of 3D cooperative interaction and some design principles for edutainment experiences, which FaTe2 has adapted, extended, and applied to young kids' collaborative storytelling and edutainment.

STORYTELLING
Many studies in the psychological and pedagogical literature suggest that *storytelling* (meant as the capacity to listen, tell, and reflect on stories) is an extremely important developmental area for children, promoting a wide spectrum of cognitive functions and skills: expression, communication, recognition, recall, interpretation, analysis, and synthesis [7]. FaTe2 supports kids not only as story "consumers" or "spectators" but also as "narrators" and "directors" [12,13,15]. We provide a 2D interaction space where kids can watch, read, or listen to a multimedia fairy tale, and manipulate the multimedia characters and objects in each scene (e.g., triggering movements, music, or dialogues). We also offer an open ended *story framework* (figures 1, 2 and 3) where kids can personalize characters (e.g., by dressing them), write characters' dialogues (in a comic-style [1]) and modify or create a scene, thus changing the story world. By giving space to "children's voice" [4] and promoting spontaneous storytelling, we provide a means to stretch kids' imagination, practice their language, and

develop important narrative skills. Our storytelling framework is structured accordingly to the *Story Grammar* theory, originated in the field of linguistics and semiotics from the researches on narrative structures by V. Propp [14]. A story grammar denotes the morphology (and syntax) of (a category of) stories, defining their typical structural elements (and their composition rules) [17]. We investigated the use of (paper based) story grammar tools in schools during the FaTe ethnographical study. As confirmed by several pedagogical studies [5], a story grammar approach helps children to better understand a story and to structure their own narratives, being particularly effective in students who present proficiency problems in storytelling and writing. FaTe2 adopts the story grammar theory currently used in many Italian elementary schools, which includes the structural components *initiating event* (that sets up a problem), *subjective* (internal) *response* (by the protagonist, to the problem), *objective* (external) *response* (by the protagonist, to solve the problem), *consequence* (of the protagonist's attempt), *reaction* (by the protagonist, to the consequence). A FaTe2 story comprises at least a "scene" for each story grammar element. To help kids understand and reflect on story grammar concepts, visual cues appear in each scene, highlighting the corresponding story-grammar component. In addition, some games focus on story grammar concepts, as discussed in the next section.

EDUTAINMENT ACTIVITIES

The idea underlying *edutainment* is to promote learning by merging *edu*cational contents and enter*tainment* activities that increase engagement, emotion, and motivation. FaTe2 exploits the edutainment paradigm by integrating the 2D storytelling environment with a *3D interaction space* and a variety of *games*. The 3D interaction space is composed of a set of fantasy worlds; each one corresponds to a 2D story "scene" and is populated with the corresponding scenario, characters, and objects. The 3D worlds are more than 3D renderings of 2D story scenes; they are enriched with interactive (and non interactive) elements that stretch kids' imagination and illusion – key factors to make the story situations more compelling, and a means to focus attention on what is educationally more important at a given moment. Entering a 3D fantasy world, a kid's presence is rendered by an avatar and she becomes actively engaged in the surrounding environment. This provides a kind of "immersion" [9] that increases the sense of *psychological proximity* (a concept of game theory that denotes "…the extent to which a situation compels users to use empathy and imagination to put themselves into the experience" [10]).

Games are integrated with the story telling environment, and exploit both 2D and 3D interaction. They are inspired by story characters and events, and involve various story elements and story grammar concepts. Games have been designed to increase kids' *intrinsic motivation* [11] towards narrative activities and also to achieve other complementary educational benefits. *Ability games* (e.g., moving an avatar across a sequence of flying circles or traversing a 2D labyrinth) promote psychomotor skills. *Problem-solving games* (e.g., treasure hunt in the 3D space, or puzzles in the 2D space) stimulate creative problem-solving capability. *Content-oriented games* (e.g., quizzes about story grammar concepts) foster story-structure comprehension, critical thinking, symbolic

Fig.1a: Triggering character personalization

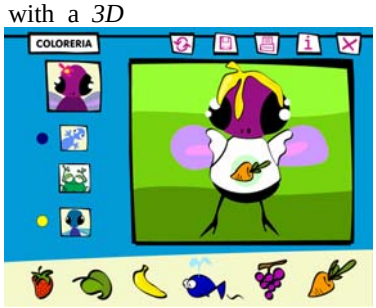

Fig.1b: Personalizing a character...

Fig.1c: …and seeing the effects in the 3D

Fig.2a: Creating comics…

Fig.2b: …and seeing the effects in 3D

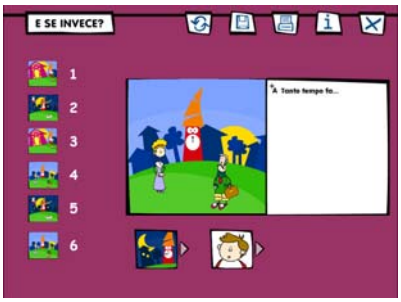

Fig.3: Creating/Modifying a scene

imagination, recognition and recall, and provide a field for their exercise, thus preparing the way for the development of abstract thinking and higher mental processes. *Linguistic games*, inspired by the "theory of fantasy grammar" of the Italian writer G. Rodari, stimulate linguistic skills and promote creative writing [16]. All 2D games start by selecting a character or a "special object" (*game object*) in the 3D space (e.g., a flower), which changes in colour and shape when the activity is completed.

