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

During the last decades, *educational goals* and *learning activities* have been changed. 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. Students now are no longer seen as passive recipients of information but rather as active learners that should be involved in the development of their learning activities. This change was also sped because ICT became more and more important in the educational field. e-Learning methodologies also evolved and changed 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 literature (Black, Alison, 2010) observe that in *Digital Age* students express a need for more varied forms of communication and report being easily bored with traditional learning methods. NetGen[1] called also Millennials or Digital natives, need self-directed learning opportunities, interactive environments, multiple forms of peer feedback, and assignment choices that use different resources to create personally meaningful learning experiences. NetGen want more hands-on, inquiry-based approaches to learning and are less willing simply to absorb what is put before them (Barnes et al, 2007) .

New learners want to construct their knowledge. They want to immediately engage in the process. As the higher education paradigm shifts from *teacher-centered* to *learning-centered classrooms*, so the educators needs to provide the environments and mechanisms for learning by effectively reaching NetGen using a variety of instructional delivery methods and activities to engage students within their own learning process (Prensky, 2006) .

The field of educational technology considers the research of news models and the experimentations of news methods as the major challenge for educational designers. How can educators provide a productive and engaging learning environment for Millennials?

The research about new type of activities in education explains that the *Connect* activities[2], as storytelling, help learners close the gap between learning and concrete situations. *Connect activites* prepare learners to apply learning in situations they encounter at work, in later learning efforts, and in their personal lives. The storytelling is one of the most successful forms used to get students to be responsible for their own learning and maximize the lesson learned in particular context like emergency situations. This enables them to interact with course-mates, sharing their ideas and supporting each other in the way they learn.

The ALICE Project[3] 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 defined from a personalized sequence of Complex Learning Resource.

According to this pedagogical vision, WP6 focuses the attention on narrative learning, 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 in educational contexts.

As observed by Bruner (Bruner 2002), the narrative in all its forms is a dialectic between expectations and events and a call for problems, not a lesson on how to solve them. The narrative is a privileged instrument for

[1] Net Gen: in such a changing age, today's students are already different from students of the past in terms of how they have grown up with and use technologies (McGee & Diaz, 2007). Today's educator must understand the learner style of Millennials: a new generation of teaching audience. The majority of today's students, as show in Figure 1, fall into the generational group of Millennials (a.k.a. NextGen, GenY, C Generation, M Generation, and Echo Boomers), i.e. the generation born 1980 though 2000.

[2] *Connect activities:* The new teacher style able to guarantee the instructional design for digital learner is an *"active teacher style" that use different engaged teaching methods.* A Teacher can organize their action in different categories type: do, connect, play, share (Horton, 2011). Connect activities help learners close the gap between learning and the rest of their lives. They prepare learners to apply learning in situations they encounter at work, in later learning efforts, and in their personal lives.

[3] "Adaptive Learning via an Intuitive, interactive, Collaborative, Emotional system", ALICE, VII Framework Program, Theme ICT-2009.4.2, Grant Agreement n. 257639

developing cognitive skills and organizing knowledge, it is a powerful cognitive tool thanks to its potential to support the learner in the meaning construction process.

Digital Storytelling is the practice of using computer-based tools to tell stories and potentially is a very useful teaching and learning tool. Storytelling is recognized to have many uses and benefits in education because the learners tend to pay much more attention to what is told when the information is put into an interesting or exciting story. The stories allow students to express themselves as they are narrated by the students themselves from students' own words. For students who are encouraged to reflect on what they have learnt and to make sense of their learning experience and organize information into a short and easily accessible multimedia clip, making a digital story poses interesting challenges on several levels. It also has the advantage (and challenge) of involving many different skills both creative and technical, some of which may be new to them. The challenge that digital storytelling in education poses is how to harness the massive potential of the story form, with its possibilities to inspire, engage, transform, through a process that will endow it with opportunity for reflection, critical thinking and problem solving (Ohler, 2006) (McDrury & Alterio, 2003).

Recently, the different advantages of the use of digital storytelling in education are listed (Van Gils 2005). The first advantage of digital storytelling is that it can offer more variation than traditional practicing methods. This gives a big advantage, because once story-based educational content is developed it can be used over and over again by learners without becoming repetitious and boring. Another one of the major advantages of the use of digital storytelling is that education can become more personalized. Systems could be developed in such a way that the level of education can be adjusted to the level the learner needs. A third advantage is that if a story is told in a good way it is compelling. Research has shown that active learning is a really effective way to learn subject-matter. Digital storytelling systems can offer several types of interactive learning and improve the involvement of students in the learning process. By taking advantage of the inherent structure of narrative, the digital storytelling offers significant potential for supporting guided exploratory learning and can provide engaging situations in which students are actively involved in story-centric problem-solving activities.

Storytelling has long been a medium for human entertainment, but over the course of many years, its potential as a form of interaction has slipped into the background. 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 WP6 is to investigate among the educational research and to define a Storytelling Design Model (SDM) aiming at developing storytelling complex learning object, that can be functional to the efficient transmission of lessons learnt inside a complex learning experience, on the theme of risks management. In this document we will define a Storytelling Model able to generate a rich didactic, dynamic and adaptive resource, which requires a multidimensional evaluation of its experiential, cognitive and emotional aspects. Taking in to consideration the results output of previous projects and experiences in interactive storytelling we will define a Storytelling Design Model and specific educational processes needed to guarantee the learning achievement in storytelling flow. From an original composition between story visual portrait, educational processes and learning outcomes we present a Storytelling Design Model characterized by a strong pedagogical relationship between technical and educational views, was used as "guidance" to realize an intensive and adaptive learning resource.

1.1 Related works

Storytelling research is investigated in numerous EU projects testifying the strong interest towards this kind of educational strategy. The outcome of those projects have been mainly platforms and tools, which ease the creation process and enable even non-specialist users to develop interactive stories by offering an interactive visual representation of the story as part of a user friendly and intuitive interface.

In the following a description of the most relevant research projects providing models, methodologies and authoring tools is provided. The outcome of most important projects have been authoring tools, such as INSCAPE, STORYTEC, PASSAGE, and VIRTUAL STORYTELLER. In Chapter 2 we focalize more attention on categories and typology of storytelling system.

1.1.1 INSCAPE

INSCAPE[4] – 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 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 generated and developed 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". INSCAPE address issues such as the acquisition, the creation, the management and the sharing of interactive stories or their real-time multi-sensorial rendering combined with natural agent behaviours and multimodal interfaces. It provided innovative natural interfaces and devices for intuitively creating or living interactive stories within multi-dimensional virtual, augmented and mixed realities. INSCAPE goes beyond "standard" content creation research and technology development projects and will address scientific and industrial simulation, training, education, poetry, art, emotions, cultural and human context and diversity.

INSCAPE developed an authoring tool, as well as the underlying data model, able to describe interactive stories in structural terms using a story format ICML (Inscape Communication mark-up language). In a Story Editor a story is visualized as a graph structure, in order to manage the overall story flow, branches etc. In addition a specific behaviour editors enable the authors to integrate predefined scripts and associate them to story objects, or to add, set, or delete properties and variables.

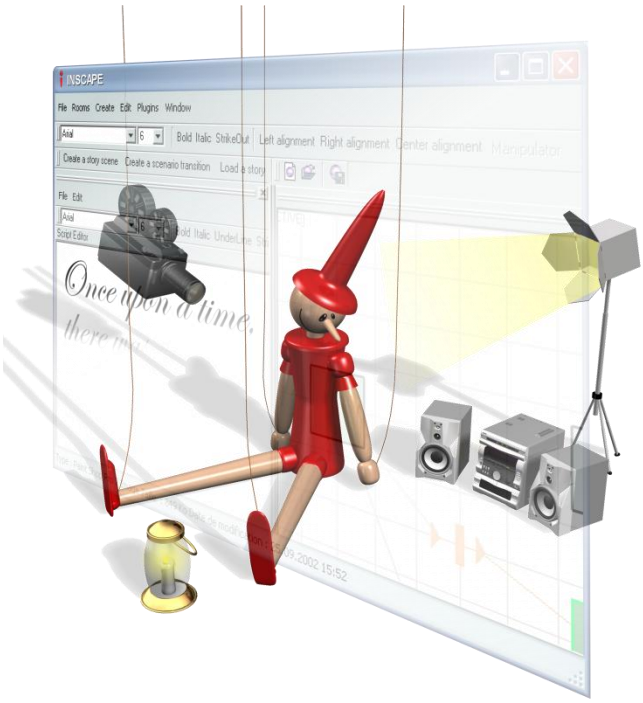

Figure 1.1 INSCAPE

INSCAPE depends of a suite of applications (plug-ins) that provides the necessary story authoring innovations. conceiving publishing and experiencing interactive stories whatever their form, be it theatre, movie, cartoon, puppet show, video-games, interactive manuals, training simulators, and enabling authors to easily and quickly “emotionally” change the environment and characters.

1.1.2 STORYTEC

STORYTEC is a platform for interactive Digital Storytelling applications developed in the context of the INSCAPE project (EU RTD contract IST-2004-004150). Storytec is a comprehensive authoring framework with

[4] **INSCAPE- INTERACTIVE STORYTELLING FOR CREATIVE PEOPLE** http://www.inscapers.com/

different editors enabling authors (without programming skills) to create interactive stories and a runtime engine, responsible for a fluent story and story control execution. 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.

Figure 1.2 Story Editor in STORYTEC

Figure 1.3 Stage Editor in STORYTEC

The runtime engine core builds a Narration Controller loading a story encoded in ICML and controlling the interactive scenario based on user's interactions and strategies defined beforehand by the author.

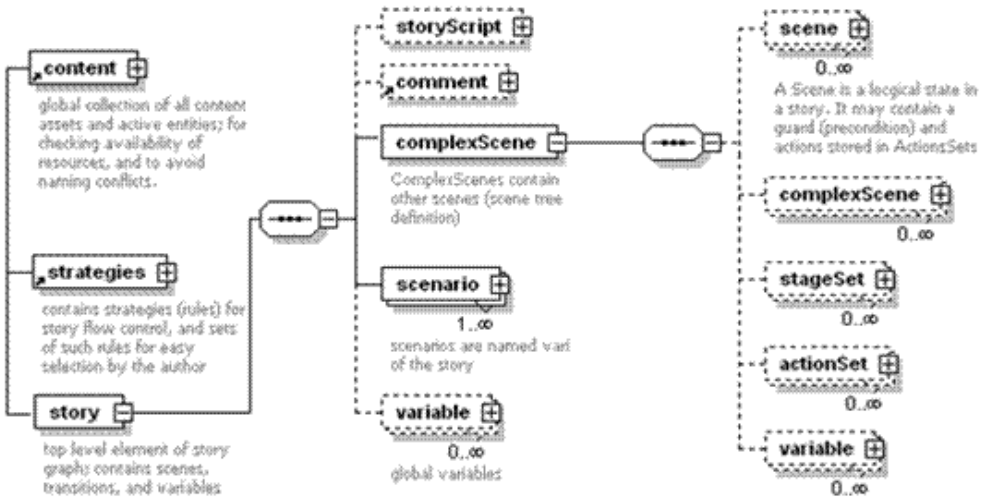

Figure 1.4 ICML format

The result of the authoring process is a computer readable description of the story which can be read by any application which incorporates StoryTec's runtime library. Compared to INSCAPE, a major benefit results in that the story structure and story content are strictly separated. Hence, it is possible to create and play different story

peculiarities (for instance 2D vs. 3D) based on the same story structure and subsequently to use different players to be controlled via high-level commands from the Narration Controller.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.

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, PaSSAGE[5] (Player- Specific Stories via Automatically Generated Events), is an interactive storytelling system that has defined some player types basing on Robin Laws' rules to create a player 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 Actors (who prefer taking dramatic actions). The system uses this knowledge about the player style to dynamically adapt the content of an interactive story.

Figure 1.5 PaSSAGE

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)

1.1.4 Virtual Storyteller

In the Virtual Storyteller project[6], supported by the GATE project, funded by the Netherlands Organization for Scientific Research (NWO) and the Netherlands ICT Research and Innovation Authority (ICT Regie), is a multi-agent framework for generating stories. These stories emerge from a simulation of virtual characters in a story

[5] Main project page https://sites.google.com/a/ualberta.ca/ircl/projects/passage

[6] Mai project page http://wwwhome.ewi.utwente.nl/~theune/VS/

world. Story generation happens in two phases: (1) simulation and (2) presentation. 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.

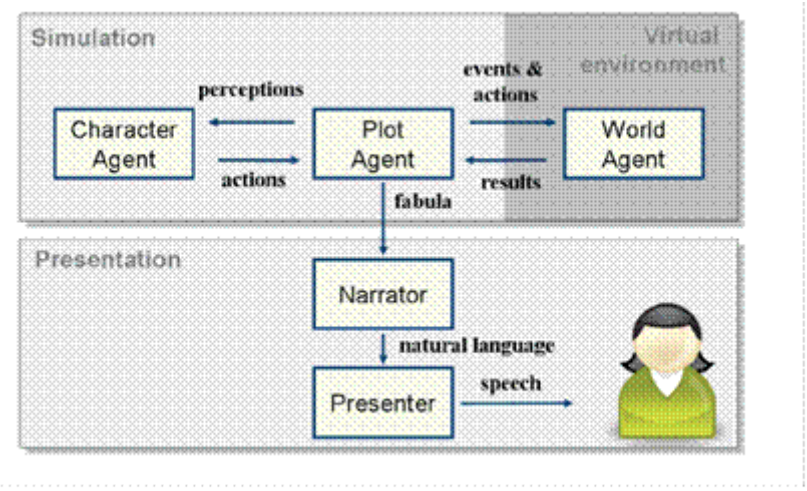

Figure 1.6 Virtual Storyteller components

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.

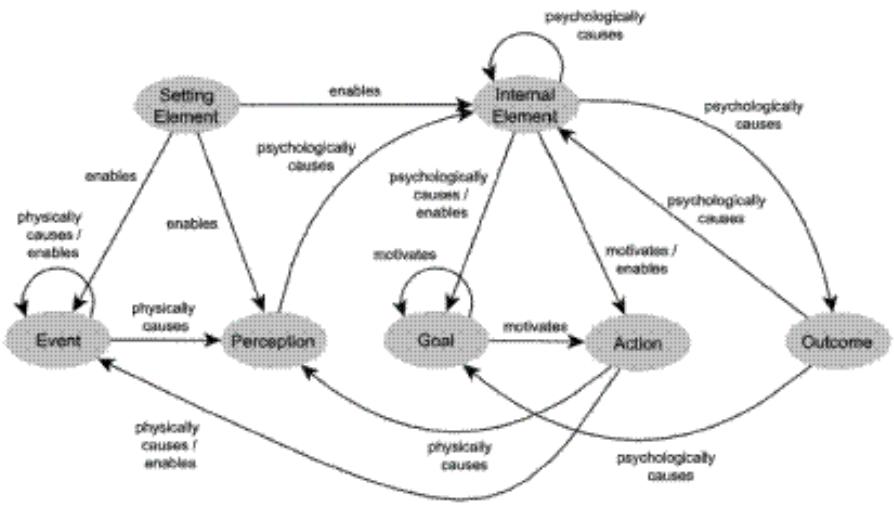

Figure 1.6 Formal fabula representation

The fabula model defines causal relationships between seven types of elements: setting elements, goals, actions, outcomes, events, perceptions and internal elements. 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. Currently, the knowledge bases of the characters and the director are very limited, allowing only for the creation of extremely simple stories.

1.2 The storytelling as added value in the ALICE Project

Research in Interactive Storytelling (IS) in education has increased significantly because it is a potential solution to go beyond traditional education enabling learners to interact with the learning process, engaging them in a series of challenging dilemmas and problem-solving activities.

In recent years, several paradigms have emerged in the context of IS that in particular refers the duality between *character-based* and *plot-based* storytelling. The plot-based approach refers to story systems that are developed around the fundamental idea that stories have to follow a set of rules (the story structure). Several Research Projects are focused on the definition of tools generating story plots. For instance, STORYTEC refers to this first approach. Narrative representation based on roles rather than narrative functions. adapts and personalizes the story follow a character-based approach. PaSSAGE Project, previously analyzed, uses a player modeling approach to automatically learn the preferred play style of a player, and uses this knowledge to dynamically adapt the content of an interactive story.

In order to combine the story-based approach with the character-based approach, some hybrid architectures are emerging in the context of advanced intelligent system that combines plot-based story authoring and character-based behaviour modeling by using a multi-agents approach integrated with Fuzzy Logic techniques or that uses a partial-order planning algorithm to simulate narratives in accordance with a formal model of a story.

This work aims to overcome the shortcomings of existing researches in the interactive storytelling which mainly concern the lack of a pedagogical model that ensures the achievement of learning objectives through an educational process based on the playful aspects of digital storytelling integrated with aspects such as, for instance, the adaptive learning, affettive learning and collaborative learning

The ALICE Project explores the use of storytelling as a valid educational approach that introduces novel opportunities for supporting student problem solving and learning in specific contexts (e.g. civil protection training for huge risks). The digital story tales are interactive didactic elements, oriented to a student-centered teaching approach able to involve emotionally, provide guidance and make the reflection easier. In this work a Storytelling Design Model is defined, by using the most promising results of other research activities in order to support the design and authoring of Storytelling Complex Learning Objects (SCLO).

The defined model synergistically applies both plot-based and character-based approaches. The Storytelling Design Model (SDM) aims to fill the lacks of existing storytelling models by providing ways to:

- empower the pedagogical drivers during the storytelling definition phase in order to connect storytelling situations and events to achieve specific levels of educational objectives;
- exploit branching logic in order to design micro-adaptivity mechanisms by using indications coming from the three different types of educational principles to define remedial paths tailored to meet the learning progress of the learner;
- enhance the character-based approach by defining role playing, taking and making strategies in order to support telling, re-telling and re-living;
- sustain the cognitive transformations by exploiting collaborative learning activities, based on a storyWiki, in order to maximize the role making strategy;
- improve the learning process by exploiting emotion analysis in order to refine the micro-adaptivity mechanism enabling the emotion-based role taking;
- improve assessment strategy by providing a new approach to implicit assessment by tracking, collecting and analysing learners' interactions with the storytelling system.

In this work we refer to a specific declination of SCLO 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.

The **pedagogical and technological 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 of existing environments and solutions for storytelling provides an exhaustive classification with a focus on multimedia authoring tools. The analysis shows the need to find an instructional model useful to guide the design of a template-based storytelling system.

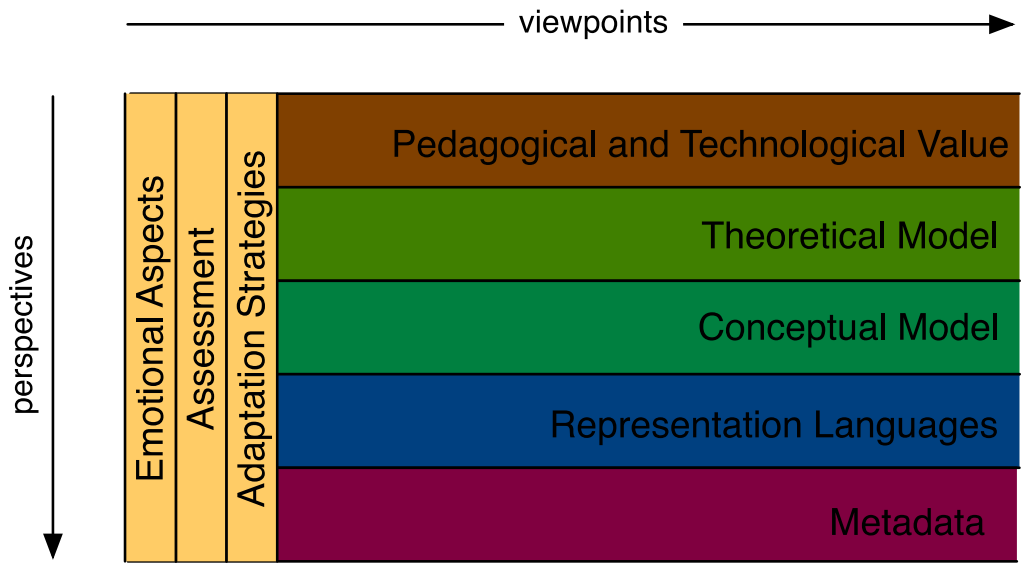

Figure 1.7 ViewPoints and perspectives

Chapter 3 addresses - from a **theoretical model** - the definition of a teaching narrative model. The storytelling complex learning object (SCLO) 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 Storytelling Visual Portrait (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.

Chapter 4 includes discussions about assessment and adaptation strategies. The **assessment** is designed as a component that guides the micro-adaptivity process through the narrative situations. The assessment on the principles of teaching, cognitive and social presence. Three assessment strategies are defined in the present work. In particular, the first one is the summative assessment realized by exploiting the Bloom's Taxonomy to specific types of questions. The summative assessment enables the **microadaptivity** in the SCLO. The second one is the implicit assessment allowing to analyse learners' behaviours and actions in order to evaluate the whole learning process. The last one is the collaborative assessment that is used to foster the story recall by means of role making process.

Chapter 5 is focused on emotional aspects. The **emotional aspects** perspective is used to improve the role taking by admitting different viewpoints from which a learner can lives (or re-lives) situations in the story. The chapter presents a methodology to detect learner's emotional state and to bind it to the emotional axes by considering specific narrative archetypes.

Chapter 6 provides a conceptual analysis of the storytelling design model. In order to develop a significant and more **conceptual model** we provide an **ontological representation** of the Storytelling Design Model. In particular, the main concepts of the SDM are described by emphasizing the relations among themselves. In the second part of the chapter, a discussion on the existing **storytelling representation languages** is provided. The last part of the chapter is dedicated to IMS-LD. In particular, the learning design specification is analysed with respect to the modeling of a SCLO following the principles of SDM.

In **Chapter 7** 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 SCLO 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

2. Narrative learning tools and narrative learning environments

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 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).

Bruner (1990), 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 mental 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 centred 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".

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 method has received increased attention in education over the last two decades (Dettori, 2007) 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).

The narrative experience can provide the guidance essential for effective exploratory learning and the "affective scaffolding" for achieving high levels of motivation and engagement.There are several narrative theories in literature that highlight as narrative could serve as the foundation for guided exploratory learning and the storytelling can be used as an effective tool for exploring the structure and process of "meaning making."

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).

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 – 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 has 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 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 centred learning environments can enable learners to participate in the following 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?

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).

- **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
- **Multimedia and narrative editors**: The final 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.
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.

2.2 Focus on Multimedia Authoring tools for storytelling: dimensions and examples

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. 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.

With respect to content production and the authoring process, there are many ways to assess stories and analyze digital storytelling processes as depicted in Figure 2.2 A short description follows.

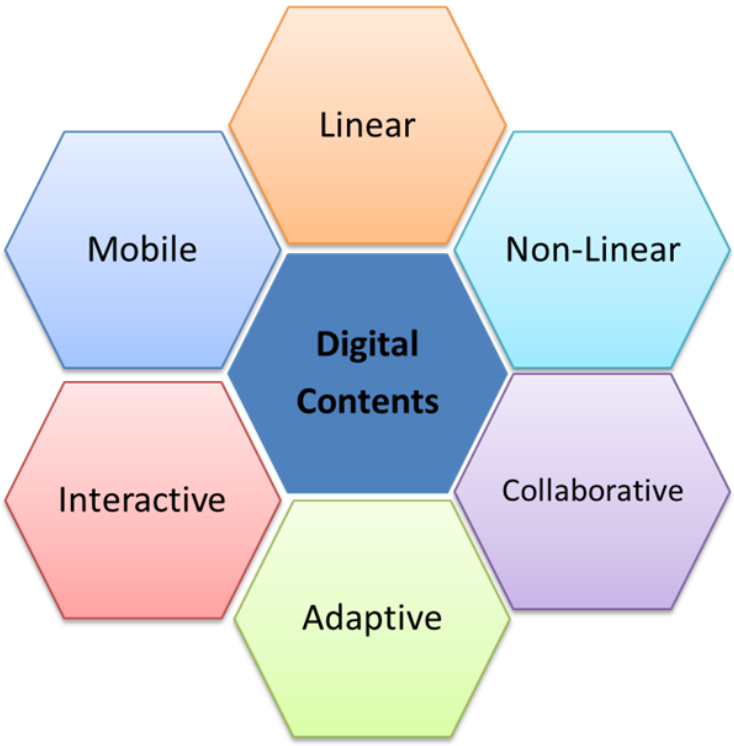

Figure 2.2 Storytelling approaches

The storytelling process has different focuses on the conceptual level:

- **Linear vs. non-linear storytelling** are differentiated based on action sequences of the media occurring in the story. Nonlinearity enables storytellers to tell more complex stories with different storylines within the same story. Non-linear stories may be told in several versions with different content sequences. The interactive storytelling process enables storytellers as well as story listeners to make their own decisions actively to determine the further course of the storyline. Dynamic narratives are created with which users can interact at each part.
- **Adaptive/Interactive storytelling** gives storytellers the opportunity to interact with their audience through adaptive storytelling techniques. Some concepts of digital storytelling show that the narrative component is simultaneously decreasing with increasing interactivity. Adaptive digital storytelling techniques are used to encounter this problem.
- **A collaborative/social storytelling** process can help design of active experience. Moreover, storytelling on the Web 2.0 can help developers in designing and developing advanced multimedia systems to meet requirements of the storytelling user communities also using social facilities.
- **Mobile/ubiquitous storytelling** takes place in a physical environment where people actually move around and interact with digital content as well as with each other using mobile devices and communication technologies. The mobile storytelling approach can carry out tasks related to ubiquitous multimedia management as well.

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 within several projects and initiatives.

The outcome of those projects and initiatives have been authoring tools, which ease the creation process and enable even non-specialist users to develop interactive stories by offering an interactive visual representation of the story as part of a user friendly and intuitive interface.

Dramatica is a comprehensive framework suitable to create multimedia stories with semantic knowledge. However, it does not allow any kind of non-linearity. This tool is designated to writers of dramatic fiction,

providing a structured theory of drama and an approved model of authoring for the user. By answering its questions about characters, plots and development, Dramatica guides the author (Figure 2.3) to create a believable, well-argued and dramaturgically correct story. Unfortunately, it is only useful for creating linear, non-interactive narrations. In Dramatica a story represents a particular model called the "story mind". It is left to the creativity of the authors to express their episodic knowledge as a linear story so that dedicated aspects of the story are filled with content. Dramatica is also capable supporting semantic knowledge.

