A·L·I·C·E
Adaptive Learning via Intuitive/Interactive Collaborative and Emotional systems

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SEVENTH FRAMEWORK PROGRAMME

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1 Introduction to Complex Learning and Narrative Learning

Learning is no more defined as a transmission or accumulation of contents: the learner must become the real protagonist of this change, making education a strategic lever for their growth and making innovation the key for the transformation process. A lifelong education requires the ability of integrating different open and flexible didactic methodologies from a reticular and multidimensional point of view, for a meaningful learning where the subject is active and responsible for the structuring of his knowledge, know-how and existential competence, autonomously choosing his educational path (Calvani, 2001).

The linchpin shifts from instructional agent to learner, which assumes a stronger control of the process, to carry out choice, programming, resource finding and building, self-assessment: in brief, a customized learning process. E-learning often replicates a controllable learning pattern and a close educational model. Setting free from this model means to acquire and enhance the open character of the net through customized paths (Guspini, 2004) upsetting traditional schemes we usually implement when we begin a learning task. The acknowledgement of a different learning model can help us to discover various and new opportunities offered by the net in an educational experience (Ferri, 2005). In this perspective the term “complex” explains the re-configuration amongst different typologies of e-learning models, new links and new hierarchies amongst media, new languages and new interaction way, therefore “remediation” (Bolter, Grusin, 2002). The result is bigger than the sum of its components (McDonald, 2006). The Complex Learning (Ferri, 2005, Nacamulli, 2003) is an innovative vision to define an educational approach characterized by an active and explorative learning process, whose protagonist is the learner, who learns what knowledge is necessary for him/her to use and sort out problems experienced in real life situations. The complex learning can be defined as a fourth stage of distance learning, a form of active, reasoned, critical, social, and self-directed learning,

Learnitivity is the key concept of the complex learning. Learnativity means fusion of learning with activity, creativity and productivity, as well as reflexivity, responsibility, capability. Learnativity also refers to an active and creative reflection on the experience, acquisition of responsibility, awareness and effectiveness in its operations? targeted professional, and above all, personal emancipation. "Learnativity is "knowledge in action ", which combines training and experience, engagement and emulation. The complex learning is related to the acquisition of an integrated set of learning objectives and to multiple performance goals and, conversely, has little to do with learning separate skills.

A definition of complex learning, as a new educational paradigm, has been discussed by Guglielman Vettraino starting from different definitions in the article "Learning Complex, a possible way of being Dulp" (2009). According to Vettraino and Guglielman "the learning complex can be described as an emerging training model that attempts to answer to the challenge posed by the increasing knowledge complexity and to change our knowledge attitude within an increasingly globalized world where reality assumes the connotation of unpredictability and liquidity." A theory is lacking today to unify the different definitions and positions; thus, we would have to start from the practice in order to reconstruct a unifying theory.

The ALICE Project has the purpose to bridge that breaking-off between formalized theories and experimented applications, building an adaptive and innovative environment for the Complex Learning Experience, and generating a Comprehensive Learning Path, or CLO. A CLO is meant here as an

"intensive resource" characterized by its capability to support high-level learning processes thanks to a remediation of languages, tools and roles. A CLO is a rich didactic, dynamic and flexible resource, which requires a multidimensional evaluation of its experiential, cognitive and emotional aspects. The narrative learning, according to this pedagogical vision, is seen as a method which refers to the complex learning approach and that makes use of elements like dramaturgy, suspense, emotions and immersion, to intervene and maximize the learnt lessons. By accepting the idea to overcome educational models that reproduce receptive educational architectures and that are based on a static condition of roles, tasks and environments, the main objective of Task 1.2 is to investigate among the educational research what is new about narrative Models and Complex Learning approach and to define a Storytelling Design Model (SDM) aiming at developing narrative sessions, that can be functional to the efficient transmission of lessons learnt inside a complex learning experience, on the theme of risks management.

1.1 Results of Major Projects

There are two significant and parallel directions within the interactive narrative research project community. The first direction contends with questions of computationally structuring interactive narratives. This perspective grapples with issues of automatic plot generation, the optimization of reader's path through story trees, the direction of the behaviors of autonomous narrative agents, and the creation of intelligent drama management systems. The second direction asks questions about the conceptual nature of narrative as a phenomenon, and its relationship to interaction.

The outcome of most important projects have been authoring tools are INSCAPE, STORYTEC, PASSAGE, and Virtual Storyteller.

1.1.1 INSCAPE

INSCAPE – Interactive Storytelling for Creative People. FP6, IST. The INSCAPE project wants to involve end-users and potential creative authors in each stage of the development of the proposed authoring software toolbox for interactive storytelling. The specifications for this tool will be driven by an analysis of the needs of real world users participating in the project as partners or involved in the INSCAPE Open Community. The INSCAPE tool aims at enabling ordinary people to use and master the latest Information Society Technologies for interactively conceiving, authoring, publishing and experiencing interactive stories whatever their form, be it theatre, movie, cartoon, puppet show, video-games, interactive manuals, training simulators, etc. INSCAPE will generate and develop the knowledge in the emerging domain of Interactive Storytelling by researching, implementing, demonstrating and disseminating a complete suite of innovative concepts, tools and working methods tightly integrated in a homogeneous web-based framework and offering a full chain to people with no particular computer skills, from content acquisition and creation, organizing, processing, sharing, and using all the way to publishing, from creators to "viewers". The intended GUI concept for the INSCAPE authoring tool, as well as the underlying data model, describe interactive stories in such structural terms as used in the INSCAPE story format ICML (Inscape Communication mark-up language), namely trees and graphs of connected objects and their diverse attributed properties. The GUI design provides four main areas, or functional blocks, to define an interactive story. In a first step, authors can use one part of the interface in a top down fashion to describe a story in a "story-board like" manner: A common-style text editing environment is used, including the possibility to insert sketches, icons etc. In contrast to that, there is another part following more the bottom-up approach: This part of the GUI provides visible library of all story assets (objects, props), in a symbolic form, e.g. by showing icons for each library item. In the central part of the GUI, we will find the interfaces used for editing the stages (assemblies of objects, and their positions within the stage), for defining interactive scenes taking place within these stages, and for previewing the INSCAPE stories in a 2D or

3D performance mode. In a special area (called the Story Editor), a visual representation of the story's transition graph is visualized as a graph structure, in order to manage the overall story flow, branches etc. In addition to these basic functions, there will be specific behaviour editors, where authors can either integrate/reference predefined scripts and associate them to story objects, or to add, set, or delete properties and variables.

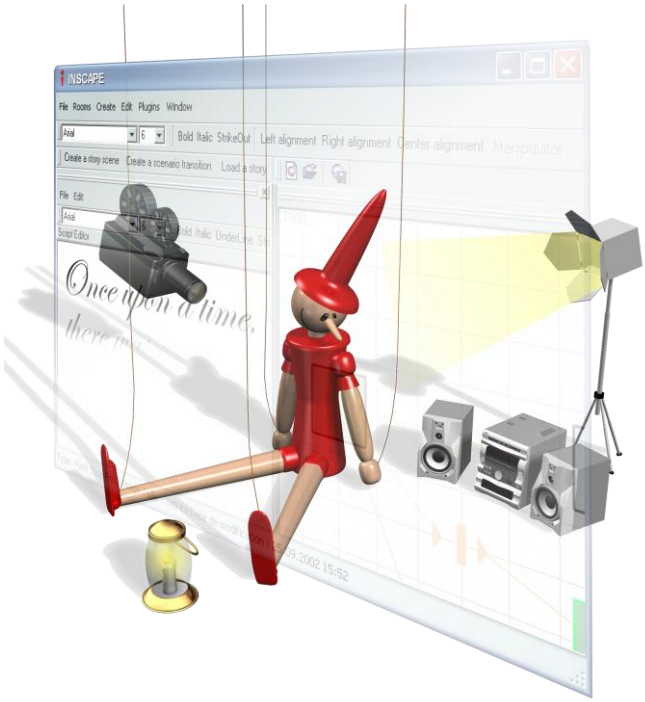

Figure 1.1 INSCAPE

The conditions for possible transitions between the different story situations and stages are also defined at this level. Of course, all these editors are interlinked and synchronized on a system level, which is a main advantage of INSCAPE's integrated approach. To accomplish these goals, INSCAPE depends of a suite of applications (plug-ins) that provides the necessary authoring innovations. Emotion Wizard (EW) it's an authoring module in INSCAPE that will enable authors to easily and quickly "emotionally" change the environment and characters. The Emotion Wizard will be made of audiovisual templates and character behaviours models that the author can use to speed up work or to aid in finding the right emotional tone for the scene he or she is creating. The emotion modules described in this paper act as such additional component (optional plug-ins) of the INSCAPE system, based on the INSCAPE data model ICML, and providing links to the different editors. For instance, overall strategies and variables for emotion expression and experience will be introduced via the Story Editor part (linked to the Emotion Wizard module) and placed as INSCAPE objects in the story's asset library. For instance, there might be four ICML variables (see ICML hierarchy -> story -> variable) for describing emotional states: Theta, Beta, Delta and Alpha; representing Tension, Happy, Sad and Relax. These might be further diversified in order to define more detailed emotions in the story, e.g. emotional states of specific characters. The ICML section for 'strategies' may be used to define rules and conditions for changes in emotional states. Such emotion-related parameters, if available on the stage or scene level, may then influence the characteristics of the entire stage (e.g. light, camera, colour), as well as the visual representation of specific story objects (e.g. the mood of a virtual character, as expressed by facial animation).

1.1.2 STORYTEC

STORYTEC is performed in the frame of the INSCAPE Integrated Project (EU RTD contract IST-2004-004150), which is funded by the European Commission under the sixth Framework Programme. StoryTec consists of a comprehensive authoring framework with different editors enabling authors (without programming skills) to create interactive stories and a runtime engine responsible for a fluent story and story control during runtime. Components of the authoring environment include a Story Editor to create, organize and manage stories (structures), a Stage Editor to create and manipulate story units (complex scenes and scenes), an Action Set Editor to define transitions among scenes and an Asset Manager and Property Editor to access and manipulate story objects. The core of the runtime engine builds a Narration Controller loading a story encoded in ICML and controlling the interactive scenario based on user interactions and strategies defined by the author in advance. Storytelling applications consist of two major components: An authoring environment as well as a runtime engine. The authoring part of the platform is based on a pluggable framework and is composed of five visual components:

The Story Editor is the place for managing the story structure. A story is structured by a hierarchically organized story graph consisting of two layers: Scenes and complex scenes. A complex scene typically defines a particular location within the story world and contains the physical surroundings (decor, no interactive elements), which make up the background of the story. A scene, in contrast, is a specific state of the story graph, a logical part of the story and usually contains the active elements (e.g. virtual characters and their behaviors, interactive story objects, etc.). Scenes can only exist within a complex scene. In other words, a complex scene might be understood as container for scenes and refers to a global structure for several scenes with common elements. The Story Editor provides an interactive 2D representation of the story graph, containing the scenes/complex scenes, the transitions between the scenes and the story elements.

Figure 1.2 Story Editor in STORYTEC

The Stage Editor represents the place to create scenes (either in 2D or 3D) via inserting objects from the objects library (using drag-and-drop mechanisms) or to access and modify story elements (via picking the objects. All objects with a physical representation (e.g. characters, props, etc.) are visible in actual size, position, etc. and can be directly positioned and manipulated. Since the authoring environment is based on a pluggable framework, it is possible to have different Stage Editors for different types of application. For instance, there might be a 3D Stage Editor for interactive 3D scenarios in the training and simulation field as well as a 2D Stage Editor for cartoons or ELearning courses.

Figure 1.3 Stage Editor in STORYTEC

The Action Set Editor provides a visual programming environment for defining the high-level story logic for every scene. The logic is described by a set of rules, which are composed of actions (e.g.walkTo 'Door', playSound 'intro.wav') and conditions (e.g. 'if player1 enters the castle'). The author can directly select elements with the mouse and add new conditions and actions.

The Asset Manager is responsible for importing various types of assets (3D models, sound files, cameras, lights, props, etc.) to the asset library. Icons and preview images in a separate window contained in the main GUI of the authoring environment visualize the assets. The Asset Manager enables the author to directly drag assets from the asset view into a scene or complex scene in the Story Editor or into the Stage Editor window.

The Property Editor consists of a simple 'attribute/value' list that visualizes the properties of the current selected story element. Here, the author can directly modify the values, for example the name of a character, the volume of a sound, etc. Stories created with the authoring platform are encoded in the ICML format. It is used to load and save stories as a well as to import and export stories to different runtime systems

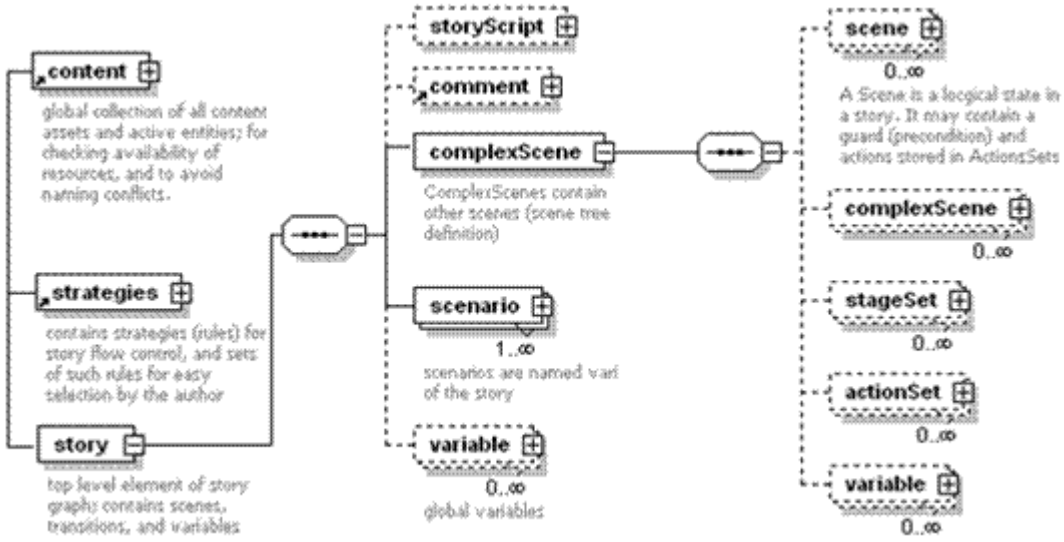

Figure 1.4 ICML format

The StoryTec platform is currently available in a prototype status and will be enhanced in terms of usability, stability, scalability as well as additional technical features such as multi-user, collaborative authoring and web-based access to the platform and authoring environment. Also, within the EU funded project 80 Days, the symbiosis among storytelling (StoryTec Narration Controller), learning (adaptive learning engine) and gaming (game engine) will be examined and ICML will be further cultivated in the direction of collaborative authoring and digital mobile learning appliances.

1.1.3 PASSAGE

Recent interactive storytelling systems take advantage of inferred player state to guide their storytelling decisions. Deferring storytelling decisions to run-time can greatly improve the flexibility and replay value of a storytelling game. To achieve this deferral, we introduce PaSSAGE (Player- Specific Stories via Automatically Generated Events), an interactive storytelling system that uses player modeling to automatically learn the preferred play style of the current player, and uses this knowledge to dynamically adapt the content of an interactive story. By learning a model of player preferences through automatic observation and using the model to dynamically choose the content of an interactive story, PaSSAGE aims to substantially improve the enjoyment of players on a person-by-person basis. PaSSAGE (Player-Specific Stories via Automatically Generated Events) is an interactive storytelling system, which uses player modeling to automatically learn the preferred play style of the current player, and uses this knowledge to dynamically adapt the content of an interactive story. Following Peinado and Gerv´as, we use the player types from Robin Laws' rules as the basis for our model; these include Fighters (who prefer combat), Power Gamers (who prefer gaining special items and riches), Tacticians (who prefer thinking creatively), Storytellers (who prefer complex plots) and Method Actors (who prefer to take dramatic actions).

Figure 1.5 PaSSAGE

During game play, PaSSAGE learns a player model expressed as weights for each of these five styles of play; the higher the weight, the stronger the model's belief that the player prefers that style. Before run-time, potential courses of action are identified by the designer and augmented with weight deltas, allowing the model to be updated based on the player's actions in-game. For example, the following vectors show how the player model changes when the player asks for a reward in exchange for assistance; since the player is showing an interest in gaining riches, the model's value for the Power Gamer type increases: (Fighter=1 Method- Actor=81 Storyteller=1 Tactician=1 PowerGamer=41) becomes (F=1 M=81 S=1 T=1 P=141).

PaSSAGE makes significant use of inferred player information, basing the Time, Place, and Actors of its events on its model of the player along with her position in the story's virtual world. The clear way in which PaSSAGE can further inform its decision-making lies in the Reasons for the actions of its actors; current work on PaSSAGE is focused on modeling personality attributes for its actors, toward motivating the actions that they take. PaSSAGE tells its stories by drawing from a library of possible events, called encounters, each of which has been annotated by an author with information concerning which player types it would be suitable for. For example, being attacked by challenging monsters in a forest might be ideal for players who play as Fighters, and could also appeal to Power Gamers if special items are left behind when the monsters are defeated. Each encounter additionally has one or more branches - potential courses of action for the player to take in that situation. When searching for an encounter to run, PaSSAGE examines each encounter's set of branches, and chooses the encounter whose branch best fits the current values in the player model via an inner-product calculation. To help maintain a strong sense of story, encounters are grouped into sets corresponding to the many phases of a story portrait of Joseph Campbell's Monomyth (Campbell 1949) - a general structure for myths that was used prescriptively to create several feature films, including the Star Wars and Matrix trilogies. To make story events independent of time, place, and actor identity, PaSSAGE extends the concept of role passing presented by Riedl and Stern to the game's environment as a whole (Riedl & Stern 2006); encounters are scripted generically, and details (such as exactly where an encounter should occur) are determined at run-time.

1.1.4 Virtual Storyteller

In the Virtual Storyteller project, we investigate under which conditions stories emerge through character interactions, with the characters being played by intelligent agents. This research has been supported by the GATE project, funded by the Netherlands Organization for Scientific Research (NWO) and the Netherlands ICT Research and Innovation Authority (ICT Regie). The Virtual Storyteller is a framework for story creation by co-operating intelligent agents. In this framework, a collection of agents is responsible for the creation of different story levels: plot, narrative, and presentation. In the Virtual Storyteller, plots are automatically created based on the actions of autonomous characters whose plot creation is only constrained by general plot requirements. This approach lacks the disadvantages of pure character-based plot development, where the characters are fully autonomous, and of scripted approaches, where the plot content is pre-defined and the characters have no autonomy at all. The Virtual Storyteller is part of the AVEIRO project, that is aimed at building virtual environments inhabited by autonomous embodied . language and speech technology, humanoid animation and virtual reality are combined. Specific research issues to be addressed are the following:

- Automatic plot development by characters as intelligent agents

- Control of the character agents to achieve a well-structured plot
- Turning a plot into a narrative using natural language generation
- Story presentation by embodied, speaking agents in a virtual environment
- Involving the user in the story creation process (interactivity)

An assumption we make is that we can later replace one of the characters in this setup by creating an interface for a human interaction without having to change much in the rest of the architecture.

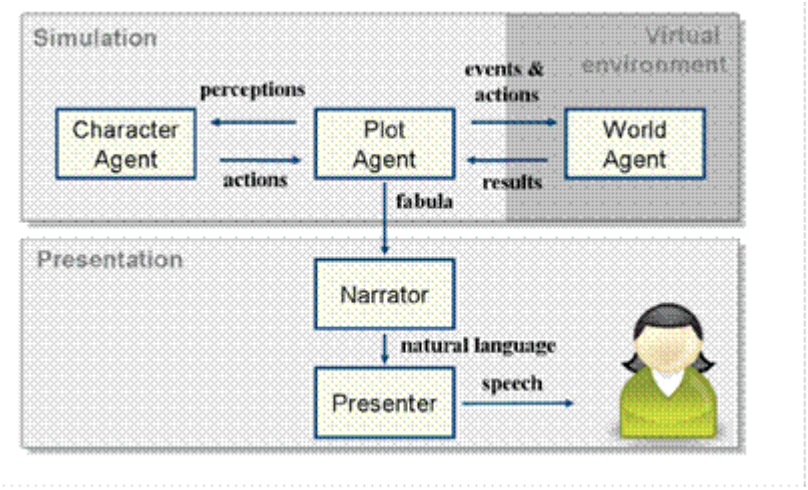

Figure 1.6 Virtual Storyteller components

The Virtual Storyteller is a multi-agent framework for generating stories. These stories emerge from a simulation of virtual characters in a story world. Story generation happens in two phases: (1) simulation and (2) presentation (see figure 1.4). In the simulation phase, Character Agents work together with a Plot Agent to produce an interesting event sequence. The Character Agents simulate a character's life in the story world. They pursue goals, reason about their perceptions, experience emotions and make decisions in the context of this world. In order to constrain the authoring of engaging characters to a manageable degree, we focus on a particular domain of pirate stories. The Plot Agent facilitates the simulation by starting up scenes that specify the initial state of characters and story world for the particular scene. The event sequence resulting from the interaction of the Character Agents is captured by the Plot Agent in a formal representation (the fabula) that forms the input for the presentation phase. The World Agent manages a knowledge representation of the virtual world, executing actions and events as they occur, and sending back the results to the Plot Agent the Narrator component turns the formal fabula representation into an actual story by selecting the content to tell from the fabula, and applying language generation techniques to it in order to produce a text.

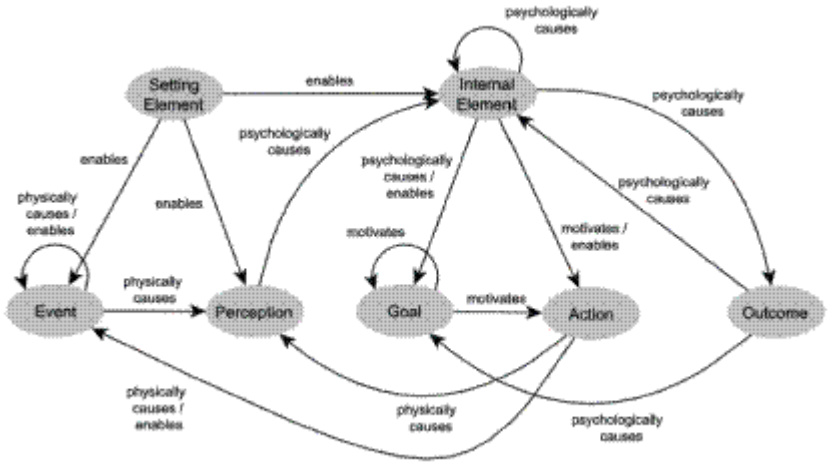

Figure 1.7 Formal fabula representation

Our fabula model defines causal relationships between seven types of elements: setting elements, goals, actions, outcomes, events, perceptions and internal elements (see figure 1.7). A setting element describes an aspect of the story world that all the characters share and consider to be true. A goal is the main drive for a character to act. A goal in this context describes a desire to attain, maintain, leave or avoid certain states, activities or objects. The state of the story world is changed through actions and events. The difference is that actions are performed intentionally by a character, whilst events are not; they just happen. An outcome is a mental concept that relates a goal to its fulfilment or failure. When a character believes that one of its goals is fulfilled, the goal has a positive

outcome, but if the character believes that the performed actions did not succeed in fulfilling the goal, the outcome is negative. A perception describes properties of the world that a character witnesses. Everything else that goes on within a character, such as cognitions, emotions, feelings and beliefs, is classified as an internal element. In a fabula, these elements are connected by four types of causalities: physical and psychological causality e present unintentional causes of either physical or mental nature, motivation represents an intentional cause and enablement represents any cause where the causing element is making it possible for the resulting element to occur

At the basis of story production lays the simulation of the story world. The aim of the simulation is to produce a fabula that contains interesting event sequences for the presentation phase. The fabula production is done by modelling virtual characters whose interactions with each other and the story world determine how the story develops. The simulation is based on a multi-agent system in which Character Agents play out the role of the characters they represent, and share responsibility over plot progression. The design of these Character Agents is informed by improvisational theater. The simulation is divided into rounds. Each round, the Plot Agent takes the initiative and requests each Character Agent to select an action. In response, each Character Agent goes through a deliberation cycle and responds with an action it wants to perform, or refuses the, for instance because it is already performing an action, or because it cannot think of any action. When an action finishes, its effects are translated into perceptions that each Character Agent receives. The final responsibility for the simulation of the story world is with the Plot Agent. The Plot Agent has a facilitating role in the simulation, both outside and inside the simulated world. It exerts global control over the simulation by synchronizing its rounds. It captures the fabula elements that the Character Agents produce during the simulation and organizes them in a causal network for subsequent narration. It is also able to scale up the simulation by using scene definitions. A scene definition determines the setting, characters and

their goals for a part of the simulation. The simplest story world simulation would consist of one scene defining the start state of the story world, and defining which characters occur in that story world. To start up a scene, the Plot Agent starts up new Character Agents if necessary, and casts them to play the required roles.

Virtual Storyteller can be categorized as an intermediate approach, in the sense that the characters do not have full autonomy in making up the plot, but are guided in their actions to achieve a well-structured plot. An important difference with other approaches is that our director agent does not work with a pre-specified (possibly branching) plot, but only has general knowledge on what makes a good plot. This means that the content of the story is not known in advance, but determined by the characters pursuing their individual goals in their virtual environment. The characters themselves ensure the consistency of the plot. The director can use the following methods to control the characters' actions: I) **Environmental** (introducing new characters and objects into the story world), II)**Motivational** (giving a character a goal to pursue) and III) **Proscriptive** (disallowing a character's intended action). The director's use of these control methods depends on the rules in his knowledge base. In our current implementation, the director has knowledge about global plot structure in the fairy tale domain, which is encoded in his knowledge base in the form of a set of rules stating that a story must have a beginning (where the characters and the environment are introduced), a middle (where the main action takes place, i.e., the characters attempt to achieve their respective goals), and a happy end. To get the plot going, the director creates a setting (environmental control) and gives the characters a goal (motivational control). Before performing any action, the characters must ask the director for permission, which is where proscriptive control comes into play. Currently, the knowledge bases of the characters and the director are very limited, allowing only for the creation of extremely simple stories. In the near future, we intend to give the characters more (story) world knowledge, so that they can make more, and more sophisticated, plans.

1.2 Purpose of research

The Storytelling Design Model, for the implementation of a Story Learning Object (SLO) is an educational method able to answer to principles of reflexion, collaboration and emotional learning, in order to allow the design of experiences composed of LOs being functional to an efficient transmission of learnt lessons. For this purpose, we have taken advantage of the results achieved by International projects of reference, trying to extend and maximize some unsystematized components for the learning. In particular, we focused on the pedagogical valorization of the cognitive transformations required by a complex and formal learning experience, and have inserted the emotional component as a factor able to intervene and at the same time sustain the achievement of educational objectives. The Storytelling Design Model takes as a model the story logics, included into INSCAPE and also utilized in Storytec for the scene sequence editing associated to a scene and situation, and integrates it inside a Story Visual Portrait (Ohler, 2008) that, in a systemic perspective, encourages the construction of a complete narrative experience. The SDM puts together SVP and Level of Competency (Dreyfuss, 2006) with respect to a concept of domain, and the specific phases or episodes with cognitive situations. Each cognitive situation responds to a Bloom's type of knowledge (Bloom, 1996). The SVP structure as an SDM will support the student during his/her transformational process, as it happens for a meaningful learning able to encompass all types of knowledge objectives in a specific level of competence. The model is characterized by an innovative way of applying concepts of macro and micro-adaptive didactics and of implementing the "role taking" model that gradually aims at supporting the development of student's metacognitive and regulative skills in emergency contexts.

At a **micro-adaptive level**, the story is characterized by a sequencing of cognitive situations associated to a test-driven adaptive process, finalized to estimate the type of targeted knowledge

acquired and to help the student bridge possible deficiencies. An assessment driven adaptive model, which makes use of a cognitive assessment model for knowledge transformation in storytelling portrait, is able to manage micro-adaptive processes to drive learners to the achievement of skills and knowledge associated to the Story learning phase. The transformational process is thought as a scaffold path that meets the educational presences requirements (Anderson and Garrisong, 2001) and that envisages, for each level, a type presence: (I) on the teaching presence (adaptivity bounded to multiple media enrichment with respect to preferences about learning styles or situational changes in order to refer to the problem posing generalization), (II) on the cognitive presence (adaptivity bounded to the valorization of role taking as an element of reflection and assimilation of errors and a correct decision making) and, finally, (III) on the social presence , that is manifested through a pedagogical help seeking (individual guidance through agents that take a specific role and a given character). The emotional and affective inputs are crucial to test the learner' specific state and to generate a sequencing of stimulus to bridge the gap with respect to the optimal value for a specific role in a specific event so to achieve the signed learning results. The added value consists in linking emotion to learning and assigning a didactic function of control to such a variable in order to lead the user to a state that can be considered ideal in view of cognitive assessment tests. The emotional component, to test the learner's condition at a given moment of the situation, makes use of a strategy that enables the student for the role taking, analyses the outputs and associates them to a specific and even complex emotional state/condition. The assessment model and the specific type of testing for different knowledge levels will improve a virtuous process of adaptive learning. Unlike micro-adaptivity types envisaged in the previous projects, which supposed a run time change in the story's logics with respect to feedbacks received from user's player models (Passage) or from skills to be acquired for the problem solving (80Days), our model extends and points out the formal learning component and associates adaptivity to knowledge types as well as their achievement, also through a process that guides the learner to maximize the cognitive and metacognitive component, by conceptualizing emotion and role.