COLLABORATION

There is abundant evidence, from the pedagogical literature, that performing educational learning activities in small groups promotes collaboration skills and fosters learning [3, 18].To support *collaboration*, the 3D worlds provide shared WYSIWIS ("What You See Is What I See") spaces for interaction, exploration, and playing, which synchronize both users' movements and object manipulation. Up to 8 kids can be simultaneously connected to the network. Co-presence and multi-user awareness are achieved in various ways. Visible "user embodiments" (*avatars*) give the perception of where the actual users are and what they are looking at. *Widgets* (see buttons on the right side of fig. 4) allow a kid to change her view of the 3D space – from top ("air view"), from the avatar's eye and from her back. To render what other users do, the shared 3D space is synchronized with the 2D space so that the effects of the 2D tasks of a single user are perceived by all users. A "game object" changes when the corresponding game is completed; a character personalized in 2D appears under its new shape in 3D (fig. 1a-1b); a character sentence written in 2D is shown in the characters' speech bubble in 3D (fig. 2a-2b). The 2D scenes created using the story authoring tool (fig. 3), are displayed as panels in a "special" 3D room called *story lab* (fig. 4). In this virtual social space kids can look at and read their narrative works and the ones created by the others, increasing the feeling of "*storytelling community*".

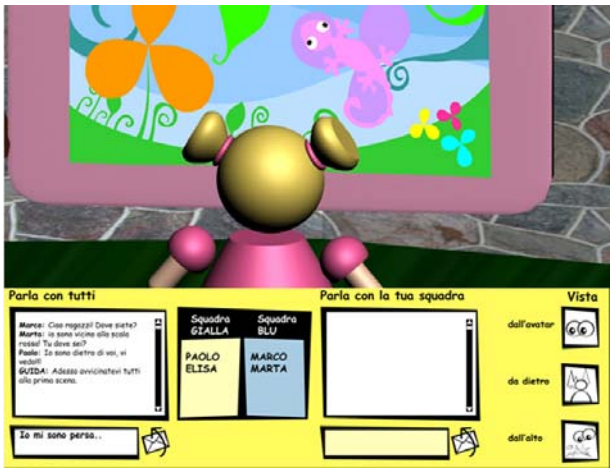

Fig. 4: "Story lab" (top) and control panel (bottom)

A locking mechanism manages the 3D shared objects, e.g., the elements that must be discovered during treasure hunt, or the "game objects" that triggers a game, or the characters that can be personalized: a shared object is exclusively allocated to the first kid who "grasps" it. Although in 2D each user steers her own view point, visual cues make her aware of what the other users have done for the same task (e.g., the locked characters that have been personalized by others are marked). Scene creation and update are governed by the same turn-taking rules as the "round-robin" storytelling game played by children in class at elementary schools.

Competition is a way to increase interest and engage kids emotionally [11]. In a FaTe2 experience, children can be organized in two teams, and when a kid completes a game, she gains points for her team**.** 3D diamonds, visible in all worlds (fig. 5), represent the team score, and grow as points are gained. Different team members can play, in turn, and a "team panel" shows the names of currently co-present kids for each team (see fig. 4-central area at the bottom).

Fig. 5: "Score diamonds"

Finally, FaTe2 supports *social interaction* that goes beyond collaborative storytelling and gaming. A *chat* tool supports verbal interaction, collective decision making, conflict resolution, enabling both broadcast messages, visible by all users (fig. 4-left) and "whisper messages", visible within a team only (fig. 4-right). The chat also promotes the sense of *collaboration on community*, since, for example, remotely located kids can introduce themselves and their class, express who they are to each other, and comment/discuss the experience as it evolves.

EXPERIENCE WORKFLOW

Since young children routinely navigate complex interaction spaces as part of regular and frequent game playing, the interaction in the FaTe2 environment results easily understandable for the majority of our target users. Still, the variety of the proposed activities increases the risk of wasting time and ineffective interaction and cooperation. To keep it *educationally effective*, a Fate2 experience should be structured in multiple sessions; each one should be focused on a specific set of activities and follow a carefully designed workflow. The evaluation studies carried on in the Webtalk project [6], and the

preliminary design evaluation study of Fate2 suggest that: "workflow" management is a critical issue, and that any FaTe2 experience should be preceded by a preliminary stage of "workflow design". With the school teachers involved in the project we have defined a tentative "optimal" workflow of activities to achieve the most effective educational benefits through a FaTe2 experience (which we cannot discuss here for lack of space). In addition, our studies suggest the need of constant monitoring and scaffolding to "keep users on focus", and that there should be the presence of an on-line human *"guide"* during all sessions. As in the previous Webtalk applications, the guide appears as a special avatar and has the control on the 3D space, "locking" or "unlocking" the access to the different 3D and 2D worlds. She communicates with the children through a dedicated chat area (bottom of figure 4), to propose which activities to undertake, to give hints, to assign penalties for improper behavior and scores for ability games.

THE IMPLEMENTATION ARCHITECTURE

FaTe2 extends the WebTalk system by supporting cooperation and co-presence in 3D *and* 2D interaction spaces. The current architecture implements the communication and interoperability between the 3D and 2D spaces, so that the effects of user interactions in 2D affect the state of the 3D worlds. The Flash Communication Server manages the interactions among the clients, and maintains the consistency of the state of 3D and 2D shared worlds. It detects the events triggered by the different users and distributes the effects on the various clients, so that they can be perceived by all users in the shared environment. A Flash movie starts each time a 3D game object is selected by a kid, providing her with a "personal" 2D interaction space (where only unlocked elements are available). The effects of her 2D activity on the 3D environment are sent to the server and broadcasted to all clients.

EVALUATION

An inspection-based usability study has been performed by our usability experts , leading to some minor re-design of FaTe2. A preliminary design evaluation study of Fate2 has been carried on through three focus groups with the teachers involved in the project, mainly addressing pedagogical aspects (e.g., the design of games and story-authoring activities vs. the intended educational benefits). An empirical study of FaTe2, involving the kids of four elementary school classes located in two different cities in Italy, is scheduled in May-June 2006.

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