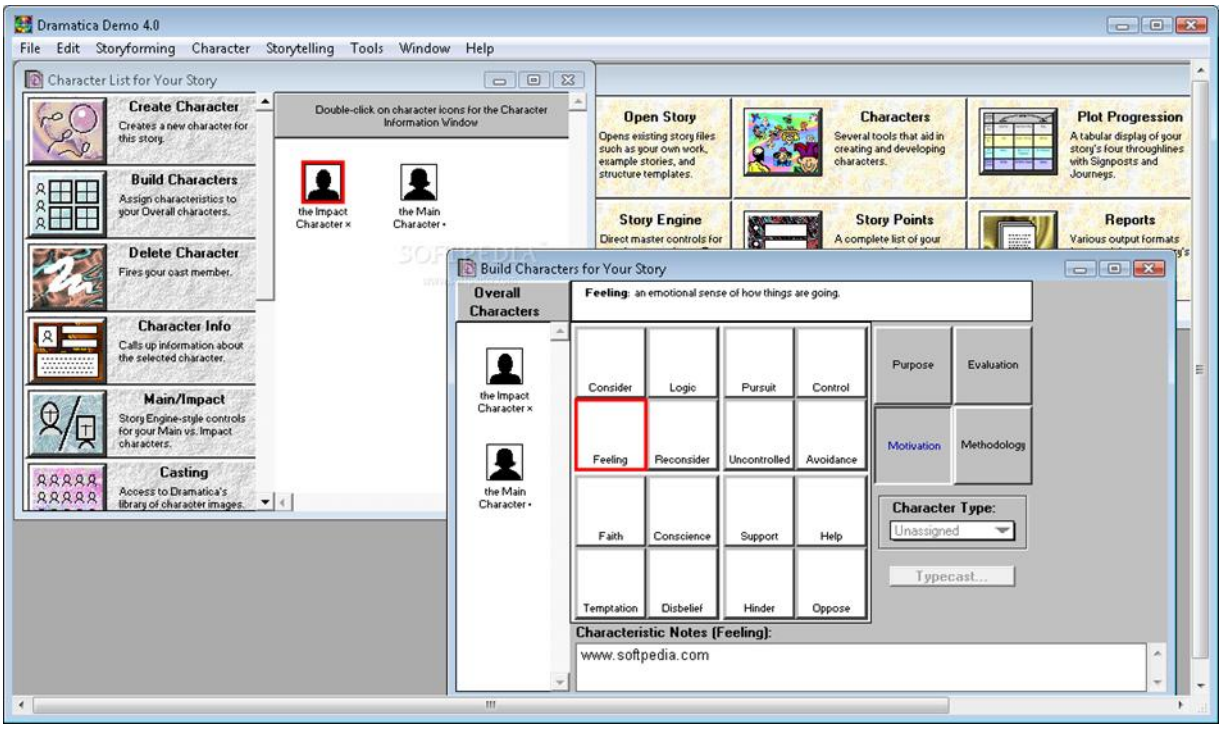

Figure 2.3 Dramatica Interface

The Centre for Computer Graphics in Darmstadt introduced the Storyengine, which is based on the morphologic functions by Vladimir Propp (1968). He defined a story as a set of morphological functions and showed how new storylines can be generated by the algorithmic processing of the semiotic structure. This authoring concept is being evaluated for the first time with the Geist project[7]. This Storyengine is part of a storytelling system that narrates such interactive, non-linear stories. The Story-Engine (Braun, 2001) needs a story model, which is implemented as a separate module.

[7] Geist project, http://www.tourgeist.de

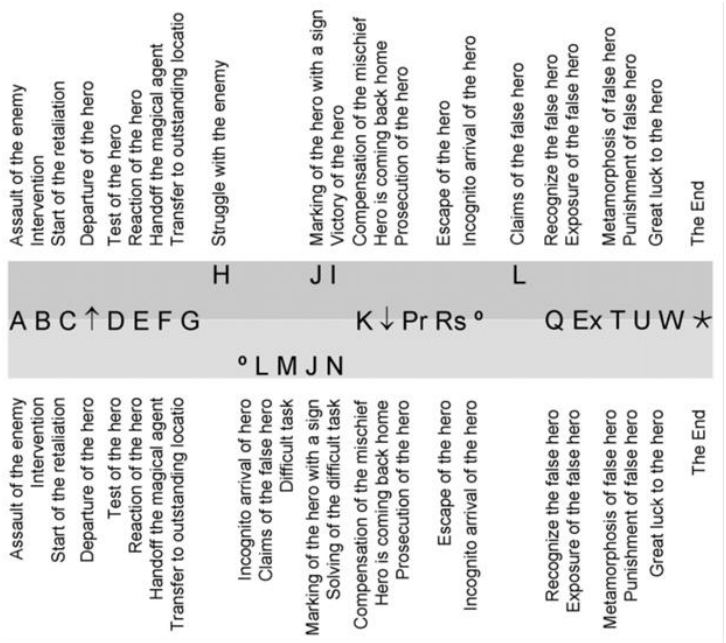

Figure 2.4 Morphologic Function

The Scene-Engine maps the Propp-functions on real scenes using the scene model, which contains dramatic functions at the level of concrete actions and settings. It uses rules based on dramatic laws, which are modeled like single shots in films. Thus, Digital Storytelling narrates variants of a story. These variants are affected by the authors' constraints and the user interaction.

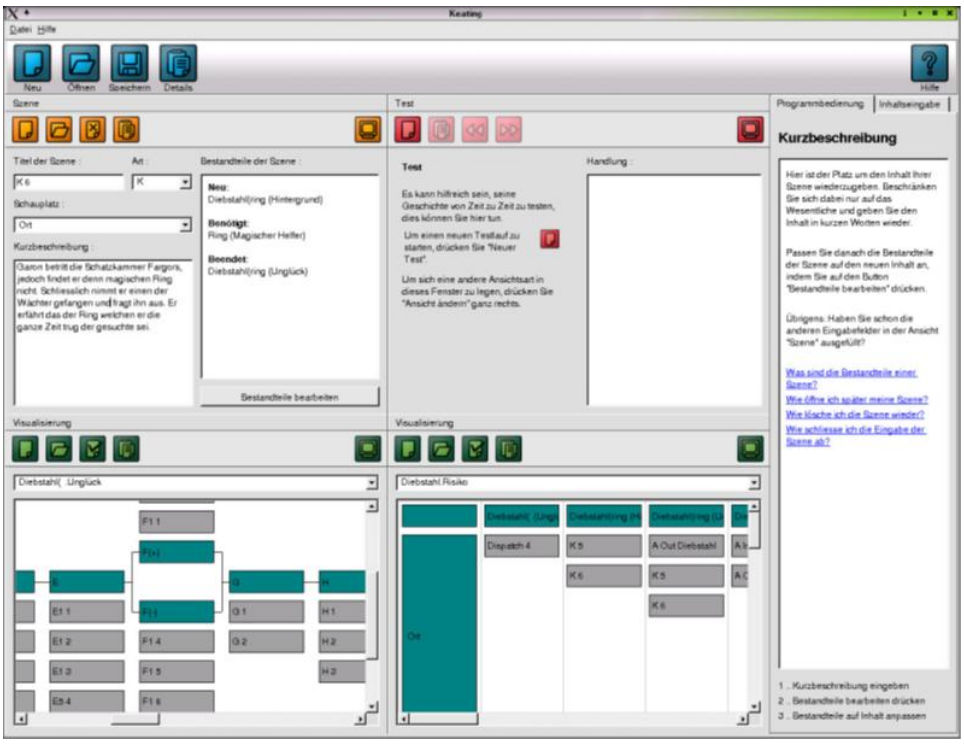

Figure 2.5 story engine authoring environment

In contrast to alternative actual solutions, the Story engine gives human authors access to provide their own stories for narration. The author in authoring environment (Figure 2.5) has the possibility to access the system on several levels of interaction design, story design, and dramaturgical design. Nonetheless, in reality, just a small minority have the possibility to write interactive stories for the Storyengine. This is due to the fact that the needed data for such stories is still too complex.

StoryTec (Gobel et al 2008), as seen in the previous chapter, is a platform for interactive Digital Storytelling applications developed in the context of the INSCAPE European project. (Gobel et al., 2005)

Figure 2.6 StoryTeC interface

Storywriter Toolkit[8] 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. the instructor or author can choose from a range of templates, which map out possible routes through the story and show the decision points encountered on the way. 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 author can create as many stories and depending on their choice, the story follows a different path, and arrives at a different ending.

MIST (Richard et al., 2010) and **YouTell** (Cao et al., 2008) are two cross-related prototypes. MIST is a Java application and allows the creation (editor) and consumption (player) of multimedia stories. The editor allows users to create new or edit already existing multimedia stories. The viewer is used for the consumption of existing multimedia stories. The player allows the visualization of versatile media (Figure. 2.9)such as movies, music, text or images. According to the media transitions defined in the editor's story-board the user might selected a medium of his choice in case there is more than one available.

MIST does not support collaborative storytelling by different users. Users can create their own stories. However, how the story is further used by other users is not traced at all. In order to overcome these limitations the MIST's authors propose YouTell as a collaborative storytelling environment within community of practice using Web 2.0 technologies.

YouTell is based on the idea of Personalized Storytelling Environment (**PESE**). The Web 2.0 features such as tagging and ranking stories are part of the environment. In addition, experts with certain knowledge can be identified in communities of practice. In particular, PESE enables communities to have joint enterprises (i.e. story creation), to build a shared repertoire (i.e. stories) and to engage mutually (i.e. expert contacts). The PESE uses

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

a role model (Figure 2.7) . Experts are users who have the knowledge to help other users. Users who have questions can contact an expert. Search facilities are provided by the PESE for finding experts.

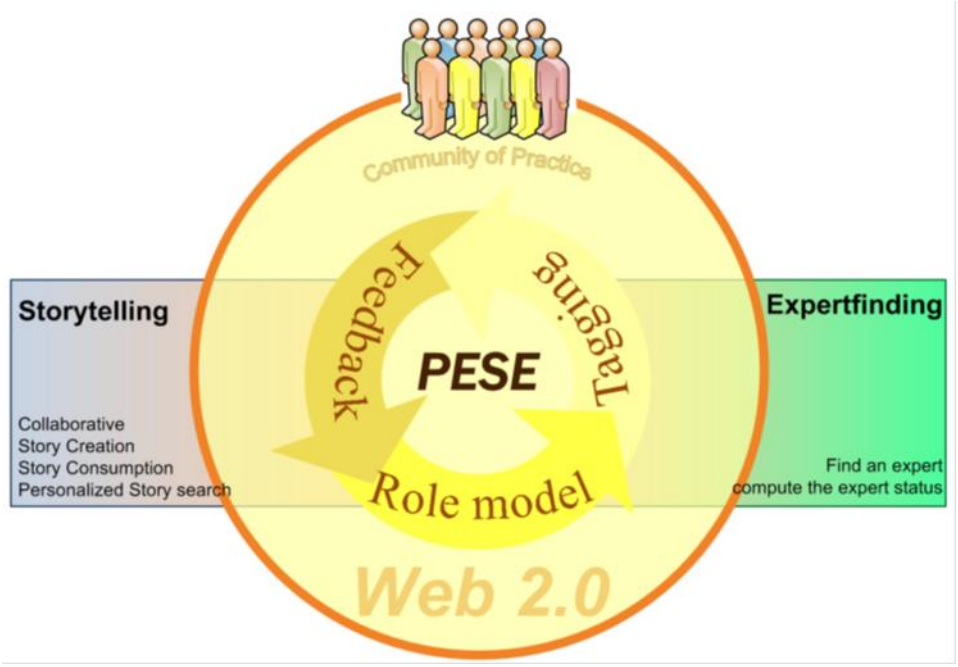

Figure 2.7 PESE approach

Users can provide feedbacks on the stories using either explicit or implicit feedback techniques. After visiting a story respectively getting an expert advice the user has the possibility to fill out a questionnaire. This explicit form of giving feedback is fundamental for PESE. But not every user likes filling out questionnaires. Therefore also implicit feedback is used. Although this is not as accurate as explicit feedback it can be an effective substitute. In PESE the following user behavior will be considered: The more one user visits one story the more interesting it is. The more a story is visited by all users, the more popular it will be.

YouTell embeds digital non-linear storytelling in a collaborative Web 2.0 environment with expert knowledge and recommendation (Figure.2.8). The Web 2.0 features such as tagging and ranking stories are also employed. In addition, experts with certain knowledge can be identified in communities of practice. The storytelling process is intertwined with a set of Web 2.0 approaches and expert finding.

Figure 2.8 YouTell interface

The multimedia story player of MIST (shown in Figure 2.9) consists again of three tabs. In the middle, the player is located. Here, the problems addressed by the plot are presented as multimedia contents. The player allows

the visualization of versatile media such as movies, music, text or images. The tab on the right contains additional semantic annotations related with the medium. In the tab on the left the succeeding media are shown in a thumbnail preview.

According to the media transitions defined in the editor's story-board the user might selected a medium of his choice in case there is more than one available.

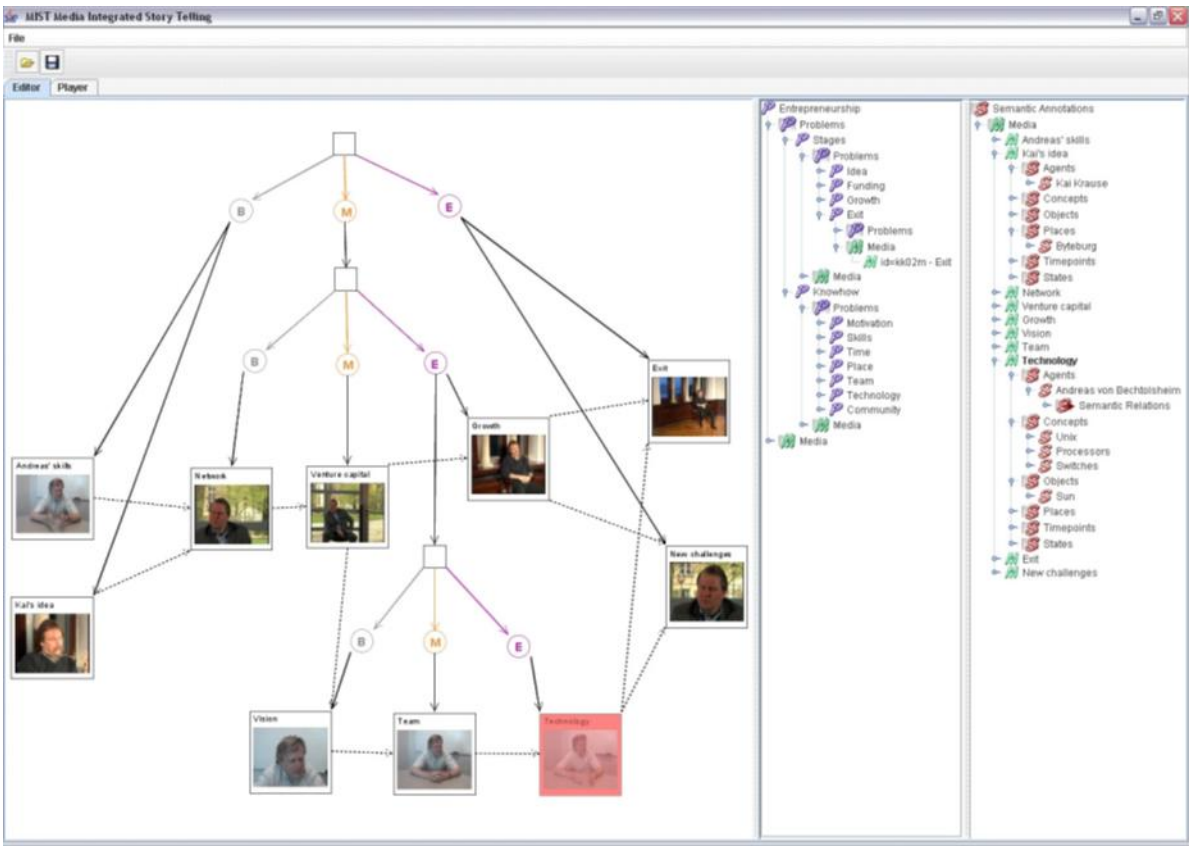

Figure 2.9 MIST interface

As mobile technologies become ubiquitous (through the growth of netbooks and common mobile phone technologies), this "21st century computing platform" has emerged as one way to address the many challenges of educating young people even in developing countries. Anytime, anywhere computing, can lead to affordable and portable paths to information access and learning. Therefore we have been adapting and enhancing the technologies of digital books, multi-sensory story creation, and distributed storytelling for the mobile platform to be used by disadvantaged learners at the extremes of life (older adults and children).

However, little research has been done to date with mobile technologies to support children in developing multiple forms of literacy through children's literature and storytelling. Informal educational experiences with grandparents and other older adults can be an important component of children's education, especially in circumstances where high quality educational services and facilities are not readily available. Mobile devices offer unique capabilities to support such interactions.

StoryKit extends the mobile reading application from the International Children's Digital Library (ICDL)3 (Bederson et al., 2009) to integrate story creation and editing features (Druin et al., 2009). Children can create and save original stories, or modify sample ICDL stories4 with their own photos, drawings, and audio. The StoryKit application guides the user through this process with a template email that can be modified for select recipients before sending. The reading interaction is the same for created books as it is for the ICDL in general (Bederson et al., 2009). StoryKit was designed by an intergenerational participatory design group at the University of Maryland from fall of 2008 through late summer 2009. Five design sessions were held over the course of the year, including a final all-day field session one month before the application was released in the Apple iPhone App store. Design sessions included both iPhones and iPod Touches. The iPod Touch includes the same software and touch screen as the phone, but lacks a camera, microphone and speaker. Designing for

both devices is important due to the increasing use of the less expensive iPods in K-12 contexts (Murray & Sloan, (Murray et al 2008).

StoryKit authors can also share their stories with friends and family via the Internet. The StoryKit interface and interaction flow is shown in Figures 2.11 and 2.12. The interface consists primarily of full-screen views, and a few dialogs. In keeping with its ICDL history and storybook metaphor, the initial view shows a bookshelf from which sample ICDL books or original creations can be read and edited. From the bookshelf view, a user can browse and manage the stories stored on the device, and open storybooks for viewing, editing, or sharing. A "New Book" option is available at the top left (Figure 2.11).

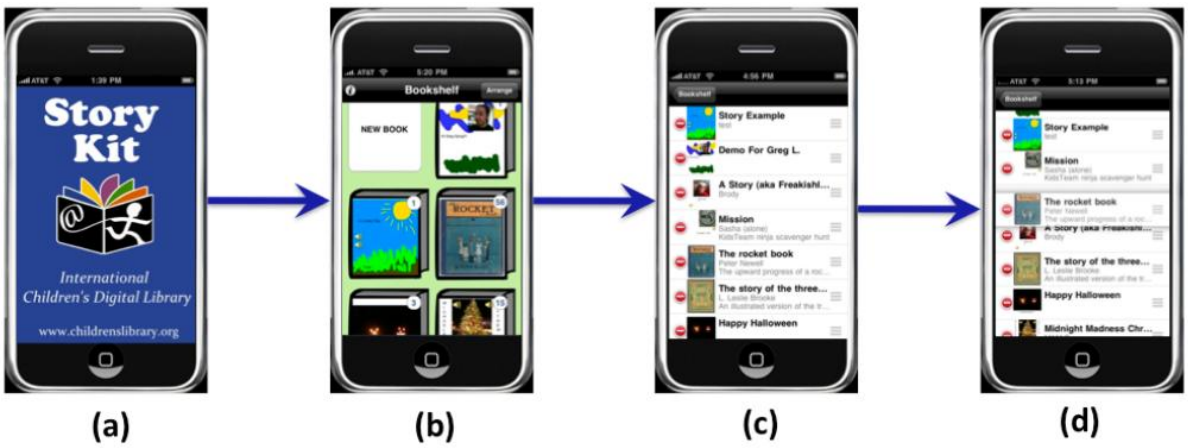

Figure 2.10 StoryKi t(a) StoryKit Launch Screen; (b) Main Bookshelf View; (c) Edit Bookshelf Overview; (d) Rearranging books in your Bookshelf

Once in edit mode, a user can choose to add text, record sound(s), paint/draw, take 'live' pictures, or use existing images from an image gallery to incorporate into a story (Figures 2.12). To share a story, a user can forward hyperlinks to the story (stored on the ICDL server) via email (Figure 2.13).

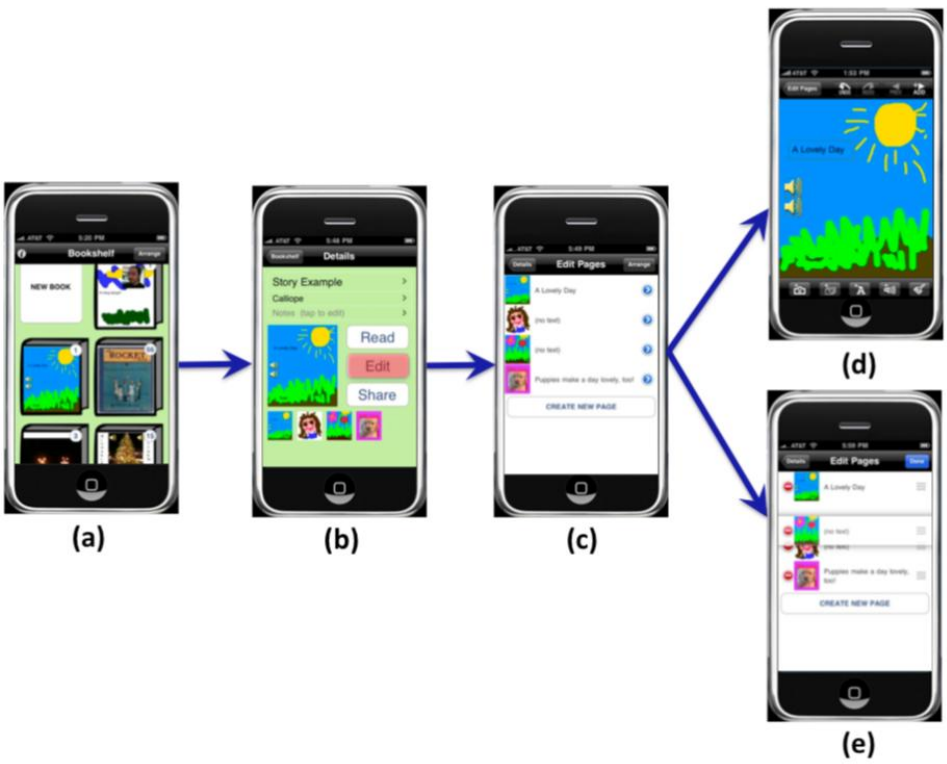

Figure 2.11 (a) Main Bookshelf View (b) Individual Story Screen, going to "Edit" (c) Edit Pages Overview(d) Edit Individual Page View (Tools Palette at bottom) (e) Rearranging Pages

The StoryKit application guides the user through this process with a template email that can be modified for select recipients before sending. The reading interaction is the same for created books as it is for the ICDL in general (Bederson et al., 2009).

Figure 2.12 Editing the book, *The Three Little Pigs.* (a) Original book page. (b) Altering the illustration. (c) Changing the text.

Guided learning or tutored approach concept, which is lacking in existing tool, was incorporated in the design to provide guidance on the story creation. G-Flash (Jumail et al 2011) introduce the use of illustrated flashcards to act as a guide in the terms of a `tool for memory recall of user experiences as well as idea generation. As a media element, the series of flashcards is used to guide story creation. The presence of virtual tutor or guide which can be called at any time further provide users with assistance in composing the story as well as on how to use the tool itself. As an online tool, user interacts with the system using a web-based client using internet as the running platform. A database is built in a server to save user personal information, story information, and documenting completed stories.

Figure 2.13 illustrates the system's conceptual design and the relations between the key elements.

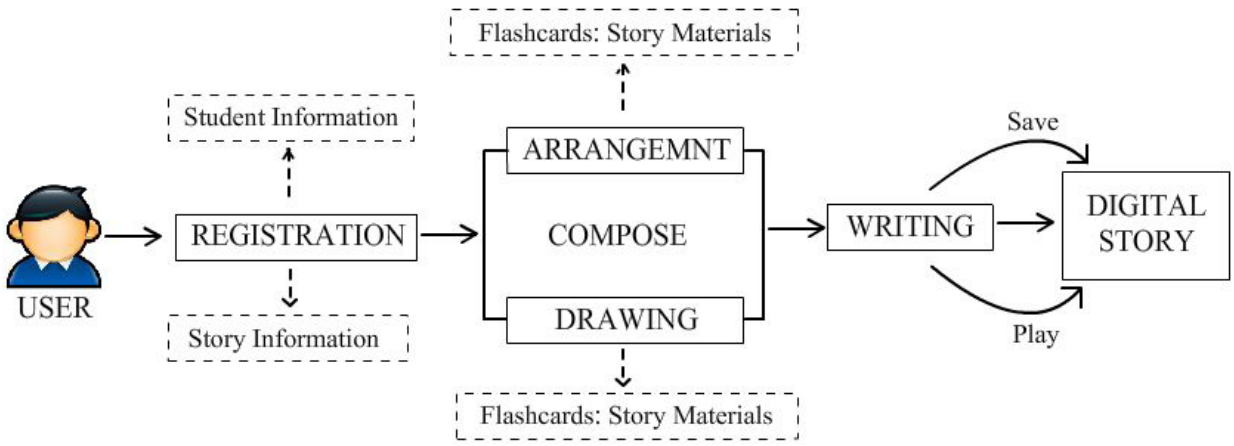

Figure 2.13 System flow for the G-Flash authoring tool application

Assistance giving or guided learning refers to a condition where assistance is needed to motivate and encourage student understanding on the idea of story creation. Tutored approach is one form of guided learning condition designed to create a balance between giving and withholding assistance. Future works have to take in consideration a template based storytelling that integrate the educational affordance and validity whit the usability.

2.3 Questions and challenges for Storytelling Complex learning object

There is a plethora of components of narrative performance (e.g., character development, internal dialogue, focalization, diegesis, etc.) that could be used to compare representational approaches if the details of each of the story representations were known. What is available for comparison is the set of capabilities that each corresponding interactive narrative system is afforded by the representation.

The following are the major capabilities of the relevant systems to date. Story mediation is the execution of actions in the story world by a coordination agent called a story director or drama manager. Story mediation is used typically to address potential conflicts between player actions and authored story content, which is called a boundary problem (Magerko, 2007). The director typically executes control of autonomous synthetic characters. Content instantiation is the ability of a narrative system to intelligently refine selected abstract plot content to fit a particular situation. Prediction of player behavior is used to pre-emptively avoid likely boundary problems (Magerko, 2007). Systems may perform real-time heuristic selection of plot content, which adds structure to story content as the player executes actions and makes decisions. Systems may also integrate different performance modalities for synthetic characters, such as discourse, body language, physical manipulation of the environment, etc.

The previous works and focus, to determine the direction of research and development of novel authoring paradigms, brings out the following issues in authoring storytelling research in education:

- **Challenges for design of authoring tools** for interactive narrative in education: How is authoring for educational story and training applications different from those systems designed for traditional storytelling?
- **Users and their expectations** from authoring tools: What do learners who live complex content expect from authoring tools? And how does that (profile, emotions, attitudes) differ per content type?
- **Assessment knowledge based :** Besides the actual design and implementation, we see more and more that authoring applications do not well include assessment events in story for analyzing the knowledge process and learning outcomes in order to adapt story and guide the student in achivements.

Pedagogical Support is needed for good story creation and storing in educational database. Suitable authoring tools enable educators to create engaging and interactive lessons that facilitate the learning with the integration of a myriad of multimedia contents. Unfortunately, many of the currently available tools are too complex to be used by the so called “digital immigrant educators”, subsequently a great number of scientific and learning associations are facing quite a critical point and also debates in the field are focused on who has really to use such tools: teachers or knowledge engineers. The need for simpler e-learning authoring tools that could lower the skill barrier and allow more teachers to participate in the development and customization process is ever-increasing. Moreover, to be really useful these tools should be able to reduce development time, effort, and cost, by allowing the reuse, enrichment and customization of available learning contents and the emphasis on the pedagogical dimension of the defined learning experiences.