At **macro-adaptivity level**, in storytelling learning objects, we refers to traditional techniques (used in IWT) of adaptation, such as adaptive learning path sequencing and adaptive navigation inter learning objects (C-LOs) within a Complex Learning Experience (C-LE). Generally, macro-adaptive interventions are based on the interaction between student model (learner model), acquired knowledge (knowledge model), didactic strategy (didactic model). The acquired knowledge assessment and the reached transformational level can determine the planning of a new and better path the user must follow to fill in the gap.

The type of stories that best fit to the project objective, whose SDM effectiveness will be assessed, are called "Stories About a Person"(stories honouring the memories of departed people) and "Stories About Events" whose didactic objective is to help and support the learner in "remembering people passed away". In this work we refer to a specific declination of SLO in the category of Memorial Stories related to big risk events, in order to demonstrate how such a Storytelling Design Model is more suitable than transmitting learnt lessons.

1.3 Viewpoints and Perspectives

In order to describe a SDM, we need to define a set of viewpoints focusing on specific aspects related to the life-cycle of the storytelling complex learning object. In addition, some perspectives have to be defined in order to capture the aspects involving more than one viewpoint.

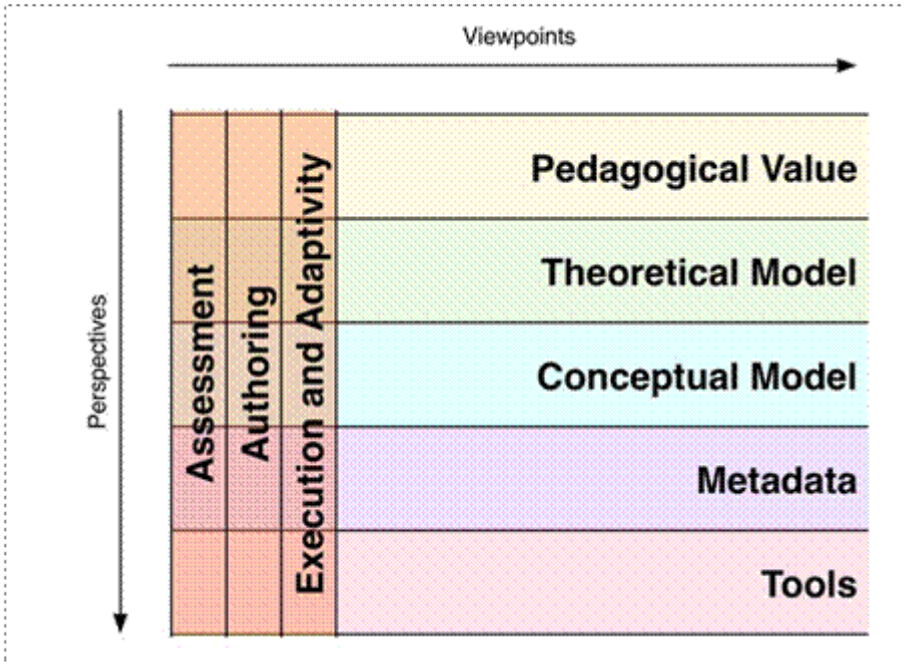

Figure 1.8 ViewPoints and perspectives

The **pedagogical value** of storytelling - as teaching mode relating to complex learning -is foreseen and motivated in Chapter 1 and then again in Chapter 2 in order to specify more precisely how the educational power of digital storytelling lies within the cognitive function that is inherent in the nature of narrative forms. The study on narrative learning environments (NLE) and their main types (NLE Intelligent, Multimedia and narrative editors, Home-made NLE) allows, on one hand, to understand how these environments differ in size, on the other hand it enhances the added value of experience story-based problem-solving activities. Two key challenges posed by narrative-centered environments for guided exploratory learning are i) supporting the hypothesis-generation-testing cycles that form the basis for exploratory learning, and ii) orchestrating all of the events in the unfolding story to support appropriate levels of student motivation, engagement, and self-efficacy for effective learning.

Chapter 3 addresses - from a **theoretical perspective** - the definition of a teaching narrative model. The storytelling learning object (SLO) is presented as an educational resource characterized by complex cross-linked narrative sequences, which we call story scripts. After a presentation of sector studies - in particular relating to the Story Map, we'll locate the SVP and its story core elements as the theoretical reference on which specialize the key component of our SDM. We also identify the logical elements and the educational facilities to guarantee changes in cognitive understanding them as changes in terms of competency and level of knowledge related to the target level of competency.

The **assessment** is seen as a component through the model that guides access to a process of narrative situations microadaptivity, which builds on the principles of teaching, cognitive and social presence. Techniques of **microadaptation** and individualization are essentially adaptive scenarios presentation, adaptive navigation story supporting role-taking and collaborative help. The emotional variable is inserted as an emotional element to ensure preventive and corrective element, functional to guarantee pedagogical efficiency to the lived experience.

The flow of the story, represented by the visual portrait story, depends on the theme conception or narrative sequences of events. Sets of related order of events are responsible for the flow of the story. In order to develop a significant and more **conceptual model** to create storytelling applications and processes, we need to focus the solution on the manner the general plan and the content are

organized and conveyed to the user. That is to say, we need to choose a topic map, that is a formal, explicit specification of our conceptualization to share. Conceptual mapping is studied in Chapter 4 as a useful teaching complex experience on the authoring side, to visualize different kinds of situations, events and roles, allowing the teacher to constitute the theme for a story and an episode. The mind map is a formal way of representing knowledge related to the story design model and can be utilized for the semantic reasoning of the stories. Helping the teacher in theme conception for generating new stories and new possibilities.

In chapter 5 an extension of the **metadata model** relating to the standard IEEE LOM is studied to facilitate the recovery and reuse of CLO and in particular of the SLO in the construction of collaborative complex experiences, allowing to search complex fields on pedagogically relevant information that supports the teacher or an intelligent engine (such as the one present in the solution IWT) to select and retrieve the resource able to complete the learning path suited to complex learning experiences.

Chapter 6 finally presents a reasoned **authoring tools** selection based on the requirements of its multimedia storytelling model and technology vision of the ALICE project. Furthermore, implementation issues will be given in order to fill the gap between the architecture model and the specific **executive and implementative decisions**.

2 Pedagogical Value: narrative learning and narrative learning environments

The narrative has received increased attention in education over the last two decades (Dettori, 2007). In the educational framework, a milestone is the definition given by Bruner (1990), which is rather general but well focused on the characterizing elements of narrative. He defines narrative as a "unique sequence of events, mental states, happenings involving human beings as characters or actors: these are its constituents. But these constituents do not, as it were, have a life or meaning of their own. Their meaning is given by their place in the overall configuration of the sequence as a whole- its plot or fabula".

The main point of this definition is the detection of a sequence of events as the characterizing aspect of narrative, which gives rise to a meaning construction process by the users, based on how they perceive the relation between the various elements and the whole sequence. This definition is consistent with the characterization of narrative worked out within literary studies. Ricoeur (1981), for instance, highlights the distinction between a chronological sequence of episodes and a configuration; he points out the need to mentally construct a configuration starting from a sequence of elements in order to build a narrative: "the activity of narrating does not consist simply in adding episodes to one another; it also constructs meaningful totalities out of scattered events. The art of narrating, as well as the corresponding art of following a story, therefore require that we are able to extract a configuration from a sequence".

Figure 2.1 Narrative learning Tag cloud (Dickey, 2006)

Other definitions of narrative by different authors spot slightly different characterizing aspects (e.g. causal dimension), yet always highlighting the need to fulfill some constraint to give rise to meaningful and consistent narratives. For instance, Aylett (2006) argues: "…we may see story as the interplay between the two poles of character and causation. From characters come the aspects of personality, emotional state and social standing, linked to causation via motives, intentions, plans and actions. From causation come the aspects of temporality and sequence, linked to characters by events and their outcomes. […]. The extent of this interplay has an effect on how far the result is experienced as

story at all: at one end of the spectrum, character disconnected from causation is experienced more as a cocktail party than a story (as in many online chat environments) while at the other, causation disconnected from character is experienced more as am game or puzzle than a story. However, from a perspective centered on learning, one can in any case take a view of story as a process of internal structuring of experience; of sense-making via narrative organization. Here, story is not so much the novel, play or film as the internal structure that results from reading or watching: the result of what we have termed the storification process through which this internal narrative is constructed". It is clear from these definitions that narrative can be a powerful cognitive tool thanks to its potential to support the construction of configurations from a set of elements and to start a meaning construction process in people who receive or produce it. It is on this support, which is intrinsic to narrative that its cognitive value relies.

The narrative is a privileged instrument for developing cognitive skills and organizing knowledge (Shank, 2000). This potential depends on the fact that the narrative has built, mostly in implicit form, induced by the juxtaposition of events, logical links between the elements involved as a result, each component contributes to shape the global meaning and this in turn , gives meaning to each element (Bruner, 2003). In this manner, and interacts with a narrative (as author or as a user) extends to more than is explicitly stated, this gives rise to a process of meaning construction. Although motivation and emotions, which are important aspects of learning, like knowledge, are positively affected by the narrative. As observed by Bruner [2003], "the narrative in all its forms is a dialectic between expectations and events" (p. 15), and "a call for problems, not a lesson on how to solve them" (p. 20).

This increasing interest in educational context is due to the important roles that narrative can play in human thinking, such as external representation (Turner and Turner, 2003; Porter Abbott, 2002; Lieblich et al., 1998); organizational principle (Polkinghorne, 1988; Pléh, 2003; McEvan, 1997; Kvernbekk, 2003) and cognitive process (Luckin et al., 2001; Scalise Sugiyama, 2001). There are several narrative theories in literature, mainly developed in the context of narratology, that highlight as narrative could serve as the foundation for guided exploratory learning and can be used as an effective tool for exploring the structure and process of "meaning making." The narrative experience can provide the guidance essential for effective exploratory learning and the "affective scaffolding" for achieving high levels of motivation and engagement.

The use of narrative in learning can be exciting and stimulating curiosity and imagination, which are essential components of intrinsic motivation according to the taxonomy proposed by Malone and Leppers [Rowe et al, 2007]. The positive influence on emotional results from the fact that the stories are based on an interaction between characters and causality [Aylett, 2006], which leads the subject to capture aspects of personality, emotional status and social positions of the characters and the reasons and intentions behind their actions. Stories are related to emotions and hence giving attention to narrative in education helps us understand that learning is not just about knowledge and cognition, but also about motivation, engagement, social interaction, and personal meaningfulness (Aylett, 2006; Gussin Paley, 2004).

The whole set of facets are practically involved in our project. Narrative crosses our educational proposal becoming media narrative that is complex digital storytelling. A new way to exploit narrative nowadays is through digital contexts. The development of ICT (Information and Communication Technology) and its increasing use in education has provided a variety of tools and techniques – from 3D graphics and animation to intelligent agents, from communication means to augmented reality – apt to exploit and strengthen the use of stories, giving rise to many different approaches to the use of narrative as a support for learning, as well as to a variety of Narrative Learning Experience with different applications and aims.

Following early studies in cognitive psychology, the area of Information and Communication Technology (ICT) has also begun to focus on the use of narrative as a tool to support learning. If we consider narrative and ICT together in the context of learning, some basic questions are in order. Is there an added value in using technology to realize narrative learning experiences? What are the advantages of embedding narrative in technology-based learning environments?

The use of narrative to relay information in the form of models of the world has been a large component of teaching and training. Most learners are familiar with the use of narrative in the form of stories and this has been used extensively in the development of the use of narrative in interactive multimedia. Narrative is principally used to provide structure and support in the on-line learning environment and learners respond well to narrative (Weller 2000). In the absence of narrative, learning environments can be unfocused and inconclusive (Laurillard 1996).

Weller (2000) explains that narrative is comprised of two components: the story and the discourse (or story telling mode). The story telling mode is influenced by the skills of the narrator. The authorial voice provides the pace of learning (Laurillard 1996) and signifies when significant points have been encountered. Learning in this way could be seen as acquisition in the absence of reflective thought. Because narrative plays such a central role in cognition and culture, narrative-centered curricula have been the subject of increasing attention. One of the most intriguing possibilities raised by the emergence of narrative intelligence is the potential to create narrative-centered learning environments. Engaging narrative-centered learning environments could play a central role in such a curriculum. They offer much promise for addressing the twin pedagogical goals of learning effectiveness and motivation. The notion of learning effectiveness has evolved considerably in recent years as many educators have embraced constructivist learning, which emphasizes knowledge construction instead of rote learning. Constructivist learning, with its emphasis on the active role played by the learner as she acquires new concepts and procedures (Piaget 1954), has made substantial gains over more didactic approaches. Because of the active nature of narrative, by immersing learners in a captivating world populated by intriguing characters, narrative centered learning environments can enable learners to participate in the following families of activities:

- Co-Construction: Participate in the construction of the narrative.
- Exploration: Engage in active exploration of the narrative, e.g., by considering how characters' intentions affect their actions in the evolving narrative.
- Reaction: Engage in post-hoc analysis activities by reacting on narrative experiences and their underlying subject matter.

By taking advantage of the inherent structure of narrative, narrative-centered learning environments could provide engaging worlds in which students are actively involved in \story-centric" problem-solving activities. Narrative-centered learning environments offer significant potential for supporting guided exploratory learning.

2.1 Getting to Know Narrative Learning Environments (NLE)

NLE are learning environments where stories are used with the aim to facilitate and improve learning. In general, the use of stories can be realized either by presenting a story somehow connected with the tasks at hand or by providing an environment where stories can be created. Each of these possibilities can in turn be implemented in a variety of different forms. It is important to reflect on the fact that not any learning environment that includes a story can properly be considered a narrative one. Let us think, for example, of one where a story is given as an appealing background where a number of problem solving tasks are proposed, without a conceptual integration between the given tasks and the narrative fruition process. This is frequently the case with many computer games or drill-and-practice educational software tools. In this case, the back-story simply aims to provide a generic motivation

encouraging the learner to tackle the assigned tasks. This may appear strategic in disciplines that are scarcely appealing for the students (e.g. mathematics), as a way to put sugar on an unpleasant pill (Aylett, 2006), but it does not characterize those environments as narrative. This does not mean however, that providing a motivating narrative always functions only as sugar on the pill. It may very well be the case that a narrative is used to motivate careful and higher-order analysis of a given situation, so as to deepen understanding or help the construction of personal meaning (e.g., Timchenko, 2006). In fact, the cognitive purpose and the motivational one are often intertwined. When this is the case, the learning environment can properly be considered a narrative one.

Analogously, as concerns the environments where a narrative is created by the learners, the tasks should be formulated and the activities guided so as to lead to the construction of cognitively meaningful narratives, that is, logically consistent configurations of causally connected events. An ever increasing number of studies on technology-enhanced narrative environments, however, has highlighted that the use of different media (Fusai et al, 2003) and technological tools (Aylett, 2006) affects the learning affordances of an environment, so that the use of different ICT tools influences the kind of cognitive activities that can be carried out in a narrative environment, and hence the learning that is expected to take place in it. What do narrative learning environments look like? There is not a single answer to this question. They include environments providing different tools for the creation of narrative (from multimedia features to functions checking story consistence), computer games, drama and storytelling, as well as activities of various kinds where story construction is part of an overall task or where a back-story helps to connect different subtasks in meaningful way.

How is it possible that such a variety of different environments were created and all are NLE?

2.2 Narrative Learning Environment Type

The point is that the educational potential of narrative has raised the interest of different research fields working with education (and not only), which have considered it from different points of view and hence exploited it in different ways to build effective learning environments. Hence, environments of this kind have been originated independently in different fields, in particular within studies on Artificial intelligence, Multimedia, and Instructional design. Following the varied origin of the different approaches, we can roughly spot three kinds of NLE, corresponding to the 3 above mentioned research fields:

Intelligent NLE: The first group originated from research in the field of Artificial Intelligence (AI). Besides being the most numerous, this group has also been the first to be developed in a systematic way. The expression NLE started to be used in this context and hence it is not surprising that it is sometimes employed to mean only these environments. This group consists of interactive NLE, that is, technological environments in which the users interact in not trivial way with the system to generate consistent narrative, thanks to the implementation of intelligent agents and other AI techniques. Among them, we find virtual drama and storytelling, as well as a variety of computer games and augmented reality environments, where interaction takes place not only by using standard I/O devices but also by manipulating real objects or moving in a physical space equipped ad hoc (the name augmented-reality means that they are based on a mixture of virtual and real elements). Several intelligent environments have been developed in the past decade within a number of research projects; unfortunately, most of them remained in the form of prototypes and are not commercially available. Implementing this kind of environments entails working out a solution to a number of technological and conceptual issues. A major issue regards making computers automatically generate consistent and believable narratives. To this end, researchers have been drawing from narrative theories formulated within narratology studies (Cavazza & Pizzi 2006) in order to spot the main constituent elements of a story, or derive formalism for their implementation. Another important issue

concerns granting real interactivity between human and computer on narrative construction. This entails addressing a number of questions to balance user's freedom and system's intended aims. Research in this field has given rise to a number of different approaches (Paiva, 2005), leading to a variety of solutions for the creation of the so-called emergent narrative, that is, consistent stories collaboratively created by means of human-computer interaction (Aylett, 1999). Due to the presence of intelligent functions, turning the use of such environments into real narrative learning experiences (i.e. exploiting the educational potential of narrative) usually does not require much intervention of a teacher or mentor, since interactive environments can be explored by the students rather independently. An overall coordination of the activity is always advisable, however, by an experienced person who can suggest what kind of activity can be suitable in each learning situation considered). Well known examples are:

- Carmen's Bright Ideas (http://www.isi.edu/isd/carte/proj_parented/)
- FearNot! (http://info.nicve.salford.ac.uk/victec/)
- Teatrix (http://gaips.inesc-id.pt/teatrix)

Multimedia and narrative editors: The second group of NLE, which sprang from research in multimedia, includes hypermedia environments with some narrative guidance, and narrative editors, that is, multimedia editors explicitly oriented to the creation of narratives in the form of cartoon strips or short movies (Earp & Giannetti, 2006). As concerns hypermedia products presenting a narrative, they can properly be considered NLE only if the given story leads the users to consider the variety of elements involved in a complex problem situation, hence helping them to build a (mental) configuration of it and work out a strategy to look for solutions. In this case, the story provided has the role of a container to highlight the elements of the considered problem and help the user relate them with each other in a meaning creation process, which is functional to the construction of a solution. This data-highlighting role in complex situations is not trivial nor irrelevant in relation to learning, in that some research studies underline that problem solving is more often hindered by an incomplete or inaccurate analysis of the data involved than by the lack of a suitable solution strategy (Sutherland, 2002). As concerns the learning environments based on multimedia and narrative editors, they require a precise didactical guidance in order to really exploit the educational potential of narrative, in that an inexperienced learner may fail to check the consistency of the stories/mental configurations constructed or to reason on causal constraints if not suitably guided or prompted to do so. Several narrative authoring tools of good level are currently commercialized, such as:

- Kar2ouche Composer (http://www.mediastage.net/kar2ouche/)
- MediaStage (http://www.mediastage.net/mediastage/)
- Story Maker 2 (http://www.spasoft.co.uk/storymaker.html)

Multimedia editors usually offer analogous, and sometimes better, facilities for multimedia composition, but do not provide choices of characters and story-like backgrounds, as it is the case with narrative ones. A teacher or mentor can conceptually build an NLE on top of narrative or multimedia editors by proposing meaningful tasks and suitably guiding students' activity.

Homemade NLE: we can find in the literature examples of NLE, which make use of general-purpose technology and envisage some narrative task within the overall design of a learning activity. An example is provided by De Vries (2006), who reports a case study on a narrative activity realized by exploiting experiential narration and using e-mail as communication tool, with the aim to stimulate reflective thought in the learners. Another example is provided by Dolk & Den Hertog (2006), who challenges student teachers to collaboratively develop narratives of paradigmatic classroom situations in mathematics education. All such environments are characterized by a strong human component, since human intervention is necessary to plan the activity and include a meaningful phase of narrative construction. Some technological tool is used in connection with the narrative activity, to amplify its

impact: in the mentioned cases, it is email for De Vries and a multimedia environment to show videos, named MILE. Such “homemade” NLE usually do not require any sophisticated technological tool, but require a good knowledge of educational theory and of NLE in order to plan meaningful and consistent narrative activities, well articulated with the overall learning design. They also require care and attention while carrying them out. Due to the scarce amount of specialized software involved in such environments, it is easy, for the inexperienced reader, to mistakenly include in this group educational experiences of other kind, like the use of narratives by teachers to make their lessons more effective, appealing and motivating. Without denying the importance of such uses of narrative, we wish to remind the definition of NLE given in a previous section, which implies a focus on learning, together with some active involvement on the part of the students and the use of some technological tools, in order to support learning by exploiting the intrinsic potential of narrative

2.3 Taxonomies and NLE

Different dimensions of NLE can be detected, namely the role of the student, the educational approach and the technological means.

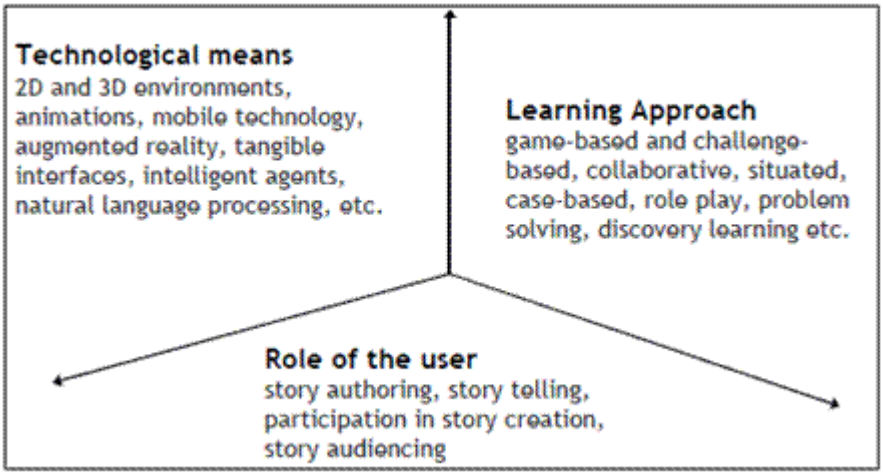

Figure 2.2 Dimesions of NLE (Dettori, 2006)

Each of them is shortly explained below.

Role of the student. Each student can be associate with different narrative (definite role) to play, he can be given a format to follow, that is a model role to take (role taking) or can be given free opportunity to create and produce a narrative (role make). Story production, thus, includes creation, telling and participation at different levels. Each of such activities puts into play different abilities. When creating a story, the learner invents it and makes a (usually external) representation of it in some format afforded by the tools available. On the other hand, when taking a storytelling activity, the user follows a detailed format but has the freedom to adapt it to his own style and needs; finally, when carrying out a storytelling activity, the learner tells a (more or less well known) story created by somebody else. In the first case, creativity is stimulated, while in the second case memory and the ability to personalize yet preserving consistency with the original are involved; in the third case, only the ability to act and perform a certain script is involved. In all the cases the activity can be carried out individually or in cooperation with some (human or virtual) agent, which entails negotiating the overall development of the story. If in joint story creation each (human or virtual) agent involved handles

his/her/its own characters, and hence the narrative rises from the actions individually decided by each of the agents, then we speak of participation in story construction.

Learning approach. We mean by this term the approach to learning and the educational strategies underlying the activity to be carried out within the environment. NLE can be realized following different approaches that aim at supporting cognitive, metacognitive as well as affective levels of learning, such as inquiry or discovery learning, problem-based learning, experiential learning, collaborative and cooperative learning, role play, etc.

Technological means. Among the variety of technological means that have been used in NLE, some influence the appearance of the environment and user interaction mode, while others determine the environment's structure and kind of narrative experience afforded. The first group includes 2D and 3D graphics, animations, sound, tactile interface. Intelligent agents, natural language processing, multimedia editors and general purpose tools, in particular communication ones like email or blogs, belong to the second group. If we consider each environment as the combination of the possible values of these three dimensions, it is not difficult to figure out what great variety of NLE is possible

In order to clearly detect the educational potential of a narrative environment it is necessary to carefully analyze the cognitive tasks implied and the abilities put at play. Let us see, for example, what different applicability and learning can be offered by three environments that an inexperienced user might consider similar in that both aiming to help the creation of stories.

2.3.1 Carmen's Bright IDEAS

Carmen's Bright IDEAS (IDEAS is an acronym derived from: Identify a solvable problem, Develop possible solutions, Evaluate your options, Act on your plan and See If It Worked) is a system that uses Artificial Intelligence designed to help parents young cancer patients to cope with the disease and manage the complexity of a family situation that is unavoidably compromised. This educational program aims to guide users to the acquisition of a methodology for problem solving to address real problems. The characters of the story presented by the software are Carmen and Gina. Carmen, who has two children, one with leukaemia, is faced with a difficult family situation, Gina, his consultant, helps with his advice. Autonomous intelligent agents drive the characters, then there is no storyline default, where the user can only choose its own path of reading, but the episodes are generated during execution. The user may in part influence the course of history by choosing between several "options" presented as the thoughts of the character Carmen in some parts of the story. The program was tested in the United States in several clinical studies and received a positive evaluation on its effectiveness as a training tool for developing problem-solving skills in the family, in relation to this clinical situation. The environment and its characters are the people seemed credible and convincing. Referring to the dimensions of the individual observer to history is presented but may partly affect the course. The educational approach is based on case study and use of participatory storytelling. Technological means used include 2D graphics with intelligent agents.

Figure 2.3 User must choose between Carmen's thinks (Marsella, 2000)

2.3.2 Teatrix

Teatrix is a learning environment for children and teens, developed to help both the collaborative creation of stories in the staging of the same. The system provides a database of scenery, props and characters, along with two different working environments, called back-stage and onstage. In the first users determine the structure of the story, choosing the scenes where the action will take place and define their sequence. Then establish the characters, choosing from eight predefined types (infant, child, fairy, witch, Little Red Riding Hood, Grandma, hunter and wolf), assigning them a role, choose between 6 basic roles of the characterization of Propp (1971) - hero rogue, mage, parent, loved one, helping - giving them a name and completing the description of their characteristics and some characters have predefined characteristics, e.g. the witch is always bad, while others, like the child, are set at the discretion of the students. Each character-type can be chosen several times, the characters of the same type may be classified for a description of their characteristics and to the name you assign.

Figure 2.4 Function of hot seating – teatrix

At the time of representation, some characters are animated by the children, while those defined but not interpreted by the children are motivated by the system using intelligent agents. During the creation of history, the system provides a particular function performed by means of intelligent agents, called hot-seating to guide children to think about the history made by checking the consistency between the definition of their characters and the different actions they perform. As for the dimensions mentioned in the previous section, this system can be classified as follows: The user can play the role of author or participant in the creation of a story, and of course the narrator of a story already known, the teaching approach made adopted consists in a role-play, the technological means used include two-and three-dimensional graphics with simple animation, and intelligent agents.

2.3.3 Media Stage

Media Stage is software for creating three-dimensional animations. The program has two different environments for the creation of history and for its display. Students can direct the authors of the history leading to virtual characters and their movements by making them recite strings of dialogue that can be written by the students of the program or selected from the repertoire of phrases and sentences in English. The dialogue can be recorded or reproduced by the students with a text-to-speech, which produces oral sentences from sentences written proposals by the user. For these characteristics, the environment aims to promote the development of communication skills, particularly in English. The user can create, or participate in the creation of telling a story. The educational approach is constructivist, and may include role-play, although it is not given an explicit description and distinctive character. The technological tools used consist of more complex 3D graphics and animations, are not provided intelligent features.

Figure 2.5 Building of a story and visualization in Media Stage

2.4 Reflections about differences and challenges

Regarding the role of the user, the examples presented belong in pairs respectively to all the places where you can create a narrative (Teatrix and Media Stage) or enjoy a narrative (Carmen's Bright Ideas). In each of these groups, however, the presence of a different educational approach and functionality implemented through various technological tools enables different narrative experiences, meeting other educational objectives. If we compare the two environments author for the creation of narrative, and Teatrix Media Stage, we see how the experience of building a story can be structured and developed in different ways. In Teatrix, the types of character available to build a story are in limited number, but are completed by a description, which constrains their possible behaviour. Hence, constructing a narrative in this environment actually results in a role-play activity. The environment includes an intelligent function (the hot-seating tool), which aims to detect inconsistencies in characters' behaviour and monitor the overall consistency of the story, thus encouraging the conception of an intentional dimension for the characters. This environment, therefore, strongly supports the development of a narrative competence, in particular as concerns causal reasoning. Media Stage, on the other hand, is more oriented to the development of communication skills. It pays attention to dialogues formulation, providing archives of sentences and multimedia facilities, like the possibility to record people speaking or produce spoken sentences by means of a text-to speech tool. It offers a library of backgrounds, props and characters, which is much richer than that provided by Teatrix, with more complex animations and a more refined graphics. These features can not only support the creation of more articulated and fancy stories, but also favour the acquisition of a technological literacy in relation with multimedia expressive abilities; these are not irrelevant skills in the current cultural context influenced by an ever increasing diffusion of powerful technological tools. The two environments share the use of visual elements (backgrounds, props and characters), which encourage creativity and make story creation more concrete and faster than it would be possible in traditional classroom work (i.e. by drawing or dramatization), where often time constraints strongly limit the good development of such activities.

By taking advantage of the inherent structure of narrative, narrative-cantered environments provide students with engaging worlds in which they actively participate in motivating story-based problem-solving activities. Two key challenges posed by narrative- centred environments for guided exploratory learning are (1) supporting the hypothesis-generation-testing cycles that form the basis for exploratory learning, and (2) orchestrating all of the events in the unfolding story to support appropriate levels of student motivation, engagement, and self-efficacy for effective learning.

3 Theorical Model ViewPoint

Previous studies (see section 2) on the narrative learning environment map the features of a new model of storytelling learning object (SLO). A Storytelling Learning Object (SLO) is a complex educational resource characterized by cross-linked narrative sequences, which we call story scripts. After a presentation of sector studies, relating in particular to the Story Map, will move on to a story requires the presentation of our model and micro-adaptivity. Finally, we will devote part of the model to the transformation envisaged in our story learning object in terms cognitive and emotional transformations, as they are functional to the process of adaptive assessment and the sequencing of instructional components defined as provided in SLO.

3.1 Story maps & Story elements

Story mapping is basically a process of fleshing out the story core with story details. There are many approaches to story mapping (Ohler, 2008). Aristotle dramatic diagram. Long, long ago, in an English classroom on the campus of the University of Toronto, one professor sketched out the following diagram to depict the nature and flow of what Aristotle considered to be “effective drama” or in our terms, “a good story.” It is derived from Aristotle’s famous treatise about art and drama (among other things), called THE POETICS. While THE POETICS isn’t what I would call a page-turner, it is amazing how well it describes the essential elements of a good story, even today. The basic shape is a hill or mountain, which characters must climb to live out the story. Aristotle called conflict creation “the tying of the knot;” tension resolution was “the untying of the knot.”

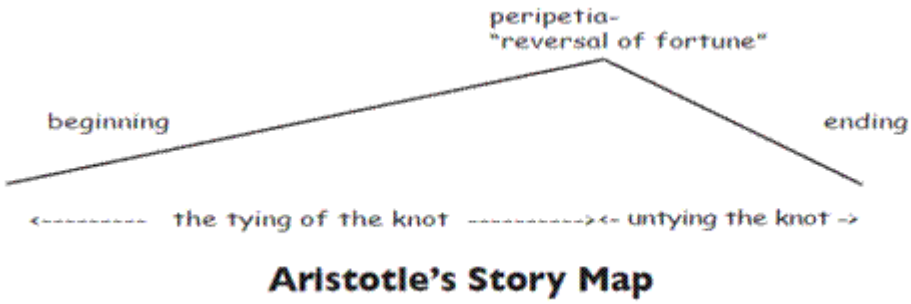

Figure 3.1 Aristotle's map (Ohler, 2008)

Transformation is brought about through “a reversal of fortune” of the hero at the top of the mountain. In Aristotle’s day, endings were important, though most of them weren’t happy. Pretty much people ticked off the gods, suffered and died. But they did so according to the particular formula presented here. Aristotle’s story map has a nice kinaesthetic quality to it, and this map is easy to relate to. It shows the rising and falling of the story in simple terms; it is basic yet powerful.

Modified Joseph Campbell Map: Joseph Campbell’s work (1973) has done more to inform storytelling than any other body of work. He spent his lifetime finding similarities in myths and stories throughout the world, and presenting a coherent view of the kinds of universal emotional, psychological and social needs that stories meet. No book on storytelling would be complete without referencing his work. The modified version of his story map (from Campbell) presented here fits better with the “keep it simple” approach to mapping we are using in this book. Compare this with the original

in the appendix and you will note that Campbell has used different names and included a lot more detail. But the basic journey – or story – is the same. The basic shape is the circle, which conjures up a number of useful images: the never-ending story, the journey home, and so on. Campbell believed that heroes ended up where they began, though they were changed by their experience.

In our work we focus our attention on a new model that has been guiding in the last years the development of story based didactic resources. We consider the story map developed by Brett Dillingham (2001), called a "visual portrait of a story" (VPS). Take a good look at this story map. Walk through it in your mind a few times, following the solid black line as though you were following a path on a journey into new yet somehow familiar territory. Now let's look at the essential story elements and how they are accommodated by the VPS.

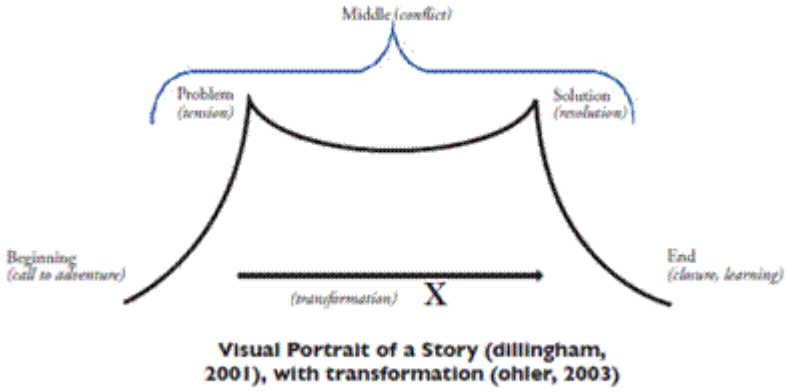

Figure 3.2 Visual Portrait of Story (Ohler, 2008)

A story core has the following three basic elements defined Story Core's Elements

The central challenge that creates the story's tension and forward momentum. This can be a question, a problem, an obstacle, an opportunity or a goal that needs to be addressed by the main character in the story. The challenge creates tension that gives the story its forward momentum, which in turn produces listener involvement. The main character can be anything from a rock, to a group of animals, to a student, to, in some cases, the audience itself.

Character transformation that facilitates the response to the challenge. Transformation is difficult and is often resisted, a portrayed in the picture below. Transformation is the essential change that a character needs to undergo to address the challenge, obstacle or opportunity. Sometimes the transformation occurs at the end, and, rarely, at the beginning. But it is usually most powerful when it occurs in the middle and facilitates the response to the challenge. Typically, change is a struggle. Either "life" or the "old you" pushes back as new circumstances or a "new you" struggles to emerge. If change comes too easily in a story, the audience disengages.

The response to the challenge that resolves the tension and leads to story closure. The character addresses the challenge made possible by the transformation. This can mean solving a mystery, slaying a dragon, reaching a goal, applying new academic knowledge or learning processes, overcoming an obstacle… anything that addresses the challenge,

resolves the tension and leads to closure. Closure by no means implies a happy ending, just a resolution of events.

3.2 Visual Portrait of Story Learning Object (SLO)

A Storytelling Complex Learning Object is an educational object characterized by cross-linked narrative sequences. In a Storytelling CLO, a script is a logic composition of various situations, based on the phases of a visual story portrait (beginning, call adventure, problem, middle transformation, solution, closure).

The episode and related situation referring to a Visual Story portrait (VSP). The basic VPS adapted by Ohler (2008) it appears below:

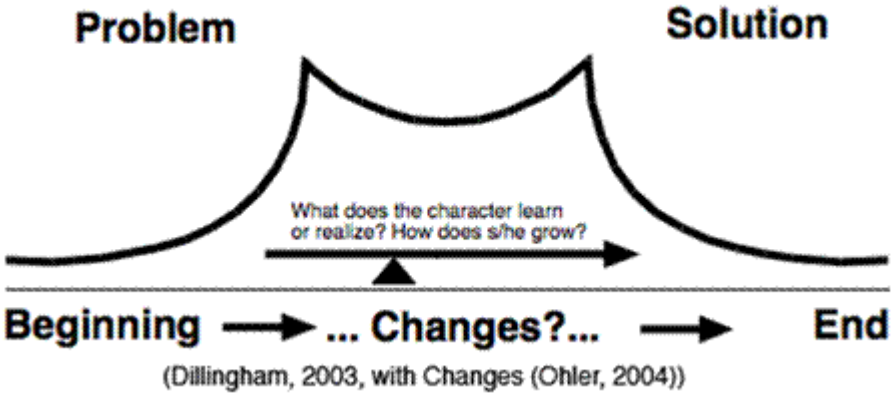

Figure 3.3 Transformations in digital storytelling

The map shows the five essential components of the VPS and are explained below:

Elements of a beginning (call to adventure). The story begins by moving out of the flat, ordinary events of life to new heights of experience. The upward movement of the curve suggests that characters are going to need to climb to get to where they are going. The key elements and characteristics of the beginning are:

- Information is presented that grounds the listener in the ordinary life of a character or group of characters.
- A hero or main character is “called to adventure” (Campbell, 1973) in which the ordinary routine of life is interrupted. It is because of the suspension of ordinary events that a story emerges.
- A quest of some kind is described or begun. The listener understands that the main character, perhaps with help from others, needs to accomplish something or go somewhere. This establishes the beginning of a problem that must be solved, and/or a conflict that needs resolution

Elements of a middle (conflict, consisting of problem/solution, tension/resolution). Elements and characteristics of the middle (conflict) are:

- The full extent of the tension, problem or conflict is made apparent. The story focuses on a series of adventures that are related to solving the problem and relieving the tension. “Problems” can be challenges or opportunities as well as obstacles.
- Tension is increased through the use of situations that beg for some kind of resolution; readers subconsciously want to know “What’s going to happen next?” Failure to answer that question (by providing extraneous detail, special effects, etc.) dilutes the story. There can be a series of such situations in which the characters, through failure, persistence and personal growth, finally achieve a goal.
- In the process of traversing the path from problem to solution, the character learns, grows and becomes a new person in some significant respect. Vicariously, the listeners do, too. I address this separately in the next section on transformation.

Transformation (middle, continued). Let’s consider the transformation part of the middle separately for a moment. Note how it is represented, as an arrow moving toward the resolution, which has an X (shorthand for “transformation”) as its off-centre fulcrum. Visually, it makes the arrow tip up, implying a positive but uphill change. That is, things may get better but it will take work to make it happen. The key to transformation is that the central character (or group) cannot solve the problem of the story easily or simply; s/he needs to change in order to do it. S/he has to be pushed and tested by the situation to grow and learn something new. If the central character does not undergo some sort of transformation on the way to solving the problem, then listeners are dissatisfied, often feeling cheated by their listening experience. Elements and characteristics of transformation are:

- The **main character** needs to transform in order to solve the problem or achieve resolution. S/he needs to become stronger, smarter, wiser, more mature or some combination of these. Transformation is covered in some detail in the chapter “transformation formations.”
- Transformation runs the gamut from the sublime (Luke Skywalker needing to become a Jedi to defeat the Dark Side) to the banal (a character in an advertisement realizing which deodorant to buy in order to make him more successful in life).
- Transformation usually needs to involve slaying some personal, internal dragon, such as insecurity, misunderstanding, ignorance, cowardice, close-mindedness or some other character flaw.

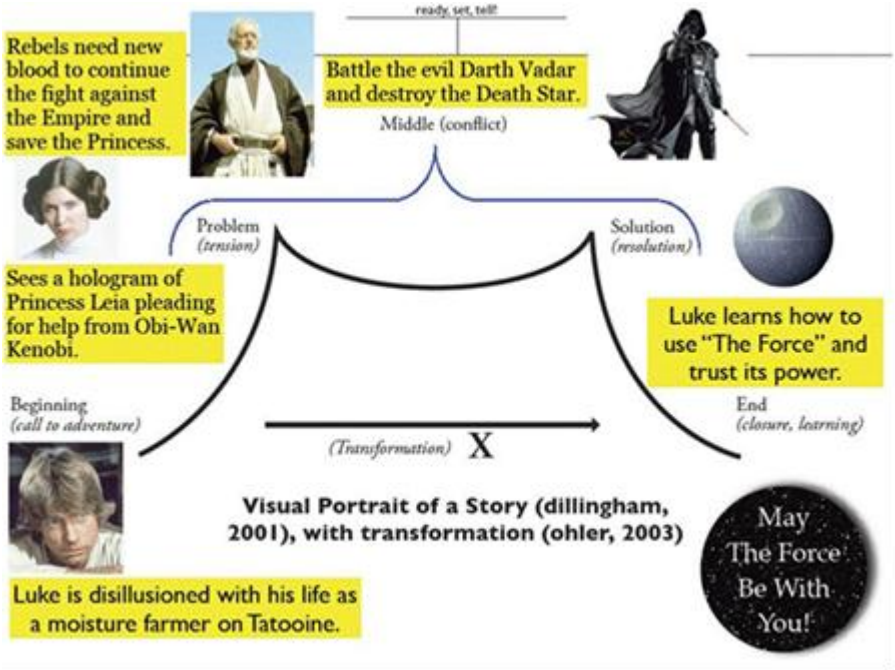

Figure 3.4 Visual portrait of Star Wars[1]

Elements of an end (*closure*). After the story's problem is solved, there needs to be closure that doesn't leave the listener feeling like the story teller 'has simply run out of material'(Egan, 1988). This does not necessarily mean a triumphant or a "they-lived-happy-ever-after" ending. It simply means that the listener needs to feel as though a goal has been reached, that s/he has come full circle, or that events have been concluded. Essential elements and characteristics of an end are:

- Stories need closure. Stories need to have endings that allow listeners to feel as though their personal investment in listening has not been in vain.
- The essential transformation, and what is learned from it, is somehow put into play. Life goes forward differently because people have been transformed. You, the listener also feel changed. You feel you understand something, or have experienced something, you would not have otherwise.
- Stories can conclude in an obvious way, such as stating what has been learned in the form of a moral or personal revelation. Or the story can move forward with some action that shows the learning has been internalized by the characters; this is what is called in writing "showing rather than telling."

3.3 "Transformation formations" and assessment in SLO

As a way to assess the power or "storyability" of situations may be better to conceptualize a story in terms of "transformation formations". The main character transforms in some significant way, such as learning something important, becoming more skilled, mature or courageous, or developing personal insight and understanding. Characters can transform at as many of these levels as make sense. The levels are not mutually exclusive by any means, therefore characters often transform at more than one level at the same time.

[1] from http://www.slideshare.net/Fiona/virtual-portrait-of-a-story

Level	Kind	Explanation
1	Physical/kinesthetic	Character develops strength or dexterity. Popeye eats spinach and grows muscles; 'Baby' (Jennifer Grey in **Dirty Dancing**) learns how to dance and wins the contest.
2	Inner strength	Character develops courage, overcomes fear, at great risk to themselves. Lucilla and Proximo (Connie Neilson and Oliver Reed in **Gladiator**) help Maximus (Russell Crowe) in his effort to restore the republic of Rome.
3	Emotional	Character matures, thinks beyond his or her own needs; Hans Solo returns to fight the good fight in **Star Wars**.
4	Moral	Character develops a conscience; Schindler develops his list
5	Psychological	Character develops insight, self-awareness. Neo (Keannu Reeves in **Matrix**) understands who he is in relation to the Matrix.
6	Social	Character accepts new responsibility with respect to family, community or a group; Max (Mel Gibson in **Road Warrior**) sticks around and helps the small oil refinery community defend itself against terrorist bike gangs.
7	Intellectual/creative	Character advances intellectual/creative ability to learn or do something new, allows him/her to solve a problem, puzzle or mystery (Neo in the **Matrix**). This level captures the essence of making students heros of their own learning stories.
8	Spiritual	Character has an awakening, which changes his or her entire perspective. With the help of a lama, Larry Darrell (Bill Murray in **Razor's Edge**) achieves a kind of enlightenment that alters his perspective of what is important about life.

Figure 3.5 Trasformations in SVP (Ohler, 2008)

Our storytelling model mostly considers the intellectual transformations seeen as changes in terms of competency and cognitive level linked to the target competency level.

According to Le Boterf (1994) competence is not a state but a process which resides in the mobilization of resources of the individual (both procedural and theoretical knowledge, know-how, experiential and social), and thus be able to know how to act or react later to a particular situation or problem (situation) in a given context so as to achieve a performance. In this sense, every situation has a performance to be achieved by the learner.

The level of final competence (Dreyfus, 1986) reached will be expressed following the above list of definitions: novice, advanced beginner, competent, proficient, and expert.

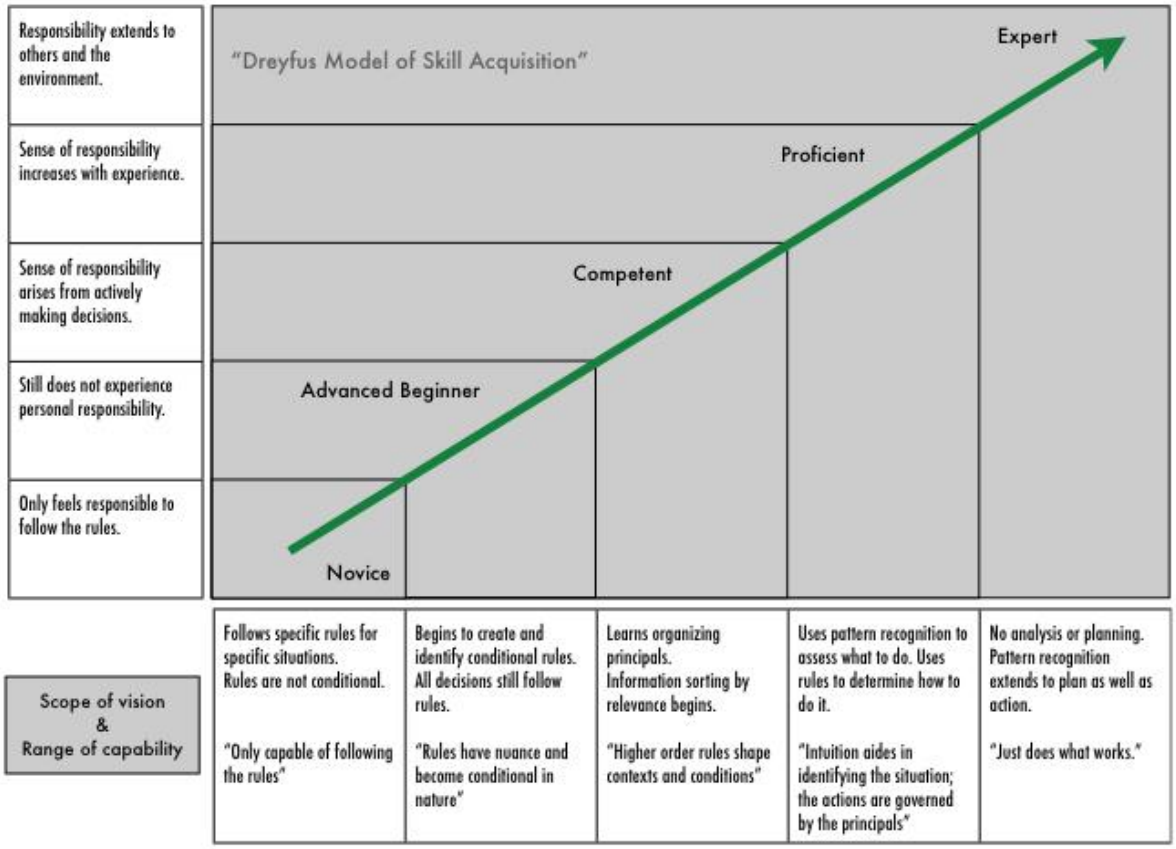

Figure 3.6 Level of Competency (dreyfus, 2003)

Every situation is in relation with level of competence and to Novice-to-expert scale. In un'esperienza narrativa che mira a raggiungere uno specifico livello di competency il learner va incontro ad alcune trasformazioni che possiamo dire "cognitive" in riferimento alla tassonomia di Bloom. Essentially what Bloom has developed is a hierarchy of transformation.

Bloom's Taxonomy of Cognitive "Transformation"		
Level	Kind	Explanation
1	Knowledge	Character knows, remembers or describes something
2	Comprehension	Character explains, interprets, predicts something
3	Application	Character discovers, constructs or changes something; applies understanding to a new situation
4	Analysis	Character deconstructs a situation, distinguishes among options, plans or organizes something, compares and contrasts different things
5	Synthesis	Character pieces together parts to form a new understanding of a situation
6	Evaluation	Character assesses a situation, critiques and/or defends an idea, person; evaluates a situation in order to respond to it

Figure 3.7 Bloom's Taxonomy and transformation (Ohler, 2008)

We have linked the cognitive transformations with Blooms taxonomy and correspond to the phases of the visual portrait (see figure below)

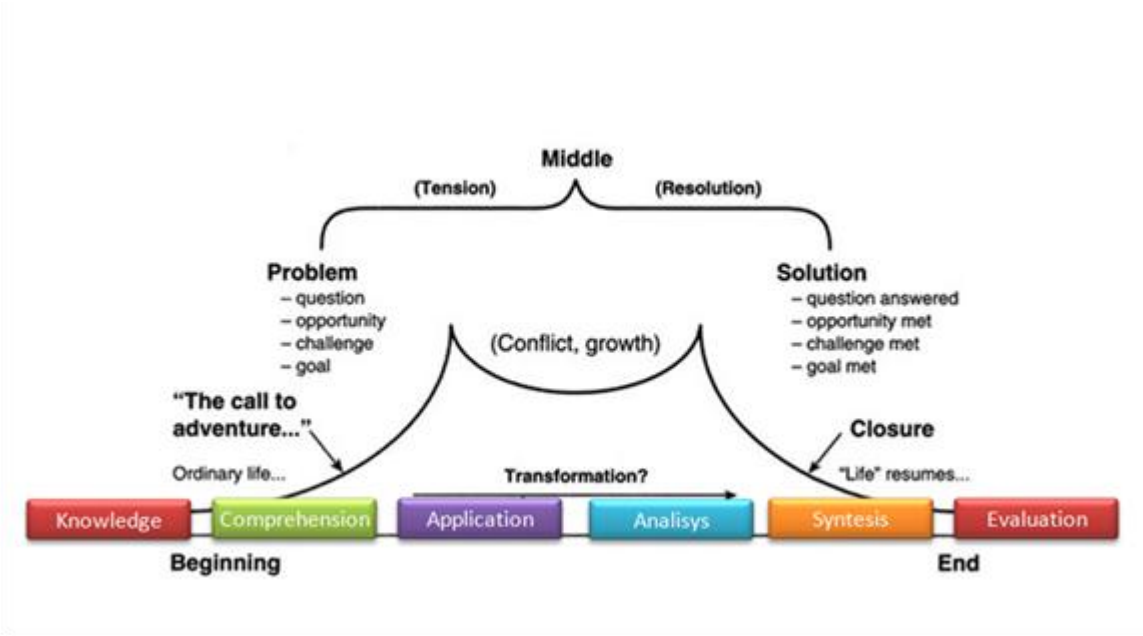

Figure 3.8 Match between visual portrait and Bloom taxonomy

Cognitive assessment: assessment of knowledge on the considered topic. For example, when a learner has to choose objects to put inside the emergency bag or when he has to describe the situation in the chat box. The right choice or description have a positive feedback on his cognitive state and influences the selection of the next situation.

3.4 Storytelling situations and general composition for Knowledge acquisition

In a Storytelling CLO, a script is a logic composition of various **situations**, based on the phases of a visual story portrait (beginning, call adventure, problem, middle transformation, solution, closure). A situation is a combination of circumstances at a given time and place in the flow of story.

Every situation has a music in background different and in relation with phases of Visual Portrait of Ohler. This is for a learner a guide during the story so s/he knows where s/he is in the story (beginning, middle ect...)

We have the following elements that characterize different **situations**:

- **Stage**: the background for the situations
- **Event**: something that happens at a given time and place and that can determine or change a situation
- **Action**: a possible action to be performed in a situation
- **Role and Character**: In digital storytelling, we have two major categories of characters: the player character (the heroes) and non-player characters (assistants, helpers, antagonists, they are functional to the heroes development) chosen among an established range and has one or more roles to portray, according to the situations and the flow of the story. Instead, a character in the story can be for example a doctor, a fire fighter who can take on different roles at different times.

The combination of these elements for each situation has the objective to enhance the desiderata learning level and to sustain the learners' cognitive transformation. In order not to lose the reader, we

present the macro components of a situational SLO so as to understand what are the factors that the design tool should help to define within the resource complex.

Each story situation has 4 parts:

1) **advancer event**
2) **learning event**
3) **reflection event**
4) **assessment event**

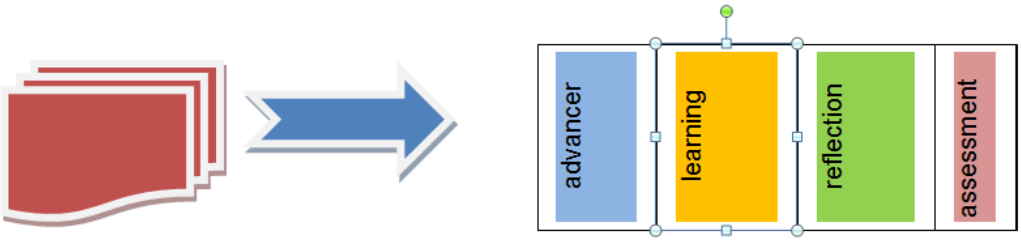

Figure 3.9 story situation structure

The user plays different characters observer, the protagonist, the STC's character is assigned by the system according to their profile test. Initially assessed through a system composed of the situation based on the results of the final events evaluative cognitive and emotional / affective each situation (see 4.4 and 4.5).

3.4.1 Storytelling Situation's examples

Example of situation to sustain Knowledge as educational objective

- **Advancer event** screen shows a text in the form of a newspaper article in which we read of an earthquake
- **Learning event** we see two animated figures a father and son who speak each other through comics (cartoon), the father teaches the child what is an earthquake, it is recognized as an earthquake, what are the warning signs, adverse events
- **Reflection event** we see several scenes in which they represented different types of earthquakes
- **Assessment event** we see a scene with a road in which objects move swaying and you see three icons representing three options: earthquakes, landslides, outbreak of something.

Learner can, if he wants in assessment, call a helper (a teacher, other expert student online, a pedagogical agent), he sees on desktop a telephone and he can click on an icon that represents a teacher, student, a pedagogical agent, so he goes in a Collaborative Situation.

Example of situation to sustain Synthesis as educational objective

- **Advancer event**: a text, shaped as a newspaper article is shown on the screen, describing an earthquake and the safety rules to adopt during this seismic event.
- **Learning event**: two animated figures, a father and his child, are talking through a cartoon and telling about a seismic event they have lived through and how have escaped.
- **Reflection event**: there is an earthquake scene in which some characters are trying to escape, some of them fall down under collapses, some others get saved applying appropriate behavioural rules for that event.

- **Assessment event**: cognitive and emotional/affective type. In a room some objects fall down from the shelves, a chandelier sways and other icons representing three safer places to seek for shelter during an earthquake. The learner has to choose the right icon to be safe, otherwise, receiving a negative feedback for each error (emotional assessment), gets wounded by that event, while two more icons appear, one of them is a telephone that the learner can use to call for help (a friend – the fire-fighters brigade etc.)

The learner can, if he wants in assessment, call a helper (a teacher, other online expert student, a pedagogical agent), he sees a telephone on his/her desktop and can click on icon that represents a teacher, a student, a pedagogical agent, entering a Collaborative Situation.

Example of situation for sustain evaluation as educational objective

- **Advancer event** a voice is coming from a radio that the user has to turn on at the beginning of the situation.
- **Learning event** two men talk one another about an earthquake and the rules to follow during the earthquake.
- **Reflexion event** an earthquake scene in which some characters act and talk one another, according to the above mentioned rules. They ask questions to the learner, who answers using the icons on the desktop (i.e. Where is the fire extinguisher? – the learner has to click on it – Where are the stairs? etc.).
- **Assessment event** a list of rules is shown to the learner who has to create a brochure using the right rules.