The Story templates can be applied to create stories in an interactive, adaptive and collaborative way easily. It has been approved that many stories have common patterns. Joseph Campbell’s seminal work of comparative mythology illustrates an archetypal hero or protagonist from various mythologies. A similar template is about the four phases for story elements introduced by the Russian thinker Vladimir Propp. The hero’s pattern is often repeated in criminal movies in which the hero is embodied in a policeman, an agent or a detective. In order to take advantages of storytelling for improving learning processes a pedagogical support is needed. In Chapter 3 we present a new Storytelling Design Model (SDM) for education that aims to overcome the shortcomings of existing researches which mainly concern the lack of a pedagogical model that ensures the achievement of learning objectives through an educational process based on the playful aspects of digital storytelling integrated with instructional aspect aspects such as, assessment and emotion in order to define an adaptive experience.

3. Theorical Model ViewPoint

Previous studies on the narrative learning environment map the features of a new model of storytelling learning object (SCLO). A Storytelling Learning Object (SCLO) is a complex educational resource characterized by cross-linked narrative sequences, which we call story scripts. After a presentation of important studies, relating in particular to the Story Map, will move on to a story requires the presentation of our story model and adaptive instruction logic. We will devote more attention to the "*transformation formations* " concept introducing the process of adaptive assessment and role management in SCLO.

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."

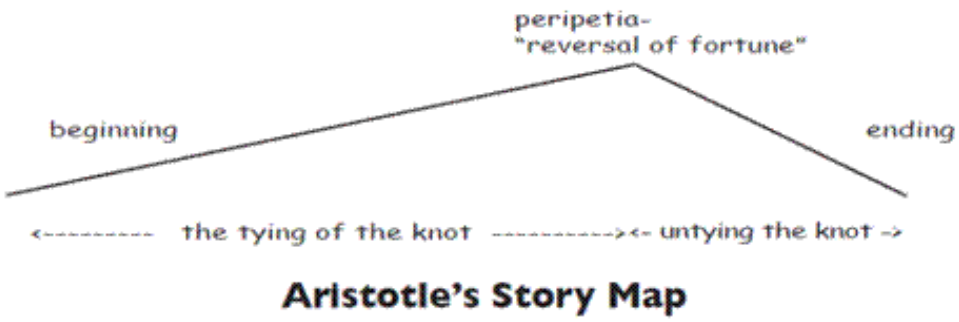

Figure 3.1 Aristotle's map (Ohler, 2008)

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.

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.

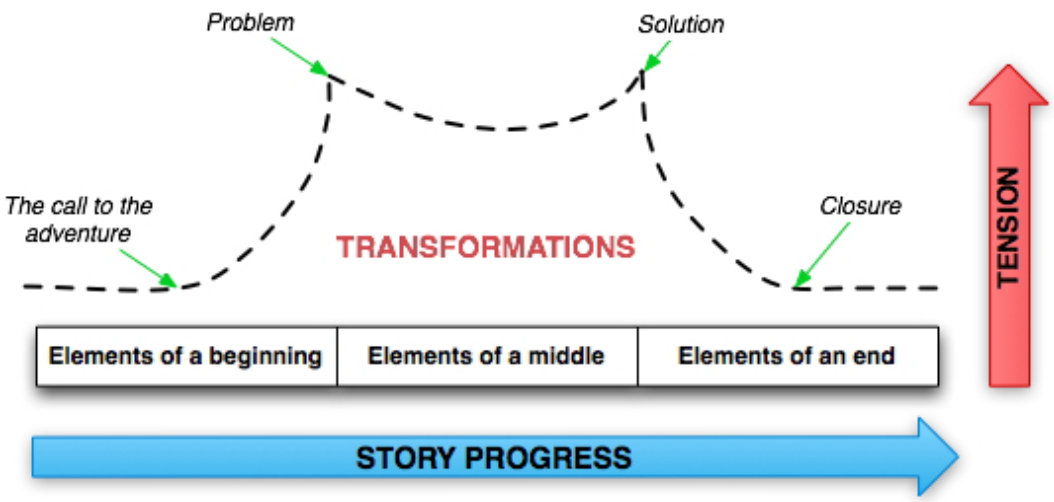

Figure 3.2 Visual Portrait of Story (Ohler, 2008)

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 (SCLO)

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) appears in (Figure 3.2).

The map shows the five essential components of the VPS, which 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). 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. 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.”

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.

3.3 "Transformation formations" and assessment in SCLO

As a way to assess the power or “storyability” of situations may be better to conceptualize a story in terms of “transformation formations”. The defined SDM exploits the concept of transformation formations, i.e. the transformation of characters. The characters can undergo different kinds of transformation. The literature identifies *eight level of transformations* in a story map: Physical/kinesthetic, Inner Strength, Emotional, Moral, Intellectual, Psychological, Social and Spiritual *(Ohler, 2008).* The levels are not mutually exclusive, therefore characters often transform at more than one level at the same time.

The proposed model considers the *intellectual transformations* as changes in terms of learning objectives. At this level of transformation, learners (who lead the characters) are asked to use intellectual-creative abilities in order to solve a problem.

In particular, the SDM proposes an extension to the association between Bloom’s Taxonomy and character transformations provided by Ohler, in order to map each transformation with a specific phase of the VPS. Figure 3.5 reports a table with the mapping among VSP situations, Bloom’s learning objectives and character transformations in the story flow.

The Blooms hierarchy of transformation, identifies a taxonomy of intellectual changes in term of six different levels of learning objectives, that are considered in increasing order of difficulty, from basic to higher levels of critical thinking skills.

Table 3.1 Mapping among VSP situations, Bloom's learning objectives and character transformations in the story flow

VSP situation	Bloom's Learning objectives	Character's transformation
Beginning	Knowledge	Character knows, remember or describe a concept or law in a story
Call to adventure	Comprehension	Character explains, interprets causal relationship between event and predict new events
Problem	Application	Character discovers, constructs and applies understanding to a situation or event.
Middle	Analysis	Character deconstruct a situation, define different option, plan or organized some action, compare and contrast different variable and opportunities.
Solution	Synthesis	Character pieces together parts to form an abstract comprehension of a situation
Closure	Evaluation	Character assesses a situation, critique or defends an idea and evaluate a situation in order to act using in the correct manner concept an law acquired.

In the SDM the learning situations, based on the phases of VPS (beginning, call to the adventure, problem, middle transformation, solution, closure) have been related with the aforementioned levels. In our model the storytelling is a logic composition of various **situations**, a combination of circumstances at a given time and place in the flow of story.

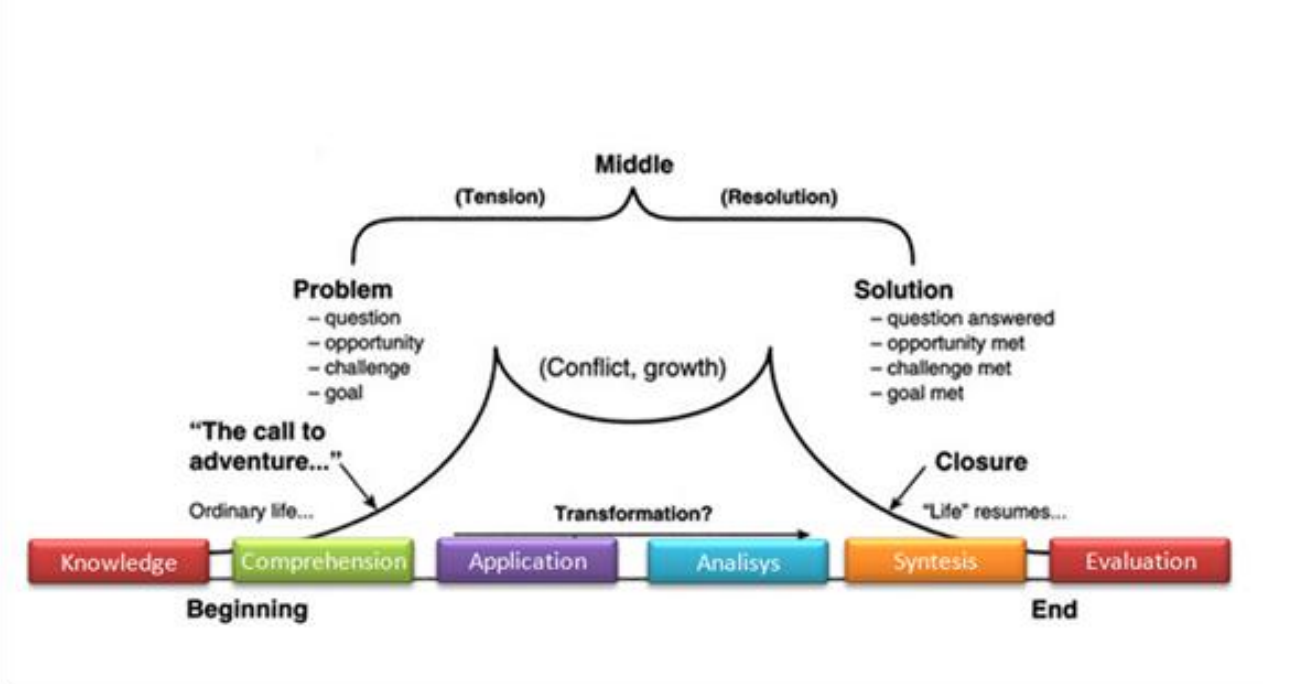

Figure 3.3 Match between visual portrait and Bloom taxonomy

We have linked the cognitive transformations with Blooms taxonomy and correspond to the situations of the visual portrait. The detailed explanation of Bloom's Taxonomy and mapping whit specific assessment test for each situation and final assessment is now in Chapter 4.2.

In order to ensure the achievement of the assigned learning objectives, each situation presents itself as the composition of events whose structure favours the development of the organization, selection and integration of information carried out by the learners in order to maximize the results for a specific learning objective that identifies a specific level of knowledge. The following events are repeated for each VPS situation:

- **advancer event**, that is designed to activate the precursor prior knowledge of the student and ensure his initial involvement in the situation;
- **learning event**, that sustains the learner's understanding of the topic goal and is based on a guided approach;
- **reflection event**, that is designed to sustain the learner in reflecting on the learned concepts and to allow him to consolidate the acquired knowledge.
- **assessment event**, that proposes to learners a test (with respect to the specific VPS situation in which the learner is involved) to assess the type of transformation that is happened.

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 Assessment and Adaptive Instruction

Recognizing the acquired knowledge in the different levels by the user and using this measurements in order to identify the *instructional treatments* able to support the learner in the overcoming gaps, implies the adoption of adaptive instruction approach. Adapting instruction to specific learner characteristics and needs comprises the major part of research on technology enhanced education (Shute & Zapata- Rivera, 2008).

In recently overviews of adaptive instruction (Lee & Park, 2008; Mödritscher, Garcia-Barrios, & Gütl, 2004; Regian & Shute, 1992) three main approaches are identified: Macro adaptive instruction, Aptitude-treatment interaction (ATI) and Micro adaptive instruction. The first approach is to adapt instruction on a macro-level by allowing different alternatives in selecting only a few main components of instruction such as instructional goals, depth of curriculum content, and delivery systems. The second approach, Aptitude-treatment interaction (ATI), is to adapt specific instructional procedures and strategies to specific student characteristics. The third approach is to adapt instruction on a micro-level by diagnosing the student's specific learning needs during instruction and providing instructional prescriptions for the needs.

Although the different approaches to adaptive instruction offer valuable contributions to the development of adaptive learning environments, a great deal of research on adaptive learning environments stands on its own and is sparsely relied on other research or instructional design theories. We present some possible directions to develop and implement adaptive instruction in the storytelling, inserted in a complex learning experience generated by an Intelligent Learning System, have taken different approaches based on the aspects of instruction that are intended to adapt to different students.

Referring to the **Macro-approach**, instructional alternatives (different Complex Learning Object) are selected on the basis of the student's instructional goals, prior knowledge, achievement levels in the curriculum structure. Macro-adaptivity refers to adaptation the learning path sequencing within a complex learning experience generated by an ITS. Macro-adaptive interventions in IWT are based on the interaction between the student model (learner model), the acquired knowledge (knowledge model), the better didactic strategy associated to (didactic model). The prior knowledge measured intervene to adapt the sequence of complex learning object and eventually the learning style recognition is used to select the type of complex learning object useful to explain a specific concept (for example the storytelling learning object to explore the domain of civil emergency) and select the delivery model (pc, mobile and so on). 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.

Referring to **Aptitude-treatment interaction** (ATI) and **Micro adaptive instruction** in the storytelling we propose a useful combination. Instructional conditions are established based on pre-task measures of the learner's aptitude variables, such as cognition and affectivity. A story engine provides adjustment in time of instructional conditions by using procedures that are response-sensitive to specific learner's needs. Micro-adaptive instructional models using on-task measures (rather than pre-task measures as the macro adaptive instruction). of student behavior and performance, such as response errors, response latencies, and emotional states, can be valuable sources for making adaptive instructional decisions during the storytelling process. Such measures taken during the course of instruction can be applied to the manipulation and optimization of instructional treatments and sequences on a much more refined scale (Federico, 1999). The diagnosis and prescriptions are performed from (explicit and implicit) analysis of the student's performance on the assessment event and in general often continuously log a story path in order to define the remedial path for a specific

situation (following paragraph explain the micro adaptivity types), suggest new tutoring actions or collaborative activities (chapter 4). Based on the suggestion of Cronbach (1977) to identify the learner's critical aptitudes we take in to consideration the affective dimension to differentiate treatments in order to maximize the probability of success in a storytelling complex learning object, using the emotional state to change the point of view in the story (chapter 5).

In the following section we focus on the comprehension of the different types of microadaptivity within the structure of storytelling complex 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.

3.4.1 Micro adaptivity in storytelling experience

A story can be linked with one or more learning 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.

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 situations 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 path aiming at facilitating, supporting and motivating the user in reaching the teaching/learning objectives.

In SDM, the assessment points support the mechanism of branching logic in the story plot. The model allows to link the alternative routes to the level of knowledge achieved by a learner (and assessed, for instance, through e-testing) in order to route him to remedial paths, aiming to support and motivate him to achieve his learning objectives. 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 scenario, situation and role.

In SDM, the remedial paths are defined in order to satisfy three types of micro-adaptivity referring to specific instructional treats:

- **Type A** is activated if the learner achieves a score between 50% and 75% of the admissible maximum score. In this case the same events (in the same situation) are re-lived by the learner with different media. This level is defined according to the idea that that the most effective learning occurs when the learning activities most closely match the learners preferred style.
- **Type B** is activated if the learner achieves a score between 25% and 50% of the admissible maximum score. In this case the same events (in the same situation) are re-lived by the learner in a different scenario (context). This level is defined according to the situated learning approach
- **Type C** is activated if the learner achieves a score between 0% and 25% of the admissible maximum score. In this case the same events (in the same situation) are re-lived by the learner taking a new character with a new role in the story. This level is defined according to a novel approach based on the concept of Point of View (PoV) in a story, where a given narrative situation can be represented differently depending on the perspective of a specific character (with a specific role) taking part in that action.

Following the different types and the time they are foreseen in the story. If in a microadaptivity, user still finds some difficulties in assessment test, then he exploits a simplified test or a collaborative mode to rewrite the story (chapter 4).

3.4.2 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 50%-75% 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 3.7 microadaptivity A

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3.4.3 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 25% and 50% .....***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 3.8 microadaptivity B

3.4.4 Level C change a role taking

C	**IF** the level of knowledge learnt is less than or equal to 0 - 25%. …***then t***he learner will have the possibility to choose/make one or more roles proposed in the LO		
	IF the learner keeps on having unsatisfactory results, then he will have to choose a collaborative/cooperative mode	A pedagogical agent that can help the user complete the assessment moment.	
		The gets in contact (through chat multiplayer mode) with his peers (in the same class) who are active and can help with the test.	

Figure 3.9 Microadaptivity C

In the following picture we synthesize a model for the adaptive management of the story-based experience. The Figure 3.10 shows the flow of events within each situation. Flow foresees two iterations. In the first one a role is assigned to the learner who is engaged into a sequence of four event as shown in the Figure 3.10. In the fourth event, the learner assesses his knowledge. The system adapts the situation (for the second iteration) by considering the score achieved by the learner during the assessment and by using the aforementioned rules corresponding to micro-adaptivity level A, level B or level C. In the second iteration, a further assessment is executed in an assisted way; that happens if the score of the assessment event is less than 50% of the admissible maximum score. The whole process is repeated for all the six situations of the SDM.

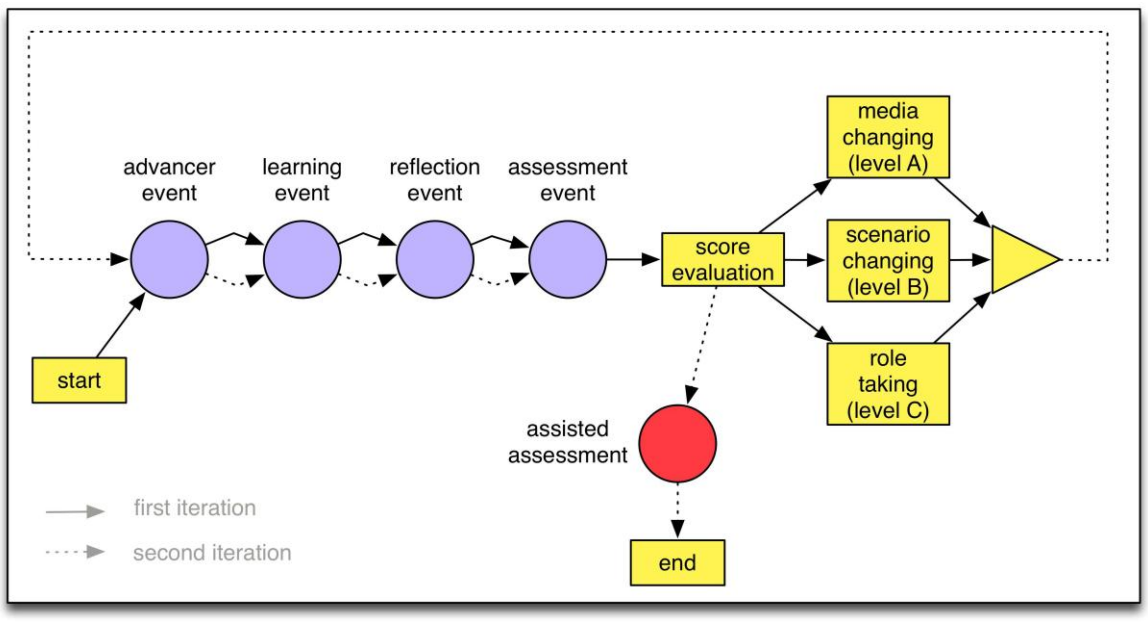


Figure 3.10 Microadaptivity flows in storytelling model

The Management of Roles (role playing, role taking and role making) is fundamental for the educational aspects of the defined SDM. The interactionist perspective focuses on how individuals adopt and act out roles during interaction. Individuals perform their roles to others in a social context (role-playing), analogous to actors on a stage (Goffman 1959). Individuals also take on the role of others in order to anticipate their actions and perspectives (role-taking) and continually produce and reproduce roles (role-making) (Turner 1956). In the SDM the characters in the story play specific roles that allow learners to live situations and events from a specific viewpoint. Changing the role of a learner means to modify the viewpoint by which he interacts with the story and the didactic value of the story. The role management in SDM provides a logical articulation of the learning experience that meets the three key activities to achieve effective learning by using story-based digital content: storytelling (role playing), retelling (role taking) and reliving (role making). A learner plays a role when he embodies a character living a story from its specific viewpoint (role playing). A role is assigned to a learner when the story starts and he takes a new role according to level C micro-adaptivity (role taking) and considering the emotional state (chapter 5) The role making refers to a collaborative problem-solving session (parallel to the storytelling) where a specific learner chooses his role and assigns other roles to his peers. The role making in collaborative wiki story will be exploited in the chapter 4. The role taking perspectives emotion based will be exploited in the chapter 4.

3.5 The ARCS Model of Motivational Design for SCLO

A model which stresses the question how SCLO 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).

According to motivational design theory, in order to create an effective, efficient and attractive instructional design, the elements of motivation which are handled in five categories have to be understood well.

1. *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.
2. *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.
3. *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).
4. *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.

The original model was recently expanded by volition and self-regulation (Keller, 2008):

5. *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.

We use several guidelines aimed at enhancing an interesting instructional design of SCLO 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, humour, 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 clarifies that an ideal learning interface is offered if narrative methods are used early on in the production process. In both models there are four phases or sections, which are almost identical in their goals. Both can be harmonized easily:

Figure 3.11 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. Assessment and Adaptive instruction in SCLO

Instructional design for storytelling complex learning object aims at developing narrative learning experiences that promote and support learners' knowledge or skill acquisition. These learning experiences include assessment activities able to redirect the story in different branches, to give instructional feedback, and to use the implicit data to alert the tutor and to define alternative activities. Defining *instructional treatments* to specific learner's abilities, learner's needs and learner's preferences refers to the major research lines on adaptive instruction. In this way, adaptivity can be defined as the capability of a system to alter its behavior according to learner needs and other characteristics (Shute & Zapata-Rivera, 2008).

In overview of adaptive instruction (Lee & Park, 2008; Mödritscheret al, 2004;) as anticipated in the previous chapter, three main approaches are identified:

- ***Macro-adaptive instruction***, such as Keller's Plan or Personalized System of Instruction (PSI; Keller, 1968) as an example of the *mastery learning* approach. This approach assumes that learners primarily differ on their learning rate and that adaptive instruction exists in permitting learners to move through the course at a speed according to their ability and other demands upon their time (go-at-your-own-pace feature); Intelligent Tutoring Systems (ITSs) like IWT (Capuano 2009) are examples of adaptive systems, using artificial intelligence techniques in order to provide tailored and on-time instruction to the learner (Lee & Park, 2008).
- ***Aptitude-treatment interaction*** (ATI), based act to identify the learner's critical aptitudes based on pre-task measures and to differentiate treatments in such a way as to maximize their interaction with learners' aptitude or the individual characteristics that determines the probability of success in a given treatment or instruction. Aptitudes may include knowledge, attitudes, (cognitive) abilities, skills and so on. More recently, cognitive processing capacity was acknowledged as an influencing aptitude, and new adaptive systems have been developed that integrate the insights of cognitive load theory into the field of adaptive instruction (Corbalan, et al 2008; Corbalan et al 2009);
- ***Micro-adaptive instruction****,* that puts information processing central, diagnoses learner's specific learning needs during instruction and subsequently provides appropriate instructional prescription for these needs (Mödritscher et al., 2004). Contrary to macro-adaptive instruction, micro-adaptive models are dynamic and use within-task measures or temporal learner characteristics such as motivation levels to define which instructional treatments are most appropriate in a given situation (Lee & Park, 2008). Typically micro-adaptive models are more fine-grained as they include more learner variables or characteristics than macro-adaptive models.

A storytelling complex learning object aims to establish a differentiated or adaptive interaction between learner and system by making use of measures about knowledge about the learner and redirect the story path in term of content (different situations), space (individual or collaborative space) and roles (different archetype for a new point of view coherently to emotional states). The combination of empirical research on effectiveness of adaptive systems with theoretical propositions for the development or optimization of educational system, leads to the classification of three groups of data to evaluate and that are placed centrally in a storytelling complex learning object and in assessment strategy:

- **Cognition**. A first group of data consists of cognition related characteristics such as w*orking memory capacity* (Graf et al., 2008), *intelligence* (Kelly & Tangney, 2002), *prior knowledge* (Graesser, Jackson, & McDaniel, 2007), *cognitive style* (Triantafillou, Pomportsis, Demetriadis, & Georgiadou, 2004), *learning style* (Germanakos, Tsianos, Lekkas, Mourlas, & Samaras, 2008; Graf et al., 2008), and *learning goals or goal orientation* (Kelly & Tangney, 2002).
- **Affect**. A second group of data comprises affective characteristics of the learner, like *frustration, confusion* and *anxiety* (Graesser et al., 2008), *certainty* and *self-efficacy* (McQuiggan, Mott, & Lester, 2008), with this last notion situated on the boundaries between cognition and affect.
- **Behavior.** These behavioral characteristics data can be considered as forthcoming from the learner's cognitive and/or affective states and are therefore strongly related to them. Individual characteristics that interact with the learner's behavior in the learning environment are also called interaction parameters and may include the need for *learner control*, the need for *help or feedback* (Koutsojannis, Prentzas, &

Hatzilygeroudis, 2001), the degree of *self-regulated learning* (Azevedo, 2005), or the *number of tries per task*, *received grades and the exercises already made* (Hospers, Kroezen, Nijholt, opden Akker, & Heylen, 2003).

Below we will see how the storytelling complex learning resource, inserted in a broader context related to Intelligent learning system (IWT), makes use of a series of relevant data, related to macro-types listed above (affect, cognition and behavior) to manage the adaptivity at different levels in order to enhance the educational effectiveness during interactive narrative experience.

4.1 Assessment in SCLOs within in an enriched learning environment

The model depicted in Figure 4.1 can be considered to ensure a comprehensive picture of assessment conditions[9], and used (also partially)in an assessment process for specific complex learning resource. Additionally, the options relevant for storytelling design model, and useful to realize a first prototype if storytelling complex learning object, are emphasized by means of a green background. Regarding the area of assessment, the affective/emotional domain is not highlighted in this context, because it is part of WP2 and exploited in the chapter 5.

In the following, the aspects of different assessment forms (see Figure 4.1) are discussed. Since our focus is on the personalization of learning environments, the aspect of adaptivity is emphasized by discussing each aspect with respect to macro- and micro-adaptivity (which actually constitutes the fifth aspect in the assessment sub-model). Generally, macro-adaptive personalization concerns the change of the learning path according to the results of an assessment at the end of a storytelling situation, whereas micro-adaptive personalization concerns changes within a situation by either changing the media, the scenario (context), or the role (point of view) in the story. The respective assessments can either be explicit (invasive) by posing questions to the learner and elaborate the answers or implicit (non-invasive) by tracking the behaviour of the learner and using them to individuate specific educational traits.

Furthermore, we will outline, how the tools developed in WP5 (see D5.2.1, ALICE 2011), namely the Automatic Question Creator (AQC) and the Co-writing wiki, can be used within SCLOs and how they can be utilized for a micro- and macro-adaptive personalization of learning paths.

[9] Please refer to D5.1.2 (ALICE, 2011, Chapter 7) for a detailed description of the IMA and the assessment sub-model.