The learner can, if he wants in assessment, call a helper (a teacher, other online expert student, a pedagogical agent), he sees a telephone on his/her desktop and can click on a icon that represents a teacher, a student, a pedagogical agent, entering a Collaborative Situation.

For each phase of the visual portrait, different types of situation exist with a standard format, The learner has to pass each step to reach the final competencies. In order to check the transformation, each situation foresees some assessment cases/inputs that assess the specific targeted knowledge in the distinct phases of the story.

3.5 Cognitive assessment in SLO and microadaptivity

In order to test different levels of knowledge it's necessary to plan moments of on-going and final "test", presented at the end of specific phases of a visual story portrait. It is useful to show a value linked to the achievement of the desired level. The result, in terms of measurement of the acquired knowledge level should determine a remodelling of the story and the hero's path aiming at facilitating, supporting and motivating the user in reaching the teaching/learning objectives. At this point we must also identify and treat the type of Adaptivity (Peirce N., et al 2008) the assessment process implies and then foresee when they can be considered to be implemented. We could say that the assessment should have an impact at different levels:

- *Macroadaptation Level*: Macro-adaptivity in the storytelling learning object refers to traditional techniques of adaptation such as adaptive learning path sequencing and adaptive navigation inter learning objects (LOs) within a complex learning experience. Generally, macro-adaptive interventions are based on the interaction between the student model (learner model), the acquired knowledge (knowledge model), the didactic strategy (didact model). The acquired knowledge assessment and the reached transformational level can determine the planning of

a new and better path the user must follow to fill in the gap. (Law, E. L.-C.,Kickmeier-Rust, 2008).

- *Microadaptation Level*: if macroadaptivity implies the whole learning path and aims at defining a complex learning experience, Micro-adaptivity happens within the storytelling learning object, these are non-invasive interventions (meaning that an overall narrative and the related learning objective is not compromised) and affect the presentation of a specific scenarios, situation and role. Techniques of microadaptation and individualization are essentially adaptive scenarios presentation, adaptive story navigation supporting role taking and collaborative help. (Kickmeier-Rust 2008)

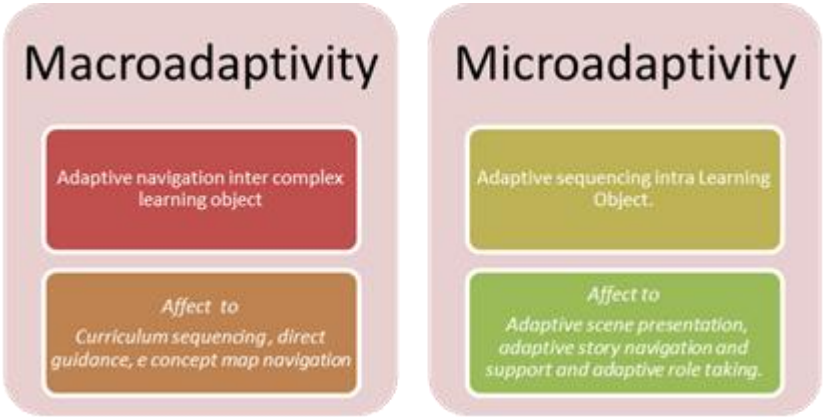

Figure 3.10 Macro and micro adaptivity in learning experience

A story can be linked with one or more objectives; therefore so not only the structure but also the same moments of verification should be more responsive to assess the acquired knowledge and the related level reached. Recognizing the acquired knowledge in the different levels by the user and the management of possible gaps in the distinct phases of the story, implies the adoption of an innovative assessment that is linked to the concept of microadaptivity.

In this work we focus on the comprehension of the different types of microadaptivity within the structure of a single learning object. An assessment does not meet the minimum threshold of knowledge that can be addressed through remedial work elements. To each type of microadaptivity particular didactic reactions correspond; it supports the learner in reaching the learning objectives in every phase of the knowledge transformational process.

Following the different types and the time they are foreseen in the story.

3.5.1 Microadaptation: Type A

A Note: when a test result shows a knowledge between the 25%-50%	**IF** the first test result shows a knowledge between the 25%-50% referring to the learning established threshold, ***then*** the user has the possibility to run the path again within the same scenario with a variation about communication channels (media mix)	
	IF once in a different media scenario, user still finds some difficulties in passing the assessment test, ***then*** the user will have the opportunity to exploit a collaborative mode.	A pedagogical agent that can help the user complete the assessment moment.
		The user gets in contact (through chat multiplayer mode) with his peers (in the same class) who are active and can help with the test.

Figure 3.11 microadptivity A

The first test result shows a knowledge between the 25%-50% referring to the learning established threshold, the user will benefit from facilitating elements, and that is to say he/she has the possibility to run the path again within the same scenario, in individual mode, with a variation depending on the main communication channels.

- From a scenario where visual elements are dominant, to a different one where the main channel can be an audio, textual or kinaesthetic one.
- If, once in a different scenario, still finds some difficulties in passing the assessment test, he will have the opportunity to exploit a collaborative mode. This implies the possibility for the user interface to visualize three typologies (through icons)
    - Possibilities to introduce a pedagogical agent that can help the user complete the assessment moment.
    - A possibility to get in contact (through chat multiplayer mode) with his peers (in the same class) who are active and can help with the test.
    - A possibility to look for other users, belonging to the e-learning environment, but not in the same class.

The last can help tank to the acquired skill and thus can enter spontaneously in the experience and help with the test. Please pay attention: view that collaboration is the solving mode to reach the target objective; it is not possible that the student doesn't pass the text. Hence the passage to an upper knowledge level.

Let's try to give an example of Microadaptivity Type A: supposed that Francesco personas (cfr WP6 scenarios) is acting a specific role in a specific scenario through a visual and audio channel. At the end of the application phase, he undergoes a test. He doesn't pass it.

- Francesco sees the same situation, where there is a new thing, there is a note in the screen with a hint. This is a suggestion for Francesco to do the test.
- Francesco sees the same situation but in the bottom of screen there is scrolling text. Assessment of stimuli that have some tips within them (the first letter if it is to write a series of

words in sequence, evidence also suggests that the visual response, the sound signal to drive the wrong item , deleting a wrong location, leaving few alternatives involved,).

- Francesco doesn't reach the desired knowledge level. Can thus exploit a collaborative alternative mode. The entry into the scene of a Pedagogical assistant (a friend, another character in the story) helps him adding information related to his previous action

Again, as an example we can imagine a visual feedback where the response to the previous assessment (which has shown an initial score) should help to overcome the situation. Francesco, being unable to deal with wrong answers, should give the correct answers.

3.5.2 Microadaptivity Type B Changing situation in the story.

B Note:when a the student makes mistakes ranging under the desired knowledge level between 50% and 75%	**IF** the student makes mistakes ranging under the desired knowledge level between 50% and 75% .....***then*** an alternative mode is suggested, a new scenario is proposed to the learner who plays the same role.	
	IF he, once in a different scenario, the student still finds it difficult to pass the assessment test, then he will have the opportunity to exploit a collaborative mode.	A pedagogical agent that can help the user complete the assessment moment.
		The user gets in contact (through chat multiplayer mode) with his peers (in the same class) who are active and can help with the test.

Figure 3.12 microadaptivity B

When the student makes mistakes ranging under the desired threshold level between 50% and 75% an alternative mode is suggested, a new scenario is proposed to the learner with play the same role. For example, in the first scenario, the setting is in the street, in a second at school.

If he, once in a different scenario, still finds it difficult to pass the assessment test, he will have the opportunity to exploit a collaborative mode. This implies the possibility for the user interface to visualize three typologies (through icons)

- A possibility to introduce a pedagogical agent that can help the user complete the assessment moment.
- A possibility to get in contact (through chat multiplayer mode) with his peers (in the same class) who are active and can help with the test.
- A possibility to look for other users, belonging to the elearning environment, but not in the same class. The last can help tank to the acquired skill and thus can enter spontaneously in the experience and help with the test.

Please pay attention: view that collaboration is the solving mode to reach the target objective, it is not possible that the student doesn't pass the text. Hence the passage to an upper knowledge level.

3.5.3 Level C change a role taking

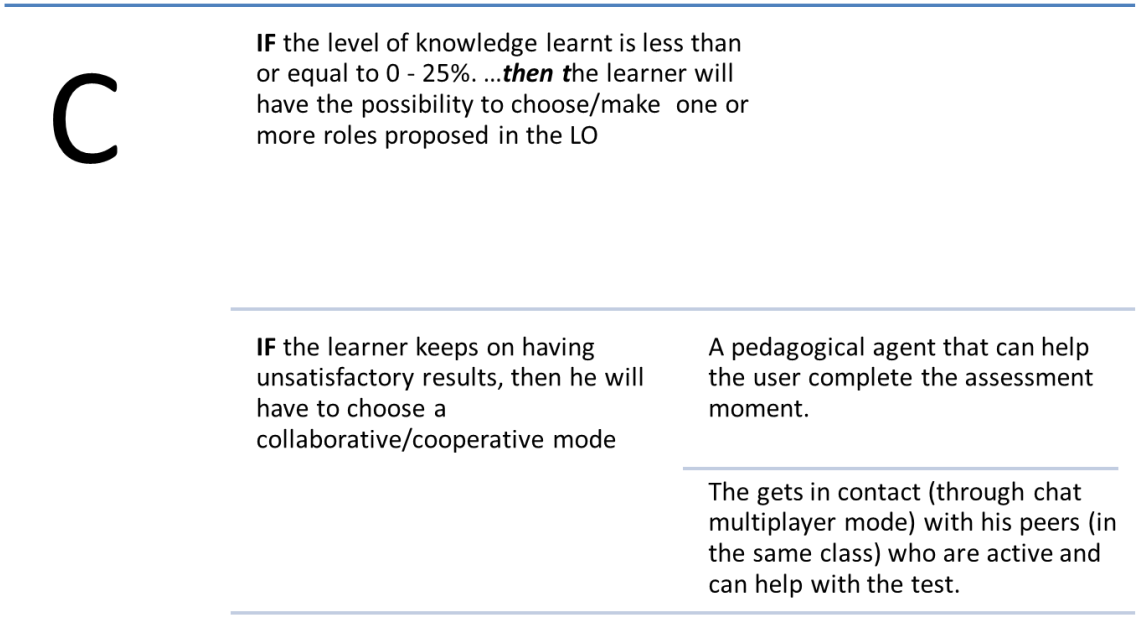

Figure 3.13 Microadaptivity C

It introduces an alternative route playing a new role when the level of knowledge learnt is less than or equal to 0 - 25%. The learner will have the possibility to choose one or more roles proposed in the LO (e.g victim or helper), once he/she has passed the final test of the situation; in the following situation he/she will gain the hero role again (e.g. fireman, doctor, etc.). Therefore, if the student, after the assessment test, doesn't reach the threshold, he/she can change his role aiming at understanding the storytelling essentials through a different point of view. If the learner keeps on having unsatisfactory results, he will have to choose a collaborative/cooperative mode (see before). This implies the possibility for the user interface to visualize three typologies (through icons)

- A possibility to introduce a pedagogical agent that can help the user complete the assessment moment.
- A possibility to get in contact (through chat multiplayer mode) with his peers (in the same class) who are active and can help with the test.
- A possibility to look for other users, belonging to the elearning environment, but not in the same class. The last can help tank to the acquired skill and thus can enter spontaneously in the experience and help with the test.

Please pay attention: view that collaboration is the solving mode to reach the target objective, it is not possible that the student doesn't pass the text. Hence the passage to an upper knowledge level. (***Hypothesis*** *to be extended in SLO production*: we imagine that Francesco is in a scene where, after viewing a video in which a fire fighter tells what are the rules to be followed during an earthquake, he is asked to join the scene figures crucial to proper management, or to write words and sentences into a given list. For a negative score he can be found at the beginning of the path, but dressed as a fireman or a medical auxiliary).

In the following picture we synthesizes a model for the adaptive management of the story-based experience

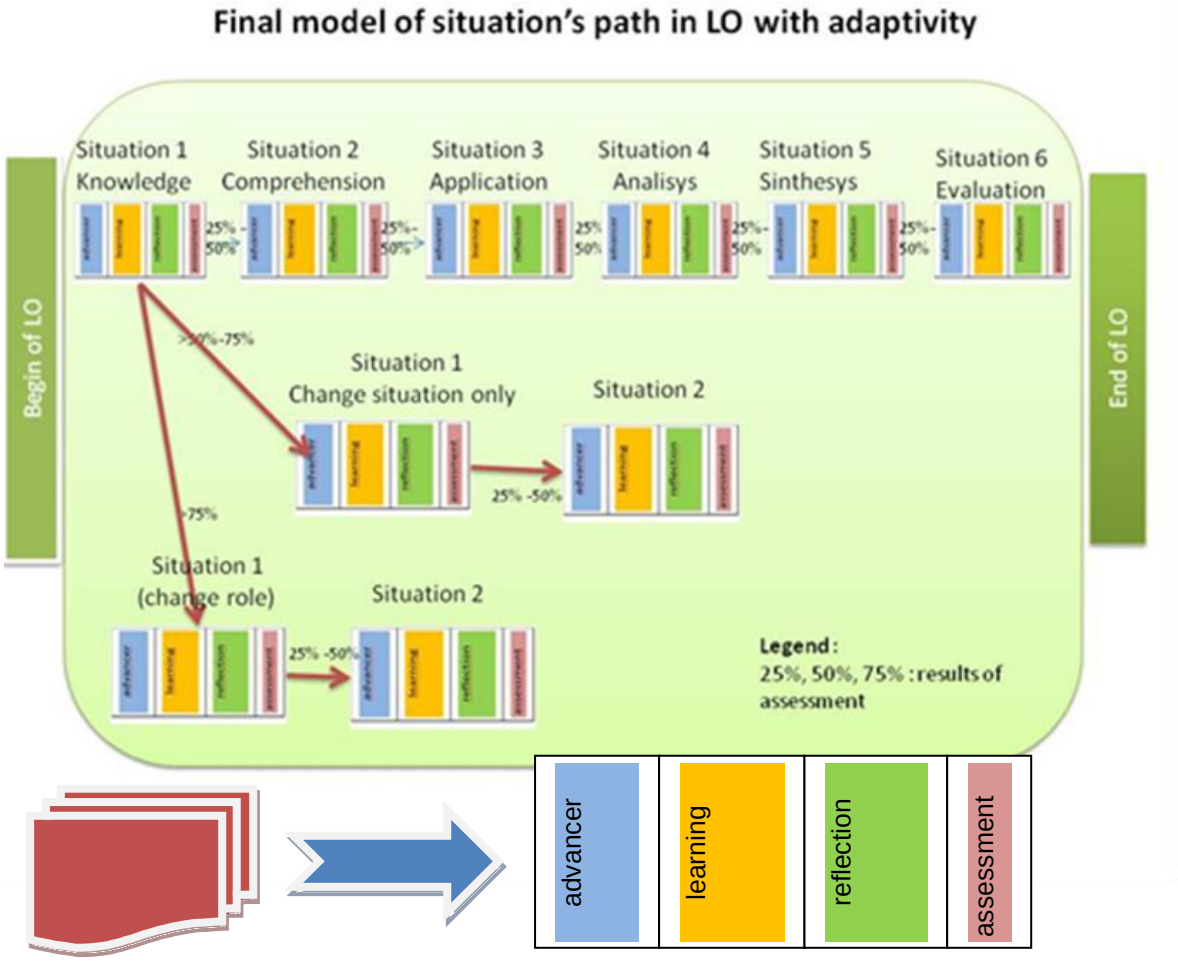

Figure 3.14 Microadaptivity flows

The path experienced by the student is constantly drawn to obtain a final viewer that allows to get an overview of the results of assessment tests, the level of microadaptivity intervened, and the effects of these on the achievement of the knowledge gap and fully recorded by the test.

A we note that Storytelling allows two kinds of collaborative actions:

- Mediated by virtual pedagogical agents, for example, choosing to have a guide that follows the student in the story, or a chat box with firemen agents.
- Direct, as in the case of the entry of other students in the scene called by a learner to choose a strategic action.

For the above, a Storytelling: i) Presents Conversational Interface Agents, to personify the system's support in the form of an animated person, or other character, and present interactions in a conversational form; ii) Permits a multiplayer synchronous execution mode to allow multiple users to interact and help in evolving history

3.6 Hypothesis of validation

In experimentation perspective of the adaptive Model considered for the SLO, we present a hypothesis of validation session shared with TUG, that can be enhanced later in the Project phases of experimentation and validation.

Just for example, we made a testing for Microadaptivity type A: There is a profile test at the start of the path about the users' learning style. Hence, the media provided in the path is the media that matches the individual learning style best. If they have to rerun the path with a different media in case they cannot complete the task successfully this means that (a) they either might have to use a media in the rerun which they not necessarily prefer or does not match their learning style (and would thus perhaps not enhance their learning outcomes) or (b) that the assigned media at the beginning might not have been appropriate. Perhaps they should not be forced to rerun the path in a different media but they should have the choice to rerun it in the same or a different media. Or the assessment at the beginning should rank the preferred learning styles so that in the rerun the "second-best" media is used.

Experiment phase: Only Type A is tested and users have to rerun the path in a different mode when they do not reach a predetermined criterion (e.g., 75%). But such an experiment could also be adapted to the other Types (B,C) by changing/not changing the situation/role. Half of the users who completed the task unsuccessfully have to rerun the path in the same media; the other half in a different media. Alternate: One third: rerun with the same media, one third: second-best media and one third not preferred media. Learning outcomes can be compared after the rerun (but before an additional collaborative mode).

Hypotheses: If changing the media enhances learning outcomes then groups with different media in the rerun should perform better than control group (with the same media in the rerun).

3.6.1 Comparison between Microadaptivity Types A, B, C

Following microadaptivity types are given:

Type A: rerun the path in a different media when first test results are between 25% and 50%

Type B: change the situation when first test results are between 50 and 75%

Type C: change the role when results are between 0% and 25%.

The experiment drawn here tests the assumption that the assignment of the paths with respect to the test results is appropriate.

Experiment: Depending on the subjects' results they are divided into 3 groups (I: 0-25;II: 25-50; III: <75). Within each group, subjects are randomly assigned to the three different adaptivity types (A,B,C). Thus, there are 9 resulting groups (Group IA, IB, IC; IIA,IIB, IIC; IIIA, IIIB, IIIC). Results from the group that had more than 75% correct could be used as a control group. Learning outcomes (tested after the rerun of the path) for each group can then be investigated depending on the provided adaptivity type. E.g., In Group I, learning outcomes should be the best for group A (who had to rerun the path in a different mode).

Note. To get enough data for statistical analysis, many (about 100?) subjects would have to be tested (because it is not possible to ensure that enough/an equal amount of subjects will be assigned to the 3 experimental groups; Furthermore within the groups, again three groups have to be built).

Perhaps it is a good idea to have another control group that only has to perform the second test.

3.6.2 Testing on the Mycroadaptive Level

When the outcomes of the different paths are experimented, it might be helpful to have an overall test due to which the success of the different paths can be compared (ie., to show that even if students are lead through different paths, they have the same learning outcome afterwards; it might be more difficult to do such test within the microadaptive level because not all students will have the same assessments at the same time).

Experiment 1a: Subjects pass the paths as described in the document (Microadaptivity A, B,C). After the last step (ie. before the collaboration mode); they have to perform a test. There should be two control groups: Control group 1 only has to perform one test (i.e., no Microdaptivity); also control group 2 should perform only one test but then should join immediately the collaboration mode.

Expected Results: All groups should perform better than control group 1 (i.e., there should be a general enhancement in the learning outcomes due to the adaptivity) and better than control group 2 (a collaborative mode alone does not enhance learning outcome/supports reaching the learning goals). Learning outcomes should be the same for all experimental groups, however.

Experiment 1b: The same as before except that the subjects are tested after the end of the collaboration mode. Testing the model of progression for levels of knowledge and expertise

Experiment 1a: For each level, different assessments types (eg: multiple choice, hangman etc for level 1) are compared to at least one assessment type for which it has been already demonstrated that this type assesses the respective level. For instance, a typical knowledge test with open-ended questions is known to be appropriate for to test the first level of Bloom (“Remember”). Thus, when subjects perform as well in the knowledge test compared to the tests provided (hangman etc.) then it can be assumed that the provided tests are appropriate for the level.

Alternate1: For each level, the different assessments types provided (eg: multiple choice, hangman etc for level 1) are compared to each other. When there is one assessment type not appropriate for the level, the results of this test should be worse compared to the others of the same level. (e.g., when in Level 1 one test is given that investigates the application of knowledge rather than “remembering” knowledge itself, the results for this test will be worse than for the other tests).

However, such a method will mainly work for superordinate levels. For instance, when “application” should be tested it can be expected that tests that are mainly intended to assess “remembering” are solved in almost the same manner.

Alternate2: It might be also possible not to experiment the types but validate them using experts’ ratings. E.g., experts are asked whether a specific assessment is suitable for the level. When an assessment type is appropriate, it will have high ratings from all the experts. When an assessment type does not fit, it will have lower ratings.

3.7 The role-playing, role-making and role-taking as metacognitive learning elements

In our model roles have a key function that is strictly related to the users’ meta-cognitive learning process. The leading motif of this choice lies, in fact, in the idea that proposing three different role levels users can have, following the learning path, we can best monitor their progress. The chosen roles are the following: a role-play, a role-take and a role-make. Let’s define the terminology first, according to the existing literature:

- The role-playing is when users are given a definite narrative role to play.
- The role-taking is when users are given only a format to follow and they have to act the role by themselves
- The role-making is when users are given free opportunity to create and produce a narrative.

The assumption of each different role has a precise didactic value, and cannot be considered if not within the whole learning experience and analyzed according to its progress at the different steps of the digital storytelling object.

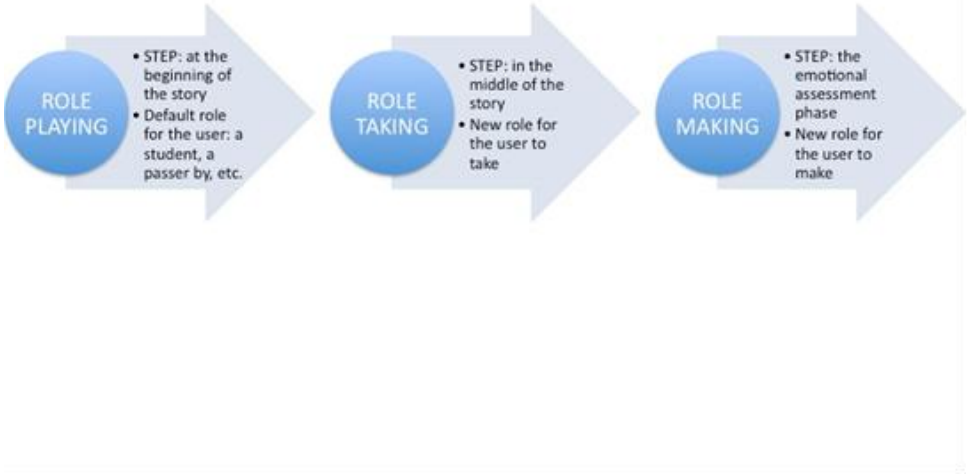

Figure 3.15 role playing, taking and making in SDM

The three different steps involve three different modes as far as role assumption is concerned:

- The role-playing is given to the user - by default at the beginning of the story. It can be the student role, the passer-by role, etc.
- The role taking characterizes the microadaptivity phase, at level C, when the user changes his/her role, as well as his/her character. The added value is to enhance the comprehension level through a different point of view (ex: victim) for a better learning.
- The role making regards the emotional and cognitive assessment phases and is used also as monitoring strategy. Users are asked to act a different not-given but only suggested role and they have to give shape to/create an agent he would have into the scene (a helper, a fireman)

As a person can take more than one role in a given learning experience, the requirements that a user must ensure to play a role have to be clearly defined. In learning experiences where only one role exists, learning object contracts were proposed towards that end. In fact, such a situation is a particular case of a learning experience where the user matches the role. The learning object contract connects then the activity with the learner, although it should actually connect the role with the user. This is because the learning object is the sole activity and there is only one learner: the user. When multiple roles are possible, requirements will probably be a combination of the requirements for the activities the role has to perform. In that sense, learning object design by contract could be extended as to reflect the compromise between a role and a user. In a role contract, the preconditions will be formed by a combination of the preconditions of the activities to be completed.

Story production and user's learning progress, thus, include creation, telling and participation at different levels. Each of such activities puts into play different abilities. When creating a story, the learner invents it and makes a (usually external) representation of it in some format afforded by the tools available. On the other hand, when taking a storytelling activity, the user follows a detailed format but has the freedom to adapt it to his/her own style and needs; finally, when carrying out a storytelling activity, the learner tells a (more or less well known) story created by somebody else. In the first case, creativity is stimulated, while in the second case memory and the ability to personalize yet preserving consistency with the original are involved; in the third case, only the ability to act and perform a certain script is involved. In all the cases the activity can be carried out individually or in cooperation with some (human or virtual) agent, which entails negotiating the overall development of the story. If in joint story creation each (human or virtual) agent involved handles his/her/its own characters, and hence the narrative rises from the actions individually decided by each of the agents, then we speak of participation in story construction. This entails a different kind of negotiation from the cooperation mentioned above, where the consistence checks are made more complex by the need to control one's character(s) in an overall framework that depends on integrating the ideas of several different participants. Finally, also receiving a story created and told by others implies a cognitive activity of the student, consisting in the elaboration of a mental representation of the facts narrated as well as of the causal and temporal connections among them.

3.8 Micro and macroadaptivity in storytelling, retelling e reliving

Digital Stories have two functions for learning in the epistemological and transformative view. In the epistemological view, stories include a certain kind of knowledge that learners should possess to construct their experiences. In the transformative view, stories are designed to provide moral messages taken to heart and to transform the way of life. For the former view, stories can be used as exemplars of concepts, principles, or theories, and as cases to represent a real situation or a problematic situation to be solved (Jonassen & Hernandez-Serrano, 2002). For the latter view, it should be considered for learners to provide an opportunity to rethink the given stories and retell the story in terms of their interpretation or point of view. Through retelling or rewriting or creating a story, individuals can enlarge their experience and be involved in mutual interdependence and growth (Crick, 2003). To compose their own stories of experience is central of narrative inquiry, and a way of enhancing individuals' experience and social interaction. Based upon the assumptions, two kinds of learning activities are selected: listening and watching a story, and telling and retelling a story. Storytelling and retelling, as a way of narrative inquiry, would be considered to offer learners to get genuine learning experience and to transform the whole life in special and temporal contexts. Within the inquiry field, student live out a story, tell story of those experiences, and modify them by retelling and reliving them. The StoryVisual Portrait and micro-adptive mechanism provides a logical articulation of the path that meets the three key activities recognized for effective story-based activities: storytelling, retelling and reliving.Inside story of the visual portrait, which the canonical architecture of a story based Complex learning objects, different types of microadattività constitute moments of listening and watching (scene pre-designed animation as a story is presented in the multiple media mix mode), retelling (situations story are re-articulated and reviewed in text and graphic styles) and reliving (requires learners to retelling or creating their own story from different perspective (role taking) or using collaborative scaffolding (help seeking resources). Each story consists of a problematic situation related to environmental conditions, characters concerning the situation, and a plot configuring to beginning, middle and end phases. When individuals retell or rewrite their own stories beyond listening and watching situation, many more chances take place in enhancement of reflective experience and in mutual interdependence and growth (Crick, 2003). To compose their own stories of experience allows learners to transform individual experience and social interaction (Clandinin, and Connelly, 2000; Fusai et al., 2003). Within the inquiry field, student lives

out stories, tell stories of those experiences, and modifys them by retelling and reliving them. The whole steps set up in a recursive, non-linear way, which learners can go ahead and back within the learning process by their choice. In the activity of telling, retelling and reliving a story, students construct their own story in the basis of concepts or principles extracted from the reviewed situation and storyphases. This activity would provide learners transformative experience differentiated from that of the beginning state.

3.9 Type of Assessment for S-LO

Referring to the idea of assessment for the WP6 (related to scenarios presented in the wiki) we would like to try - starting from the current state of IWT (LMS which will build the project which will be deliberated on Alice and the CLE provided) - to propose new types of input / cognitive stimulus for storytelling, assuming the reactions at the level of narrative. Below there is the current status of IWT in relation to the types of tests and applications available, without neglecting the enumeration of certain social instruments often used by teachers for purposes of monitoring and evaluation. The types of tests supported in the conduct of an experience story based can be described as Test assessed automatically. These tests can be evaluated automatically according to predetermined criteria. Thus the results can be recorded and will appear in reports generated by the system (currently this is true only for testing static and dynamic) and intervene in the reconstruction of story path.

3.9.1 Types of tests available, useful for the assessment in storytelling

The types of tests currently supported in IWT are as follows.

- **static text**. It allows you to combine different applications, establish criteria for the excess (minimum score) and various parameters associated with execution (the barrier, running multiple feedback, receive correct answers at the end of execution, etc.)
- **dynamic text**. As the static test except that the questions are not always the same but are randomly selected from a list established by the teacher.
- **narrative grid**. It allows the definition of a concept map of a given planning domain by a student. The map is assessed by the teacher on the basis of terms and relations, and level of detail
- **exercise of dictation**. It allows the student to enter as a free text transcript of an audio file (or audio / video). The transcript can be provided automatically assessed for similarity to a text provided by the teacher.

The static and dynamic tests consist of questions of different types.

- **multiple choice question**. Application where you can choose a correct answer in a list presented. The correct answer, incorrect or missing may be associated with a score.
- **multiple choice question**. Application where you can choose more correct answers in a list presented. The correct answer, incorrect or missing may be associated with a score.
- **True / false questions**. Application where you can choose between a right answer "true or false." The correct answer, incorrect or missing may be associated with a score.
- **Question correspondence**. Must match the elements of the list on the left with those on the list on the right. The exact match, incorrect or missing may be associated with a score.

New Types of Question desirable to be included in the storytelling**.** Based on the analysis of the leading test management systems (eg Questionmark, QuestionWriter, Captivate, etc.). and the specific tests and to represent the most common applications (eg IMS-QTI), it is useful to propose the add a set of demand types editable and manageable IWT able to cover the items most commonly used by management systems such as Questionmark test, QuestionWriter and standard compliant

whit IMS-QTI. The following will describe the new types of application the proposal and its compatibility with IMS-QTI.

3.9.2 New Types of Question desirable to be included in the storytelling

All questions proposed below can be evaluated automatically, and thus may be part of static and dynamic tests and be included in simple or custom courses.Every test is possible or made in different level in relation with different levels of learning (A, B, C).

Question Completion with Selection.

Allows you to select the correct word or phrase from a drop-down list corresponding to an empty text. Similar to the application to completion with the difference that the learner should not fill an empty box with arbitrary text, but select the exact phrase from a list. Could be implemented as an extension of a type of completion.

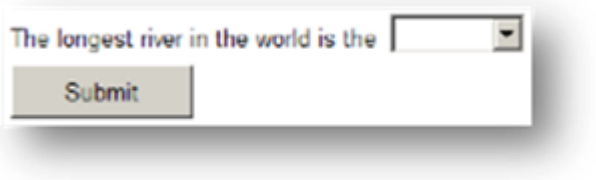

Figure 3.16 Question Completion with Selection

Example: Francesco displays a video of a fire fighter who said the rules of conduct in case of earthquake warning. Subsequently, Francis undergoes a moment of assessment in which he must write in a text, selecting the correct answer.

Drag & Drop.

Allows you to place an arbitrary number of labels on a graphic background.

Figure 3.17 Drag&Drop

Example: Francesco is called to identify on a map some ways for safety . Francesco displays a design where there are some objects to handle an emergency (map of escape routes, helmet, emergency stairs, etc..) the icons to choose from those that are missing from the drawing appear.

A variant is Live a Note.

Figure 3.18 Live a Note

Example: Francesco displays a bulletin board with the post-it notes on which are shown to behave during an earthquake and Francesco must choose the right ones to be included in the showcase with a drag.

HOTSPOT

Is to place a marker on a single graphic image to indicate the answer. Similar to drag and drop could be implemented as a single type.

Figure 3.19 Hotspot

In Hot spots some depth cards can be made to match that in case of negative assessment, allow navigation around the image when the user can present the wrong image guided reading based on a menu sections.

Variant is a Memory test. Francesco displays a memory where clicking on one of the squares appears a question and Francesco must select the corresponding response.

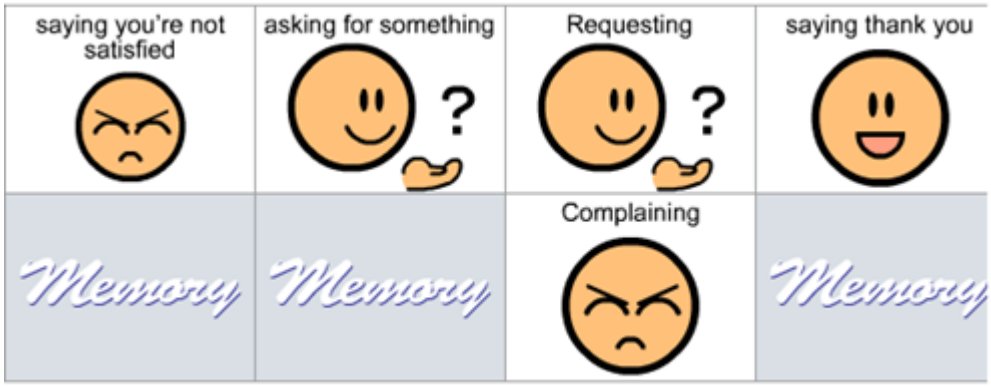

Figure 3.20 Memory Test

Open questions

Inserts a word (or short phrase) in free text in a box and assess the response considering the correspondence with one or more words (or phrases) to be correct. They are recognized as a test of sentence and reconstruction of the test period to assess the understanding of a song or a learning resource. Also this mode if extended to a large text is called test writers

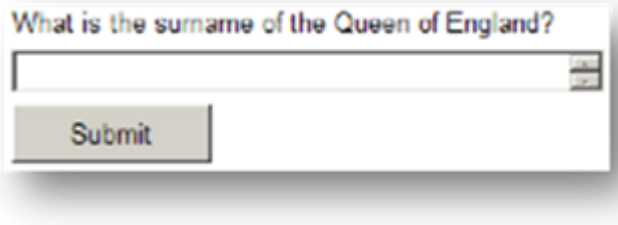

Figure 3.21 Open question

Example: Assume that Francesco should lead a group of friends to come out from school along less dangerous the roads. Francesco displays a balloon in which to write the correct information.

Application of Sorting.

Sorts a list of options. Could be simulated with a pull-down list where the various possible options for each answer are numbers that represent the possible positions (see figure). Could be made more graphically appealing, giving the ability to drag and drop the labels in order to move up or down in a list.

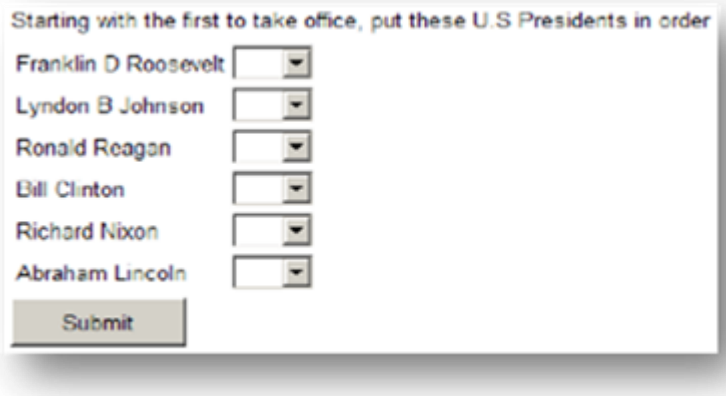

Figure 3.22 Application of Sorting

Example: Francesco must determine prioritization of how to behave in case of earthquakes.

Demand pull down list

Allows you to select a response from a drop-down list. One or more choices may be presented in a single application. It can be seen as a set of multiple choice questions and is similar to match demand with the difference that each list is independent from the others. Could be implemented as an extension of the application or correspondence as an alternative mode of display of multiple-choice question.

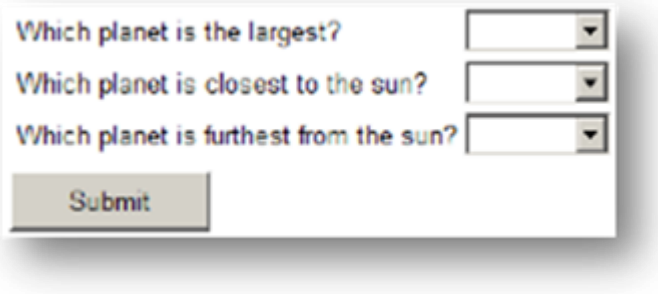

Figure 3.23 Pull down list

Example: Francesco has to answer some questions that are asked by the fire fighters for clarity of the emergency. Francesco must select all the right words for the correct display.

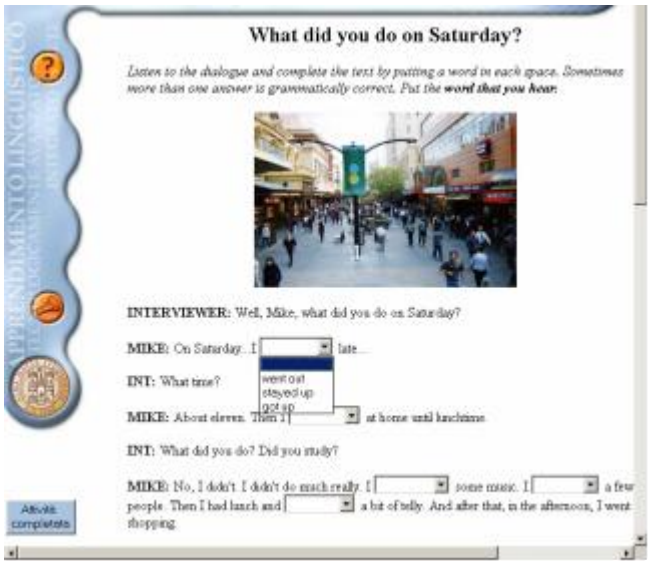

Figure 3.24 Pull down list 2

LABIRINTH or CRUCIVERB

The user chooses the definition for that row or column you want by clicking the checkbox at the bottom left ('D9' in the example). The A (Across) indicates the horizontal definition, D (Down) the vertical ones. Reply to this definition by writing the word in the box alongside and click 'OK'. If the word is correct, it will appear in the crossword. If you prefer, you can skip that do not know the answer and continue with another definition.

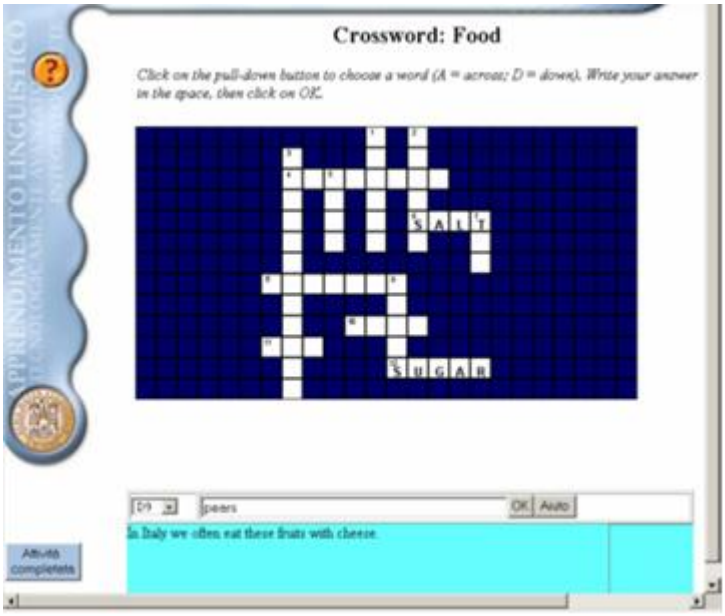

Figure 3.25 Cruciverb

A variation would be to **the maze** (obviously fell within the Treaty).

Example: Francesco after following and obtained information related to how to read maps for the exits exodus from unsafe structure displays a map with a little man that as Pac man must go through the correct way. (Otherwise the earthquake swallows).

LISTEN AND CHOOSE

Student listens to a voice that says some information and then he displays a table that includes only some information and other circumstances, he must enter other information missing.

Figure 3.26 Listen and Choose

Example: Francesco has certain information through a loudspeaker. A firefighter heading lists in the rules of conduct during the earthquake. At the bottom of the screen Francesco displays icons in wich there are rules. Francesco must select those corresponding to what he hears.

3.9.3 Link to QTI standard

Questions are at the heart of this system. We support various types of question besides standardizing the created questions. Table shows that there are twenty different types supported in in Digital Storytelling from IMS QTI 2.1

Table 1 Question types in S-LO

Question Type	***Description***	***Response Type***
true/false	selecting a response from the choices 'True' and 'False'	LID
single response	selecting a single response from the choices	LID
multiple response	selecting multiple responses from the choices	LID
order	reordering the choices that are displayed initially	LID
associate	pairing up the choices that are displayed initially	GRP
match	pairing up choices from a source set into a target set	GRP
gap match	filling gaps from an associated set of choices	GRP
inline choice	filling gaps from a shared stock of choices	LID
text entry	filling gaps by constructing a simple piece of text	STR/NUM
extended text	entering an extended amount of text	STR/NUM
hot text	selecting choices embedded within a surrounding context	LID
hot spot	selecting areas (hotspots) in the graphic image	LID
select point	selecting points in the graphic image	XY
graphic order	reordering the choices that are presented as hotspots on a graphic image	LID
graphic associate	pairing up the choices that are presented as hotspots on a graphic image	GRP
graphic gap match	a graphical interaction of filling gaps from an set of choices	GRP
position object	positioning a given object on the image	XY
slider	selecting a numerical value between a lower and upper bound	NUM
drawing	using a common set of drawing tools to modify a given graphical image	FILE
upload	uploading a pre-prepared file representing the response	FILE

These questions types can be classified into six categories of base response types according to the response styles of answers. They are:

- LID (Logical Identifier)
  - A category of response styles that presents various choices and provides a mechanism for the test taker to select one or more choices.
- XY (X-Y Co-ordinate)
  - A category of response styles that presents an image, or various images, for the test taker to select a position on the image or images to indicate their choice.
- STR (String)
  - A category of response styles that allows the test taker to enter text.
- NUM (Numeric)

- A category of response styles that allows the test taker enters a number to indicate their choice. The entered number can be integer or float data type.
- GRP (Logical Group)
  - A category of response styles that allows a test taker to group objects together to indicate their choice. It can be classified into 2 sub-categories: pair and directed-pair.
- FILE
  - A category of response styles that allows a test taker to upload a file.

The following figure shows the model of progression for levels of knowledge and expertise, and types of tests microadatptivity, performances.

Table 2 Visual Portrait Phases (Ohler), Learning level(Bloom's Taxonomy), ILOs (Intended Learning Outcome) and Type of Test.

Visual Portrait phase (tratte da 0hler, 2006)	Level of learning	Intended Learning Outcome	Type of testing
Beginning	**knowledge**	**Knowledge and understanding (theory/knowledge)** Which is the basic information and concepts gained by learner	multiple choice true/false
The call to adventure	**Comprehension**	**Knowledge and understanding** Which is the basic information and concepts gained by learner	Drag & drop Demand pull down list. GapMatch
Middle (tension and resolution)	**Application**	**Practical skill** Student's abilities of applying studied topic To know how to do	Drag & drop Hotspot Demand pull down list.
Solution	**Analysis**	**Intellectual skills** which are the mental talents developed during learning process (analysis, creative reasoning and problem solving abilities To know how to do and To know how to be	What's missing? Question completion with selection Listen and choose Leave a note
Closure	**Synthesis**	**General and transferable skills** Specifies skills that can be applied in any other topic or domain. To know how to be To know how to act	Labyrinth Memory Open question
End	**Evaluation**	**Summary Competence learnt** Practice aims in real context (To knpw + to know how to do + to know how to be)	A mix

The user, after the first two stages relating to the objectives of knowledge (know) is evaluated with specific knowledge and understanding tests and based on performance (see microadaptivity) the path is repeated or varied. The user with satisfactory levels of performance goes to the next stage At the end of the stage of application and analysis phases (knowing how, when, why, where,…) the learner is subjected to cognitive assessment in relation to these objectives of competence (know-how, procedural skills), with an unsatisfactory response (levels of microadaptivity), the system reacts proposing an alternative route to the learner based on a range of fixed values, if the learner responds with a satisfactory performance (according to the levels set) will go on to the stage to objectives of competence (know-how skills of product), here will be subject to evaluation and the system will respond by offering alternate routes in response to unsatisfactory levels of performance. The last stage of the LOS is able to act on the aim of competence in which targets are evaluated in the context of systemic practice / real, complete performance, real and complex).

Learning outcome is a statement of learning achievement states what a learner knows, understands and is able to do on completion of a learning process. It covers knowledge, understanding, intellectual skills, practical skills and personal, social and/or methodological abilities that a learner should attain when successfully having finished a SLO. Assessment item should be linked with a metadata of what ILOs types it measures. These ILOs may be one of the following types:

- **Knowledge and understanding:** which is the basic information and concepts gained by learner
- **Intellectual skills**: which are the mental talents developed during learning process. They may include analysis, creative reasoning and problem solving abilities
- **Professional and practical skills**: describe student's abilities of applying studied topics professionally. Communication, managerial and training skills are examples of such skills.
- **General and transferable skills**: specifies skills that can be applied in any other topic or domain. Examples include leadership and development, teamwork, and using modern technology skills.

3.9.4 The assessment feedback type in SLO

We have explored assessment feedback in terms of Rogers' (1951) classification into evaluative, interpretive, supportive, probing, and understanding forms (Dunwell et al., 2010a).

Table 3 feedback type in assessment

Feedback Type	**Example for a score-based element**	**Technical demands (cumulative)**
Evaluative	You got a score of 120/200	Measure variables
Interpretive	You got a score of 120/200 because you failed to respond quickly enough	Measure variables and model their relationships
Supportive	You got a score of 120/200, and need to improve your response times to challenges	Present and format measured data in a form relevant to the learner
Probing	You got a score of 120/200, because your response times were too low, was this because the user interface was too complex, or due to the game being too hard, or was it something else?	User interaction model and support for responsive dynamicism and adaptivity through (for example) pedagogical agent

Understanding	You got a score of 120/200, because you found the user interface too complex, and as a result you responded too slowly to the challenges, you should complete the tutorial on the user interface	Link expert system to intelligent guidance to determine root causes of failure

As Table illustrates, the simplicity of assessment variable itself, in this case a score, belies the technological complexity required in order to autonomously interpret it and feed it back to the user in a useful form.

3.10 Emotions and affective transformations in SLO

Reference can be made to a second type of emotional transformations that lead to a change in the learner's narrative experience. Studies have demonstrated that a satisfying decision-making process is impossible without emotions. It is largely accepted that cognition cannot be completely understood disregarding the emotions, and that there are some deep interactions between cognitive and affective behavior. Different juxtapositions of cognition and emotion are evident in various teaching/learning theory frameworks. Some of these frameworks recognize the importance of emotion but position the affective domain as being somehow separate from, but nevertheless providing a basis for, functioning in the cognitive domain. In the tradition of Bloom's (1956) and Krathwohl, Bloom and Masia's (1956) taxonomies of cognitive and affective objectives, the existence of these two educationally relevant domains is acknowledged, but they are positioned as being distinct from each other. This underpinning model persists in studies such as McLeod's (1994) review of research into emotion and learning in mathematics, which identifies separate cognitive and affective domains. Shelton (2000), too, writing of the importance of emotion in learning addresses the need to develop certain 'emotional competencies' before learning can proceed satisfactorily. Similarly, Postle (1993) talks of the importance of 'emotional competence' in relation to learning. In his terms, learning can be inhibited by emotional incompetence. He draws on Heron's model of multi-modal learning in which action, conceptual and imaginable learning all depends on the capacity to learn at an emotional level. So, with this approach, emotion is relevant to learning in that it provides a base or substrate out of which healthy cognitive functioning can occur. From the storytelling standpoint and also its fundamental characteristic, namely being able to present to the student situations whose actions produce narrative forks, the learner is a decision-maker and as such is continuously involved into a balance process between rational and emotional choices. We can actually hypothesize that in most decisions the cognitive problem solving (presented through assessment moments) is simultaneous to an emotional problem solving, which depends on the type of emotion felt by the learner in that specific situation.

The underlying assumption, which generates the work and lines up with the macro perspective of the Alice Project, is that a real separation between emotion and cognition cannot exist; the former is a dual of the latter. The emotion is a form of cognition and vice versa. So the learner's emotions depend on the way he/she lives a given situation and, on its turn, the interpretation of that situation depends on how the learner reacts to that emotionally. The concept of personal narrative or illness narrative denotes a dynamic and complex process of construction of affective and cognitive meanings that the students, playing the storytelling, are involved in. In this sense, the assessment of emotion during the course of the learner in story learning object allows you to introduce corrective elements that will bring the excitement of the subject learner in the appropriate range of emotional learning situation.We thus identify the emotional transormations, referring to Bloom's taxonomy, about the affective domain: the world of emotions and feelings (Ohler, 2008) The story framework of learning objects is based on the

definition of the situation of a visual story portrait (so we define the architecture / global model of storytelling) linked to civil emergences incorporating innovative elements, moments of emotional/affective episodic checks. This to "record the status and intervene to obtain the functional changes in the learning of the user that is playing a particular role by staging a particular character. The Storytelling LO presents some assessment objects to track the emotional status of the student in specific situations. The emotional feedback can be used to choose a better path (eg. more compelling), a different user's role, and generally to choose a better following situation in the story.

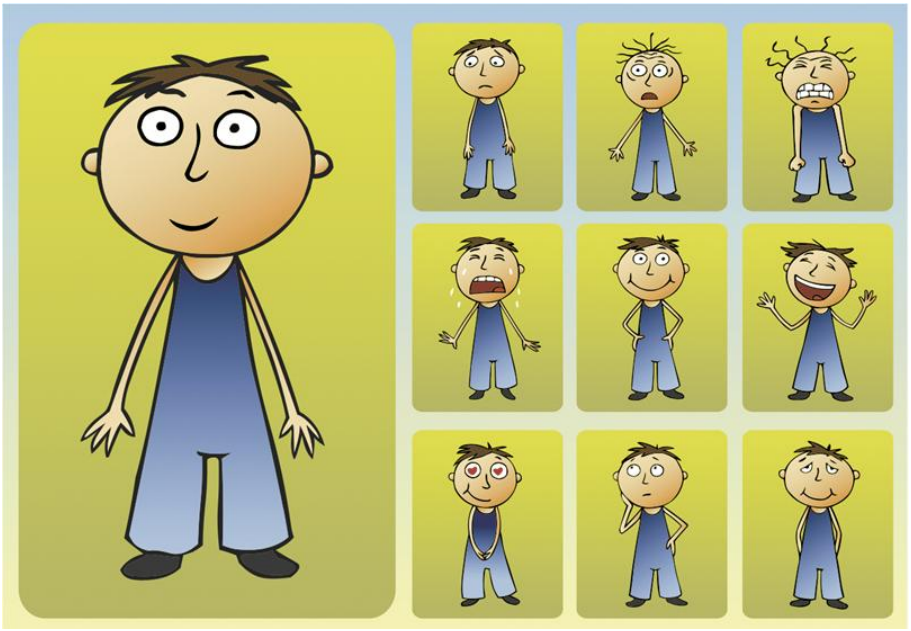

Figure 3.27 emotional EXPRESSIONS

The emotions, indeed, play a role of training for the learner to overcome given assessment moments, with respect to management or knowledge ability of an event that for the target domain requires an emotional state which is functional and able to intervene, positively or negatively, in carrying out some activities. Emotions that we have chosen for our model of Storytelling learning object are the primary emotions, according to a recent definition of Robert Plutchik (2001). The emotions wheel he/she created, highlights both opposites and decreasing intensity of emotions, as well as the different intermediate states (the emotions, decreasing in intensity tend to mix up more easily).

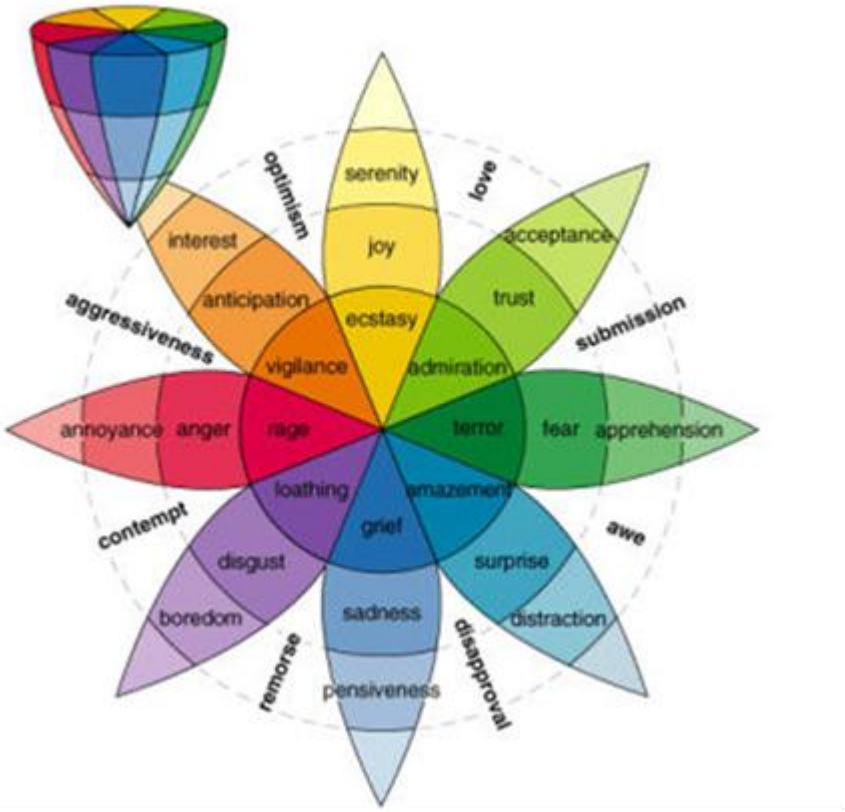

Figure 3.28 circle of emotion (Plutchik R. 2001)

Assume that in certain stages of a specific history (story visual portrait) there are some prevailing emotional states (indicated by a minimum and a maximum allowable) for effective learning. Assume as an example of simplification to have already selected four classes of basic emotions that are important to any story told, and made their own provisions along an axis.

anger----------fear

sadness----------joy

surprise----------expected

disgust ----------acceptance

The moments of assessment of affective and / or emotional state are designed as inputs that, as a result of choices made by the user, can record a status value on two levels

1) to a level of identification of the state, that gives Boolean feedback (yes / no).

2) to a level of quoting ie measuring / quantification of the state (-1, 0. 1)

The assessment of emotional Boolean type, occurs in response to a stimulus at a given action. The quantitative emotional assessment brings to locate the axis of correspondence of the emotion. The quantitative analysis brings to assign a score where the score -1 corresponds to an extreme, the score

1 to the other extreme, the score 0 to indifference towards that emotion. The distinction between levels of user status (Boolean and quantitative) can add a variation on the type of emotion in terms of positivity / negativity.

3.10.1 Hypothesis of emotional stimuli

Then in phase X, the user will be subjected to a stimulus evaluation that is able to give a measure of this emotional state. To do this it is considered appropriate to use a class devoted to the analysis of stimuli of each emotional axis: then I will have a set of elements that can give me a measure of the state of security / anxiety, and another set can tell me something about state of self / frustration and so on. This stimulus will be designed taking into account those who are "root of stimulus event" of an emotion that will guide the identification of types of moments / input stimulus / emotional tracking. In literature there are very useful associations of these cases

stimulus event	cognition	feeling state	overt behavior	effect
threat	"danger"	fear	escape	safety
obstacle	"enemy"	anger	attack	destroy obstacle
gain of valued object	"possess"	joy	retain or repeat	gain resources
loss of valued object	"abandonment"	sadness	cry	reattach to lost object
member of one's group	"friend"	acceptance	groom	mutual support
unpalatable object	"poison"	disgust	vomit	eject poison
new territory	"examine"	expectation	map	knowledge of territory
unexpected event	"what is it?"	surprise	stop	gain time to orient

Figure 3.29 Root of stimulus event(Plutchik, 2001)

Suppose then the user is given a moment of analysis of his emotional state through some conversational elements based on action scenes.

This moment of recording in a first level will tell me if the user and his character show a high degree of excitement and a second level will give me more information on the type of excitation (eg in terms of -1 / 0 / +1).

The output in terms of impact of the emotional level on the path is manifested in terms of change in terms of the story situation, which could present contents and actions more appropriate to the user's emotional state (or able to re-direct it to the want and more in line with the character used) and serve as positive reinforcement (scenes audio, video footage, collaborative reflections) and then continue a later with a measurement of the state and its variation.

Once submitted the stimulus, the emotional state will be parameterized with a parallel modification of character with which the user is playing. If the result does not fall within the value established at the beginning, elements of "response" / scaffolds will be presented to the user , the ones designed for each axis (and assuming in classes of affective or emotional scaffolds) that go to rebalance the affective / emotional axis; this makes the character reach the desired value for the phase in which the story is.