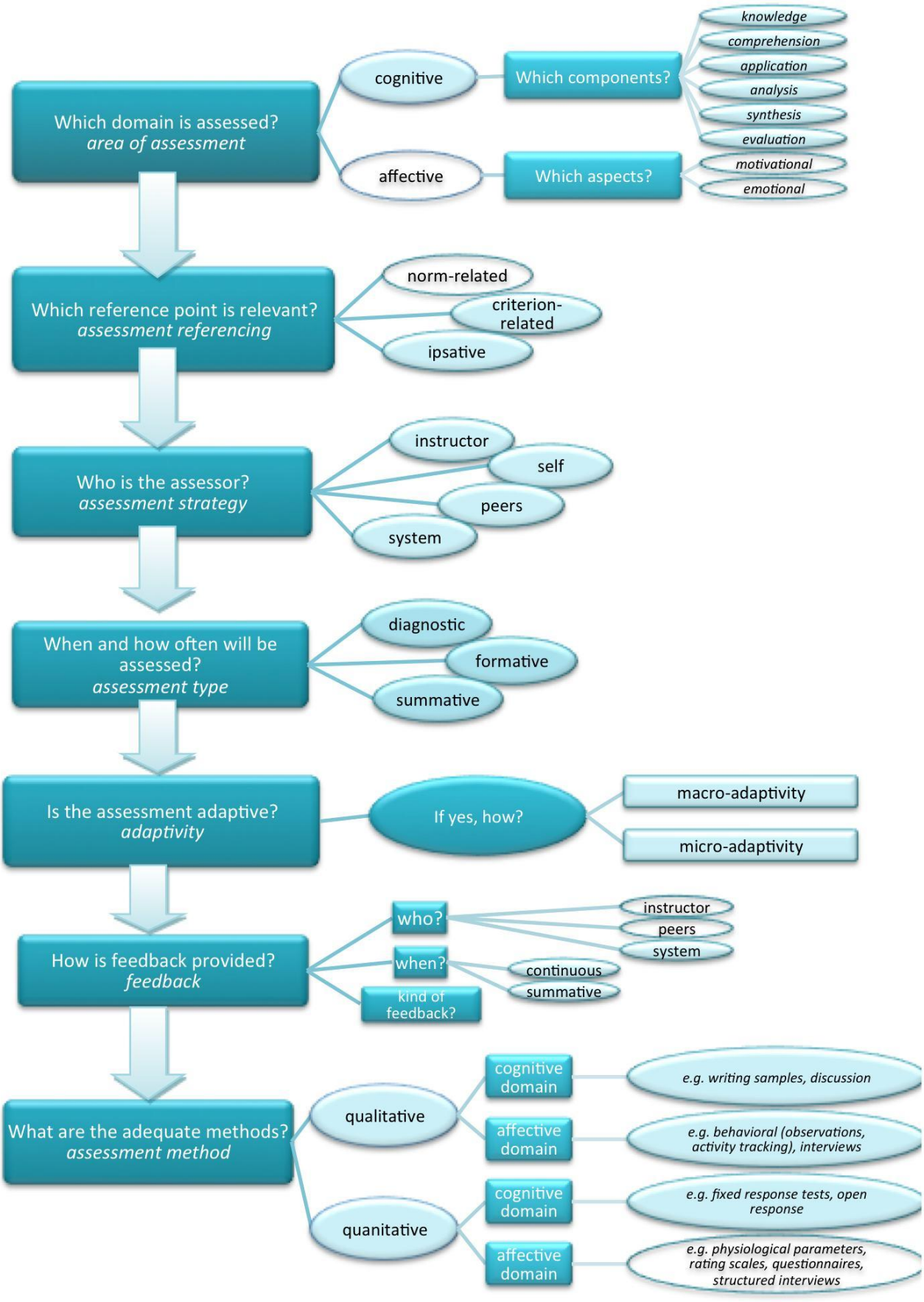


Figure 4.1 The Vision of Assessment in Storytelling

Assessment domain/area. The aim of storytelling is to improve knowledge and skills of learners with respect to emergency management. Hence, in this case, cognitive competencies are in the focus of interest. On the *level of macro-adaptivity*, learners show, whether they reached a specific learning goal by taking a knowledge test at the end of each learning situation. The outcome of this assessment will then influence the remaining learning path, i.e. the next situation to be presented. Another possibility for macro-adaptivity is a knowledge test at the beginning of a learning activity. This would show prior knowledge of learners and give them a first idea of the topic. Additionally the advancer event of the story can be adapted to the individual knowledge of a learner. Efficient assessments of knowledge and comprehension at a macro-adaptive level can be reached by employing automatically create questions on the topic of interest (taken by text material provided by the instructor or from Wikipedia documents that are searched online by the learner).

On the level of micro-adaptivity the mapping of the six learning objectives identified by Bloom (1956) to the six learning situations or phases of the VPS (see Figure. 3.6) shows that assessment is possible on all levels of cognition. In addition to the mentioned item types, the AQC and the co-writing WIKI can be used for the following situations. Using AQC, questions automatically generated from text documents, are categorized as lower-level items, i.e. testing the knowledge, comprehension, or application of the learning content. This can be useful, whenever the student wants to deepen his or her knowledge or needs more information on a specific point in the story before going on in the predefined narrative flow. The additional content can either be retrieved from documents linked by the instructor or by searching the Wikipedia. In order to make sure that the main concepts are really understood a test generated by the AQC can be taken. By this, students can explore and learn progressively by studying additional material that is different from the ones structured within the story. In contrast, co-writing Wiki provides a collaborative learning environment where learners also analyse and evaluate the learning content, e.g. by assessing their peers' working products. In the context of storytelling, co-writing Wiki can e.g. be employed, whenever a student is given the possibility to learn in a collaborative mode (Fan 2010). As outlined this can be the case, if the learner repeatedly doesn't reach a pre-specified threshold in the assessment event of a situation. In this case, the tutor can suggest alternative activity to overcame the knowledge gap in assisted assessment could provide a problem-based CLO, using for instance the co-writing WIKI (chapter 5) where the learner, making a specific role, might be given a problem to be solved collaboratively, e.g. planning the optimal escape routes.

However, at this point it should be mentioned that the majority of the introduced assessment methods are invasive, that is the learner has to leave the situation to take a test. For micro-adaptive instruction methods for non-invasive assessments (depicted in Section 4.2), behavioural assessment, can be achieved within a digital story object by activity tracking, i.e. the tool itself detects and logs learners' behaviour and uses this data to change the media, situation, or role according to the thresholds set for the micro-.adaptive assessment event (see Figure 3.10). Thus, in this case, not a test result but the user's behavior triggers the assessment rule in the model, which leads to a non-invasive formative assessment.

Assessment referencing. The reference point which is used to evaluate a learner's status of knowledge, is either *criterion-related* or *ipsative.* We talk about *criterion-related referencing* if the actual status of an individual is compared to a pre-defined domain-criterion. The three levels of micro-adaptivity which are discussed above (see 3.5) for the storytelling model are *pre-defined criterions.* The reference is used in order to set an intervention whenever the learner falls below a specific threshold. Depending on the reached score, either the media, the scenario, or the role can be changed. Criterion-related referencing also takes place on the level of macro-adaptivity when the learning path and activities are adapted to the learner's actual status of knowledge at the end of specific learning object or learning activities. Ipsative referencing is defined as a comparison of the learner's actual performance with his or her own performance in the past. So macro-adaptive assessments can be ipsative by comparing the results of two knowledge tests (one at the beginning of a SCLO and one at the end) in order to show and monitor the learning progress of an individual. Micro-adaptive assessments can also be done in an ipsative mode by, for example using behaviour logs to monitor a user's learning progress and subsequently match the mode of micro-adaptive changes as suggested for the second iteration in Figure 3.10.

Assessment strategy and adaptive learning. In a storytelling complex learning object, the assessment can be *system-based*, meaning that the system itself detects a *pattern of actions* which triggers a change within the current situation (micro-adaptivity) or a change of learning path (macro-adaptivity). For instance, the result of an

automatically created knowledge test (initiated by the system or by the learner himself) could determine the path of the story in order to adapt content and information to the individual knowledge of a learner. Or, the different levels of change based on the results of the assessment event (see Figure 3.10) can be linked directly to the learner's behaviour. Regarding the tools developed in WP5, the AQC can be used on the level of macro-adaptivity as well as on the level of micro-adaptivity, whereas the functions provided in the Co-writing wiki support learners primary on the level of micro-adaptivity, e.g. self-, peer- and group-assessment within a learning activity.

Assessment type. On the level of macro-adaptivity, diagnostic assessment concerns the learner's knowledge at the beginning of the learning process. Summative assessment considers the learner's knowledge at the end of a learning activity or complex learning resource. A summative assessment is the most common form of assessment and shows whether a learner has reached the learning goal. Regarding micro-adaptivity, short tests during the single learning activity o complex learning object, formative assessment (using for example the automatic question creator) support learners in self-reflecting their learning performance by giving feedback frequently and thus enhance their learning process. Additionally, in a collaborative context, co-writing Wiki can provide formative assessment by means of self- and peer-reviews during the learning activity.

Feedback. Feedback is important for learners in order to become aware of gaps in their knowledge, skills, and understanding of a topic. On the level of macro-adaptivity, feedback is given only at the beginning and the end of a SCLO (summative feedback). This can e.g. be done by reporting the results of the assessment. In order to achieve an ipsative referencing, the feedback should refer to a learner's progress by comparing the results coming from assessments at the beginning and the end of an SCLO. On the level of micro-adaptivity, feedback can be given continuously and thus formative. The feedback can be based on invasive as well as non-invasive assessments, i.e. refer to the results from e.g. questions, tests, or behaviour tracking. It can be given in form of avatars or in form of the other roles integrated in the story. When using the collaborative mode with the co-writing wiki different forms of feedback are possible. The learners can rate their peers' work on a star rating scale. Additionally they can give verbal feedback in form of comments in order to explain reasons for the rating. In addition learners receive feedback continuously by discussing ideas and suggestions with their colleagues.

Assessment Method. Regarding the variety of item types used in the context of storytelling (see Sections 4.2 and 4.3) in addition to the emotional test incorporated in the IWT, all possible assessment methods can be covered (qualitative as well as quantitative, cognitive as well as affective). With respect to the tools developed in WP5, the AQC provides four different question types such as fill in the blank, open ended, multiple and single choice. These fixed and open response tests can be used in order to test learners' state of knowledge. Hence, automatically generated tests rank among quantitative methods and refer to the cognitive domain. Concerning the Co-writing wiki, also qualitative methods such as discussions and observations can be used in order to investigate learners' needs respect to their actual state of knowledge. Besides, provided functions such as contribution graphs also consider motivational aspects (affective domain) of learning process.

4.2 Cognitive Assessment for Storytelling

Referring to the idea of assessment for the WP6 (related to different Knowledge level of Bloom's taxonomy) we would like to try to propose different types of input / cognitive stimulus for storytelling, assuming the reactions at the level of narrative. The storytelling complex learning object present, at the end of narrative path a summative assessment able to measure the different level of knowledge assigned to specific situations in a SDM. Bloom's Taxonomy (Bloom, 1956) widely used as a classification scheme to determine different levels of cognitive competencies. Appropriate questions can then be developed to assess the desired level. Bloom's levels are: (1)Knowledge , (2) Comprehension , (3) Application, (4) Analysis , (4) Synthesis, (5) Evaluation. (Tab 4.1)

The taxonomy is hierarchical; each level is subsumed by the higher levels. In other words, a student functioning at the "application" level has also mastered the material at the "knowledge" and "comprehension" levels. However, it is a widely accepted system, and is useful in illustrating how certain question types are better choices for assessing different levels of student mastery. What's important is the idea that student knowledge is not all equal; there are levels of mastery ranging from simple recitation of facts, to formulating informed opinions regarding complex issues.

An awareness of these levels can help one determine how well students really know educational content. Students need to develop thinking and learning at all six cognitive levels Literature refers to thinking prompts[10], questions related to the six thinking skills in Bloom's Taxonomy, that can be used as *hint* to ensure students are are correctly stimulated to respond to all levels of the cognitive domain. (Gregory and Chapman, 2007).

Cues, questions, and advance organizers are three common ways that a classroom teacher helps students use what they already know about a topic to learn new information.

Table 4.1 Learner action and question cues for different Knowledge level (adapted from Holden 2010[11])

Level	**Learner Action**	**Question Prompts**
Knowledge	The learner should be able to recognizes in-formation, ideas, principles in the approximate form in which they were presented.	List, define, label, identify, name
Comprehension	The student should be able to translate, comprehend, or interpret in-formation based on the knowledge.	Describe, associate, categorise, summarise
Application	The student selects, transfers, and uses data and principles to complete a problem or task.	Apply, calculate, illustrate, solve
Analysis	The student examines, classifies, break complex concepts or situations down into their component parts, analyses how the parts are related to one another and draws conclusions.	Analyse, compare, separate, order, explain
Synthesis	The student originates, integrates, and combines ideas into something that is new.	Combine, modify, rearrange, "what-if"
Evaluation	The student appraises, assesses or make judgments basis of specific criteria.	Assess, decide, grade, recommend, explain, judge

In order to design specific question prompts for each situation (and bloom's cognitive level) in the storytelling model we mapped six different levels of knowledge with different types of tests that can be useful to detect specific information about knowledge acquired and to define instructional treatments and feedback:

- **Remember:** True/False tests on knowledge elements (explicitly mentioned in didactical materials) to acquire mnemonic knowledge elements. Short-answer items simple recall questions (mnemonic activity of "recall") ; Open ended (Single fill in the blank item) useful to detect misunderstandings and the frequency with which they repeat themselves; Fill-in-the-blank/cloze; to detect chronologically ordered knowledge we can use the numerical scale test.
- **Understand**: the subject's ability to interpret given information to generate new one not explicitly provided by the teaching materials, identifying key points of speech and secondary elements. Multiple-choice items; Open ended learning understanding items (short essay) on predefined metrics to evaluate the ability of understanding; items for transposition of representational forms (e.g. from a textual form of a map or flow). Classification items; constructed item response; essay questions;

[10] http://www.ucdoer.ie/index.php/How_to_Ask_Questions_that_Prompt_Critical_Thinking

[11]Holden, 2010. *A QUICK REFERENCE GUIDE TO DEVELOPING COGNITIVE LEARNING OBJECTIVES* http://fgdla.us/uploads/A_Quick_Reference_Guide_to_Developing_Cognitive_Learning_Objectives_FGDLA.pdf

- **Apply**: the learner's ability to solve a concrete problem situation through the application of a conceptual sequence of operations; Problem items or Open ended or Multiple choice exercises; Performance assessment items (the learner must create papers in accordance with certain standards, spoken thinking) evaluated with rubrics whose descriptors are the abilities to assess (ex.: create an Excel spreadsheet); oral interview/thinking aloud on a task to evaluate the ability to apply resolving procedures.
- **Analyze**: The category refers to the ability of the learner to identify and separate elements of knowledge, to highlight the relationships that bind them and the general organizational principles that allow sorting elements and relations in knowledge structures. True/False Items with motivation (so that the student, by motivating his or her response, exerts analysis skills); Extended response; Matching items; Textual Analysis items (that stimulate inference abilities); Analysis items with problem resolution; Problem solutions items; Argumentative maps (from a given stimulus or without it); items with case analysis and multiple case analysis; items with a criteria and categories reconstruction;
- **Evaluate**: learner's ability to express evaluative judgments of their papers or others developed in terms of certain evaluation criteria chosen by the learner or proposed by the tutor. Situational Judgement tests; open-ended interviews; tests based on completeness ratings; tests based on the construction of evaluation criteria; tests based on interaction evaluation; argumentative essays (papers, maps)
- **Synthesis**: learner's ability to combine information into a single, coherent framework in order to generate a not existing product and to define original plans and sequences of operations in compliance with specific objectives, exploratory essays and deductions on relationship systems (creative insight): Writing Task Items, where complex performances are broken down into elements with minimum measurable levels of performance expected, through model based simulation tasks; item problem posing; performance assessment item to detect creative abilities.

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 enable to intelligent engine to intervene in the alteration of story path.

Actually, types of tests currently supported in IWT Platform, intelligent learning solution used to create the final and summative assessment for storytelling complex learning object 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 questions**. 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 questions**. 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.

There are new types of question desirable to be included in the storytelling. Based on the analysis of the leading test management systems (e.g. Question mark, Question Writer, Captivate, etc.)and the specific tests, and to represent the most common applications (e.g. IMS-QTI), it is useful to propose the addition of a set of demand

types editable and manageable IWT able to cover the items most commonly used by management systems such as Question Mark test, Question Writer and standard compliant whit IMS-QTI.

4.2.1 The assessment feedback type in SCLO

We have explored assessment feedback in terms of classification into evaluative, interpretive, supportive, probing, and understanding forms (Dunwell et al., 2010). As Table 4.4 illustrates, the simplicity of the 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.

Table 4.2 Feedback types 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

The feedback in (cognitive) assessment event drive to:

- **Macroadaptivity in the intelligent tutor system (IWT)**. Given a set of Learning Objectives chosen by the teacher on the educational domain ontology, different students with the same Learning Objective will so have different courses generated by the system after the prior knowledge and characteristis evaluation. At the macro-adaptation level, the individual component allows an open-looped control of the personalization system taking into account both the instructional domain and the best learning method. Learners perceive it as a direct participation in learning experience personalization process (self-planning) and can constantly observe their cognitive status evolving and the results of their assessment activities (self-evaluation).
- **Microadaptivity in story path**: Micro-adaptation in story path is based on a non-invasive assessment exploiting branching logic in order to design different instructional treatments by using indications coming from different data to define remedial paths tailored to meet the learning progress of the learner. The model allows to link the alternative routes to the level of knowledge achieved by a learner (and assessed, for instance, through e-testing) in order to guide him to remedial paths, aiming at facilitating, supporting and motivating him to achieve his learning objectives. Along the new paths learners re-live the same situations from different viewpoints related to different roles.

4.3 Implicit Assessment in storytelling learning flow

The implicit assessment is based on the interpretation of learner´s actions and interactions (behavioral indicators) within the virtual environment. The implicit assessment in storytelling must be taken in consideration in order to obtain a relevant measure of learning achievements on task or situation, and to give the feedback for a specific learner. Online learning behaviours, on the other hand, are more complex. Different studies have tried

to differentiate as many online learning behaviours as possible. On-going efforts are needed to develop standard procedures for educational web usage mining and learning behaviour differentiation. Implicit assessment is linked to Educational Data Mining (EDM) a new research trend in education (Winters, 2006).

The following selected EDM studies:

- **Optimal learning path discovery**: Hwang and colleagues (Hsu, Tu, & Hwang, 1998; Hwang, 2003) worked on model able to guarantee dynamic learning suggestions based on the analysis of educational materials and score obtained in test assessment. Other authors (Su et al., 2006) utilized similar approach to identify the optimal learning path for learners assuming that different clusters should have an unique learning path to achieve the best learning performance. They used the decision tree technique to build a model to provide a personalized learning path. Huang, Chen, & Cheng (2007) starting from the consideration that traditional single-level learning path mining is not sufficient to guarantee a better learning path, proposed a methodology for mining frequent patterns of learners' behaviors (Mor et al., 2006; Su et al., 2006) that connects a hierarchical scheme to provide cross-level learning suggestions. Therefore, learners can get multiple learning route suggestions instead of one.
- **Instructional strategy and course design improvement**: Merceron & Yacef (2005) conducted Learning Process Analysis to identify the relationships between learners' performance and different strategies employed by the instructor. Association and clustering techniques (e.g., Merceron & Yacef, 2005) and the decision tree technique were particularly useful in this efforts. Zaiane (2001) also analyzed logs file to understand learners' behaviors and to improve the learning process accordingly. Relevant behavioral patterns for identifying learner style are presented in recent literature referring adaptive instruction. The studies have introduced an automatic student modeling approach for identifying learning styles based in LMSs. In order to make our approach applicable for LMSs in general, only commonly used features in LMSs were selected to be the basis for patterns. These features include: content objects, outlines, examples, self-assessment tests, exercises, and discussion forums.

In the theory of information foraging, human search behaviour is regarded as adaptive to the environment to gain information from external sources as effectively and efficiently as possible.For example a set of behavioural indicators for the assessment of emotion in a game (Steiner et al., 2009) as state is provided in Figure 4.2

#	Behavioural Indicator
1	Click rate
2	Length of mouse movements
3	Relative exploitation of available tools
4	Frequency of tool-usage (of each available tool)
5	Frequency of communication tool-usage
6	Frequency of interactions with NPCs
7	Frequency of expressing positive emotions via keys
8	Frequency of expressing negative emotions via keys
9	Inactivity [sec.]
10	Within-patch processing [sec.]
11	Between-patch Processing [sec.]
12	Extent of NPC-interactions weighted by amount of Within-Patch processing
13	Information gained
14	Rate of information gain

Figure 4.2 behavioural indicators for the assessment of emotion (Steiner et al., 2009)

Some of them are primarily related to activation, such as click rate (#1) or inactivity (#9). Others are primarily related to pleasantness, such as using defined keys to express positive or negative emotions (#7 and #8). The indicators 10 to 14 are directly derived from the theory of *information foraging*, which describes the strategies that people apply to search and gather information. External sources are called *patches* (e.g. online documents).

An ideal information forager maximizes the rate of gaining valuable information by seeking for a balanced ratio between explorative and exploitative search behaviour.

Even if the theory of information foraging has been initially developed in the context of navigation on the web, we apply the principles and adapt some of the indicators to the area of storytelling because of two reasons: i) the learner has to search for and to communicate with several events in order to collect all information necessary to master different scenarios and ii) it is assumed that to give opportune feedback and scaffold to the student sustain a positive emotional state and improve the motivation.

For the individualization of a possible extension of the assessment modality, able to enhance the educational logics behind the storytelling complex learning object, a feasibility study has been conducted and has conveyed into the presentation of this work hypothesis. As the SCLO concerns some indications already presented in the IMA (WP5) have been included since they are related to the integration (to the current educational and summative assessment) of implicit assessment levels.

4.4 Hypothesis on the implicit assessment integration inside storytelling logic logics

The term implicit assessment refers to the ability to use specific (and selected) behavioural patterns to trace back to indications/suggestions that may be utilized to modify both the final judgment and path and also to ask for the tutor/teacher's intervention. The individualization and selection of these behavioural patterns is the result of a first research aimed at including moments of non-invasive and really traceable analysis in storytelling.

The adoption, from the point of view of possible implementation of one or more of the following hypotheses, will imply the extension of internal tracking features and the arrangement of automatic action rules or of a visual representation that the teacher can have to modify the path. The following is a supplementary proposal of the current assessment included in the storytelling: taking into account and providing a measurement to internal paths and user's behaviours, it is possible to determine i) a normalization of the final mark or ii) an activation of supporting actions by the tutor.

The SDM is based on implicit assessment taking into consideration:

- **Formative assessment results in each situation in order to** 1) trace the users' assessment path to make the final evaluation**, and b) use the patters score in order to activate a** facilitated assessment (individual or collaborative)
- **Parameters about learner behaviors** in order to measure attention and effort as well as elements which could be interesting for the tutor

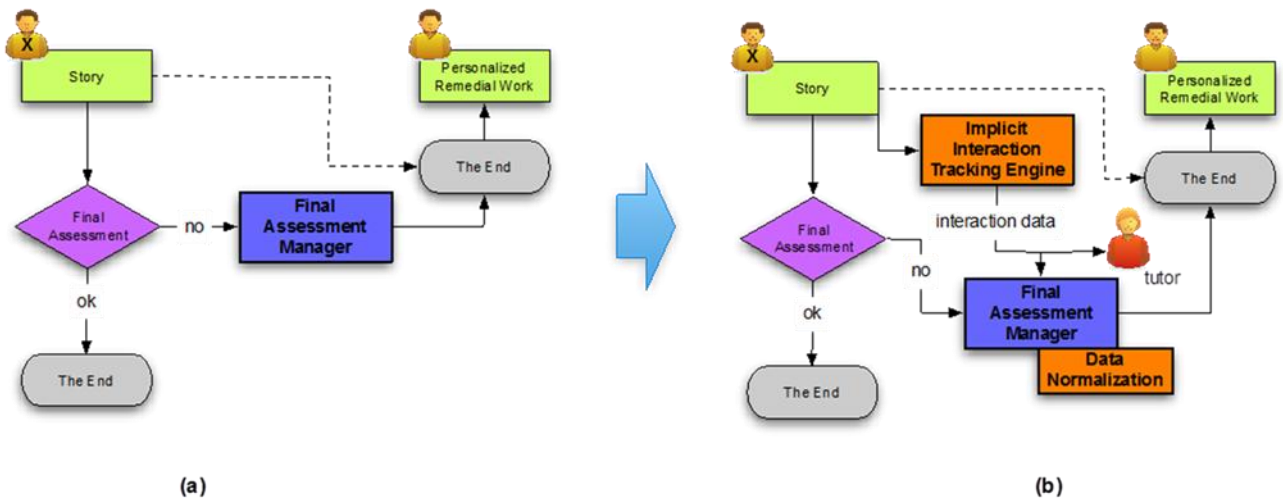


Figure 4.3 summative assessment (a) enriched from implicit assessment flow (b)

4.4.1 Implicit Assessment on Individual Narrative Paths and mediation of final mark

In the first version of the storytelling model the activities related to the in progress educational assessment, exclusively influenced a possible addressing of the student to one of three remediation paths (micro-adaptivity

level A,B,C) designed and linked to a range of detected knowledge. In consideration of the results and the type of path followed by the student in order to normalize or let this account for the final mark, it is advisable to act as follows:

Scenario 1: completion obtained using more A type micro-adaptivity Micro-adaptivity A is usually suggested when the student reaches not optimal knowledge levels: in this case the student is (automatically) suggested to improve his/her knowledge level through a situation characterized by a different media mix, able to valorise diverse learning styles (from time to time the media mix can enhance video, audio or text components or also collaborative / kinaesthetic aspects).The number and type of paths followed by the student (number /type of micro-adaptivity) should be considered to re-modulate and intervene on the final mark. The first thing is to assign to this first level micro- adaptivity path a weight, minimum but necessary to differentiate this path from another one whose first level situations is more linear and allows to always obtain optimal results in intermediate assessments. The idea is to multiply the result obtained at the end of the story by a weight ranging from 0 to 1 (excluding 0 and 1). For example in this case, having traced A type micro-adaptivity paths, the final mark/score could be multiplied by 0.9 (that is, 90% of the result).

Scenario 2: successful completion with one or more B Level micro-adaptivity Micro-adaptivity B refers to a cognitive gap greater than the A level, such a gap is always detected by means of assessment events of every situation. The student is suggested to review the same situation in a different context so that this use may help him/her activate process of generalization and recognition of some concepts and rules that can be applied to similar cases. It can be assumed that, if the student has completed the story following some situations through new contexts (micro-adaptvity B) to fill some cognitive gaps, this may have an influence on the re-modulation of the final mark. The idea is to multiply the obtained result by a weight ranging from 0 to 1 (excluding 0 and 1). For example in this case, the final mark/score could be multiplied by 0.8 (that is, 80% of the result).

Scenario 3: successful completion obtained using a C Level microadaptivity

Micro-adaptivity C is related to high knowledge gaps and to a student's addressing to reviewing the story through a new point of view, which takes better into account the detected emotional state (reference is made to the integration of emotional component). If the student is allowed to understand concepts and procedures behind specific situations from an alternative viewpoint, he/she is also given greater chance to overcome cognitive gaps of a higher level than those faced in the previous situations. It can be assumed that having passed the story using more C type situations this might have an influence on the final mark. That is why obtained result can be multiplied by a weight ranging from 0 to 1 (excluding 0 and 1). For example in this case the final mark/score is multiplied by 0.7 (namely, 70% of the result).

Scenario 4: completion obtained using one or more micro-adaptivity but only used after facilitated assessment tests

The facilitated assessment is seen as an element that can provide additional help when the student who has already completed the remedial experience at the different levels possible, is still not able to overcome the situation. This modality may mean that the student could not have overcome the gaps he/she had but only guessed the solutions and correct answers thanks to an easier representation of the questionnaire. In this case, if the event had occurred once over the whole story, this does not create any score modification, which is anyway already lowered in consideration of the used micro-adaptivity (this assessment indeed always comes after completing one of the three remedial micro-adaptivity). If instead this facilitated assessment happens more than one time during the same SCLO, then this factor will influence the final mark/score. It is possible to multiply the final mark/score by 0.9 basing on the result already lowered by the specific micro-adaptivity.