Wanting to begin to hypothesize the types of affective / emotional stimulus / tracking) we can think them as inputs / scenes of various types depending on the class you want to monitor:

- **Suspense scenes:** situations that present the user with an involvement of sound type (a mermaid, a series of screams) and require immediately the user to select or complete a sentence by a grid of terms (which may represent a series of emotional states)
  Example: Francesco is inserted into a scene where after a series of screams and sirens he must locate himself between a series of explanatory faces" emoticons" (each associated with an emotional state).
- **Conversational scenes**: scenes of dialogue type, multi-user, require entering voice or words to remember the scene words in a box (for example, the words remembered could be those most suitable to the lived state). Example: After watching a scene from a fall with people yelling at Francis asked to tell what he saw and his mood
- **Action scenes:** movie scenes that require specific actions to the user in a time where one can infer the emotional state experienced.

3.10.2 Technical notes

The recording and subsequent emotional stimulus will not impact the global plot structure (therefore on the visual portrait of the story that is predetermined during authoring and consisting in stages: beginning, call adventure, problem, middle / transformation, solution, closure) but causes variations in individual situations and actions that the user can make in these situations, as well as the type of character with which the user participates and / or operates at ' the/ experience'.

For the management of emotional feedback / emotional in story learning objects in a story, you might consider a range of services in the following order:

• a discovery service of story actions, elements affective / emotional that will serve as a kind of emotional assessment

• an engine for the computation of the assessment and the outcome in terms of emotional state that influences the sequencing of updating the history and character traits, introducing new elements into the story.

So actions can lead to the achievement of cognitive objectives through appropriate emotional / affective stimuli.

3.11 SLO and structure

Our storytelling structure adopts the "SITUATION" (building block) as its self-referential base unit. A story-learning object has as many situations as the number of key-phases of the story visual portrait. A situation answers to a cognitive objective of knowledge (see Bloom taxonomy and skills in Table 1), that will be reported in the metadata of the overall SLO and the emotional state ideal to experiment such a situation (with reference to the comprehensive Plutchik's view of emotions).

Every situation, where the learner impersonates (avatar) a hero (who could be associated to the competency level), has a basic canonical format that includes:

Advancer event of problematic context: as for instance reading a text or watching a TV news video sequence. This first asset can have different communication types/styles (journalist, narrative, political, scientific), which different types of contents correspond to. At this stage the communication can be direct or mediated by a pedagogical agent.

Learning event (varying according to the cognitive objective of a specific situation): the event can be represented by different scenes characterized by a prevailing media mix (audio, text, kinesthetic/animated). The user can play for each event an active role (inside the scene - he/she lives using the third person) or a passive one (outside the scene – he/she lives using the third person). The learning event can be multiple according to the complexity of the cognitive/knowledge objective he/she is answering to and to the operational indicators of such an objective (knowledge chunk).

Reflection event (with testing input of the emotional state): depending on the role of the hero and on his/her prevailing style (managed by IWT), different scenes will be visualized:

- For instance, the event is characterized by the introduction of a new character on stage and the user is allowed to define it (dressing up the character) retrieving from a data set the items that help him/her shape the character (i.e., basing on the emotional state, the user can decide to shape a friend, a fireman, a doctor, etc.). Once he/she has visualized a character, will be provided with information about the character's emotional state (initial emotional state: excessive anxiety) or the size of gap resulting from the desired one (final emotional state: moderate anxiety), to be adjusted through available corrective actions. A corrective action/moment acted on an emotional base is presented: for example, a pedagogical agent tells him/her about the occurred event (using the chatbot) with a minor problematic density, lowering in this way the state of the possible user's anxiety and allowing him/her to confront that event serenely.
- The user is asked to write down a text/test? after an activating stimulus that helps the drafting (if the user is a fireman "he/she will tell the operations centre colleagues what happened in a short text, so to alert them for the emergency response"). The user can choose not to write the test but to assign the task to another stand-in user present in the scene, which in his/her opinion is able to do it better. In this case, there is a concrete sign of insecurity due to the incapability to give a clear and useful definition for the colleagues. His/her substitute writes the test and asks an approval and an enhancement so to improve his/her level of in security.

Evaluation /Assessment event. Every situation has an e-test related to the knowledge objective to be reached/competency. For instance, in the case of a knowledge objective concerning a set of management rules provided for the space for critical discussions, the student will be delivered a test through which they are requested to select from a list of rules all the items that can help create a brochure to disseminate for information purposes. As for what the applicative knowledge goal concerns, the user will have to act within a scene that simulates a seismic event (moving objects, sorting a sequence of actions, organizing an emergency response team, selecting objects to take …).

Every phase of visual portrait has different types of situations with a canonical base format. The learner has to pass each phase to reach the final level of competencies.

3.12 The ARCS Model of Motivational Design for SLO

A model which stresses the question how SLO can be designed to stimulate the learner's interest is Keller's (1987) ARCS model. ARCS is an acronym for the concepts attention, relevance, confidence and satisfaction, which all four are essential to engage a person in a learning task. The ARCS model "…helps an educator to identify the component of instruction that either increases or decreases student motivation to learn and also provides motivational strategies which an educator can use to make instruction responsive to the interests and needs of students" (Wongwiwatthanaukit & Popovich, 2000, p. 190).

Motivation is individual's willing to perform required behaviours in order to attain his/her goals. According to motivational design theory, in order to create an effective, efficient and attractive

instructional design, the elements of motivation which are handled in four categories have to be understood well.

Attention: "…refers to gaining attention, building curiosity, and sustaining active engagement in the learning activity" (Keller, 2008, p. 176). Opportunities to realize this are the usage of interesting graphics or animations, mystery and unresolved problems. To keep attention it is important to use varying learning approaches.

Relevance: The motivation to learn is higher if the learner considers a personally relevant knowledge to be learned. Therefore, the learning environment should be related to the learner's goals, learning styles, and past experiences.

Confidence: In order to motivate a person to learn, it is important that the learner believes s/he is able to succeed in the task. A way to enhance confidence is to bring the person in situations where s/he can build a positive expectancy for success and can attribute success to internal factors like his/her own ability (Bandura, 1977; Weiner, 1974).

Satisfaction: To allow a person to have a continuous motivation to learn, s/he should experience satisfying consequences of the learning task. Such outcomes can be extrinsic reinforcement (like rewards) or outcomes that excite intrinsic motivation (like applying the learned knowledge). Another important condition to enable satisfaction is that the learner experiences equity, e.g. regarding the amount of work and grading.

Volition and self-regulation: To assure a continuous working on a learning task until some kind of learning goal is achieved, it is often necessary to use volitional or self-regulatory strategies. These strategies help a person not to be distracted from the goal by other things.

The first step of motivation is acquiring the **attention** of the student during the instruction period and ensuring its continuity. If the content that will be taught is not **relevant** with the requirements of the student or the state he/she is in, it will be difficult for the students, the curiosity of whom is stimulated, to preserve their interests and curiosities. **Confidence** is the student's developing positive expectation in order to perform a high degree of success. If the student loses his/her confidence, it will become quite difficult for him/her to attain success. The last element of the ARCS Model is **satisfaction**. Motivation in high degrees is realized as a result of the satisfaction that the student get from instruction. If the student observes that his/her success is not reinforced according to the natural difficulty level that the instruction includes, he/she will feel unsatisfied. The original model was recently expanded by volition and self-regulation (Keller, 2008).

We use several guidelines aimed at enhancing an interesting instructional design of SLO in terms of attention, relevance, confidence, and satisfaction (Keller, 1987), which are in part also suitable for the educational game design and are selected and summarized by Garris, Ahlers, and Driskell (2002), Keller (1987), Song and Keller (2001), or Wongwiwatthananukit and Popovich (2000).

- **To sustain or enhance the player's attention** to the instructional material in situation scene it is feasible to use flashing or inverse text, animations, and surprising or unfamiliar sounds. However, these features should not be used excessively as they may distract the learner's concentration. Further attention can be supported by question-response-feedback interactions, problem-solving situations, humor, contradictory or bizarre content, visual presentations, and examples of taught concepts, role plays, and simulations.
- **To let the student experience the learning content as relevant** for him-/herself, the material should provide clear goals and suggest future usefulness. It should be presented in a familiar way by using concrete language, concept, and rules for manage risks in situations.
- **To sustain a self-confident user**, s/he should have control over navigation and pacing. Further the story's requirements should fit the learner's knowledge, challenges should be

organized with an increasing level of difficulty, and the user should be provided with attributional feedback that relates a success to the personal ability or effort in situation.

- **The satisfaction of a role play** (take or make) who is engaged in an instructional situation can be positively influenced by using verbal praise and external rewards judiciously (immediately following the task, not too often, not for easy or intrinsically interesting tasks but while the mastering new skills or boring tasks), by allowing the student to apply acquired knowledge in a realistic setting and difficult task, and by forcing equity and consistent measurement standards for all accomplishments.

A comparison of the ARCS-model with the SDM (and Aristotelic suspense model) clarifies that an ideal learning interface is offered if narrative methods are used early on in the production process of. In both models there are four phases or sections, which are almost identical in their goals. Both can be harmonized easily:

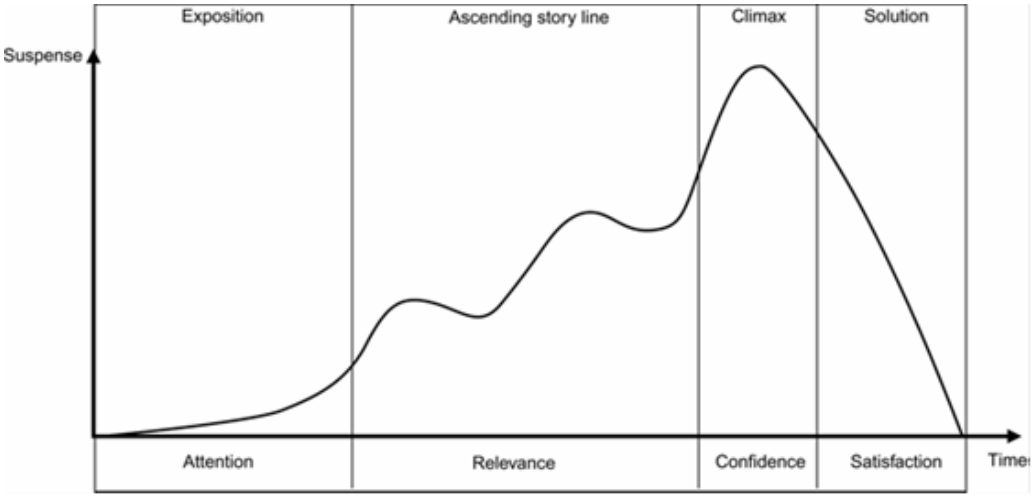

Figure 3.30 ARCS model and story circle

- The students' attention first has to be caught, similarly as the audience of a story. Their attention must be held and then maintained throughout the course. The goal of the first phase is to introduce the students to the problem field. This can be achieved by introducing event elements or alternating forms of presentation and interaction. This motivates the students and therefore contributes to maintaining the students' attention.
- The "ascending" in the storyline is the same as the increase of the students' familiarity with the problem. The increase of understanding of the material puts them into the position to be able to solve problems, which are becoming more and more difficult and complex.
- The climax occurs at that moment, at which the student achieves the first step to independently fulfilling the expectations, requirements, and evaluation criteria of the experience.
- During the last section of a story, still open conflicts are solved. The students now are offered the possibility of getting answers of their still open questions. In addition, it's useful to create natural consequences by providing learners with opportunities to use newly acquired skills.

4 Conceptual Viewpoint

In a storytelling learning object users experience immersive learning stories that are built according to a certain path and to different steps. Once users start their way, the more they progress through the learning path, the more they may have the curiosity, the need and the expectation of what is coming after. They sometimes tend to predict the flow of the story based on the previous situations, some other times they have to take a crucial decision and choose their own way, as the storytelling implies a choice towards correct learning. Predicting and choosing the flow of the story requires reasoning capacity to analyze the same. This is the reason why we here concentrate on the opportunity to provide an architecture or structure for analyzing and developing the stories line on the basis of characters, events and the situations defined in the Storytelling Model.

How do we organize and shape an experience that is supposed to be free flowing? How do we create a pathway through nonlinear experiences? Logic in digital storytelling is often expressed in if/then terms. If the user, in a specific situation, does the A, then B will happen. This construct is the foundation model of digital storytelling: the branching model, made up of many interconnected if/then constructs. It works like a pathway, which the user travels. Every so often, the user will come to a fork in the path – a decision or action point –, which may offer different choices. Upon selecting one, the user will travel a little bit farther until reaching another fork, and so on. If the user takes the wrong choice, a pedagogical agent can help him/her find his/her own way. In any case, the user's progress through the learning path produces new experiences and new insights, as well as new emotions that generate learning.

In order to develop a more generic and significant model to create storytelling applications and processes, we need to focus the solution on the manner the general plan and the content are organized and conveyed to the user. That is to say, we need to choose an ontology that is a formal, explicit specification of our conceptualization to share.

Whit ontology the author works at the model level, where we represent the concepts of the specific subject the storytelling will be about. Using conceptual mapping it is possible to reinterpret content roles, specific for the subject, as pedagogic roles. Once the storytelling outline is obtained by the story model planner, a template-based pedagogical tool can fill such an outline with actual resources and, accessing the semantic metadata of the repository and composing semantic queries for the desired resources automatically.

4.1 Critical thinking and choice of the semantic approach

The starting focus point is "the event". Most researchers assume a concept of "event" in order to organize the content of their storytelling applications, and therefore, have developed methods to deliver such events using narrative techniques. In the majority of storytelling applications, events are represented as plain text,scripted individual character actions, story world states or multimedia content (Nakasone et al 2006) . Basing on these techniques, storytelling applications can be classified (Nakasone, 2006) as:

- **Rule based:** Events are concatenated based on predefined logic rules that take into account current event status and historical information in the form of facts.
- **State Transition based**: Events are defined as states that specify the current situation in a particular point of the story. Bayesian Networks, Finite State Machines, and their variations are commonly used.

- **Goal based**: To construct a story, a goal event(s) is established as the final outcome of the story. From a set of initial conditions, a story is unfolded by the sequence of events that are needed to reach such goal event. Planners and their variations are commonly used for these applications. Permutation and Template based: Events are selected from template stories and permutated to create new narrative experiences.
- **Script based**: Stories are scripted using a high level language. The application, then, presents the events in the way specified by such scripts. In some cases, some narrative or dramatic effects are applied during the event transitions.
- **Semantic Inference based**: Applications in this category create stories based on a network of semantically organized events. The most common organization is based on RST.
- **Emergent Narrative based:** These kinds of applications do not really enforce any story or narrative principles, but give the users the appropriate tools to create their own stories based on their social interactions inside a play.
- **Narrative Function based**: Applications in this category make use of a special narrative function that tries to enforce narrative principles in the context of the whole story. Therefore, event sequencing is constrained not only by direct event relations, but also by its contribution to the overall narrative experience.

In the majority of the research works presented above, the method applied to construct stories was implemented because of the selected event definition and vice versa. Similarly, we referred to the chosen model, bending it to our own purposes and needs. In fact, even though the results obtained in these applications are mostly impressive, this cohesion of concepts makes the task of adapting these models to other domains extremely difficult. Therefore, a model in which event definition and sequencing are clearly separated is necessary to guarantee its generic attribute and to let users deeply grasp any single semantic value in its proper context. And this makes sense. Events in the world are not isolated, but interconnected by some kind of relation between one another. Even though each event itself is meaningful in its content, the relations between events are what make these events meaningful in the context of a story visual portrait. Semantic relations imply not only a relationship of meaning, but also a relationship of temporality and sequencing through the use of rhetorical extrapolations, giving us enough flexibility to create stories, regardless of the type of events, type of role played, and cognitive and emotional assessment results. Any time a user plays, takes and/or makes his/her own choices in order to follow an established path towards the transformation and the reaching of the final goals, a new relationship between events is established. Among this wide range of choices, the solution that best fits our purposes of a visual learning object portrait is mostly a “Semantic inference based one”. Semantic Inference based applications take this idea into account, but they only deal with a very limited set of relations and, in most cases, without analyzing the narrative consequences that each relation has in the context of the story. It’ s up to us to enlarge the range of this limited set, analyzing the various possibilities.

4.2 Topic Map for SDM

The flow of the story, represented by story visual portrait, depends on the theme conception or narrative sequences of events. Sets of related order of events are responsible for the flow of story. Ontology possesses different kinds of situations, events and roles, which constitute the theme for a story and episode. Concept map is essential in representation of themes, roles and events and generation of stories, as well as transformation of users. It is now being recognized as important components of information systems and information processing.

Storytelling Map helps to investigate the stories by extracting the characters, the emotions and the events from the given story and provides the semantic relation among them. Ontology is formal explicit shared conceptualization. Conceptual vision provides the domain knowledge, which can be utilized for

reasoning the stories semantically. Reasoning the stories based on the characters acts as a lead for the construction of the new different variety of stories with change in the characters, their nature and the events. Our map is constructed and based on the components of the digital story domain. It contains characters, situations, and events. The notion of "story event" is defined in several ways, each one to suit a particular way to deliver the intended message to the audience. Events can be represented as plain text, speech with intonation features, video fragments, or multimedia content based on web technology. To summarize, adopting an ontology, we can provide the instructional design with a suitable topic map tool, that aims for reasoning the stories and specific episodes– situation by situation, event by event, character by character, emotion by emotion, event by event - based on the emergence story description using a topic map. Therefore, we present our proposal for a generic storytelling concept model based on the organization of events using the relations proposed by the Rhetorical Structure Theory (RST) used in recently works (Nakasone A., 2006) and specialized in order to refer Visual story Portrait (Ohler, 2009) and storytelling Model. Furthermore, we want to analyze how narrative principles of story visual portrait can be applied to these Story Model relations to generate coherent stories. Concept map helps in theme conception for generating new stories and new possibilities. Even though constructed ontology is domain specific, it can be updated, modified, reengineered, reused for other purposes also.

4.2.1 The Concept Level

In this section, we will present our approach to define a general conceptual model for digital storytelling based on semantic Visual Story Portrait relations and its application on the different solutions. We will define not only how Visual Story Portrait relations are referenced in the context of stories, but also how narrative properties are enforced by the proper use of these relations, as well as how different users benefit from and add value to the special interrelations and interconnections that are displayed step by step. This is because, in our VSP, the digital stories are not only unique sequences of events, but also mental states, emotional and/or cognitive reactions or happenings involving human beings as characters or actors playing/making/taking different roles, thus shaping the storytelling in itself. Considering the conceptual and semantic aspects described above and the way we enhance our model, we can also propose an conceptual model, as knowledge representation to support design and authoring of storytelling Learning Object. The classes in this model were defined taking into account the many different definitions that researchers gave to their story components, but associating each class with a more general meaning that encompasses all those different definitions.

CLASSES of CONCEPT

Concept: A Concept defines a specific topic that a presentation or part of it may refer about. The hero/character faces the concept and behaves consequently
Situation: the combination of circumstances at a given time and place in the flow of story. The hero/character finds himself/herself involved in the situation and reacts to more events. This reaction determines the following progress in the story and the evolving in learning
Stage: the background for the situations.
Event: something that happens at a given time and place and that can determine or change a situation. An Event is defined as a single piece of meaningful information worthy of being presented. In particular in VSP we have cognitive and emotional events as assessment moment. An Event can now hold a reference to piece of text, video clip, image, game scene, character scripts, etc. The hero/character reacts to the event according to his knowledge and emotional state and thus shape is/her own story
Action: a possible action to be performed in a situation. This determines a cognitive transformation by the hero/character.
Role and character: We remember that in a Storytelling a user plays a specific character (chosen among an established range) and has one or more roles to portray, according to the situations and the flow of the story. Once chosen, his/her character represents the hero who leads his/her adventure

(according to Propps frame work of six characters) with the other five ones on his way towards learning. From Bloom's taxonomy we suggests that there are moments / inputs that can assess the level of knowledge of the character. In particular the following grid shows what we mean by possible users transformation in the different levels.
Relation: A Relation is a rhetorical binding between two entities, which refers to a specific rhetorical function. In a story, events are related to one another with some kind of relation. From a semantic point of view, rhetorical theories have provided us with the most useful insight on which kinds of relations can be found between pieces of story portrait. For example Relations such as CAUSE (i.e. one event is the cause of another) or BACKGROUND (i.e. one event serves as background information for the other) are very important in our model as it determines the whole framework of the Visual Portrait.
Agent: An Agent is an actor that takes part in a Situation and is affected by specific Relation. It is very important as far as the hero's progress in learning is concerned; we can have different types of agents, according to Propp's list. He/she can have a *pedagogical function* (help seeking, emotional scaffold, cognitive advancer organizer, etc) for the hero and can be represented by an individual and/or a group of people.
Scene: A Scene is defined as a graph-like structure composed of Relations. This class defines the minimum level of organization in which a story arises. A Scene can have a recursive structure. We have different kinds of scenes in our model that range according to their level of multimedia: they can thus be mono or multimedia and differ for their components.
Episode: An Episode is defined as a set of Scenes, which are grouped in the context of a single Concept.
Story: A Story class frames the whole story and is composed of more Episodes that respect the traditional steps of the Visual Story Portrait

Each class has a purpose in the context of story pattern organization, either to define a specific story component or a property of such component.

Figure 4.1 the story components

In our model, an Topic is defined as a networked organization of concept issues, which are connected through hierarchies of concepts and directed links, showing a traversing path from one concept to the other, any time different from the previous one, according to the character and its role. The main advantage of this model is that this sequenced organization of issues allows users to construct fluid and coherent stories based on the selection of a few key concepts. When a user specifies the key issues the story will be constructed around, the storytelling model engine automatically selects other concepts that must be included in other to have a fluid story. Even though a path might not be found, the engine makes sure that transitions between concepts be as smooth as possible.

4.2.2 RELATIONS AND THEIR DIFFERENT TYPE

Even though the way events are linked in any story are, in general, consistent with the definition of the complete set of Visual Story Portrait relations and the web mode they are implemented, the first set made its use impractical for the purpose of event content creation, since most human beings make use of a more limited set of relations to construct and remember stories. In order to provide more flexibility to content authors, a reduced set of unambiguous relations was needed. This set was defined as a subset of the first set of Visual Story portrait relations used. Given the fact that a set of different types of relations helps assimilate the content of a story, it is plausible to assume that the same set of relations may also be used to create such content. Therefore, we defined our set of relations taking into consideration their definition flexibility and the proper number of unambiguous relations that are needed to create generic patterns of stories. For our model, the following relations were considered:

Event and Situation Relationship

Background: In this relation, one event A is referred as the situation in which another event B happens or a character's behaviour is expected to generate another behaviour. Event or behaviour A happens to be located in the past of event or behaviour B, but it does not necessarily entice a cause and effect relation.
Cause: In this relation, one event or character behaviour is identified as the cause of another. The cause relation is one of the main relations in the ontology because it is the relation between events that people distinguish more clearly.
Purpose: This relation reflects the necessity for one event or process to be shown before another can be shown. Even though it is in direct relation with the Cause relation, its use is different since it indicates a condition for advancing in the story, which will be discussed in a following section.
Result: This relation indicates that an event/behaviour is shown as a direct consequence of another event/behavior in a situation. It is also linked to the Purpose relation, but has more immediate and final connotations. This relation is mostly used to indicate the display of final events during a story.
Contrast: For any story to have narrative quality, it must show some kind of conflict between two or more events. Conflicts, implemented as contrasts, give stories an opportunity to enhance their audiences' comprehension and interest by creating narrative tension. There are some characters in our storytelling model that perform the roles of antagonists, following Propp's model.
Solution hood: This relation provides a way to define how a Contrast relation will be solved.
Elaboration: In this relation, an event is shown to give more details about another event and add significance to the user's progression towards transformation.
Evaluation: This relation provides a way to state a final conclusion about one event/or an accomplished process of (cognitive and emotional) transformation in a situation. It is helpful for authors to convey a final message or thought to the whole story.
Sequence: This relation establishes a linear temporal and/or cause/consequence link between two events in a situation This relation is useful to enforce sequencing in stories, but it should not be used as the primary way to link events.
Cognitive progress: this relation provides the range of knowledge acquired by the user.
Emotional feedback and/or progress: this relation provides information about the user's emotional status and reaction to a certain event/situation and about the emotional progress by the user

Scene, Agent and Role Relationship. In every Scene, Agents are specified as character entities that either present the content of Events or take part during the execution of Events as actors or are victims of events to which they are unable to react. Since not every Agent can be part of every Event inside an Act/Scene, the Role object is associated with every Agent and defines in which kind and on which side of Relations it may intervene. Although the Role objects depend on the kind of application in which the ontology is used, we have predefined five roles in our model that identifies and groups the

main characteristics of the selected RST relations in terms of narrative relevance. The predefined roles for our model are:

Questioning Role: The Agent will receive the information contained in the relation will be conveyed to. (e.g. of SOLUTIONHOOD)
Informing Role: The Agent will convey the information contained in the relation (e.g.
SOLUTIONHOOD)
Contrasting Role: The Agent contrasts information of one side of the relation with another (e.g.
CONTRAST)
Helping Role: The Agent will be favoured in a help relation (HELP)
Cooperating Role: the Agent will be helped in a collaboration relation (COLLABORATION)
Convincing Role: The Agent gives a convincing explanation about the information contained in a relation (e.g. CAUSE)
Transformation Role: the Agent will benefit from the learning process and attain a transformation relation (TRANSFORMATION)
Evaluating Role: The Agent states a final conclusion or assessment in a relation (e.g. EVALUATION)

The complete diagram of the topic map is shown:

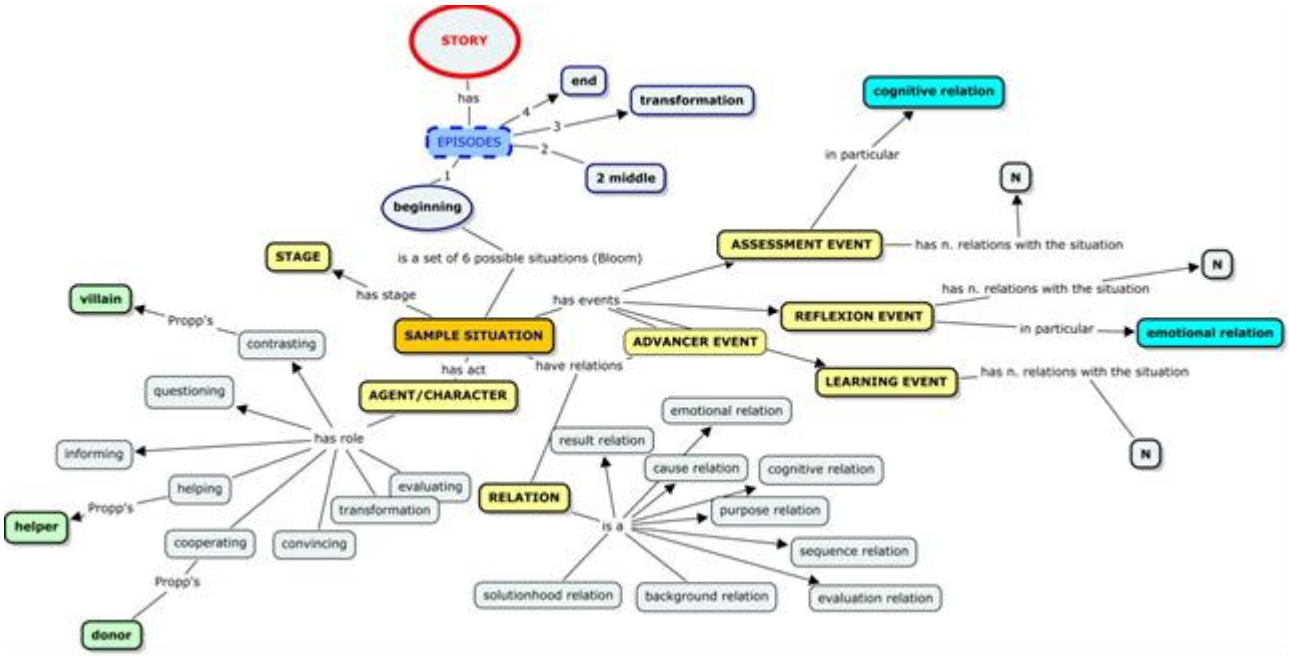

Figure 4.2 Concept map view

The Concept model described above gives us the class definitions to construct a story organization based on common and general story components.

5 Metadata Viewpoint: Educational Needs of C-LO and S-LO

An Advanced Content is, from a conceptual point of view, a new form of learning experience, composed of CLOs (traditional textual content, simulation, high emotional contents, collaborative experience, storytelling), assessing material (both cognitive and affective-emotional) able to generate an effective type of learning such as reflective learning, experiential learning, socio-cognitive learning. The metadata schema must reflect all aspects of a CLO. In this chapter we propose and define an extension of LOM with a set of metadata elements for the description of CLOs and with the aim to facilitate search, evaluation, acquisition, and use of S-LO s intended as special CLOs.

The effectiveness of retrieval and re-use processes requires a more formal description of the resources that closely fits the user's search criteria and supports software agents in personalizing the learning experiences. Existing metadata schemes (i.e. IEEE LOM) are not sufficiently expressive to describe pedagogical features of complex learning resources according to the education world's view. Moreover, the expressive power of the existing proposed metadata schemes is often unsatisfactory with respect to the underlying educational paradigm: it has been observed that existing schemes lack an learning-related vocabulary that can help users describe a type of learning, objective and context. For instance, the learningResourceType (a specific LOM metadata field) mixes pedagogical and technical/presentation information: while its Graph, Slide and Table values describe the format of a resource, other values such as Exercise, Simulation and Experiment cover the instructional type. They represent different dimensions, hence the LOM scheme needs to be reviewed. Furthermore, several instructional approaches (e.g. storytelling/narrative learning, game-based learning, etc.) and objectives (e.g. level of Competency and type of Knowledge), that are very important to identify a CLO, are not covered by the LOM. As a result, the LOM scheme fails to represent sufficiently precise instructional types to allow an automatic usage of learning objects, in particular, when it involves complex pedagogical resources composing an effective learning experience. Among theoretical studies, we recall the proposal of Jonassen & Churchill (2004), who formulate indications on the basis of the psychology of learning about possible types of LOs and ways to expand metadata in order to support meaningful learning. Another example is represented by the work of Mwanza & Engestrom (2005), who investigate the potential contribution that specific learning theories can offer to produce both pedagogically meaningful and contextually relevant content descriptions. These issues form the basis for studies that analyze educational metadata according to the Alice project and SDM pedagogical view point. We aim to improve the metadata scheme by defining new fields, capturing specific didactic features of shareable learning resources. A relevant role in the realization of this potential is played by identifying C-LO descriptors that allow for effective searching of repositories of reusable material. Accordingly, much effort has been devoted to define standards for cataloguing C-LO and SLO in particular. The characteristic features of our proposal is the introduction of a specific metadata model to describe the role that a C-LO has to play when it is integrated into the educational process.

5.1 Metadata Model for CLO

In order to obtain a pedagogical information about educational resources, it is necessary to re-define the metadata fields that allow the teacher/author to select and assign complex learning resources to the instructional strategy that best responds to a recognized educational method or approach (e.g., in the case of a narrative learning approach , a useful strategy can be the storytelling, and in particular, a storytelling learning object). Let us assume that the final result the teacher wants to achieve in the complex learning experience composition phase is to get a direct association between the

topic/subject selected by a domain ontology (knowledge layer) and the complex learning resources, that minimize the fitting with this topic (information layer). The following figure shows a synthetic view of what the teacher may want to get after searching in the C-LO repository :

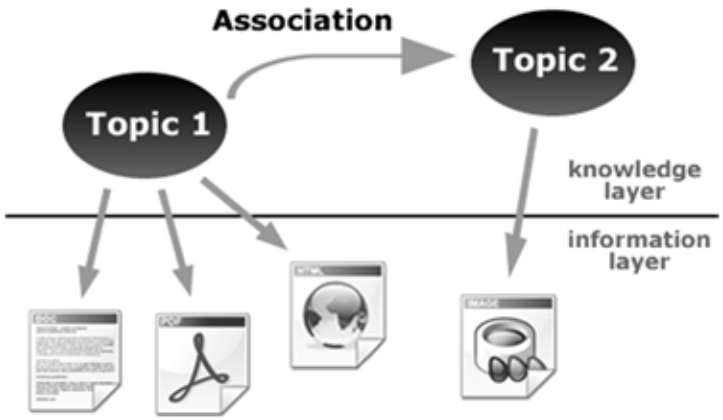

Figure 5.1 mapping beetween target concept and LO

The teacher should be able to select, from a filter list, a specific approach for selected target concepts, in order to ascend directly to set of C-LO who responds to this strategy.IEEE LOM defines a hierarchy of elements that are grouped into nine categories: General, Lifecycle, Meta-metadata, Technical, Educational, Rights, Relation, Annotation, and Classification.

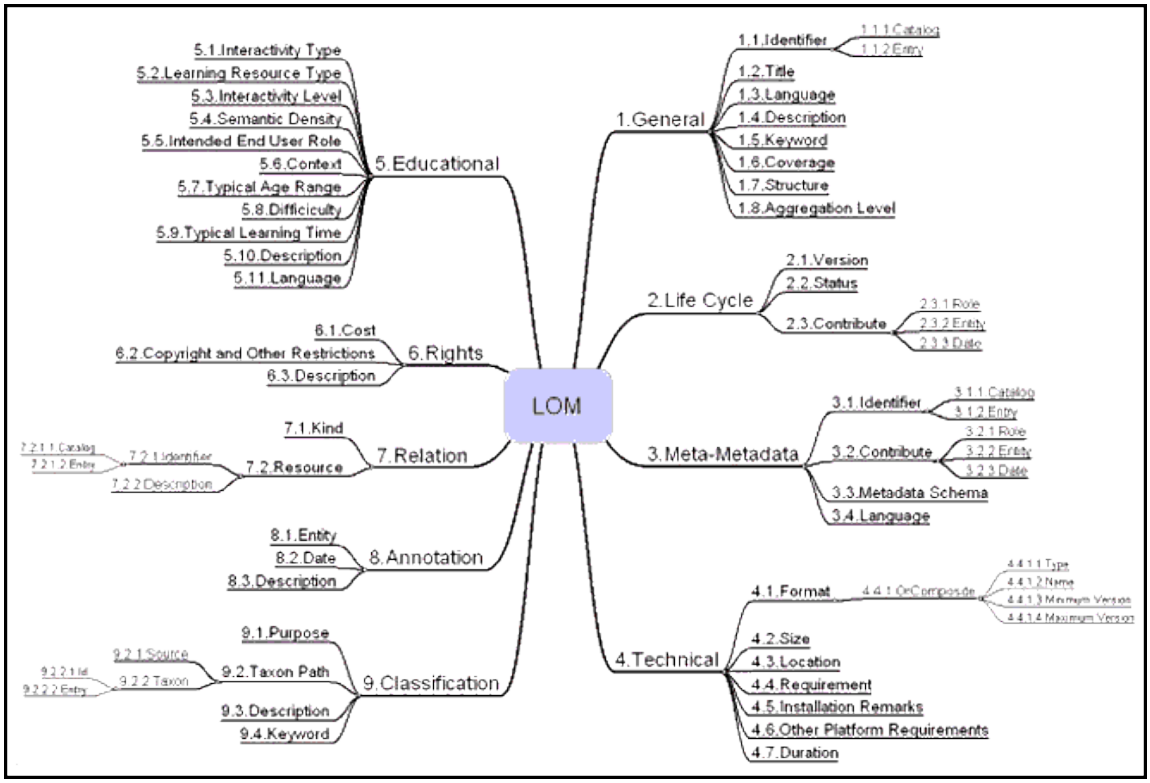

Figure 5.2 IEEE LOM

Each category consists of sub-elements that have some basic characteristics in common and appear either as a single element or as an aggregation of other elements.

The adoption of a single metadata schema is usually an inadequate way to efficiently characterize learning objects. As a solution to this problem, the use of Application Profiles is proposed. According to Duval et al. , an application profile is an aggregation of metadata elements selected among one or more metadata schemata ? and combined into a new one. Therefore, applications that utilize application profiles can benefit from exploiting the features of an existing schema and enriching them with desired characteristics. The proposal integrates descriptors from the main international metadata standards, in particular IEEE-LOM, GEM and EDNA Project (S. Alvino et al 2007; Busetti et al 2007), and Ontology of Instructional Objects (OIO) (Ullrich2005), with new ones aimed at identifying the context of use, educational features, structure and learning approach of the complex resource.

The purpose of this revision is to facilitate search, evaluation, acquisition, and use of complex learning objects, for instance by learners or instructors or automated software processes. Compared to LOM metadata fields will act extending and enriching some dictionaries

This revision also facilitates the sharing and exchange of complex learning objects, by enabling the development of catalogs and inventories while taking into account the diversity of contexts and objectives in which the C-LO and their metadata are reused.

The following table represents a complete dashboard of modifications that are suggested in order to allow the teacher to be able to provide indications related to an educational structure, a specific strategy which the CLO responds to, supported level of competency and type of knowledge associated with known taxonomies, and also resource interactivity, type of content, student's role.

IEEE LOM		ALICE C-LO Metadata		
Field	***Allowable Values***	***Field***	***Sub-Field***	***Allowable Values***
InteractivityType	Active, Expositive, Mixed	InteractivityType		Active, Expositive, Social, Mixed.
Learning ResourceType	Exercise, Simulation, Questionnaire, Diagram, Figure, Graph, Index, Slide, Table, Narrative Text, Exam, Experiment, Problem, Statement, Self Assessment, Lecture.	LearningResouceModel	InstructionalArchitecture	Case Based Learning, Critical/Incident Based Leaning, Demonstrations/Modeling, Collaborative Learning, Exploratory Learning, Storytelling, Goal Based (aka Scenario Based) Learning, Problem Based Learning, Game Based Learning, FAQ, Manual, Glossary, How-To.
			CLOtaxonomy (for SLO)	Character Stories, Memorial Stories, Adventure Stories, Accomplishment Stories, Story About a Place, Story About What I Do , Recovery Stories, Love Stories, Discovery Stories.
			MultimediaResourceFormat	Text, Image, Animation, Repeatable Animation, Interaction, Audio, Video, Simulation, Video-Simulation.
InteractivityLevel	Very Low, Low, Medium, High, Very High.	InteractivityLevel	Level	Very Low, Low, Medium, High, Very High.
			SynchronizationType	Time Based Scheduling, Event Based Scheduling.
			GuidanceType	Individual, Social

			GamingRoleType	Role Playing, Role Taking, Role Making.
			EmotionalEngagement	*WP2 will produce a vocabularies for this field.*
SemanticDensity	Very Low, Low, Medium, High, Very High.	Resource ComplexityLevel	LearningResourceConnections	*References to other LOs or CLOs.*
			SemanticDensity	Very Low, Low, Medium, High, Very High.
			Difficulty	Very Easy, Easy, Medium, Difficult, Very Difficult.
IntendedEndUserRole	Teacher, Author, Learner, Manager.	LearningAudience	IntendedEndUserRole	Teacher, Author, Learner, Manager.
			Context	School, Higher Education, Training, Other.
			Language	EN, DE, IT, …
			UserAge	"7-9", "0-5", "15", "18-", …
			UserKnowledgePrerequisites	*0 or more references to elements of ontologies (modeling educational domains).*
Context	School, Higher Education, Training, Other.	*See sub-field Context of LearningAudience*		
Typical Age Range	"7-9", "0-5", "15", "18-", …	*See sub-field UserAge of LearningAudience*		
Difficulty	Very Easy, Easy, Medium, Difficult, Very	*See sub-field Difficulty of*		

	Difficult..	*Resource ComplexityLevel*		
TypicalLearningTime	"PT1H30M", "PT1M45S", …	EducationalAdditionalFeatures	TimeNeeds	"PT1H30M", "PT1M45S", …
			FruitionMode	wb-learning, m-learning, t-learning, etc.
			InstructionalRecommendation	*Free text*
Description	*Free text*	*See sub-field InstructionalRecommendation of EducationalAdditionalFeatures*		
Language	EN, DE, IT, …	*See sub-field Language of IntendedEndUserRole*		
		AssessmentModel	AssessmentFunction	Summative, Formative.
			AssessmentType	Cognitive, Emotional.
			FeedbackType	Evaluative, Interpretive, Supportive, Probing, Understanding Form. *To be reviewed by WP5.*
		PerformanceType	CompetenceArea	*0 or more references to elements of ontologies (modeling educational domains).*
			CompetencyLevel	Novice, Beginner, Proficient,

				Competent, Expert.
			KnowledgeType	Knowledge, Comprehension, Application, Analysis, Synthesis, Evaluation. *From Bloom's Taxonomy.*

Table 4: IEEE LOM for CLO

The research has carried out a specific analysis on every Education metadata field, trying to understand whether they answer to specific pedagogical needs about metadatation and indicating possible variations in the dictionary or in the same field.

The first field which has been modified is the ***InteractivityType*.** The values accepted for this indicator have been extended in order to give satisfying information with respect to a C-LO type. To the pre-existing values, such as *Active* (suitable for a CLO that supports learner in his/her free actions and decisions), *Expositive* (indicating a resource that puts the learner in a condition of receptive learning only), *Mixed* (indicating a resource that presents both *Active* and *Expositive* characteristics, as for example a hypermedia tutorial containing a simulation, etc.), a "Social" value is also added, to indicate a complex resource that encourages the learner to make use of a peers collaborative product (e.g., a collaborative session, virtualised and delivered as a C-CLO).

The field that presents a consistent modification and makes it more explicative, is the ***InteractivityType*,** whose associated dictionary is unable to totally answer to the need for giving peculiar indications about the "measure" that the interaction between learner and LO content can modify the behaviour of the LO itself. To obtain this CLO information, we have extended the structure dividing it into sub-fields, and going beyond the sub-field, proposing the ***InteractivityLevel .Level*** (whose values are "very low" and "very high", etc.). In particular, the *Type of Guidance* sub-field is fundamental for those activities that provide *guidance* or *pedagogical* support necessary in the different ALICE project types of CLO and supplied by pedagogical agents (allowed values are *Individual* or *Social*). The ***InteractivityType*.*GamingRoleType*** sub-field is fundamental for characterising different modalities of role taking allowed by complex resources and forming a tern composed of *Role Playing* (role assigned by default), *Role Taking* (role taken by the learner) and *Role Making* (role created by the learner). An important information about CLO is given by the ***InteractivityType*.*SynchronizationType*** sub-field, whose values are Time Based Scheduling or Event Based Scheduling. The former type makes reference to a hypermedia structure of the resource, which is ruled by a system that determines its temporality as a sequence of scenes and whose presentation time is unequivocally expressed by the time line. The synchronization time is a linear time on which the events are coordinated and synchronised. The latter value instead, makes reference to a resource whose presentation elements have a prearranged time. Their behaviour is modelled on schemes that state the activation of events and is ruled by the user's interactivity. Eventually, to provide with a complete value of the interactivity level of the resource, it needs to specify the type of ***InteractivityType*.*EmotionalEngagement*** sub-field, which refers to a specific type of emotional balance (anxiety, trust, disinterest, etc.) to access to or that the CLO bases on, to reach the educational objective. The emotional Tuple is a distinctive element that indicates the emotional balance the learner is required to reach in order to access and exploit that experience. The Tuple, follows an emotional axis that is directly managed by the teacher.

The IEEE LOM field more related to the ***LearningResourceType,*** is reviewed and integrated as a sub-field inside a new field here renamed ***LearningResourceModel,*** to meet pedagogical needs specific for a CLO. Our view is confirmed by the taxonomies suggested by Bussetti et al. (2007) and Alvino et al (2009) and aims to the identification of C-LO from specific instructional function within the educational path The new field is composed of sub-fields which are able to describe the main pedagogical approach adopted by a C-LO.

The ***LearningResourceModelInstructionalArchitecture*** sub-field (using Busetti's theories and Ranieri's taxonomy it enables the teacher to indicate whether the CLO belongs to a type of *Structured LOs*, meaning by this term the fact that the LO is associated with, and follows, a special architecture(active/exposed, guided, receptive and sequential, or Collaborative/Social), or *Functional LOs*, meaning by this term resources (contextual or general) that can enrich a learning process becoming reference material (values for this descriptor include: FAQ, Manuals, Demo, Glossary, HowTo, etc.). The type of structure influences the definition of specific Complex Learning Objects, with the aim to respect general indications of different didactic approaches (possible values are: *case based learning, critical/incident based leaning, demonstrations and modeling, collaborative learning*

objects, exploratory learning, storytelling, goal based (scenario based) learning, problem based learning, game based learning, etc.). The second sub-field is ***LearningResourceModel*.*CLOTaxonomy***, referred to taxonomies available for the selected method (e.g., existing storytelling taxonomies: *Character Stories, Memorial Stories, Adventure Stories, Accomplishment Stories, Story About a Place, Story About What I Do, Recovery Stories, Love Stories, Discovery Stories*).The last one is the ***LearningResourceModel.MultimediaResourceFormat*** sub-field, which is strictly depending on the theoretical principles of the selected didactic strategy that the CLO refers to and on the information goals linked to it. It is meant as a format that varies according to the templates percentage of the resources composing it and belonging to various multimedia types (values are *Text, Image, Animation, Repeatable Animation, Interaction, Audio, Video, Simulation, Video-Simulation*).

The ***LearningAudience*** field (according to EDNA standard) describes the characteristics of the intended user of a LO from an educational standpoint. The first sub-field is represented by what in the LOM version is the main field, namely the ***LearningAudience. IntendedandUser role*** (whose values are: *teacher, learner, manager, etc*.). The ***LearningAudience.Context*** sub-field as well, is a field adapted to a lower level and whose attributes rely on vocabularies that fit the European context and the educational levels (*School, Higher Education, Training, Other*). The ***LearningAudienceUserLanguage*** sub-field intends to give information not about the language of the LO it is created for, but on a language that is ideal for the final user. The ***User age*** sub-field, indicates the presumed age of final users who are going to use the specific LO, while the ***LearningAudience.UserKnowledgePrerequisites*** refers to elements of ontologies (modelling educational domains).

The ***LearningResourcePerfomance*** field indicates what the student will have learnt after exploiting the CLO. The ***LearningResourcePerformance.CompetenceArea*** sub-field indicates the domain concept on which a LO acts through the proper area specification, with respect to known domains of competence. The ***LearningResourcePerfomance.CompetenceLevel*** sub-field indicates the level of competence and uses a known taxonomy (whose values are: *Novice, Beginner, Proficient, Competent, Expert).* The ***LearningResourcePerfomance.KnowledgeType*** is a sub-field that relies on Bloom's taxonomy (as a vocabulary for its values: *Knowledge, Comprehension, Application, Analysis, Synthesis, Evaluation).*

The ***LearningResourceComplexity*** field, includes all the information related to the level of complexity of a resource, with regard to specific identifiers. The ***LearningResourceComplexity. LearningResourceConnections*** sub-field, provides information about the type of connection between a C-LO and other LOs that the teacher/author desires to emphasize (e.g., a CLOy can "specialize", "complement", "motivate" a CLOx).

The ***LearningResourceComplexity*.*SemanticDensity*** and ***LearningResourceComplexity*.*Difficulty*** sub-fields, remain unvaried with respect to the values available in the IEEE LOM, but are inserted in this field to contribute to asserting the concept of learning complexity. An ***AssessmentModel*** field is envisaged to give a didactic value to assessment components characterising the specific CLO. The ***AssessmentModel. Assessment function*** sub-field describes the assessment function (its values are: summative or formative) influencing the type of micro or macro adaptivity that the complex resource is able to allow. The ***AssessmentModel*.*AssessmentType*** sub-field, identifies the presence of two types of assessment that the CLO can have (its values are: *Cognitive Assessment* or *Emotional Assessment*). The last sub-field is ***AssessmentModel.FeedbackType*** which classifies the types of feedback the assessment can provide (whose values are: *evaluative, interpretive, supportive, probing, and understanding form*).

The last field, namely ***EducationalAddFeatures,*** allows to describe features such as ***EducationalAddFeatures*.*TimeNeeds*** considered as necessary for a specific LO,

EducationalAddFeatures.FruitionMode (*web-learning, t-learning, m-learning*) and ***EducationalAddFeatures.InstructionalRecommandation*** *(*e.g.: comments on the CLO, like problematic aspects that emerged from previous experiences in using the resource).

6 Authoring Tool viewpoint

Storytelling is a powerful method to explain complex matters in educational formal context. 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.

There are two significant and parallel directions within the interactive narrative research project community. The first direction contends with questions of computationally structuring interactive narratives. This perspective grapples with issues of automatic plot generation (Turner S, 1994), the optimization of reader paths through story trees (Nelson et al, 2006; Riedl et al, 2006), the direction of the behaviors of autonomous narrative agents (Aylett et al, 2006; Cavazza et al, 2002), and the creation of intelligent drama management systems (Robert et al, 2007) . The second direction asks questions about the conceptual nature of narrative as a phenomenon, and its relationship to interaction. This perspective investigates non-digitally mediated interactive narrative situations, such as improvisational theater (Seif El-Nasr, 2007), and tabletop role-playing games while also asking questions about how narrative emerges in the mind of a reader (Swartjes, I. and Theune, 2009; Aylett et al 2005)), and developing systems for authoring content for interactive story experiences. (Mateas, M. and Stern, 2005)

There are several types of interactive narrative systems that have been developed in recent years. Narrative based games and simulations contain stories and interactions that are designed by human authors. AI based intelligent story generation systems have algorithms that construct narratives automatically from domain descriptions and communicative goals provided by human authors. Drama management systems manage user interaction based on strategies provided by human authors. Narrative based simulations have author specified rules for event instantiation and interaction.

While a significant amount of research has been carried out in each of these forms of interactive storytelling, the authoring tools and the authoring process has received less attention.

With respect to content production and the authoring process, a lot of existing authoring tools are available on the market, e.g. Flash, Director, 3DS, Maya, Toonz, Blender or different game engines and editors (e.g. Virtools, Quest3D, Adventure Game Studio or game specific editors such as Neverwinter Nights), which are commonly used to create these kinds of interactive stories. Most of them are restricted to a linear story representation (e.g. timelines) and there is a lack of instruments to organize and structure stories or to define object behaviors and interactivity in general. Hence, authoring complex, interactive, non-linear stories with many story branches and interactive story units might become especially for people without programming skills a long, challenging and confusing process.

Relying on the increasing relevance of Storytelling technology and the lack of suitable authoring tools in the field of interactive content creation, Storytelling research has been focused on this topic apart from fundamental considerations and methodologies in Interactive Digital Storytelling.

Recently in a discussion panel for the 2009 AAAI Spring Symposium on Challenges in Development and Design of Interactive Narrative Authoring Systems (Arnav Jhala and Martin van Velsen, 2010). This objective of this panel is to motivate discussion on understanding the process of authoring

interactive narratives, review state-of-the-art authoring paradigms, and extract practical requirements and common evaluation strategies for authoring tools.

Authors and developers of interactive storytelling systems (Medler and Magerko, 2006; Pearson and Laird, 2004; Donikian and Portugal, 2004; Carbonaro et. al. 2006, van Velsen, Jhala et. al.2008) face several challenges during the design of such systems. Interactivity brings about a branching story structure and issues of author control v/s user control of the storyline. Declarative representations of intelligent story directors do not intuitively convert to the game engine's procedural execution environment. Content from diverse media types needs additional integration and management support. Evaluation of current authoring systems is difficult due to varied approaches and different underlying representations for story generation and execution.

We can divide authoring research into the following categories:

- **Cinematic Authoring,** training and automated teaching systems are more and more using immersive 3D environments for the delivery of complex social lesson materials. For the creation of these systems novel authoring tools are needed that use knowledge from traditional storytelling media such as film and television to allow professional narrative experts to create appropriate content

- **Environment Authoring**, for systems that rely on rapidly changing immersive 3D oriented training systems. For example, those applications in which real-world data is used to prepare military personnel for the deployment into an unknown environment will need smart tools to quickly provide the correct simulation resources.

- **Character Modeling,** in high-fidelity training applications, whether it is strategy-training aides, meeting and negotiation systems or even math trainers that use a simulated mentor, virtual humans are becoming more and more prevalent and responsible for teaching core courses. Novel authoring tools are needed to provide training developers and teachers with the ability to adjust the training application to new contexts not previously anticipated by training designers.

- **AI Authoring**, this includes the authoring of current research systems in AI as well as the traditional simulation models residing in such applications as SAFs, etc. For tutoring systems this includes expert and student models as well as any AI driving the simulation in which the tutoring system resides.

Through the recently IEEE panel, to determine the direction of research and development of novel authoring paradigms, brings out the follows issues in authoring research:

- **Unique challenges for design of authoring tools for interactive narrative**: How is authoring for story and training applications different from those systems designed for traditional AI (programming) and simulation systems (SAFs).
- **User's and their expectations from authoring tools**: What do people who manage complex content expect from authoring tools? And how does that differ per content type?
- **Evaluation of authoring tools and their role in evaluation of interactive narrative**: Besides the actual design and implementation, we see more and more that authoring applications are not well evaluated or included in experiments. The authoring part is usually seen as an 'add-on'.

Many current digital storytelling authoring systems make use of the emergent narrative approach, based on virtual agents. Many current digital storytelling authoring systems make use of the emergent narrative approach, based on virtual agents. These include the Scenejo system (Spierling et al, 2006), which is mainly focused on configuring conversational agents, approaches using rehearsals for demonstrating the envisioned story to virtual characters or authoring during the playing experience

(Thue et al, 2008)]. Another project using the emergent narrative approach is the Façade (Kriegel, M., Aylett, R., 2008) system]. In the Facade (Mateas, 2003) system the user becomes involved in a couple's marital difficulties and battles. The user is able to speak to the other characters and what they say — as well as how and when they say it — will affect the story they experience. The user's actions will determine the final state of the couple's marriage. SASCE (Nelson et al, 2006) is an adapted TD-learning method for interactive narrative. This method determines, based on a user-defined evaluation function, the apparent best route for the story, depending on the actions the user is expected to take at each stage, and thus that which will lead to the highest overall score. The OPIATE (Fairclough, 2005) system creates stories based on Propp's general structures for fairy tales. This has been applied to a very simple cartoon-style world. The user's actions are integrated into the Proppian structure where possible. For each story world one Propp-style story structure is used. Characters other than the user have flexible roles in the story. FearNot! (Aylett, 2005)] is designed to help users to cope with bullying situations. They are able to interact with a victim of bullying, giving them advice and observing the results of this. The bully and victim each create plans, which are influenced by their current feelings, and the narrative emerges from interactions between these plans and the user's interactions

In the area of authoring for narrative oriented applications (with a strong bias towards AI) similar combinations of tools exist (Baecker, 1996) (Robertson, 2004), but none integrate the tools into a configurable workflow, meaning that they can't easily adapt to new research. Some more recent applications originating in the research community do allow traditional media types to be combined with novel abstract action sequences using XML documents but these systems either do not provide an intuitive mechanism for content providers to access the materials (Bulterman, 2005) (Drapeau, 1993) (Gebhard, 2003) or they do not allow nontraditional actions such as character animation or camera actions to be used (Bailey, 2001) (Harada, 1996) (Ueda,1991)

6.1 Tools for generate Story learning object

In this section we present a review of tools that could be used for supporting the authoring phase of the SLO. In order not to lose the reader, we present the macro components of a situational SLO so as to understand what are the factors that the design tool should help to define within the resource complex.

We remember that each situation has 4 parts:

- advancer event
- learning event
- reflection event
- assessment event

The user plays different characters observer, the protagonist, the STC's character is assigned by the system according to their profile test. Initially assessed through a system composed of the situation based on the results of the final events evaluative cognitive and emotional / affective each situation.

6.1.1 Comic and 3D editor tools

The research about authoring tool for Storytelling Learning Object focused on tools with a lot of media and animations features and different kind of interactive functions. Refer to SLO we have in the first time analyze comics editors and 3D editors because they were near at our vision for Storytelling Model.