4.4.2 Logs Analysis For Detecting Student's Predominant Behaviours

In this case, the focus is on implementing what it can be called a *Learnogram* (namely a graphic representation only available to teacher, a teacher's view detailed on some key parameters) that will allow the teacher to visualise besides the standard flows, also additional behaviours to "communicate" important information on the way the student is approaching the didactic experience:

- ***Between-Patch processing***: this term refers to all the times the student quits the storytelling study session, but keeps moving within the didactic environment, and re-accesses the study session in a later

time, starting from the point he/she had quitted the story before (having the system recorded his/her path status). This parameter could give the teacher a measure for the student's attention and motivation in attending the experience continuously.

- **Set of Behavioural Indicators**

  - *stop and restart:* if the number of "entrances" and "exits" to/from the resource is high, it allows to assign a value to the student's study continuity and interest shown towards the targeted study topic.

  - *Achieved learning level (after a number of entrances and exits):* this data allows to understand (guess) if the student 1) has taken advantage of the exit time for an in-depth study of some concepts as an individual activity and to carry out possible self-assessment 2) or if he/she has simply abandoned the resource, and when comes back, experiences a missed activation and a loss of context which put him/her in front of accumulated gaps

From the calculation of the two parameters, it can be possible to award the student for the constancy he/she had or to ask him/her for a greater continuity providing tutor's help seeking.

- ***Within-Patch processing**:* this term refers to the student's involvement and sensitivity towards the course subjects (giving proper value to things to be learnt).
  - **Set of Behavioural Indicators**

    - *Inserted comments/memos/tags to the resource:* they measure the deepenings.

    - *Use of deepening resources:* precisely, through available links.

    - *pacing:* namely, the student's concentration measured by the time of permanence on learning events.

In fact, indications like: the number of times the student visits a specific "event" rather than others, if he/she takes deepening resources opportunely created inside each situation, or if he/she shows taking time in line with the average time needed for the learning, estimated by the teacher in the design phase, can accurately measure both student's attention and activity.

- ***Receiver Type:*** this indicator allows to detect the user style (*auditory receiver, visual receiver or kinaesthetic receiver*) and the most suitable media mix that micro-adaptivity A must have.
  - **Set of Behavioural Indicators**
    - Time of permanence on scene with predominant media
    - exploration levels (exploration of deepening links or theme links) of scene with predominant media
    - Learning levels achieved in relation to the above two points.

For a visual style (visual- linguistic or visual-spatial) it will be advisable to re-address to alternative situations in which the media mix is more prevailing into the visual side (images, texts, videos), while for an auditory style it will be better to re-address the path to situations with prevailing spoken texts, reading aloud activities done by the student, podcasts, and finally, for more kinaesthetic styles it is good to rely on structures that present a demand for student's active actions so to keep his/her concentration and interest high.

- ***Strategies utilized to perform the tests:*** a fourth traceable element to implicitly assess the student is concerned with the understanding of "strategies" that the student applies to face moments of intermediate assessment (that is, moments included into assessment events of the six situations). By studying and adopting "best evidences" of recent sector studies, three big strategies can be used to complete a test:
  - **Set of Behavioural Indicators**
    - *Single Phase*. This strategy consists in one phase only. The time available to complete the test is managed in a way that it is possible to view all the questions in a sequence order and only one time. The student in this case tries to think of a question for an adequate period of time, sufficient for him/her to give an answer to it in the most cases.

Other later phases than the first one can be found but with a negligible duration and no responses.

- *Active Revising.* This strategy is made of two or more phases. The student intentionally visualizes all the questionnaire in the fastest time possible. The remaining time is used for one or more revising phases. Initially, the student does not provide any answer to questions for which he/she has doubts, skipping and leaving them to be done in the following phases. As a general rule, the first phase is also the longest, in fact the following phases have a decreasing duration.
- *Passive Revising.* This strategy is composed of two or more phases. The student visualizes and answers all the questions in the shortest time possible. The remaining time is used for one or more following revising phases. As a general rule the first phase is the longest, since the following ones have a decreasing duration.

The research has shown that in case of Passive Revising there are lower and more superficial learning levels. The alert could cause the teacher to warn the student to use more suitable models through which they can cope with the assessment phases.

4.5 Collaborative Assessment for Storytelling: recall in emergency context

In recent years, collaborative storytelling in multimedia forms has also received considerable attention because can facilitate students to construct meaning and attain understanding about a story (Verhallen, Bus,&de Jong, 2006). In addition, students are motivated to engage in creating stories collaboratively with the combination of visual and verbal narratives.

Many educators have emphasized the importance of collaborative storytelling in many learning domains. Examples like StoryBuilder (Antle, 2003), Kidpad (Hourcade, 2008) and FaTe2 (Garzotto & Forfori, 2006) have developed environments which facilitate students to create fairy stories in the form of picture books. Students can be attracted and encouraged to elaborate their collaborative storytelling, using social media platform that to create and exchange user-generated content (Kaplan & Haenleina, 2010).

As social media can expand worldwide participation of collaborative learning in these domains, understanding how to use social media to enhance student's collaborative storytelling becomes an important issue. Social media can take many different forms and cant to facilitate a community of storytellers to write stories in collaborative way (e.g Storybird[12] is multimedia-based social media designed to facilitate students to collaboratively create stories with texts and pre-made pictures). Following a storyline one student may focus around a protagonist in a narrative thread, and then passes the story on to the next writer for further additions or modification. Hence, such stories are created in a *linear approach* which is widely applied in many social media.The linear approach may have limitations when it comes to facilitating positive inter-dependence.

The *hypermedia approach* can enhance collaborative storytelling in social media and that enhancement can be achieved by *facilitating the collaborative process*, *enhancing peer support*, and *ensuring a sense of authorship of the stories*.

- **Facilitating the collaborative process**: The results of recent study reveal that to use social media can affect a child's tendency to apply creativity during collaborative storytelling (Knobel & Lankshear, 2008). Such results suggest that the social media supporting collaborative storytelling should reduce student's anxiety and enhance their sense of the safety of their personal stories, thus encouraging them to apply these two strategies in collaborative storytelling. The hypermedia approach, which preserves the original stories while others can remix the stories with their own to generate new stories, can encourage students to apply and accept such strategies in generating creative stories.
- **Enhancing peer support**: Peer support is critical in the creativity process of intelligent work (Fischer et al., 2005). However, the results of this study indicate that students may face a heavy cognitive load in aligning their ideas with the stories developed by others when they are only allowed to work on a shared story. This may prevent students from providing constructive support which may help others develop their stories. The

[12] http://storybird.com/

hypermedia approach, which allows multiple storylines with the node-and-link hypermedia storyboard, is more flexible than the linear approach and thus can enhance peer support during collaborative storytelling.

- **Ensuring a sense of authorship of stories**: different designs of social media can influence the sense of authorship of stories for originators and remixers who use others' stories to build their own stories. Remixers and other contributors also share the authorship and are listed among the authors of remixed stories. Such an approach can facilitate participants in perceiving a sense of achievement in subsequent value-adding activities applied to original stories.

Collaborative storytelling often takes place in a co-narration form (Norrick, 2009) in which participants communicate and exchange ideas developing interaction and self-expression abilities (Craig, Hull, Haggart, & Crowder, 2001).

4.5.1 The Roles of Peer Collaborative Storytellers

In the following sections, we look at previous research on the roles of collaborative storytellers, their speech acts, and their turn-taking behaviors. Literature identifies (Preece, 1992; Ryokai, Vaucelle, and Cassell 2003) specific co-writing roles, such as *critic, author, facilitator, collaborator, co-authors* that the students can take to produce coherent narrative structures sing a dialogic strategy. **Speech acts** are used by storytellers to carry out their various functions and responsibilities within their roles, and can be categorized by their communicative functions.

In the Table 5 We illustrate the communicative functions of each speech act with examples found in Ryokai, Vaucelle, and Cassell (2003), and we explains the means for each act according to the roles for which they are used. Participants involved in this form of storytelling can interact with others to generate ideas that constitute a story. Specifically, participants can go through a remix process in which new ideas are derived and combined with existing ideas (Knobel & Lankshear, 2008).

Table 4.5 Collaborative speech acts

Roles	***Speech act***	***Function***	***mean***
Critic and author	*Suggest*	*To suggest an event or idea to the story*	*suggestions are made by the critic to the author, and usually occur when the author is hesitating.*
	Correct	*To correct what's been said*	*critic's corrections to authors are often unsolicited, and occur when critics dispute a certain aspect of the narration.*
	Question	*To seek clarification or missing information*	*usually unsure about an aspect of the author's story, and is looking for clarification or supplemental information.*
	Answer	*To clarify or supply missing information*	*the speech act that answers the question by providing the information requested*
	Acknowledge	*To acknowledge a suggestion or correction*	*collaborators use this speech act to show acknowledgement.*
Facilitator an Collaborator	*Direct*	*To suggest storylines and designate roles*	*the facilitator explicitly coordinates the story or casts play characters. The language used to propose or elaborate play ideas by speaking out of character is called meta-narrative*

	Acknowledge	*To acknowledge a role designation or storyline suggestion*	*collaborators use this speech act to show acknowledgement.*
	Elaborate	*To narrate following suggested script*	*the facilitator or the collaborators can elaborate by supplying details to the story.*
Co author	*Role play*	*Play the role of character in the story*	*learner co-construct a narrative through their play characters*
	Simultaneous turns	*Compete for turns*	*Learners are competing for the turn, and may result in both learner speaking concurrently.*

Thus, several projects, such as Kidpad (Hourcade, 2008), TellTale (Ananny, 2002), POGO (Decortis & Rizzo, 2002) and Storymat (Cassell & Ryokai, 2001) provide collaborative platforms that enable participants to develop persistent artifacts together through which they can express, share and reflect upon stories. With the support of such platforms, students exhibited more sophisticated use of discourse connectives and story event language (Ananny, 2002).

4.6 Collaborative storytelling for recall emergency

Stories are great vehicles for wrapping together many elements of knowledge (explicit and tacit knowledge) and a very powerful way to represent multi-dimensional concepts. While a certain amount of knowledge can be reflected as information, stories hold the key to unlocking the vital knowledge, which remains beyond the reach of codified information Collective stories, i.e. stories told by groups of people can be a good way to reach consensus, to add alternative descriptions, and to discover hidden details that can be a significant contribution when designing processes or practices that able to act in specific situations associated with particular contexts. This is also the case in *emergency management scenarios*, where incident prevention plans or correct actions list must be drafted and continuously revised and where it is important to recall complete information and the key facts. Group storytelling can aid the recollection of events and lead to reflection. Reading each other's contributions may trigger individual memory or lead to discussion. Group storytelling is a technique that involves the construction and retrieval of stories in which more than one person contributes, synchronous or asynchronous, locally or in a distributed manner, through one or more media. Knowledge generated by a group storytelling process is usually richer than that generated by the individual memory and the collaborative process discloses to the group different points of view, is stimulating and dynamic, and creates synergy among participants.

Contextualizing in emergency context the preparation of prevention plans depends on an analysis of incidents that have already occurred. The lack of historic information is the main obstacle to the realize the correct policies: essential knowledge, information of vital importance to the deeper understanding of the incident. A story of an incident usually contains uncertainties, gray areas and gaps. Subjective aspects, such as human emotion and cognition must be considered. Therefore, their perceptions of the incident must be retrieved. This is tacit knowledge, which is frequently hard to obtain. To create an accurate account of events that happened, it would be useful to give a voice to the actors. For that reason, we adopt a group storytelling technique to acquire stories of past incidents, to help the development of prevention plans. When members of a response team have the opportunity to talk and argue among themselves during the process of recounting the story, the resulting knowledge is enriched by the different views of each group member and the vision of the group as a whole.

The group storytelling approach has been used in some previous works *(Santoro, 2006).* **TellStory** (Santoro, 2006) is in fact a set of web based applications that support the group storytelling metaphor. It implements categories of fragments and different forms of associations between pairs of fragments as previously described. The tool allows a group to tell a story through the contributions of each one of the members. Any registered

member of TellStory can create a story and invite new participants. An individual can participate in the story by performing one specific role (e.g. *moderator, commentator, teller*..). In TellStory, each user can insert a fragment and categorize it according to the aforementioned categories. Possible actions during the construction of the story are: inclusion, edition, union, and division of fragments. Figure 4.4 shows a flow of fragments in chronological order on the right. A template guides the elaboration of the story using features of narrative structure.

The application of the group storytelling technique shows that it is useful both for knowledge elicitation and that it can be adapted for particular domains, yielding useful results for the elaboration of incident prevention plans. Those involved in the incident will be able to record the experience close to the incident time and those responsible for drawing up prevention plans may in turn see a rich knowledge base of information that will help them build better plans. For that reason, in Storytelling Design model, we think to integrate a collaborative dimension to support the Knowledge achievement and critical thinking abilities, *competence in action*, in civil emergency situation.

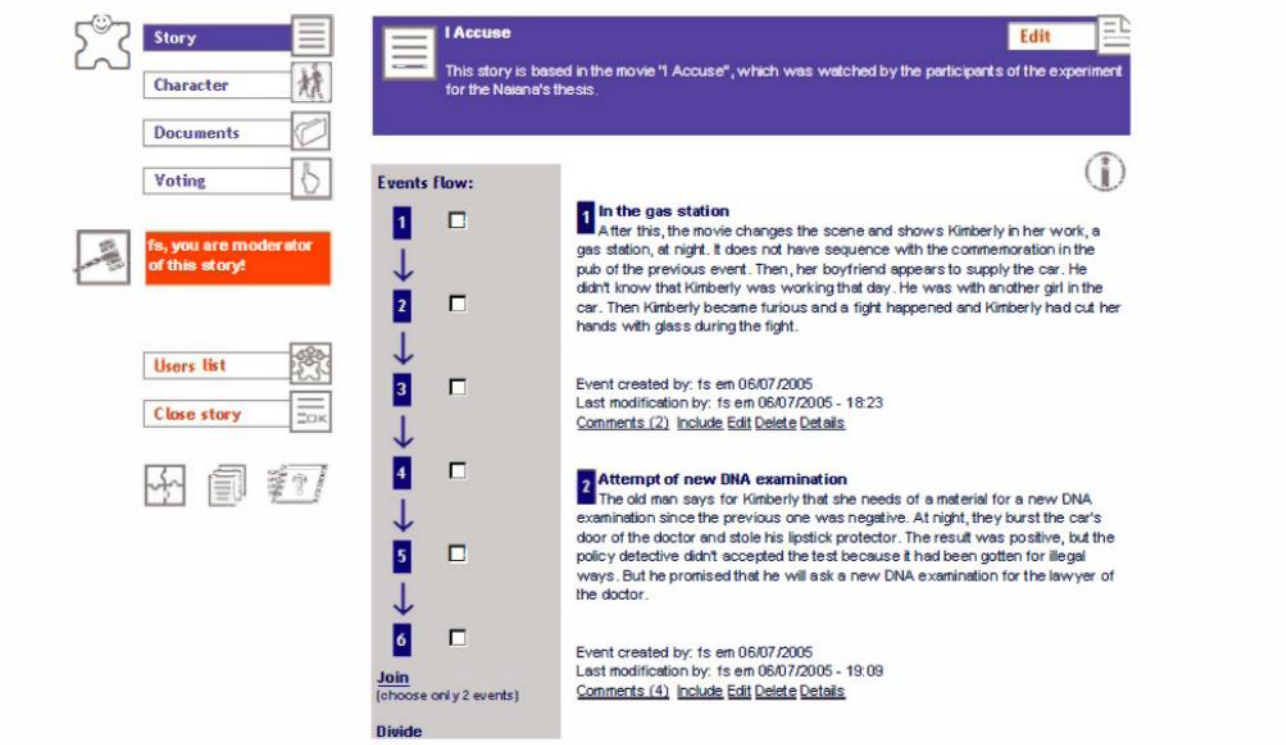


Figure 4.4 TellStory (Santoro, 2006)

The learners have the opportunity to talk and argue among different roles during the process of recounting the story. The resulting knowledge is enriched by the different views of each group member and the vision of the group as a whole. A teacher orfacilitator participates to help the dynamics and has little interference in the process, but telling of the story is the responsibility of people involved in the incident or emergency.

4.6.1 WikiStory for role making in storytelling complex learning object

The purpose of this work is to define an approach that may allow a group of students coordinated by a teacher, to review/relive a story using Wiki as a an environment for collaboration, communication and description of the story itself. The Wiki for Collaborative Storytelling has the scope to assess students. The approach includes the possibility for the students to choose their own role (role-making) and with this to relive the story; prerequisite to this, for every student, is that they need to have beforehand experienced the digital storytelling, according to the ALICE project modalities, and reached a social space where to recall the fundamentals of the didactic resource in a more participated and assessable way, both by the student and the teachers themselves.

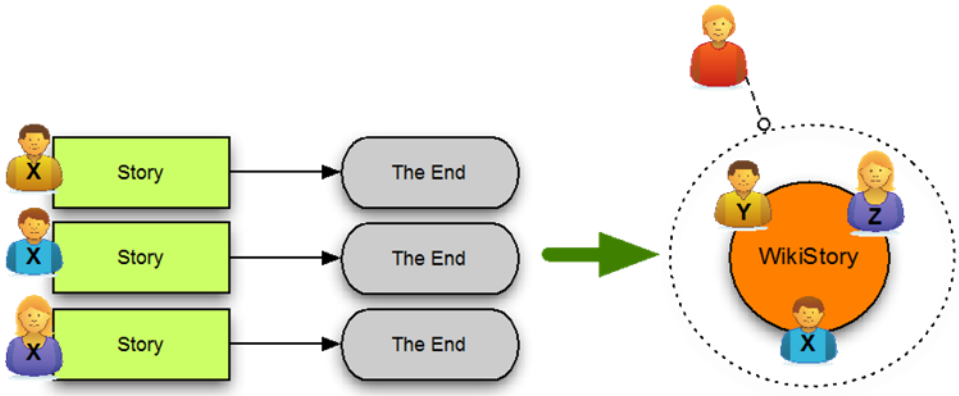


Figure 4.5 wiring wiki story

Wiki has a very simple structure, essentially consisting of pages and links between pages and a community of users able to collaboratively contribute to the document by writing texts, defining new pages and defining new links. The proposal is meant to classify the pages (or sections of a page) of the Wiki into items that represent key aspects of a story:

- State/Situation
- Event
- Object
- Environment
- Action
- Archetype/Role
- Statement

A **State** is defined by a Wiki page. The link between one State to another represents a passage, and therefore the chronological evolution of a story. A State is a photographic representation of the story. The story itself can be represented through a set of States and admissible transitions between them. A story necessarily admits one Initial State that should specify problem and initial situation, and one Final State in which the problem or mission has been completed.

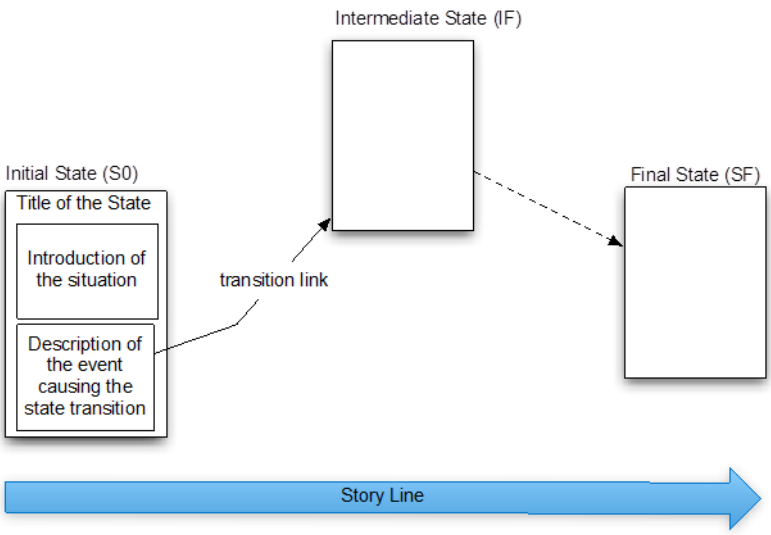


Figure 4.6 Performance of the Story and State pages

An **Event** is a section of a State page and contains the link to another State. An Event can be of two different types:

- **Discursive Event**, composed of a text which includes inside some links. Typically this type of Event is arranged by the teacher, but it can also be left incomplete for one or more students;

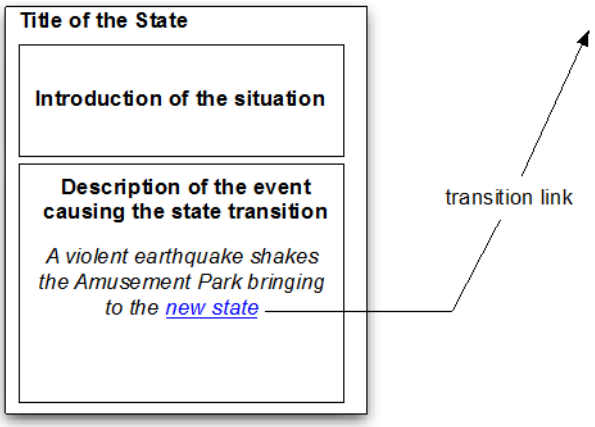


Figure 4.7 Descriptive Event and Link for the State Transition

- **Structured Event** composed of a sequence of Statements, each one provided by one of the participant (teacher or students), it can be pre-schematized by the teacher to be completed afterwards by students. The last Statement of the sequence corresponds to a change of State, that is, to a link that guides to a State page.

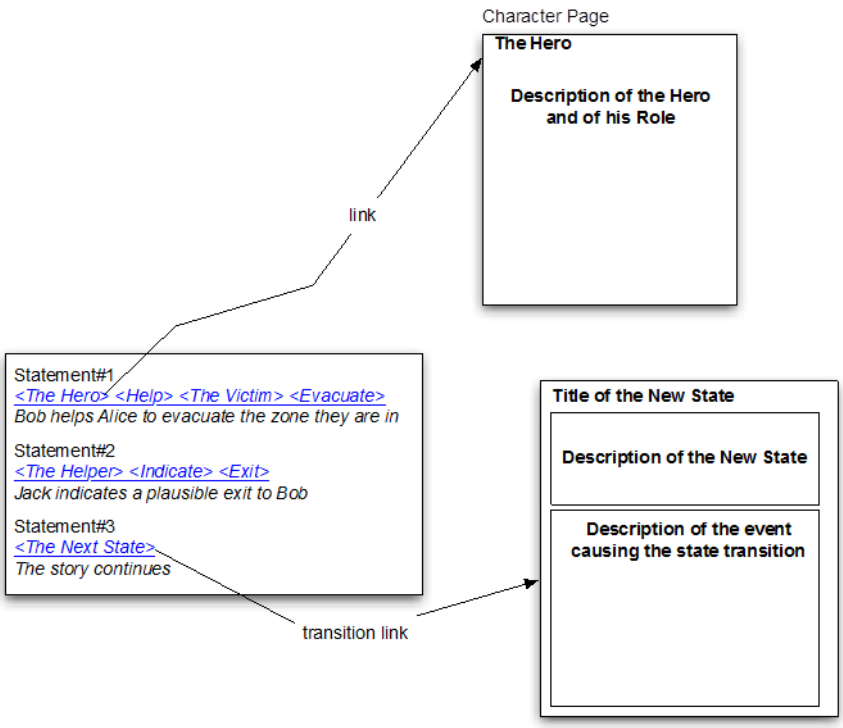


Figure 4.8 Event structured through Statements

A Statement is a tuple whose terms represent links to other Wiki pages. A possible structure is the following <Subject, Action, Target, Description Text>:

- The Subject corresponds to the Character who does the action, Typically the teacher agrees the Statement with the fixed Subject, in a way that the user who impersonates that role is able to define action, object and description of his/her action. As a matter of fact, with respect to the Wiki, the Subject is a link to a Character-type page.
- The Action corresponds to the action that the Character (Subject) does. On the Wiki, an Action is a link to an Action-type page.
- The Target corresponds to the Object of the character's action (Subject) and can be, in its turn, an Object or a Character or a Place, etc. On the Wiki, a Target is a link to a page of Object, Character Environment type, etc.
- The Description Text is a textual description of the action told in the Statement. It is mainly used in dialogues between Characters.

There is a very particular type of Statement that allows State transitions. The Statement belonging to this category presents the following order: <Current State, Transition, New State, Text> (in Figure 3 the Statement is represented by this order <The next State, Textual Description>).There is also another particular Statement with this order <Subject, Action, Target, With, Object> that requires the use of an Object to complete an action.

The admissible structures for statements can be defined by the teacher and be indicated to the students through the use of simple templates.

- An Object (e.g. fire extinguisher, car, etc.) is represented by a Wiki page thanks to a textual description and possible links that help to better specify complex objects. The object description can include indications and rules on actions that the user is enabled to do on it.
- An Environment is a Wiki page showing through a textual description an open or close space, more or less big, and the actions possible to be done on it.
- An Action is a Wiki page with a textual description, which illustrates the meaning of the action and perhaps objects and environments on which it is possible to perform such an action.
- A Character is a Wiki page with a description of the role interpreted by the specific Character.

Other possible types of pages can be: Groups, Atmospheric Phenomena, etc. that may be, in turn, referenced in the Statements. The types of pages vary according to the story. From the dynamic viewpoint, the WikiStory foresees two phases: preparation and execution. **In the preparation phase**, teacher prepares a set of States (including Initial and Final ones), together with possible Actions, Objects, Characters, etc., by arranging the Wiki pages and setting the story through the creation of links (using events modeling and preparation of Statements not completely valorized).**In the execution phase**, students choose their roles and, as a consequence, a color in the Wiki which allows the teacher to continuously monitor the students' work. The contribution of each student will be realized by living the story starting from the Initial State, and trying to execute (coordinating themselves with others) the right actions (that is, completing the assigned Statements) to let the story transit from the Current State to the appropriate New State. The dynamic of student's and teacher's intervention is depicted in Figure 4.9.

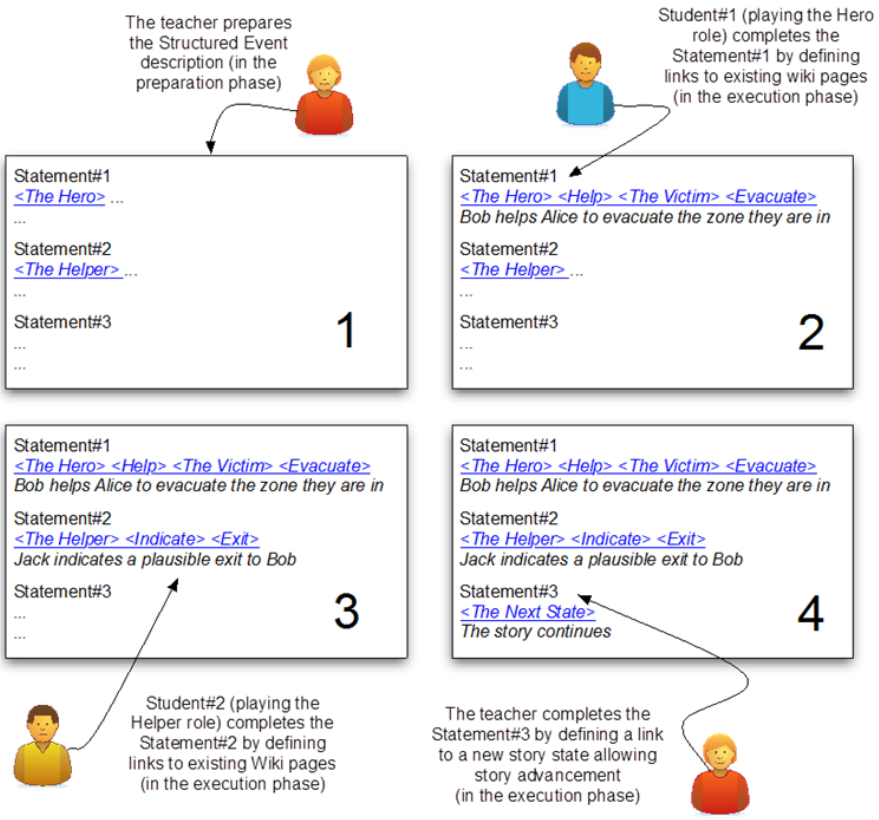


Figure 4.9 Participants contribution to the story

The teachers will have to arrange the Wiki with story elements and also partially set the Statements for the foreseen events. The teacher, asking the students divided into groups to impersonate a specific role from a previously defined list. The learners participate by rewriting key events and act on these events in accordance

with their roles. The correct interpretation of the role provides helps to measure the story consistency, defined in a participated way, and in particular the acquisition of specific knowledge. As soon as the Statements are collaborative completed, the story takes its shape and the Wiki grows, linking one after another the pages of Actions, Environments, etc. The same teacher will be enabled to assess the behaviour of every single role and the story progress and collaborative efforts.

The collaborative story wiki will aggregate all the feedbacks presenting analytical reports which are useful to the assessment.The CO-Wiki, scientific output of WP5, a wiki system opportunely created for the peer-assessment, and experimented in the first year of the ALICE project, could be the solution, if further customized, to support the (collaborative) process of knowledge elicitation in case of emergency call (e.g. seismic event at the amusement park). Looking at the Co-Wiki it is possible to paraphrase its structure and contextualise it to the group storytelling**,** so to make it become a final element of the storytelling resource able to significantly evaluate the learning achieved through complex but individual experience**.** The individual learning indeed, allows to absorb and build the first knowledge structures. The participated space allows to share and reflect through different perspectives and to consolidate the knowledge, going back to some procedures value and to causes and effects linked to the presence of various elements or actions of the story.

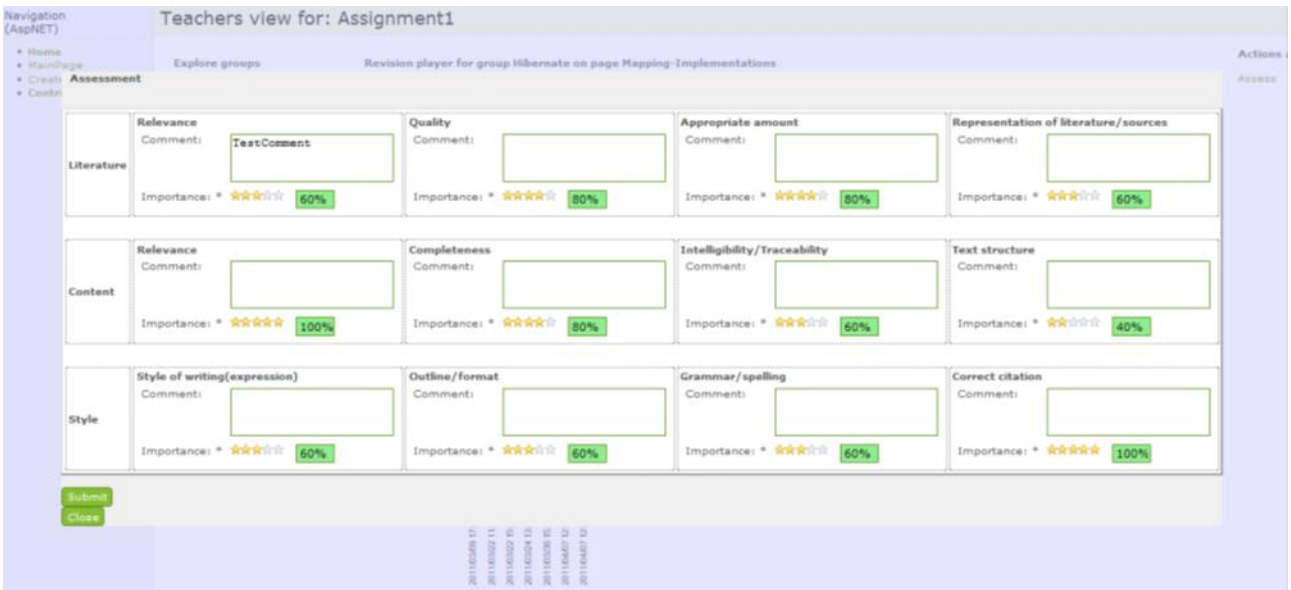


Figure 4.10 Co-Wiki (outcomes of WP5) to be adapted for StoryWiki

Teacher creates a TEST that in the case of collaborative storytelling becomes a Story, and associates an assignment, that is a task (the reasoned participation into a series of events composing the story) and a time within which the students are asked to define some of the story states. In the context of Co-Wiki, the students will have some tools helping him/her to manage:

- **Action feed**: interface for presenting all the actions of the users group that in case of a participated story should be in terms of: edited texts (added, removed) from role X into event Y, action taken (link) from role X for event Y, as for roles and links). These actions should be automatically extracted from student's interactions while he/she by covering a specific role may perform, in order to describe events that the different story states present.
- **Online peers**: interface for showing groups (i.e. different roles per groups) working on that specific story. Actually an assignment can be associated with more work groups in the same period of time.
- **Contribution charts**: interface for visualising a graph representing the number of events into which the specific role has taken part and with related weights (in terms of actions functional to a correct evolution of the story).

The teacher can have, from the Teacher View page, an integrated view of all the information relevant to evaluate how well the story is proceeding and if it fits the right structure he/she had imagined. The Teacher View, adopting the Co-Wiki structure by TUG should be made as follows:

- **Group navigation**: the teacher can visualise the status of completion of assignments linked to each group participating in the collaborative story. In this way the teacher can advance the writing activity.

- **Revision player**: the tool already available, can be used for the visualisation of roles, and not colored texts, that have taken part into the text structure as a slide show.
- **Action list**: is defined as a series of actions that the teacher can undertake as a judgment tool to assess the matching level between single role and story building and also the group work for each single event one has taken part in.
- **Useful information:** these are detailed information related to the collaboration of one or more roles in a sequence of events, so to have a framework about who may actually influence the story performance and about the level of internal dynamism.
- **Chart panel**: the information can be represented under a graphic form.

Each user who impersonates a role in the story can assess himself/herself with respect to actions performed in every event and, at the same time, can assess actions of other roles with whom the students interact inside different events related to a state. The teacher can also assess a specific assignment, providing a judgment about some properties able to give a qualitative dimension of the co-participated work.

In this case, it needs to use the Rubric offered by Co-Wiki and change some of the dimensions basing on which the teacher can do the work assessment, so that they may be more consistent with the story writing and the creation of cases based on those roles that guide the evolution (role consistency, interaction, significance of actions, story consistency, learning shown on emergency issues).

The teacher, from the Teacher View, will have the possibility to close the story once he/she has evaluated the completion of assignments. The evaluation in this space will mediate the result obtained by the complex didactic resource or be simply seen as an activity more or less instantiated in relation to the student's progress during the storytelling path. The progress in terms of learning and achieved knowledge levels can ask for the necessity of adopting the role-making to obtain a more robust and mature knowledge with respect to the learning objects characterizing the SCLO.

5. Emotional Dimension for adaptive role taking

5.1 Wiring to emotion in storytelling

Building interactive narratives certainly represents a challenge in education and we believe that the emotions felt by the learner are of prime importance in producing compelling and engaging interactive and adaptive dramas.

Modeling student emotion has become increasingly important for computational teaching systems and emotion has been named as one of the twelve major challenges for cognitive science (Jenks, Springer, 2002). Human emotion is often defined as an *intuitive feeling* derived from one's circumstance, mood or relation with others. Teachers have long recognized the central role of emotion in learning and the extent to which emotional upsets can interfere with mental life. Student interest and active participation are important factors in the learning process. Students learn less well if they are anxious, angry, or depressed; students who are caught in these states do not take in information efficiently or deal with it well (Jaques, Viccari, 2004). Emotions can paralyze a student's ability to retain information about a task. Several studies have addressed emotions involved in learning. Human emotion is completely intertwined with cognition in guiding rational behavior, including memory and decision-making. Studies have shown that a satisfactory decision-making is impossible without emotion. It is widely accepted that cognition cannot be completely understood whether or not emotions are taken into account and that there are intense interactions between the cognitive and affective behavior.

The studies of Human Computer Interaction (HCI) applied to ITS (Intelligent Tutoring System) show the opportunity to develop and design methodologies that are pedagogically guided and which would handle the emotional / affective systems of learning (Jenks, Springer 2002). Affective computing and especially what has commonly been called *'affective learning'* is a young field where theorists and practitioners from several disciplines are contributing. To date there is no comprehensive, empirically validated, theory of emotion that addresses learning.

However, emotions associated to learning should be managed to maximize engagement, participation and effective learning. Despite various studies that showed strong influences of emotional state in learning, instructional designers tend to overlook its role when designing and developing instructional materials. This is mainly due to the lack of proper method or framework in linking emotions and instructions. Though limited, several emerging approaches such as FEASP (Astelitner, 2002) and ECOLE-approach (Glaser-Zikuda, 2005) have been introduced in order to facilitate instructional designers in designing emotionally sound instructional materials (especially computer-based materials) and instructions. Recently Emotional Design of Instruction (EDI), combine the fields of emotional and instructional design. We argue in this work for the necessity to design generative mechanisms that would allow a narrative system to reflect on the user's emotion state, and for this it's important to consider the meaning of interactivity of the student in narratives.

An interactive narrative system, from an emotional perspective, would aim in either identifying emotions from learner input (i.e. actions, plot event) and suggest a course of actions in order to reach such actions in a scenario along with the intended emotions; or analyze user input and drive the scenario creation from an emotional point of view, recommending the next emotion or set of emotions to aim for. The role of emotions in interactive narrative has also been discussed in literature and we believe that this topic is highly relevant to the research on interactive storytelling and interactive dramas. Whereas it is certain that progresses are being made in this particular field on the form of the interactive drama and on mechanisms adapted to user interventions, there are still many questions and issues unsolved with regard to the content of the drama.

The ALICE Project will explore the use of storytelling as a valid educational approach that introduces novel opportunities for supporting student problem solving and learning in specific contexts (e.g. civil protection training for huge risks). The digital story tales are interactive didactic elements, oriented to a student-centered teaching approach able to involve emotionally the student, provide guidance and make the reflection easier. This chapter discusses the importance of emotion modeling within interactive drama. This chapter describes the emotion mechanisms in storytelling design model and considers the possibilities to transpose these in regard to interactivity and microadaptivity logic. In storytelling template based system, it is an interesting prospect to indeed contemplate the possibilities to, at second iteration of the model, use authoring tools for the generation of

interactive narrative that would manage characters and story world creation in a similar manner in which authorial approaches are today undertaking research in the field.

Indeed, we argue for an active role of the students where they do not only receive the information from visual, audio and contextual clues, but instead interpret and understand the emotions and feeling of characters and personal contexts, while still being conscious if the impact of their own actions on the story flow. Our emergent narrative system focuses on making the transition between the passive role of a spectator and the active role of a character (role taking) In order to achieve success with such approach, one should regard to main research topics with interest. Particular interest should be oriented towards the way in which in the story flow we can, assess and process the emotions. The other important consideration in terms of emotion in regard to a character-based approach to interactive storytelling lies in the way user emotions are assessed.

More specifically, we are proposing that the SCLO should explicitly parameterize the emotion of the student and use this as a guiding feature for on-line construction of the story and take a new perspective for story live.

The introduction of interactivity into storytelling complicates the development of stories not only from a philosophical level, but also from an architectural and structural level. In most dramatic and narrative forms, the author has complete control over the structure of the story, i.e. the storyline or story arc. Although in the educational sector the story template of Movement Oriented Design (MOD) or Hero's Journey pattern (hero) paradigm has been successfully applied in previous research, different authors have experienced its incompleteness and limitations for learning context: a more specific and pedagogy oriented template is required for multimedia story creation.

We propose the extension of Interactive Storytelling beyond that of implicit emotional content to explicit structuring of the user's emotional experience at run-time. A SCLO template based on revisited SVP (by Ohler, 2009) aims to overcome the shortcomings of existing researches which mainly concern the lack of emotional dimension connected with the learning objective linked to specific step of story path and that ensures the achievement of learning objectives through an educational process based on the playful aspects of digital storytelling integrated with educational aspects related to role taking emotional based. More specifically, we are proposing that the SCLO should explicitly parameterize the emotion of the user and use this as a guiding feature for on-line construction the story. With the emotional experience of the user continuously considered, the story engine can better choose story segments in an attempt to maintain a cohesive narrowing of dramatic potential and manage the emotional journey of the audience.

5.2 Related Works

Human emotions are known to play an important role in the users' engagement, namely by activating their attention, perception and memory skills, which in turn will help to understand the story – and hopefully perceive, or rather "feel" it as an entertaining experience. There are several different approaches to adapt narrative to the possibilities of new media.

The notion of the narrative paradox characterizes interactive narrative as a compromise between authorial control over the story flow and the freedom of interaction allowed for the user. There are different approaches to addressing the narrative paradox, ranging from plot-driven to character-based approaches (Cavazza, 2002). Interactive Narrative relies on the ability for the user (and spectator) to intervene in the course of events so as to influence the unfolding of the story. This influence is obviously different depending on the Interactive Narrative paradigm being implemented, i.e. the user being a spectator or taking part in the action herself as a character. If we consider that the narrative experience can be essentially interpreted as generating various emotional states (e.g. tension) which derive from its aesthetic qualities (e.g. suspense), a logical consequence would be to analyse student's emotional status/reactions and use these as an input to choice a new flow in an Interactive Narrative system (Cheong, Young, 2006). Such an approach would actually constitute a "feedback loop" between an Interactive Narrative inducing emotions and the analysis of intensity of such emotions expressed by the user in order to intervene in the story.

EMA (Gratch, Marsella 2004) is a framework for modeling emotion that tries to be domain independent by harnessing concepts from appraisal theories of emotion. In EMA, coping is defined as inverse operation of appraisal, i.e., the identification and influencing of the believed causes for what has been appraised as significant in the current context. The main focus of development currently lies on extending the range of coping

strategies (e.g., “mental disengagement”, “positive reinterpretation”, “further assess coping potential”, or “planning”) as responses to emotionally significant events.

Another approach is used in Facade, where the proclaimed goal is interactive drama in a real-time 3D world. Fa¸cade Facade tries to achieve an interactive drama in a real-time 3D world (Figure 5.1). The user will experience a narrative from the first person perspective, taking the part of a long time friend of a married couple that invited her for dinner, an occasion where problems unfold.

Figure 5.1 Facade Interface

The goal of the project is a very rich interaction not only through dialog but also through embodied interaction. In Fa¸cade there is also a separate component, external to the story that arranges story segments (“beats”) into a coherent story. The characters themselves act autonomously, but adhere to the constraints of the currently established story context. **The ActAffAct** project, in contrast, tries to achieve a simpler but similar effect without external control. ActAffAct is designed taking the rather extreme viewpoint on the narrative paradox that external control can be reduced substantially without abandoning the claim of dramatically appropriate interactions. The crucial point is, to our mind, the reliance on emotional processes to provide the causal structure of action sequences. For our simple story-world we present a graphical representation of an environment inhabited by four agents, taking on the roles of narrative archetypes: a hero, a mentor, a villain, and a victim (Paiva, 2001) (Fig. 5.2).

The emotion modules are being developed as part of a complete authoring tool of interactive storytelling – INSCAPE (Zagalo et al 2006). Thus, we started assuming that in the virtual interactive storytelling of the future, virtual characters will play an increasingly important role, mainly because they represent the storytelling backbone in emotional terms. We also believe that to help raising characters emotionality and believability in interactive storytelling we’ll need to start by the behaviour modeling, It is the modeling of characters emotion experience that will help in making stories more believable, increasing drama and so the user emotion experiencing.

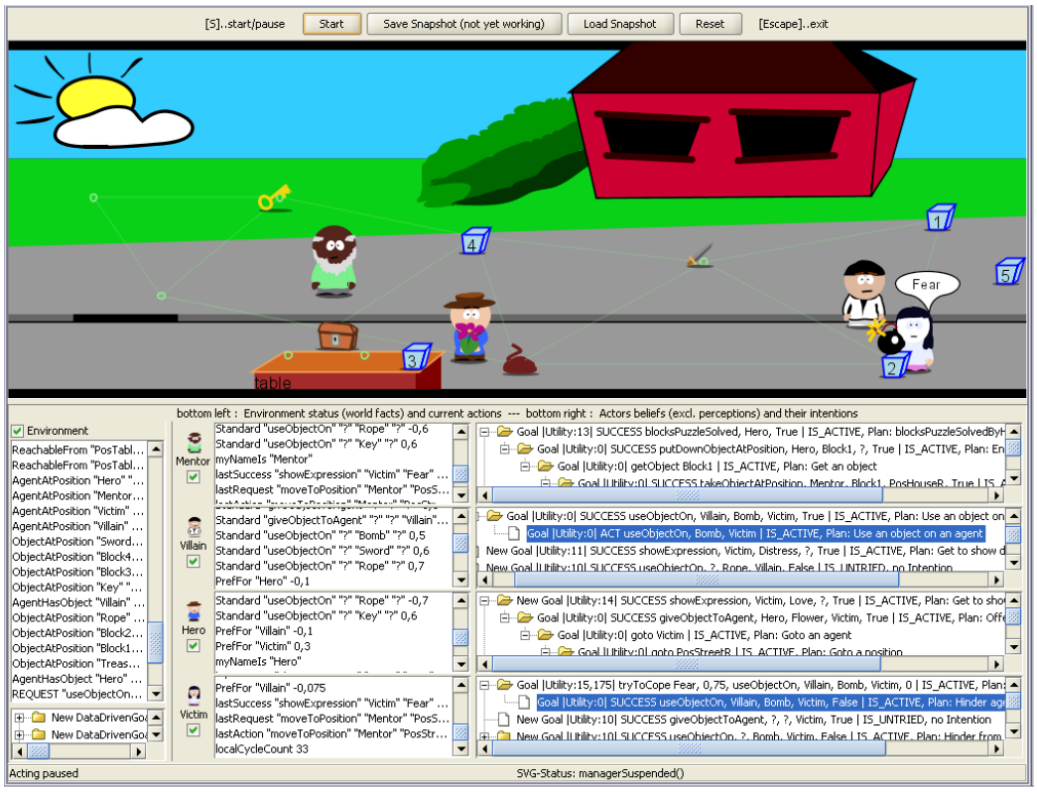


Figure 5.2 narrative archetypes in ActAffAct

Emotion Wizard (EW) it's an authoring module in INSCAPE that will enable authors to easily and quickly "emotionally" change the environment and characters. In practical terms, EW consists of a software module for the story design of "emotion cues" in real time for environments and characters focused on their dramatical impact.

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 Wizard will also be available during the story planning and prototyping phase, giving helpful suggestions about emotional possibilities on controlling lights and cameras, choosing colors or defining characters.

In most Interactive Storytelling systems, user interaction is based on natural language communication with virtual agents, either through isolated utterances or through dialogue. Natural language communication is also an essential element of interactive narratives in which the user is supposed to impersonate one of the story's characters. Whilst techniques for narrative generation and agent behaviour have made significant progress in recent years, natural language processing remains a bottleneck hampering the scalability of Interactive Storytelling systems. **EmoEmma** (Vogt 2006) introduce a novel interaction technique based solely on emotional speech recognition. EmoVoice identifies affect conveyed by the voice. It allows the user to take part in dialogue with virtual actors without any constraints on style or expressivity, by mapping the recognized emotional categories to narrative situations and virtual characters feelings.

This Interactive Storytelling system uses an emotional planner to drive characters' behaviours. The main feature of this approach is that characters' feelings are part of the planning domain and are at the heart of narrative representations. The emotional speech recognizer analyses the speech signal to produce a variety of features which can be used to define ad-hoc categories on which to train the system.

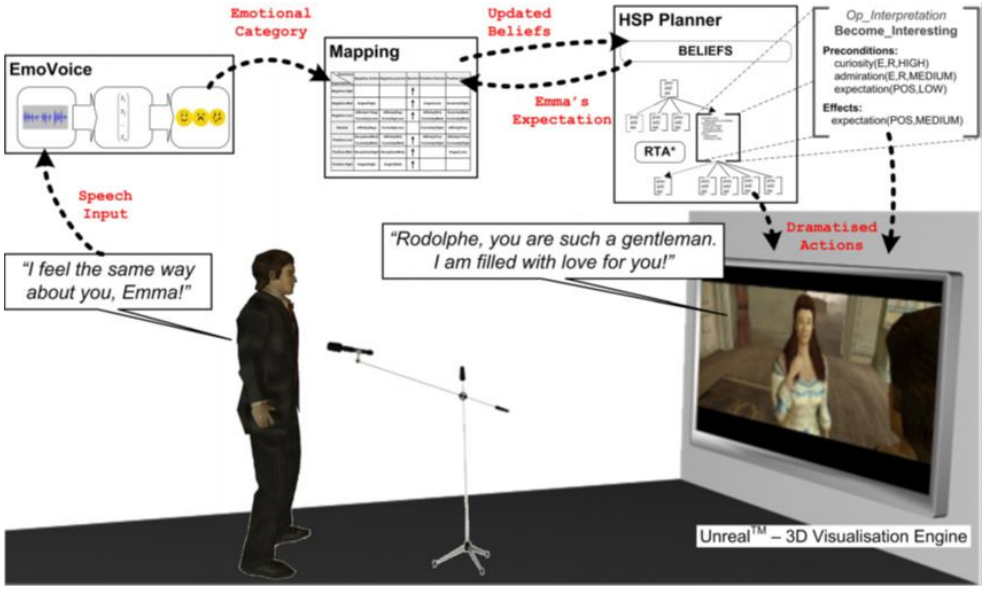


Figure 5.3 System Overview: the User Interacts with the Narrative by Impersonating Rodolphe

Several Interactive Storytelling systems to date have incorporated language interaction, whether the underlying paradigm was one of complete user involvement or user influence (Swartout, 2006). In the Callas project has been presented an integrated system for the Affective Interactive Narrative installation.

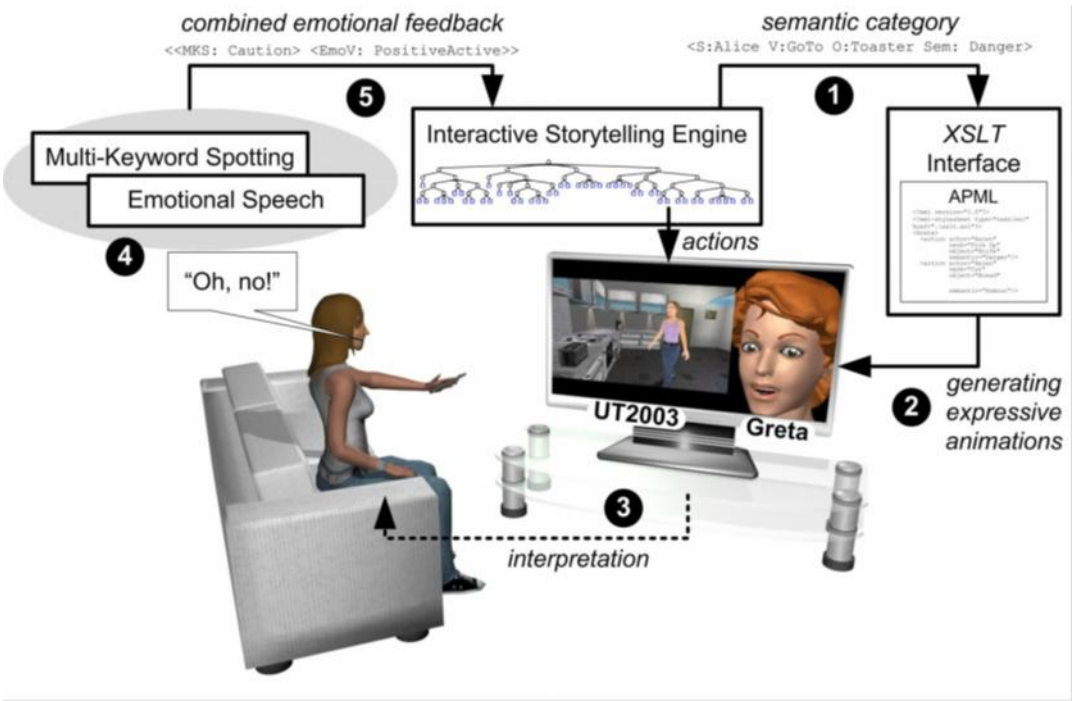


Figure 5.4 System overview illustrating the sequence of processes

The visualization component is drawn from the character-based interactive storytelling system. The system operates by generating narrative situations of various levels of intensity and tension, which are conveyed to the user via the additional channel of the expressive character (Wagner, 2007). The system then detects in real-time the emotional state of the user, in this first version mostly through its vocal reactions. Finally, the emotion detected is used as a feedback on the story generation system to reinforce (positive feedback) or slow down (negative feedback) the narrative tension of the generated story.

Papous (Silva et al 2001) is virtual narrator who reads a text enriched with control tags. These tags allow the storywriter to script the behaviour of Papous. There are four types of tags: behaviour tags, where a specific action or gesture is scripted; scene tags, that allows for Papous to change the scene where he tells the story; illumination tags, to allow a new illumination pattern of the scene; and emotion tags, to change the emotional state of Papous.

The texts, enriched with these tags, are then processed by Papous' different modules, which contain an affective speech module and an affective body expression module. The storywriter is free to use the tags as he pleases, but he should take in consideration the context of the story. For example, if the writer wants to emphasise a particularly scary part of the story, he should specify the appropriate emotional state.

The Deliberative Module receives emotion and behaviour tags and sends commands to the Affective Speech and the Affective Body Expression components. The emotion tags update the internal emotional state indicating which emotion should be changed and the new value that it must have. Internally, the emotional state of the character is represented by a set of numerical discrete values. Figure 5.5 indicates the thresholds established for the three emotions used for demonstration purposes.