Table 5 Comics and 3D editors tool

Tool – COMICS and 3D EDITORS	media	manage roles	assessment	output file tracciabile	Multimedia file in output
Toonlet[2]	storyboard and comics	yes	no	no	Comics-scenes
Celtx [3]	film, radio, Video, theatre, storyboard and comics	yes	no	no	audio-video
Springboard[4]	storyboard, video	yes	no	no	file AVI
Xtranormal[5]	To create on line video in 3d	yes	no	no	video
Vuvox[6]	slideshare,	no	no	no	slideshare
VUE [7]	maps	no	no	no	Multimedial maps
Prezi[8]	Slideshare with zooming	no	no	no	slideshare
stripgenerator[9]	Scenes, storyboard and comics	yes	no	no	Comics - scenes
makebeliefs[10]	Comics, scene, storyboard	yes	no	no	Comics-scenes
pixton[11]	Scenes, comics	yes	no	no	Comics - scenes
Storywriter toolkit[12]	Drag in speech bubbles and characters Learners are engaged in the unfolding story	Storywrite has a big virtual	yes templates, which map out	No?	Publish your comic strips to

[2] (http://toonlet.com/)

[3] (http://www.celtx.com/)

[4] (http://6sys.com/Springboard/index.html)

[5] (http://www.xtranormal.com)

[6] (http://www.vuvox.com),

[7] (http://vue.tufts.edu/)

[8] (http://prezi.com/)

[9] http://stripgenerator.com/

[10] http://www.makebeliefscomix.com/Comix/

[11] http://www.pixton.com/schools/login#video

[12] http://www.myknowledgemap.com/e-learning-solutions/rapid-e-learning-tools/storywriter-toolkit.aspx

	Comic strips can be created within minutes a suite of props, and a large assortment of speech bubbles and phrase boxes.	dressing -up box, with a cast of characte rs in a wide range of poses,	possible routes through the story and show the decision points encounter ed on the way.		whatever format you need: VLE, CD-Rom, internet, intranet, or network share
Storytron[13]	All media, video text, sound, animation	Yes user generate d avatars	yes	No?	Comics strips with text windows interactiv e

Table 6 3D editors tool

Tool – 3D EDITORS	**media**	**manage roles**	**assessment**	**output file tracciabile**	**Multimedia file in output**
BLUE MARS	All media, audio - video, text chat, animations	Yes System generated avatars	no	**no**	Multiuser environment Immersive interactive
ACTIVE WORLDS	All media, audio - video, text chat, animations	Yes user generated avatars	no	**no**	Multiuser environment Immersive interactive
SECOND LIFE	java script **scripting** All media, audio - video, text chat, animations	Yes user generated avatars	no	no	Multiuser environment Immersive interactive
OPEN SIM (opensource)	java script **scripting** All media, audio - video, text chat, animations	Yes user generated avatars	no	no	Multiuser environment Immersive interactive
DUBIT	All media, audio - video, text chat, animations	Yes user generated avatars	no	Si?	Multiuser environment Immersive interactive
HERITAGE	All media, audio - video, text chat, animations	Yes user generated avatars	no	no	Multiuser environment Immersive interactive

[13] http://www.storytron.com/

TRUESPACE7.6	model, texture, light, animate and render 3D content for online shared spaces, and for Virtual Earth traditional images and movies	Yes user generated avatars	no	no	Multiuser environment Immersive interactive X format exporter, creations to load into game engines such as XNA to develop games for Windows or the Xbox 360.
TELEPLACE	All media, audio - video, text chat, animations	Yes user generated avatars	no	no	Multiuser environment Immersive interactive
ADVENTURE AUTHOR	All media – video text animations	yes	no	no	Xml, Multi user environment immersive interactive

6.2 Technological vision

To develop a C-LO, particularly a storytelling learning object (SLO), think we shall use both the player and the editor (this should be the way to pursue in order to reuse existing tools). To use this tool with both VCS and Storytelling, such CLOs should share the same format to represent the storyboard to be played/edited. Moreover, from the SLO viewpoint we need a rich representation of the situations (scene, role and assessment input) to be played in order to have enough information to create a storyboard.

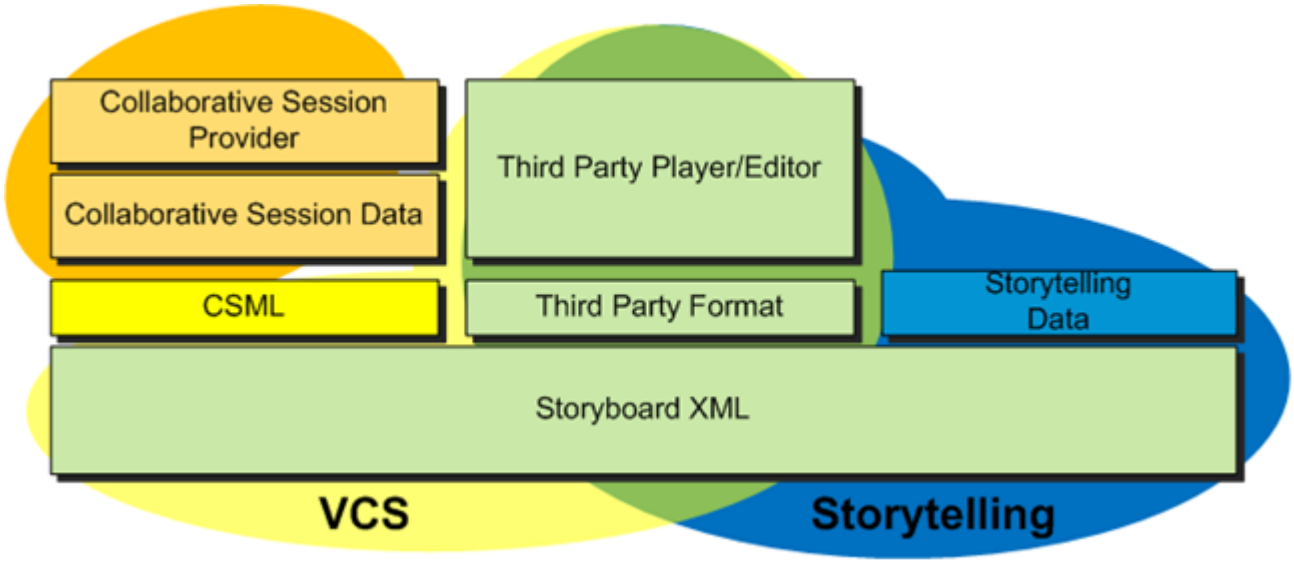

Figure 6.1 A general vision for CLO authoring tool

A Storyboard XML is a format that should be able to describe a sequence of scenes and characters interaction and discussions. A Storytelling CLO should be based on this format. A C-LO uses this format to play/edit a narrative situation s as cartoon-based sequence. We use this format if we want

to decoupled by a specific third party tool. Otherwise the Storyboard format and the Third party format are the same.

We'll analyze a selection of tools that can be used for editing and release a story situation and that can give possibility to edit narrative scripts.

The tools that can be useful are:

- Storywriter
- Storytron
- Dubit
- Open Sim
- INSCAPE

In the next paragraph we show an analysis about them. We'll analyze deeply the outcomes of INSCAPE and STORYTEC, once we have checked the possibility to use the delivered tool in order to valuate and plan an extension as a prototype.

6.2.1 Storywriter

Storywriter Toolkit (from http://www.myknowledgemap.com/e-learning-solutions/rapid-e-learning-tools/storywriter-toolkit.aspx) is a user-friendly tool, which combines interactive learning with comic strips. Each strip is given decision points, which affect the outcome of the story. Storywriter Toolkit allows anybody to get inspired, creating extraordinary custom comic strip interactions. Storywriter toolkit is a simple program for producing comic-strip scenarios with decision points leading to different outcomes. Storywriter's tools allow you to create your own world of narrative-driven interactive learning. You can choose from a range of templates, which map out possible routes through the story and show the decision points encountered on the way. Drag in speech bubbles and characters to suit your needs. Storywriter has a big virtual dressing-up box, with a cast of characters in a wide range of poses, a suite of props, and a large assortment of speech bubbles and phrase boxes. Combine interactive learning with the fun, familiar storytelling of comic strips. The comic strips are easy to build - everything's already there for you to choose from - leaving you free to focus on the story. You can create as many stories as you like, depending on their choice, the story follows a different path, and arrives at a different ending. Comic strips published in Storywriter conform to e-learning standards, ensuring their compatibility in future.

6.2.2 Storytron

Storytronics brings the ancient and compelling art of storytelling to a new, interactive medium. Romance, magic, science fiction, drama, adventure, mystery any genre is possible with Storytronics. It is an interactive storytelling through artistic works called storyworlds. Storyworlds are a new, interactive form of storytelling. In a Storytronic storyworld, we can walk down a predetermined path, or manipulating dolls. The characters we will meet in a storyworld are intelligent, feeling beings, with their own ideas and agendas. Every time we make a choice, they are evaluating, and making decisions on how to respond.. To create a storyworld we can use the Storyworld Authoring Tool, or SWAT. SWAT is the tool authors use to create a storyworld. SWAT is currently in beta, and is for professional or aspiring storyworld authors who are interested in joining a small group of professional and aspiring creators who enjoy the challenge of creating a new art form.

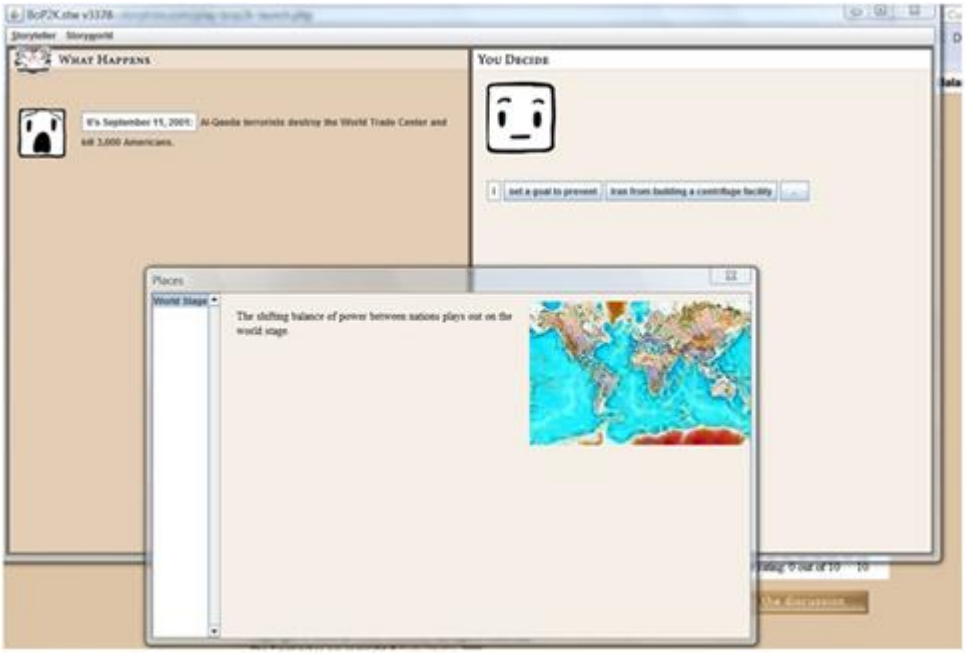

Figure 6.2 story edited in Storytron

The server side software does the calculations, we need access to Storytron's server whenever we use anything that accesses the story engine: Storyteller, Rehearsal, Scriptalyzer, and the engine-logging feature, LogLizard. This means that without an internet connection, we can still create and edit Actors, Props and Stages, and we can do scripting and some limited testing, but we can't fully test or de-tick your scripts, or play the resulting storyworld.

6.2.3 The Dubit Platform Social Gaming Worlds

Dubit developed the first Flash social gaming world, www.dubitchat.com, in 2000, winning industry awards and attracting over 500,000 users. The technology we developed was then used to create worlds for Sky Sports, Motorola, and Sky Movies. As we developed our own world, and customers worlds, we learnt about the user's motivations, what makes a world fun, and what doesn't work. But one problem troubled us more than any other: players find it very difficult to talk to new people. The first iteration of the Dubit Platform has been deployed for Cartoon Network in 2007. Game Application Markup Language (GAML) is a lightweight XML dialect for quickly creating things to do in the chat environments, such as, missions, quests, conversations with NPCs, collecting items, mini games, and more. GAML neatly reduces the complexity of building games in the chat environments, so that they can be updated frequently without long downloads. GAML was designed to: i) Differentiate your world, ii) Solve the “icebreaker” problem, iii)Enable quick and frequent updates.

GAML, the first content management system specifically for casual gaming worlds. GAML puts the production of game content in the hands of creative people. Creatives use GAML to quickly script the content without worrying about the details of network code, rendering engines, and physics engines.

Figure 6.3 avatar in Dubit

Using the Dubit Platform the world can be updated more often, with more engaging content, making a stickier site that attracts and retains more users. When a player moves around the world events are fired, in fact when the player does almost anything (collides, uses, picks up, enters, talks to, and so on) events are fired. An event is a notification that something in the world has happened but what makes a game fun is what happens because of that notification. The GAML engine captures the event and executes the script written by the game designer. The script reduces the players health while on the lava and plays an animation showing smoke coming off the players boots. If the player doesn't get off the lava in time his health continues to decrease until he dies, the script changes the player sprite to a burning animation, and the music changes to a deathly scream. Even in this simple example a lot of different things happen. A game world generates a lot of events like the lava example, GAML is the clue that ties these events together quickly and easily. Its a lightweight scripting language that allows game designers to quickly script how events are processed to create interesting scenarios for players.

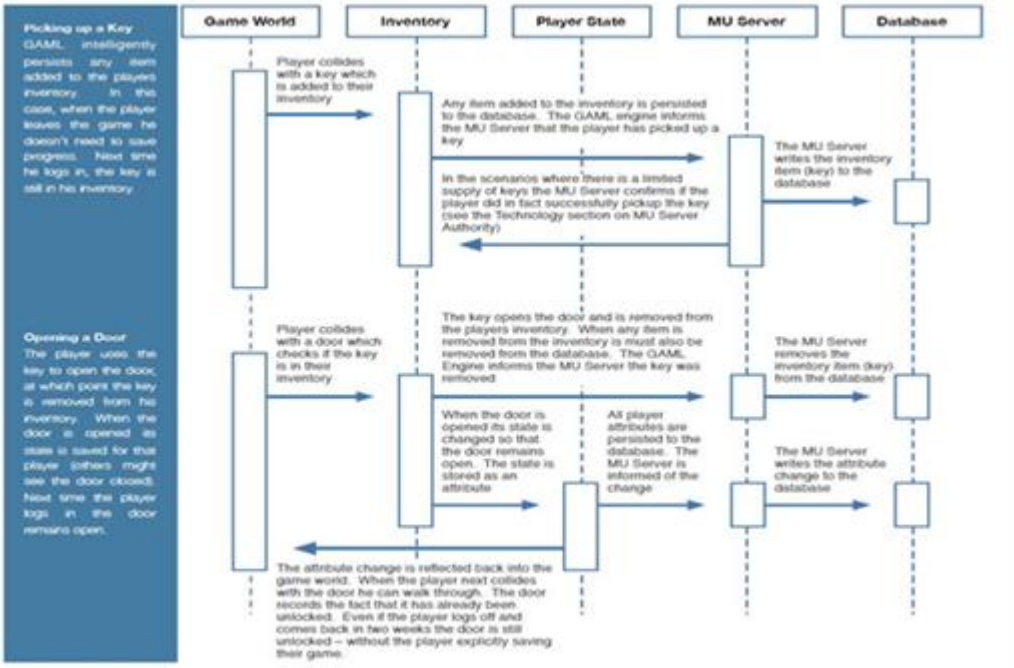

Figure 6.4 example of building of story in Dubit[14]

Dubit has a language XML for example for adding background sound and music. For each we set a different sound ID to tell them apart. Then we set their play value (whether they will play automatically when entering the room), the strength or volume of the sound, it's buffer and it's stereo width. If you're not too sure about the last two you can leave the code out and they'll work on default settings. For our background sounds, we want it to radiate from a specific point in the room and get loader/quieter as our player moves towards/away from the source. To achieve this we set X/Y co-ordinate and a carry value, which is the distance in pixels from the source before it starts to fade out.

6.2.4 OPEN SIM

Open Simulator is an open source multi-platform, multi-user 3D application server. It can be used to create a virtual environment (or world), which can be accessed through a variety of clients, on multiple protocols. Open Simulator allows virtual world developers to customize their worlds using the technologies they feel or best - we've designed the framework to be easily extensible. Open Simulator is written in C#, running both on Windows over the .NET framework and on *ix machines over the Mono framework. The source code is released under a BSD License, a commercially friendly license to embed Open Simulator in products. Out of the box, Open Simulator can be used to simulate virtual environments similar to Second Life™, given that it supports the core of SL's messaging protocol. As such, these virtual worlds can be accessed with the regular SL viewers. However, Open Simulator is neither a clone of Second Life's server nor does it aim at becoming such a clone. On the contrary, Open Simulator lacks support for many of the game-specific features of Second Life (on purpose), while pursuing innovative directions towards becoming the bare bones, but extensible, server of the 3D Web.

Features

[14] from http://dubitplatform.com

- Supports online, multi-user 3D environments as small as 1 simulator or as large as thousands of simulators.
- Supports 3D virtual spaces of variable size within one single instance.
- Supports multiple clients and protocols - access the same world at the same time via multiple protocols.
- Supports real-time Physics Simulation, with multiple engine options including ODE.
- Supports clients that create 3D content in real time.
- Supports in world scripting using a number of different languages, including LSL/OSSL, C#, JScript and VB.NET
- Provides unlimited ability to customize virtual world applications through the use of scene plug-in modules.

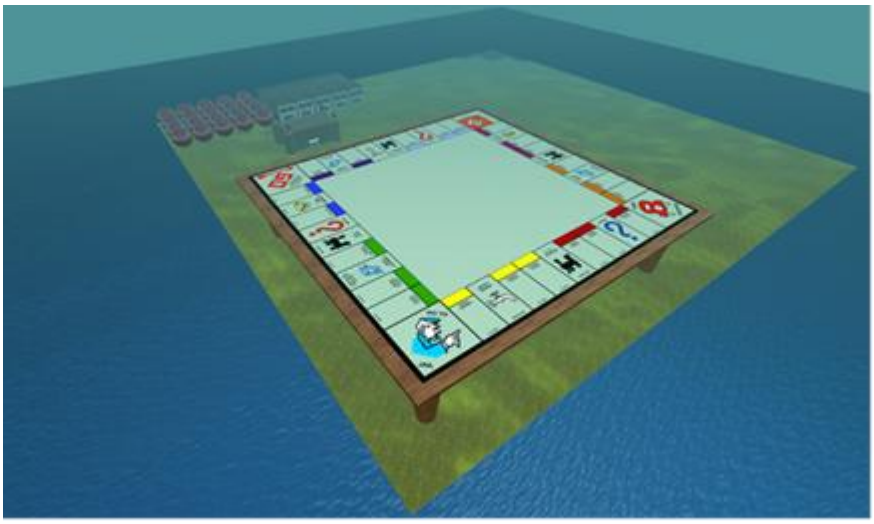

Figure 6.5 Open sim screen shot[15]

Open Simulator is an open source project, and is powered by the community members that devote time and energy to the effort. There are many ways to participate and contribute to the community:

OpenSim requires either the .Net Framework version 3.51, or Mono 2.4.2.3 or newer.

The region simulator configuration is managed using a file called OpenSim.ini. This file is used regardless of whether the sim is running in standalone or grid mode. This file references some additional configuration information from the config-include/ directory. Information about the various settings is contained in the OpenSim.ini file itself (or OpenSim.ini.example for reference). Please note, that the name OpenSim.ini can be changed via command line arguments. It is also possible to distribute the inifile settings over two files. This is useful if you want to run several OpenSim processes where most of your settings are identical except for a few. The master file is read first, then the inifile is read. Settings given in the inifile overrule settings given in the master file. The master file has the same format and the same keywords as the inifile, so the same documentation applies.

[15] from http://opensimulator.org/wiki/Main_Page

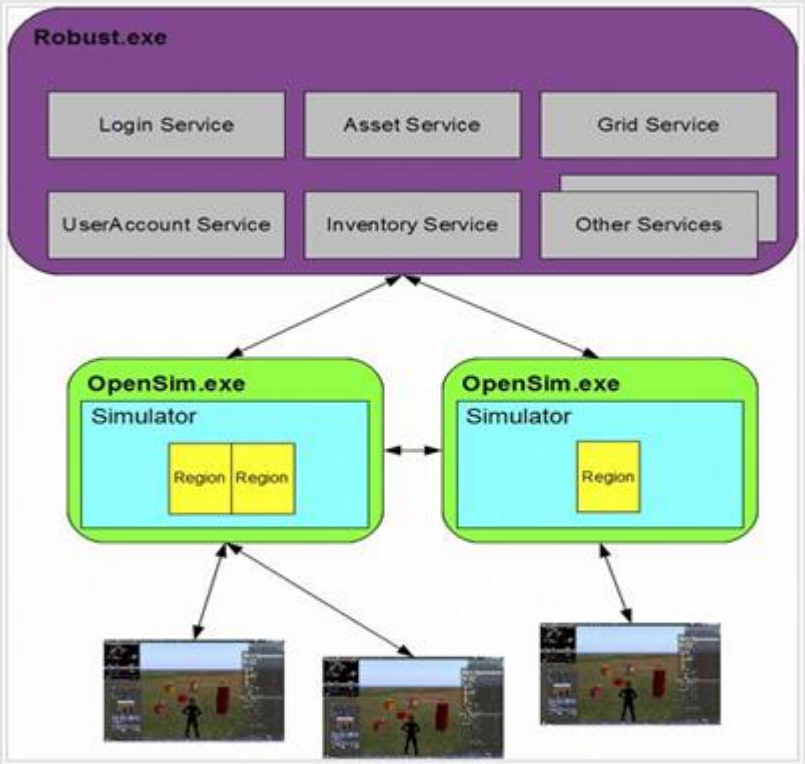

Figure 6.6 Open Sim grid[16]

6.2.5 ADVENTURE AUTHOR

Adventure Author is an environment which allows children to create 3D virtual reality interactive stories which can then be played by other children for to experiment with an innovative means for literary self-expression: interactive storytelling using multiple forms of media.

Adventure Author is a game-authoring tool designed to support interactive storytelling skills through the use of game technologies. Drawing on traditional role-playing techniques, it moves away from firstperson-shooter game formats, by emphasizing character, plot and narration.

Toolkits for creating 3D virtual reality interactive story-based games are available in some commercial games (such as Neverwinter Nights), although they tend to focus more on combat than on finely-crafted narrative. The Adventure Author system is composed of two primary components:

- an authoring interface which enables authors to specify an interactive story
- a game engine in which the story specification is rendered

The authoring interface is implemented in Java, and the game engine used in the current prototype is Unreal Tournament 2003 (UT2003). The Java diagramming library JGraph is used for creating visual representations of the story structure. Story specifications created in the authoring tool are stored in an XML format which mirrors the Java data structures used to represent the story. When a story is saved, the XML format is automatically generated from the Java objects using the Castor data binding

[16] from http://opensimulator.org/wiki/Main_Page

framework. The advantage of storing the story specification in XML format is that it separates the authoring tool implementation from any particular game platform, enabling us to explore different game technologies in the future. From the interface perspective, Adventure Author consists of two main components:

1. a tool for specifying an interactive story
2. a tool for interacting with the story within a 3D game world.

The interface for specifying the story structure was integrated with an existing commercial 3D game engine (Unreal Tournament 2003) so that the users could create game worlds with graphics of a similar standard to the commercial games with which many of the users are familiar. When specifying an interactive story, a child author uses the interface an overview of the story structure is displayed on the left as a directed acyclic graph. A story consists of a series of scenes. A scene can be thought of as a plot episode within a story, and takes place at a game location. Scenes are represented as nodes in the graph, with a picture of the location at which the scene takes place drawn within the node. A scene can comprise an overall scene description (in the form of text which the player will see upon entering the scene), one of the story characters and quite often an interactive conversation between the player and a non-player character . Scenes may also contain plot related items (such as a magic book), a feature which is not yet fully implemented. Each story has one start scene, denoted in green.

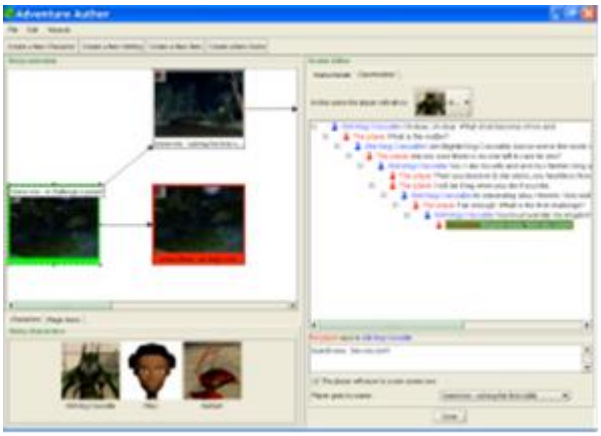

Figure 6.7 Adventure Author authoring interface[17]

Stories in Adventure Author have a branching structure, with many possible paths through the story, each having a different outcome. Branching is achieved through interactive dialogue. The author writes alternative conversation choices for the player and specifies which scene in the story should follow each choice. When a user plays through the finished story, she is presented with these alternative conversation choices, which in turn determine the scene which subsequently unfolds. When authoring a story, the user can opt to use a series of wizards to help her to create new characters, locations and scenes for her story.

[17] from http://judyrobertson.typepad.com/adventure_author/

Figure 6.8 Adventure game interface

Once she has created more than one scene, she can link the scenes together by writing an interactive conversation. At any time she can choose to test what her story looks like in the game world. Once the author is happy with her story, she can invite a friend to play it. The friend, in the role of player, interacts with the story in the 3D game world.

By modifying existing game engine technology, Adventure Author has been developed as a means to guide the young people (10-14 year-olds) through a series of steps, via 'wizards', which are aimed at supporting thinking about character and storyline development on a scene-by-scene basis. In addition, an overall map easily allows users to arrange and link scenes to support nonlinear storytelling.

7 Glossary

This part has the purpose to share some specific terms involved in this deliverable. So, in the following section, we have included a quite exhaustive list of them.

Complex Learning Experience (CLE) : it is un Advance Content, from a conceptual point of view, that refer to a new form of learning experience, composed by CLO (SLO, CCLO, etc) and new assessing material (both cognitive and affective-emotional) able to generate an effective kinds of learning such as reflective learning, experiential learning, socio-cognitive learning.

Didactic Method: Corresponding to a fixed Didactic Approach, there can be various didactic methods, that give the practical guidelines for the instantiation of the Approach (e.g. problem based learning, example-based, activity learning …). These didactic methods determine different learning activities within a teaching-learning process, structured in specific ways the learning contents.

Complex Learning Object (CLO): A CLO is meant here as an "intensive resource" characterized by its capability to support high-level learning processes thanks to a remediation of languages, tools and roles. A CLO is a rich didactic, dynamic and flexible resource, which requires a multidimensional evaluation of its experiential, cognitive and emotional aspects.

Storytelling Learning Object (SLO): A Storytelling Complex Learning Object is an educational object characterized by cross-linked narrative sequences, which we call story scripts. A Storytelling CLO deliveries a story as an interactive multimedia web video (the narration is supported by audio and video elements as well as interactive items).

Story situation: the combination of circumstances at a given time and place in the flow of the Storytelling CLO

Narrative Learning Environment (NLE) are technological environments in which a narrative activity is used to support learning. They are characterized by three variables: the role of the user with respect to the narrative, the pedagogical approach adopted to exploit narrative's educational potential, and a set of technological tools aiming to facilitate the narrative construction or fruition, as well as to amplify its impact.

Visual Story Portrait (VSP) is a narrative continuum described by Jason Ohler(2008), based on work by Dillingham (2001)

Metadata is a collection of attributes about a Learning Object (LO) describing some features such as its type (text, simulation, slide, questionnaire,...), the required educational level (high school, university,...), the language, the interactivity level and so on.

Domain concept: A Domain Concept (DC) is a concept belonging to the described educational domain and can be possibly explained by one or more LOs.

Target concepts TC part of a domain model, that have to be mastered by a given learner in order to successfully accomplish the unit of learning;

Learning path: a LPath (c1, …, cn) i.e. an ordered sequence of concepts that must be taught to a specific learner in order to let him master target concepts;

Bloom's taxonomy: Bloom identified six levels within the cognitive domain, from the simple recall or recognition of facts, as the lowest level, through increasingly more complex and abstract mental levels, to the highest order which is classified as evaluation.

Microadaptivity: A Storytelling CLO shows interactive cognitive assessment elements that determine a micro-adaptive intervention in each situations. Micro-adaptive interventions are non-invasive (that is to say an overall narrative is not compromised) and affect the presentation of a specific storytelling LO. Micro-adaptivity creates challenges in specific experience of a storytelling, and impacts on adaptive presentation and adaptive taking/playing roles.

Cognitive assessment: assessment of knowledge on the considered topic. For example, when a learner has to choose objects to put inside the emergency bag or when he has to describe the situation in the chat box. The right choice or description have a positive feedback on his cognitive state and influences the selection of the next situation

Emotional assessment: the Storytelling CLO presents some assessment objects to track the emotional status of the student in specific situations. The emotional feedback can be used to choose a better path (eg. more compelling), a different user's role, and generally to choose a better following situation in the story.

Pedagogical agent: Conversational agent used to personify the system's support in the form of an animated person, or other character, and present interactions in a conversational form

Character: In a Storytelling CLO a user plays a specific character (chosen among an established range) and has one or more roles to portray, according to the situations and the flow of the story. Once chosen, his/her character represents the hero who leads his/her adventure (according to Propp's frame work of six characters) with the other five ones on his way towards learning:

Role: According to the one the user meets on his/her way the character portrays a different role. A role may be chosen by the user, achieved, ascribed or it can be accidental in different story situations. A role can be played by a character, possibly more than one (depending on the type of aims and it is possible to speculate a remedial work that makes a change of view).

Topic Maps are a new ISO standard that can be viewed as an interchangeable hypertext navigation meta-layer above diverse electronic information sources supporting topical finding of various kinds of resources

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