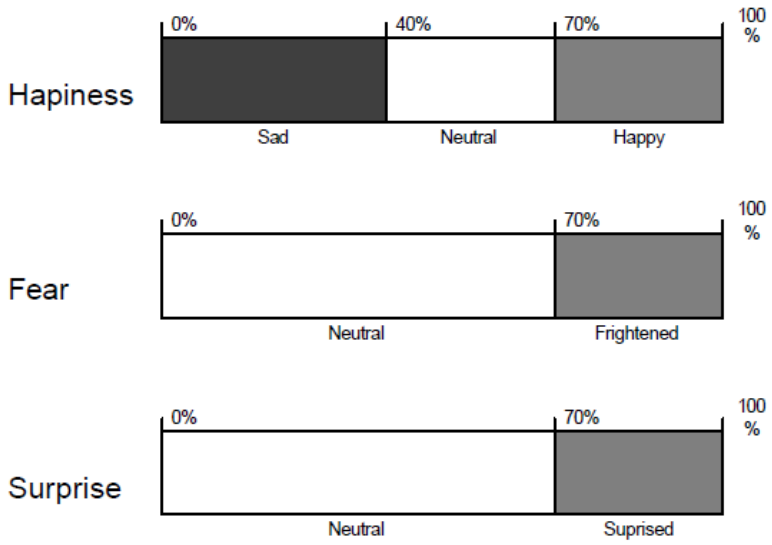


Figure 5.5 the thresholds established for the three emotions

The emotional state affects the voice and the behaviour of the character. Of course, other emotions and thresholds could be defined, and further divisions could be considered to provide a richer control over the character. The behaviour tags are associated to explicit gestures and result in direct commands to the Affective Body Expression component. To transmit emotions through the voice we established a series of relations between emotions and voice parameters based in theories of the interrelationship between speech and emotion (Scherer 2000). Figure 5.6 indicates which parameters should be changed in order to transmit the emotion we intend through the character's voice.

Emotion	Parameter	Action
Happiness/Sadness	Speed	Increase/Decrease
	Pitch Baseline	Increase/Decrease
	Pitch Fluctuation	Increase/Decrease
Fear	Pitch Baseline	Decrease
	Pitch Fluctuation	Increase
	Breathiness	Increase
Surprise	Pitch Baseline	Increase
	Pitch Fluctuation	Increase
	Speed	Decrease

Figure 5.6 Emotions / TTS parameter correlation

The Affective Body Expression component receives the current emotional state from the Deliberative Module and changes the character body in order to express the desired emotions. It can also receive commands to perform gestures explicitly indicated in the story (using behaviour tags). Papous use the body expression component provided by the SAFIRA toolkit [André et al. 2001]. This component is able to perform real-time blending between animations and body postures to convey the desired emotions. However, at the current state of development, the emotions affect only the face of the character. For demonstration purposes we considered two facial animations (happy and sad) that are related with the happiness threshold.

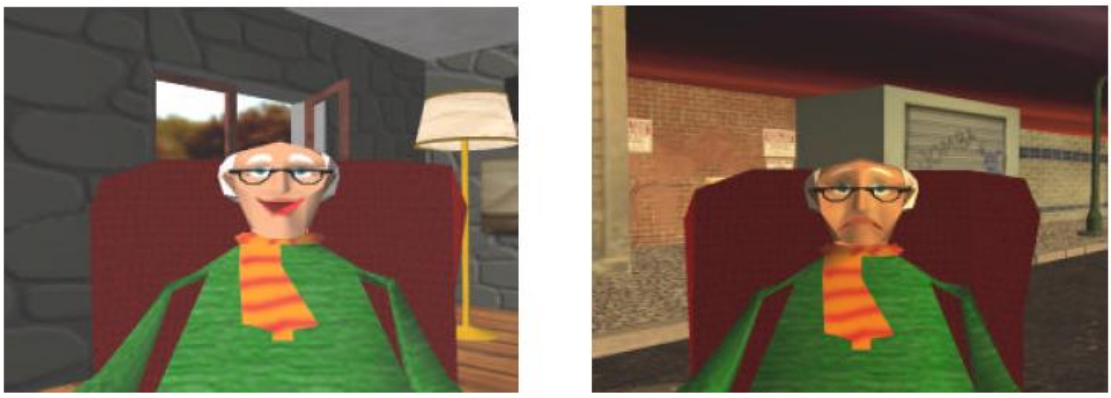


Figure 5.7 Affective Body Expression

The case of written interaction is slightly different and has been part of FearNot! (Fun with Empathic Agents to Reach Novel Outcomes in Teaching) (Louchart, Aylett 2004). In Fearnot! written input was interpreted in terms of speech acts used to influence or comfort the virtual agent. Façade adopted a theatre-like environment heavily based on dialogue, which maintained user interest high, through a strong integration of narrative representations to dialogue acts. The agents in the FearNot! Software are emotionally driven (Aylett, Louchart, 2003) and react or plan their next actions in regard to their dominant emotional state. Such an approach allows for the articulation of an emergent narrative approach and provides flexibility in regard to story articulation as envisaged in this particular narrative concept. reference to what has been mentioned already in this paper, we believe that for such a character based system to function successfully, and the agents need to be able to relate to each other emotionally. This particular idea is indeed at the centre of the FearNot! agent architecture and has been implemented in regard to the emotion definition presented by Ortony, Clore and Collins (OCC) (Alepis, Virvou, 2009)

By assessing and reacting on each other's action and reactions, the agents in FearNot! truly interpret their role in the same way an actor would interpret a character. Each agent is defined according to its role in the drama and its personality (i.e. emotional triggering thresholds) and is attributed a set of actions, goals and emotional reactions. These are developed and written in regard to the agent's personality and role.

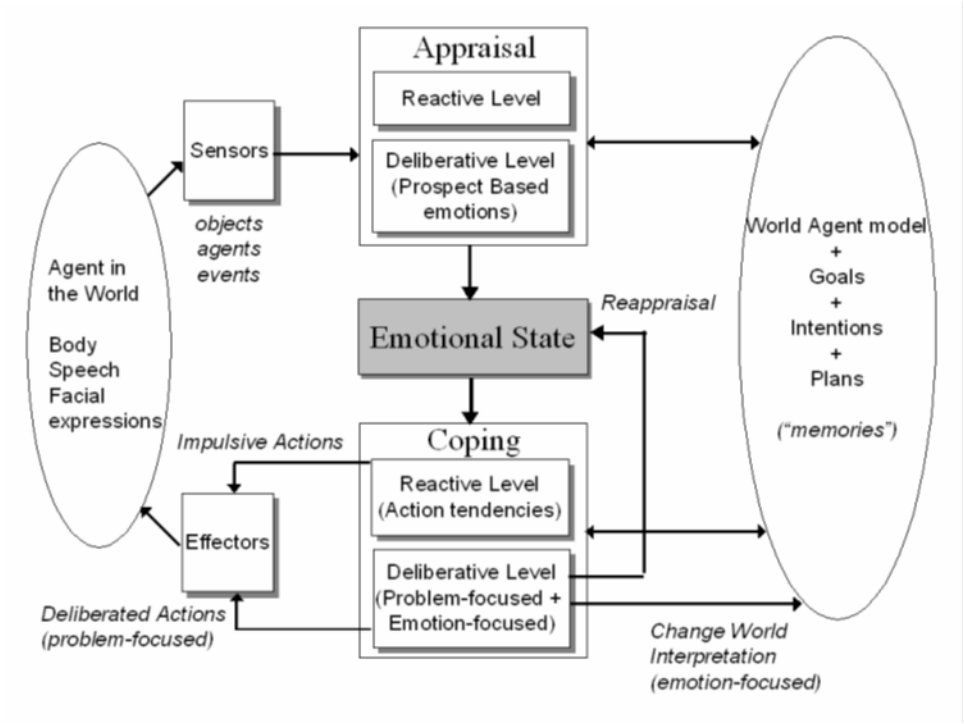


Figure 5.8 FearNot! agent architecture

The creation of empathy is seen as a way of involving the user emotionally in improvised virtual drama in an area of Personal and Social Education (PSE) and specifically in this project that of anti-bullying education for children aged 8-12. Thus, FearNot! features a virtual world inhabited by synthetic characters (that portray children) that act autonomously according to their goals and roles in the story. The roles can be ”bully”, ”victim”, ”bystander” or ”helper”. The users influence the development of the story by providing advice to the victim on what to do next.

Figure 5.9 Drama in FearNot!

Then, according to the users' answers the path of the story evolves, and in the end an educational message is given to the viewers. In Fearnot! written input was interpreted in terms of speech acts used to influence or comfort the virtual agent. The agent architecture developed for the project focused on the importance of emotions in regard to action-selection and decision-making mechanisms. The structure of FearNot! was inspired by the forum theatre approach in order to incorporate theatre into the development of political activism. In this dramatic form, an audience is split into groups, with each group taking responsibility for one of the characters in

the drama. Between episodes of dramatic enactment, each group meets the actor, who stays in role, and negotiates with them what they should do next in the drama, respecting the constraints of their role and character. This structure of dramatic episodes divided by periods in which advice can be given to a character has been adopted for FearNot!. The child user interacts with one physical bullying scenario and one relational scenario. After the introduction of the characters, school and situation, users view the first bullying episode, followed by the victimized character seeking rescue in the school library, where it starts to communicate with the child user. Within the initiated dialogue the user selects an advice from a list of coping strategies (shown as a drop down menu). The user also explains his/her selection and what he/she thinks will happen after having implemented the selected strategy, by typing it in.

Figure 5.10 Interactive interface in FearNot

However, alternative approaches have recently been proposed, one of them is the use of Tangible User Interfaces (TUI). The philosophy behind TUIs is to allow people to interact with computers via familiar tangible objects, therefore taking advantage of the richness of the tactile world allowing the users to interact with the computer in ways that are more intuitive and natural. SenToy (Paiva et al, 2003) , which detects a set of emotions that the user may want to transmit through a set of gestures.

SenToy was used to collect emotional data from users that were watching a story (Anderson et al, 2002). SenToy's components were integrated into the FearNot! application. Furthermore, as users were allowed to use SenToy all the results of that interaction needed to saved in a log file containing information about which emotions and in which part of the story those emotions were expressed with SenToy.

The results of the study show that SenToy can be used to understand how the viewers reacted to the stories portrayed, and at the same time that the emotions that were expressed with SenToy are indeed similar as the ones reported to have been felt by the users.

The ViewManager is responsible for controlling the scripted story displayed in the ViewSystem. The Doll Manager is responsible for maintaining a state that describes what emotion was last received from SenToy, which part of the story we are currently in, and creating a log file with this information. The Doll Manager is also responsible for sending the current emotion to Display Doll which is the component responsible for displaying a cartoon face with emotions in the screen each time a new emotion is detected.

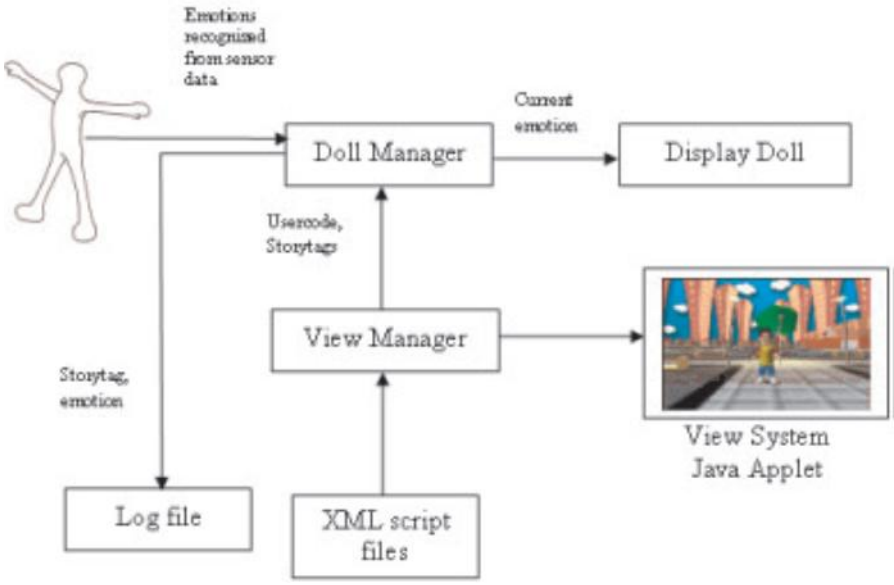


Figure 5.11 SenToy architecture

The cartoon faces were used as a way to provide immediate feedback to the child on what emotion she/he was expressing. These were immediate reactions to the gestures made with SenToy. For example, if the user expresses happiness with SenToy a cartoon face which represents that emotion will be displayed in the screen and will change only when the user expresses a different emotion (Figure 5.11)..

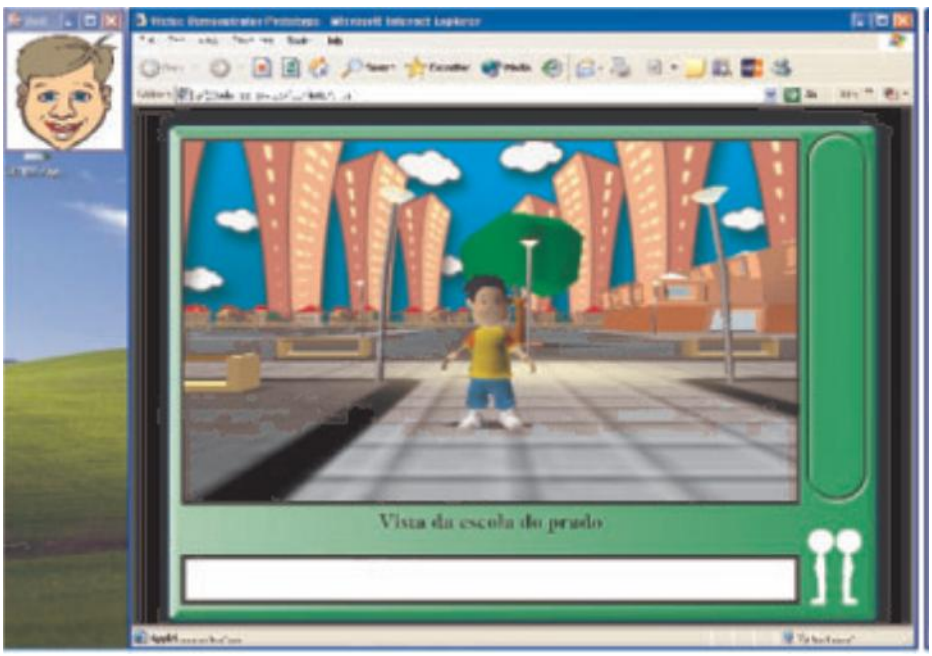


Figure 5.12 Integration of Sentoy in FearNot!

The use of SenToy was very positive not only because it confirmed again that children really liked SenToy but also because it allowed us to gather emotional data about the users of FearNot!.

Recently has been described YouTube storytelling system (Tue et al 2007). The system uses a combination of pre-authored text, question-response pairs, and a corpus of videos from YouTube to tell stories. The system will enable two orthogonal directions of future research—analysing free text to classify the emotional state of the writer and using computational models of influence to affect the choice of actions by players.

The design of narrative system was created specifically to meet two goals: 1) to tell stories interactively that will cause participants to experience specifically targeted emotions and leverage those emotions to create a labeled

data set for use in classifying free text based on the emotional state of the writer; and 2) to provide a test platform for analysing the effectiveness of using computational models constructed upon the theories of influence and persuasion as the basis for drama manager actions that guide the player's experience in the interactive story.

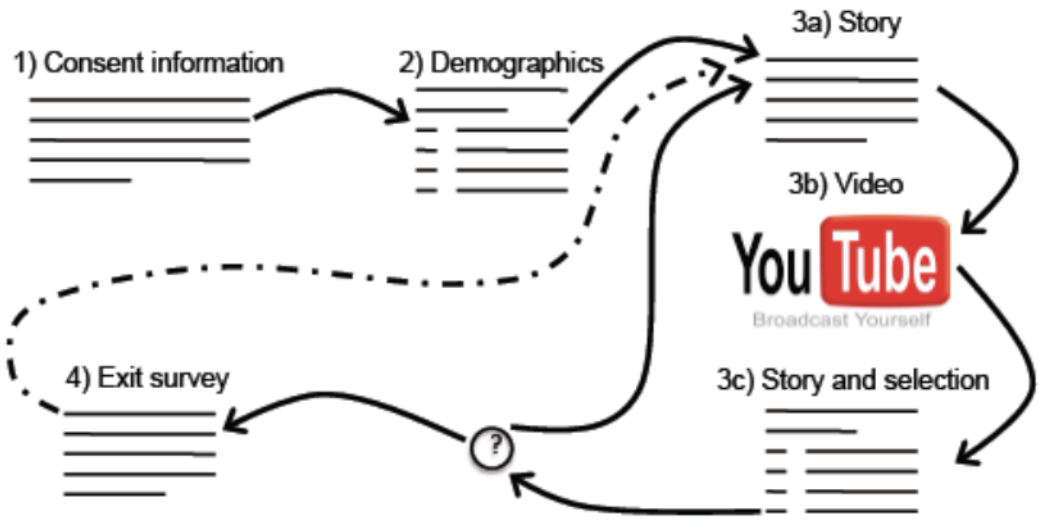


Figure 5.13 You tube storytelling

Since the author's goals are represented as emotional change over time, a model of the player's emotional reactions is vital to proper function. Therefore, the YouTube storytelling system maintains a cumulative model of player responses to videos over time.

In the next section we propose our approach to use the emotional data in order to maximize the different point of view in story path .

5.3 Proposed emotional system in Storytelling design Model

In the previous section we have presented the motivation to add on the emotional component in Storytelling and some examples of emotion detection for story path generation and management. In this section, we will propose a method of integrating explicit emotion management into the storytelling design model defined in order to support the authoring of storytelling templates.

Storytelling has an implicit goal of eliciting emotions from the audience. Interactive narratives, and storytelling in particular, employ the capabilities of the new media and face the problem of how to improve medium flexibility while still ensuring interesting plot structures. Story-worlds, based on autonomous characters, can provide an environment in which users actively participate in the creation of a plot, but this presupposes a level of competence on the part of the characters that ensures they will act appropriately and adapt to changes in their environment so that the resultant structure is plot-like. We believe that the aforementioned competence includes emotionality. This belief is empowered by the consideration that the emotional descriptions are constituents of dramatic plots.

The importance of emotions for (interactive) narrative is widely recognized. Our approach puts emotional processes as the central element for adaptive behavior in a dynamic story-world.

Existing IS (Interactive Storytelling) systems and theories follow this convention of implicit focus on eliciting emotions. Since the main aim of the storytelling is to elicit emotion in the user, Interactive Storytelling systems should take the emotion of the user explicitly into consideration.

We believe that emotion can be used as a useful parameter in re-designing an interactive storytelling system. An emotional parameter can provide the system with a structure for programmatically maintaining a better story arc and thereby enabling it to create a better user experience. We feel that such an explicit emotional consideration

can be integrated into the proposed model (D6.1.1.). In our opinion, emotional data can be exploited in order to guide role changing to enable learners to modify their viewpoints if needed.

In this work we propose to integrate the emotion management into the already defined Storytelling Design Model. Emotions will be captured and exploited by the Story Manager component in order to manage story flow, logical consistency of the story path and any other overarching functionalities like micro-adaptivity.

The Story Logic Engine is used by the Story Manager in order to operate on story segments (situations). Each of these segments is associated to certain events and conditions, which must be met in order to start the specific situation in the context of a story.

To create Emotional Storytelling, we propose to extend the IS system with several additional components. A core component to the extensions is the Emotion Tracking Engine or ETE (based on the outcome of WP2). In addition to the ETE, the story segments have to be extended to include additional information, i.e. the expected emotional impact of the segment on the user.

The Story Logic Engine or SLE is used by the Story Manager and operates on story segments. ETE is used to keep track of the user's expected emotional state. In addition to the ETE, the story segments have to be extended to include additional information, namely the expected emotional impact of the segment on the user.

As we assume the emotion is represented with a number or set of numbers, the values can be simply stored and access made available for the ETE. The final component is the Emotional Path Graph (EPG), which is a time dependent graph of what the author views as the ideal emotional experience for the user, as illustrated in Figure 5.14, Story Modeling. We expect an EPG would look similar to a modern Freytag's Graph (Bloom, BecKhause, 2005); However, the form of the curve would only reflect the traditional story arc in particular cases. Additionally, we expect that in many cases the EPG will include more than one emotional parameter, e.g. anticipation and surprise, each having a distinct curve.

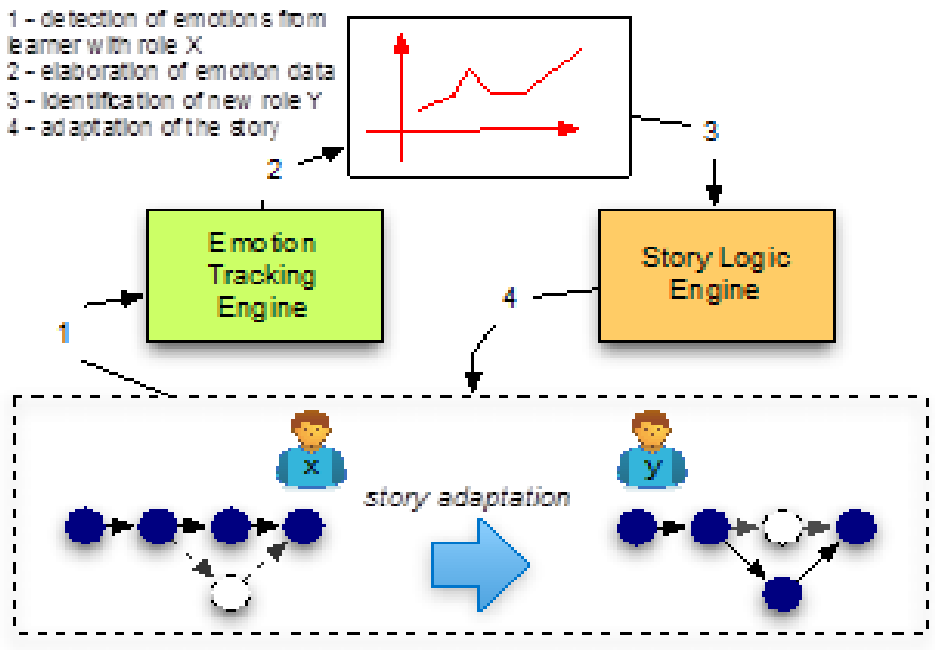


Figure 5.14 A Story Manager and components

With the proposed changes, the IS system has to have some changes to the algorithm the story manager follows. These changes mainly introduce additional steps, largely without having to modify the current algorithm.

In order to select story segments to adapt the story basing on the current user emotion, it is necessary to take care of the following parameters:

- Results of the assessment event of the situation
- Current user emotion (from ETE)
- Metadata of situations (also with aspects related to the involved role)

5.3.1 Emotional Tracking Engine (ETE)

The Affective and Emotional module of ALICE has been conceived at the aim of permitting a prompt identification of the altered emotional states of a student, during his learning activities. Following the study and analysis of the major paradigms and models for the management of emotion and affection in an ITS (Intelligent Tutoring System), we refer to those emotions suggested by Arroyo et al. (2009), which are important for learning. In their work they have identified and selected four classes of basic emotions, we present their provisions along an axis as set forth below. The parts of assessment of affective and / or emotional state are designed as inputs that, as a result of choices made by the user, are able to give a value of the state's (character's emotion) on two levels:

1) State identification, which gives Boolean feedback (yes / no).

2) Measuring / quantification of the state (-1, 0. 1).

The assessment of emotions as Boolean types is achieved following a questionnaire with twelve questions, three for each axis that will lead us to assign a score in which the value -1 corresponds to an extreme; the value 1 at the other end, 0 corresponds to indifference for emotion. The quantitative emotional assessment, identified a specific emotion, will be mapped on a scale of 1 to 10 through 10 specific questions targeted and specified for each emotional class.

The system, thus, has to be able to catch in time and distinguish alterations in the emotional state and to adopt opportune strategies in order to equilibrate it.

stage 1: Stimulus – Response. The status of an individual is characterized by the tuple S = (A, B, C, D) in V, where S indicates the state and A, B, C, D are the components of the state and V is the four-dimensional space. The target is the stimulation of the user / learner with storytelling via the system to verify and pre-quantify its emotional state. We talk about pre-quantification because the output is trivalent (-1, 0, 1), that is qualitative and not quantitative. In other words, the output will tell if the student responds positively, negatively or indifferently to the stimulus provided through the questionnaire, and so to a fixed emotion under analysis. Then S will be for example = (1, -1, -1, 0), then this will mean that the learner will be anxious (for A = 1), will be affected (because B = -1), will be excited (because C = -1) and has no sense of satisfaction or frustration because D = 0.

stage 2: Output Response – Quantity. The other parameters will be quantified in a scale of 1 to 10 (or in %) through 10 targeted and specific questions in detail in a later time. Referring to the previous example, the system will present to the learner a second questionnaire containing 30 questions (or 5 for each emotion that is 15 – this will be a result of the assessment in field to find a balancing between a good evaluation of the learner emotional status and a not boring experience), which specifically are: 10 questions to measure the degree of anxiety (A); 10 questions to measure the degree of interest (B); 10 questions to measure the degree of excitement (C);

stage 3: Estimation of Dominance. This is the stage where the different parameters (elementary emotive status) of the tuple are generalized in relation to the 2nd output of the approach and in relation to the weight given to each of the parameters of the learner. In other words, at this stage the dominant emotional state is considered and it is numerically quantified. If more value is near to 100 more the subject will be sensitive to the parameter indicated. Therefore, referring to the example with this multi-parametric analysis we will be able to tell which is the percentage level of anxiety, of interest and excitement. We will also be able to assess the dominance hierarchy of parameters. For example, if A = 70, B = 90 and C = 100 that means C > B > A. This means that the learner is primarily excited, interested secondarily, and only partially anxious; then we can conclude that you are having fun. The learner dominates the excitement, followed by the interest, followed by the anxiety.

stage 4: Evaluation of the emotions. This is the test module which computes the values of the affective and emotional state of a person. It returns a vector of nine numerical values corresponding to:

- A value describing how much a user is confident or anxious;
- A value describing how much a user is interested or disinterested;
- A value describing how much a user is thrilled or indifferent;
- A value describing how much a user is frustrated or self-esteem;
- A statistical parameter representing the absolute current emotion, incorporating the previous four parameters through their average;
- A statistical parameter representing the subjective emotion, the ratio between the absolute current emotion and the maximum absolute current emotion observed for the individual;

- A statistical parameter representing the emotional distance of the subject from its average;
- A statistical parameter representing the subject's emotional distance from the average of a group;
- A statistical parameter representing the emotional development of the subject compared to that of a group.

To have further details on the meaning of those values see (D2.2.1) /and, in particular, section 4).

Questionnaires are submitted to learners in order to detect their emotional states with respect to the storytelling experience. The questionnaire can be implemented by using e-tests (in Web-based environment) through which to determine the emotional state of a user.

The questionnaire is characterized by two types of tests:

– a test of pre-quantification through which detected changes in emotional states are considered;

– a test to measure the level of alteration of the emotion.

If the student accepts to answer the test then the pre-quantification test appears. In Figure 5.15, we present the pre quantification test for the Safety / Anxiety emotion. In case that all the emotional states result altered, the quantification test to measure the level of alteration will be presented.

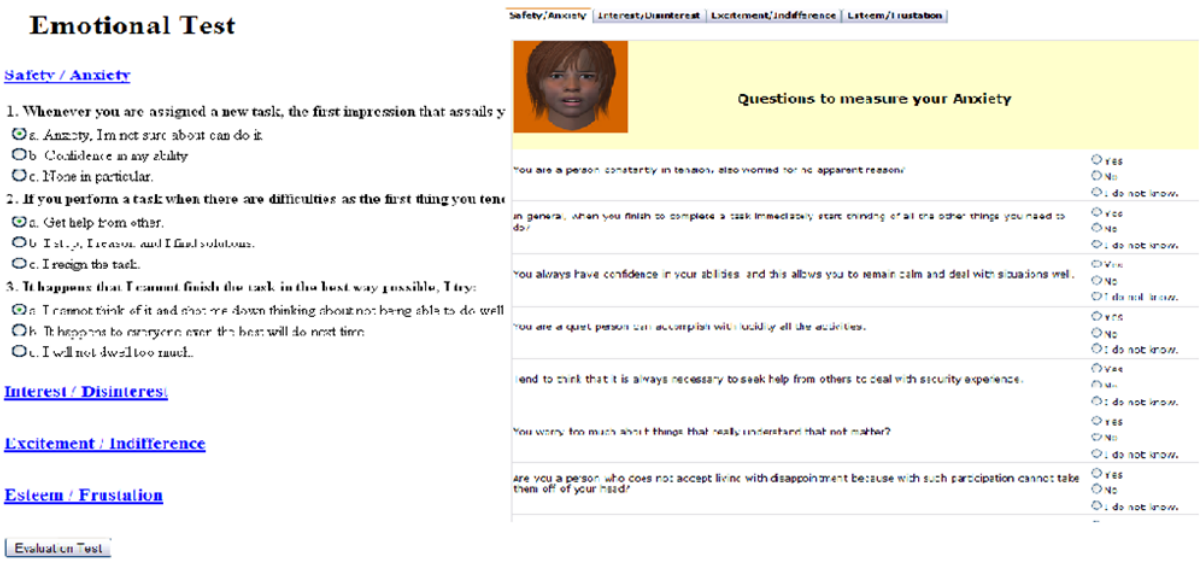


Figure 5.15 Test for Safety/Anxiety emotional axis and quantification

Finally, ETE, by Emotional Curve shows the final result of the test., Thereby, it shows a graph representing the amount of alteration of emotions.

5.3.2 Story Logic Engine (SLE)

The SLE is the module aiming at adapting (at micro-level) the story by using the score achieved by learners during an assessment Test. In particular, if the assessed learner's knowledge level (with respect to a given situation) is in a range between 0% to 25% (adaptivity of type C) of the maximum obtainable, the learner takes a new role by which he re-lives the previous situation in order to get a different viewpoint on the story.

The SLE is empowered by considering emotional data captured by the ETE. This data are used by the SLE in order to select the new role to be assigned to the learner. The selection process is executed by means of an association table supporting emotional rebalancing and reporting the following information:

- Archetype: narrative function (e.g.: protagonist)
- Role: specification of a function (e.g. warrior hero, martyr hero, etc.)
- Character: possible players able to impersonate a role (fire fighter, doctor, etc.)

In Figure 5.16 the emotion-empowered micro-adaptivity flow is reported (b) and compared to a simple story management (a). In particular, the SLE module is indicated with the combination of the Micro-Adaptivity Manager and the table Emotions-Role (Associations) that will be further detailed in the next paragraphs.

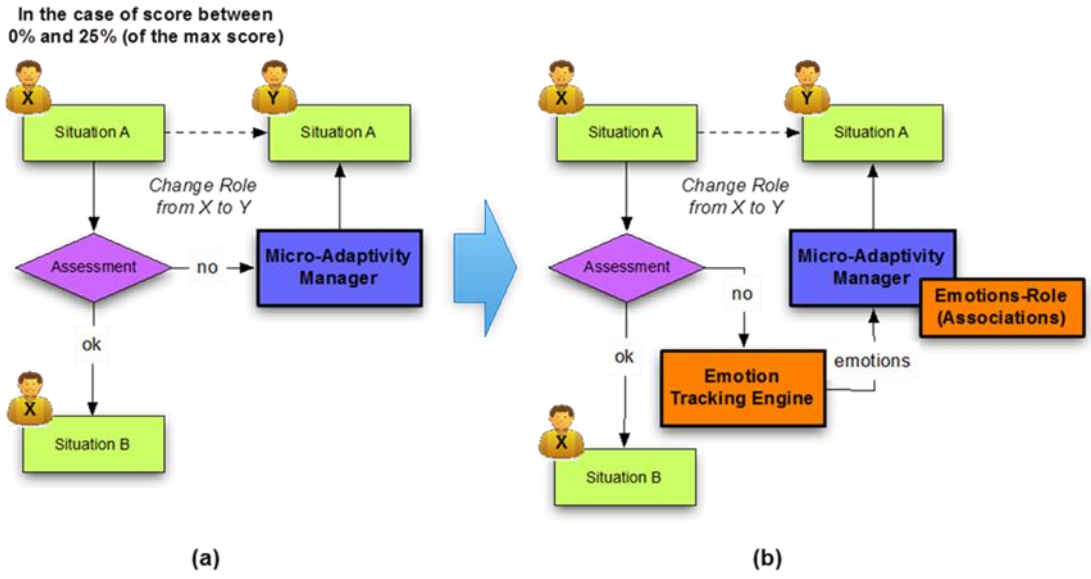


Figure5.16 The emotional inputs in micro-adaptivity flow

The following section describes a possible (experimental) mapping between emotional axes and narrative archetypes.

5.3.3 Mapping emotions and roles through archetypes

With the aim of examining the basic elements of a good story character design, we studied the basic roles of story characters, the driver of human behaviors, and the relationship of human personality, emotion, and behavior, especially nonverbal behavior. Stories are very largely made up of characters about whose lives the story rotates. The list of characters is often called the *Dramatis Personae* (especially in a theatrical setting).A person in a story may have a single character theme, but may also have a complex mix, in the way that each of us contain multiple personalities.

In literature are present specific character collections and more character family groups or archetype. The most relevant character collections in story have been defined in; Jung's characters (Jung, 1964), Propp's Dramatis Personae (Propp, 1991), Vogler's archetypes (Vogler, 1992), Pearson's heroic archetypes (Pearson, 1991), Blevins' family roles(1993), where the structures of characters depend on their roles in the story.

After conducting a study aimed at investigating research perspectives concerned with the definition of archetypes (Character types or character groupings in digital stories (personality, emotion, style) it was possible to go back to different existing taxonomies and to possible groupings of five basic archetypes (protagonist, helper, innocent, neutral and antagonist) characterized by personality traits useful to re-balance emotional states that could be non-functional or discordant with those required for the learning in a specific emergency situation of the story path.

First of all, this study starts from a reasoning about roles didactically functional with respect to a positive or negative emotional unbalancing for each of the 4 axes characterizing the emotional sphere.

Below is the logic mapping:

- **Resilience axis (A) (safety/anxiety)**

- If a student (who starts the story with a role of unintentional hero) shows a positivity state (little confidence that everything will be resolved at the best) the system can readdress him/her towards an archetype able to maximize his/her state of confidence through a more active perspective, where the student is asked for a higher responsibility and action (e.g., action hero, warrior hero, etc.).

- If the emotional trait shows confidence in the good resolution of things, despite all this is linked to an insufficient learning, it could denote that the student needs a higher level of uncertainty so to activate his/her attention and improve his/her performance (e.g., victim, antagonist).

- **Axis of curiosity about topic/event (B) (interest/disinterest)**

  - If this axis indicates a positive emotional state with respect to disinterest, the system can re-address the student to taking a different perspective that may let him/her understand what is the damage resulting from a lack of knowledge or ability to act in a given context (e.g., hero, innocent, etc..).

  - If this emotional axis indicates a negative value and therefore a student's interest but with insufficient learning results, it needs to re-address him/her to active roles of greater relevance (e.g., hero, helper, etc.).

- **Axis of engagement in a situation (C) (excitement/indifference)**

  - If this axis indicates an emotional state unbalanced towards indifference, it needs to re-address the student to higher rewarding or responsible role with respect to the story, so to increase the level of excitement and control (e.g. antagonist).

  - If the involvement axis indicates a level of excitement but also an insufficient learning, it needs to re-address the student to a more reflexive point of view (e.g. neutral, helper, etc.).

- **Self-confidence axis (D) (self-esteem/frustration)**

  - If the emotional test indicates a state prone to the positive values of this axis, it needs to re-address the student to a role enabling him/her to help in case of emergency and so to improve his/her self-confidence level (e.g. helper, neutral, etc.).

  - If the student has already reached the positive levels of this axis but shows big cognitive gaps, it needs to try to reduce his/her self-confidence level because this could lead him/her to underestimate risks and not to pay attention to the situation towards role in which the point of view belongs to the character who needs help, to overcome a situation or resolve a problem (e.g., antagonist, victim, etc.).

In the second stage, having clear in mind the logics to follow, it was possible to analyze existing taxonomies and to focus on two work levels: i) archetype (character and personality) ii) possible *roles* for archetype (sub-categories or modalities of an archetypes). Going back to the study conducted on various models, employed to describe the roles' personalities in narrative stories and their behaviors or main activities, it was imagined to map them using the emotional model lexicon in order to describe personalities and understand some archetypes able to orient the story design and the re-addressing of role micro-adaptivity.

The table 5.2 synthesizes the use approach to associate possible archetypes to emotional axes (in which we observe positivity or negativity with respect to the considered dimension). For each archetype has been hypnotized a role taxonomy to be associated on the basis of a study conducted and reported in the following paragraph.

Table 5.1 Mapping between emotions, archetype and roles

Narrative Archetype	Actions characterizing the archetype	**Roles associated to Archetype**	**Emotional axis** and value
Protagonist	*Is the character having the responsibility to overcome all tests and solve all problems in order to be awarded.*	*Hero, Martyr, Savior, Geniuos, Crusader*	A(**Resilience**; *0*); or C+(**Engagement**; *indifference*)
Helper	*Helps the protagonist overcome tests and difficulties.*	*Wise, Mentor, Magician, Caregiver, Jester*	D+(**Self-confidence**; *frustration*) or C-(**Engagement**; *excitement*)
Innocent	*Is overwhelmed by events and needs to be saved or rescued by the hero.*	*Invalid, Scapegoat, Victim*	D -(**Self-confidence**; self-*esteem*) or B+(**Curiosity**; disinterest)
Neutral	*Remains neutral and indifferent (external point of view): describe the events basing on rules to be followed.*	*Enforcer, Ruler, Narrator…*	C(**Engagement**; *0*); or A+(**Resilience**; *anxiety*);
Antagonist	*Characters that voluntarily or by chance (for lack of knowledge) oppose the hero and cause problems.*	*Bad boy, Sneak, Fanatic, Thug, Shadow*	A-(**Resilience**; safety); or B-(**Curiosity**; interest)

When disinterest emotion occurs, the system can re-address the student to taking a different perspective that may let him/her understand what is the damage resulting from a lack of knowledge or ability to act in a given context (e.g., hero, innocent, etc..). If this emotional axis indicates a negative value and therefore a student's interest but with insufficient learning results, it needs to re-address him/her to active roles of greater relevance (e.g., hero, helper, etc.). When the emotion detection indicates an state unbalanced towards indifference, it needs to re-address the student to higher rewarding or responsible role with respect to the story, so to increase the level of excitement and control (e.g. antagonist). If the student has already reached a balanced o positive engagement but shows big cognitive gaps, it needs to try to reduce his/her self-confidence level because this could lead him/her to underestimate risks and not to pay attention to the situation re-addressing the student to a more reflexive point of view belongs to the character that (wise, ruler).

Teacher, during the design phase, is called to insert characters with specific roles into the situations he is constructing. The SLE, using the following table, is able to automatically recognize the ideal archetype and to address the learner towards the situations that enable the rebalancing of the altered emotions detected from ETE.

Furthermore, Figure 5.17 shows the run-time adaptation phase by using the integration of ETE in a preexisting Story manager and updating a set of rules necessary for a SLE.

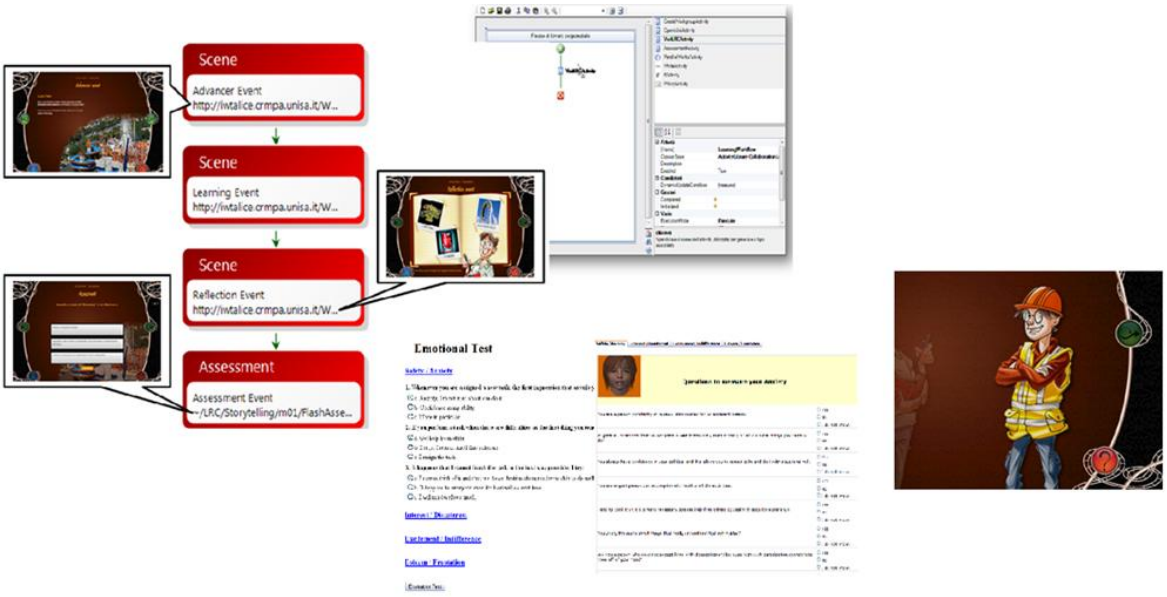


Figure 5.17 Story manager and updating the roles

The following phases (also depicted in Figure 5.18) describes the cycle of action of the Emotional Module within the storytelling logics.

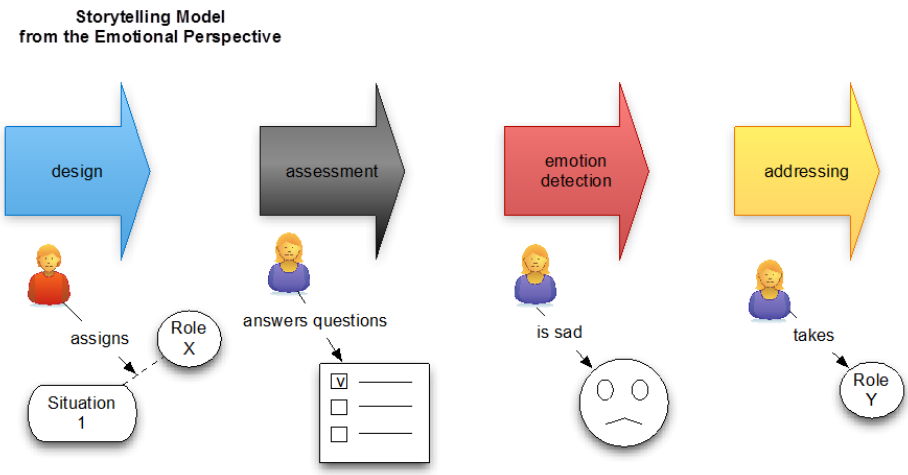


Figure 5.18 Cycle of action of the Emotional Module

- **Design Phase:** in defining the story or in the design of situations, the teacher should assign or define a situation basing on the role which the character (present in the scene) belongs to. Assigning situation-roles will facilitate in the phase of micro-adaptivity retrieval/recovery, situations whose role is compliant with the indications detected by the emotional test**.**
- **Phase of assessment** of the type of acquired knowledge connected with situation X. The assessment event provides a measurement (in a range of pre-fixed percentages) of the knowledge acquired by the student. If the knowledge level is in a range of 0-25% the system is set for addressing the student to a C type micro-adaptivity.

- **Phase of detection** of the predominate Emotional State. Having previously detected a series of possible alternatives of C micro-adaptivity (with different roles/characters) the system presents to the student a questionnaire aimed at measuring his/her emotional state and using this data to search for the best narrative archetype and therefore the micro-adaptivity which offers the highest functional role with respect to the emotional balance and the overcoming of the cognitive gap.

- **Phase of addressing** to the most matching role micro-adaptivity with respect to detection. The student is automatically addressed to review the situation through a viewpoint that falls into the type of roles

acceptable for a specific emotional asset. The student then lives his/her story with a different role and is finally subject to the assessment in order to measure the obtained knowledge retrieval/recovery. In line with the Storytelling Model:

- in case the assessment was overcome with a good score, the student is guided to situation 2 and takes the same role he/she started the story
- in case the obtained knowledge is still insufficient, it will be possible to:
- review the situation with a further role included into the group of archetypes in line with the emotional component previously measured.
- access the facilitated assessment.

Both the choices will allow the student to obtain the desired knowledge and go ahead in the story, taking the first level role.

The integration of the emotional aspects allows to release a second version of the Storytelling Model. The new version of the model allows to:

1. link the internal micro-adaptivity to the most suitable role enabling to re-balance the altered emotions (manifested by the learner) and, at the same time, to improve the learning process. Enhancing the emotional tests (at present quite generalist and unable to be contextualized to single educational tool requirements such as the storytelling), will help to orient (basing on peculiarities emerging from the texts) usable story archetypes and to recover situations that present roles that are compliant with a given archetype. The test can be revised in order to be able to formulate the most relevant questions for the basic emotional axes as well as the archetypes that they are requested to correspond;
2. improve the storytelling design process through the creation of a taxonomy of fixed narrative archetypes to which, step by step, story by story, can correspond different characters that the teacher has to create or identify when defining possible situations. These situations will be identified also for the character that lives them, by assigning the story to a specific role category *(situation X; roletype Y*). The system automatically recognizes the roles as belonging to a given archetype and uses this information in case of cognitive deficit. The use of archetypes allows to assure a useful variation in the story giving the chance to enhance and optimize the design process and the taking of viewpoints (at run-time) and maximize the learner's engagement,

Validate the Associations between Emotions and Roles (through Archetypes) by means of the analysis of aggregated (across multiple sessions executed by different learners) assessment data. This process incrementally refines the association table, improves adaptive instruction based emotions and should be intervene in order to maximize the learning achivements.

6. Ontologies and languages for Storytelling representation

Storytelling models are increasingly being used due to the fact that they realize new ways to present content as stories or “sequences of narrative significant events”. A conceptualization 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. In this chapter we present:

- our proposal for a generic storytelling ontology model based on the organization of events using the relations proposed by the Rhetorical Structure Theory (RST) and how narrative principles are applied to these RST relations to generate coherent stories;
- our proposal for a mark-up language in order to maximize the possibility to interoperate with different authoring tool IMS LD based or compliant.

6.1. Related works: how to use ontology in storytelling?

Interactive stories are not ready-made, linear texts but rather “story spaces” representing a set of characters, together with, e.g., their personalities and motivations, as well as a set of actions and events. They are related to each other by causal and temporal relations. To provide authors the possibility to create interactive stories intuitively we need authoring tools that alleviate the process. Such a tool should provide the author with building blocks, at different granularities, to create “story spaces”, and a means to ensure coherence and narrative relevance. We also need the possibility of reusing already created story elements. The main paradigms in interactive storytelling, the plot-based approach and the character-based approach both require this sort of meta-data .

In literature more studies refer to the different use of ontologies for narrative learning:

Ontology as database model: An ontology can be used to structure the content of a database in the authoring process. It provides the vocabulary to annotate the contents of the database with meta-data and models relations between the elements in the database. The DB ontology of INSCAPE (see Figure.6.1 for a partial view) defines visual and audio elements that an author may want to include in his story. They can vary according to the style chosen by the author: stills, drawings, fonts and texts, 2D animations, cartoons, movies, 3D scenes, avatars, as well as music and diverse sounds. Using the concepts defined in the ontology, story creators search the database for the object they want to participate in the story.

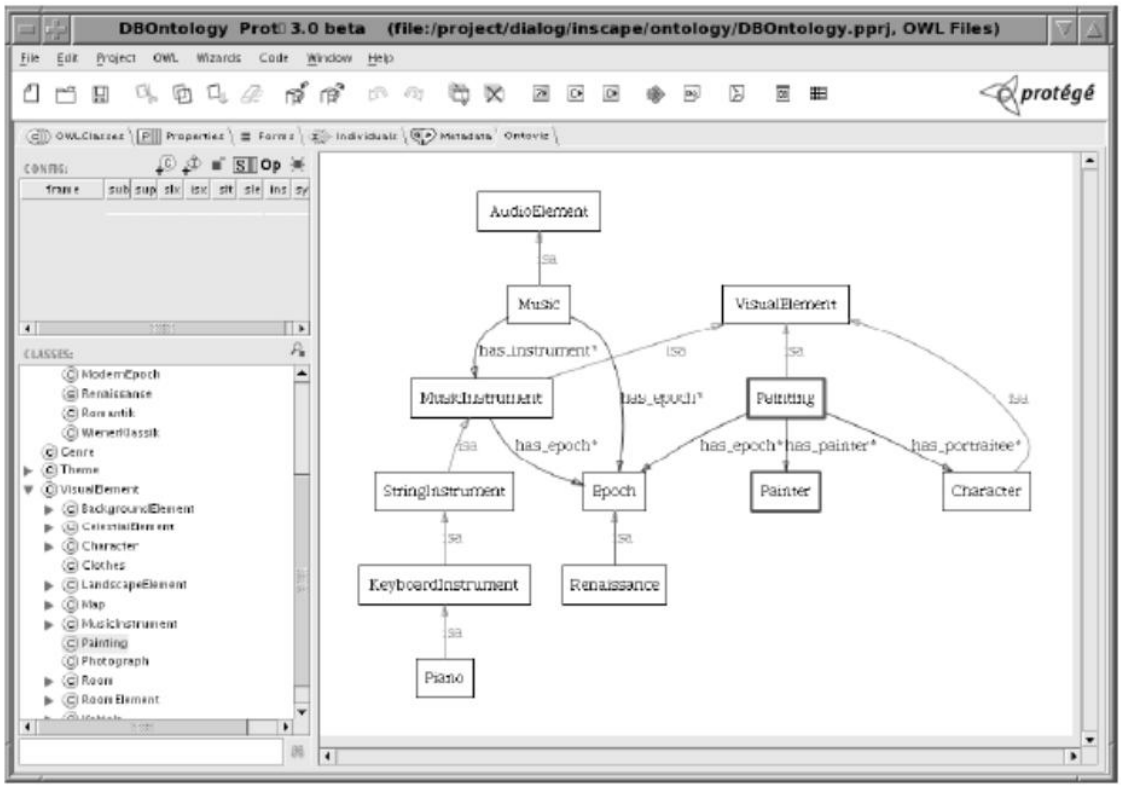


Figure 6.1 Protegè display of parts of the DB ontology

Relationships between classes and properties of classes are used for more specific queries. For example, if an author wants to include a drawing from a particular painter, with the hasPainter property of the class Painting he gets only these entries in the database that correspond to the particular painter.

Ontology for the creation of stories: The INSCAPE ontology formalizes different narrative theories, e.g. the well-known Propp theory, which suggests that stories can be built by arranging story units according to precise rules. The ontology thus provides the necessary knowledge source for different forms of narrative control. It facilitates the mapping between the actions of characters and users to narrative units that form the desired story structure. The Proppian functions are defined in the INSCAPE ontology in the class ProppFunction (see Figure. 6.2). The happensBefore and happensAfter properties describe the implicit dependencies between the functions. For example, the function Mediation cannot be applied, before the villain has caused harm or injury to some character. The ontology defines the characters to fill the roles in the story, which include Hero, Villain, Helper. Different locations, where the story can evolve, are also represented in the ontology, as well as the different objects that may appear in the story.

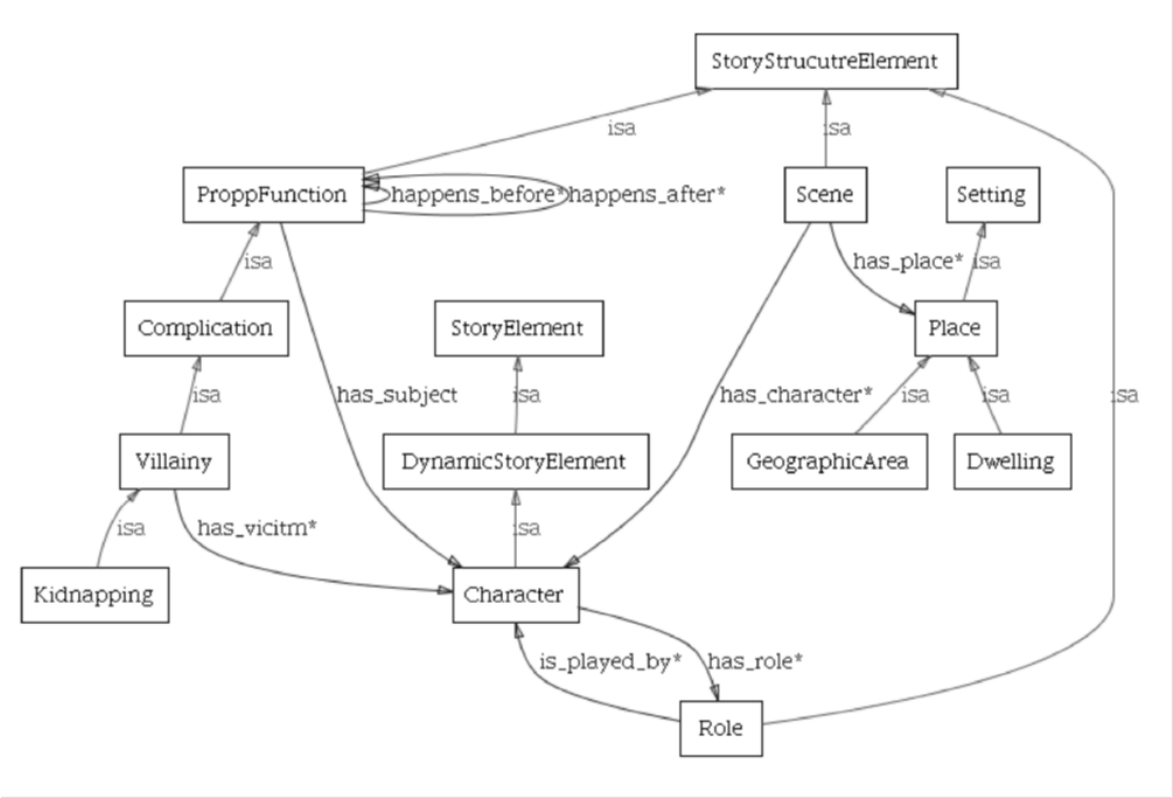


Figure 6.2 - Parts of the INSCAPE ontology

Ontology for the description of system specific domains: Clue for example is a Cluedo-like interactive game developed using technology from the VirtualHuman project. Four characters, three virtual and the user, try to find the murder of a fifth character. The action takes place in four rooms and the user becomes to see only the room in which his character is situated. The Clue ontology describes concrete and abstract objects like persons, furniture, alibi, and motivations for murder. All actions that characters can execute (walk, search for evidences, open, close, etc.) are also formalized in the ontology. The communication between characters is defined by dialogue acts, like questions, answers, statements and dialogue games, which are sequences of dialogue acts. The actions are defined with their roles, which are filled by ontological objects. For example, the action Take has as roles the object which is to be taken and the subject, who takes the object.

6.2 Conceptualization of Storytelling Design Model

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. The starting point is a recent application of RST in storytelling modeling. In Nakasone (2008) preset ISRST, a generic storytelling ontology model based on the organization of events using a subset of relations proposed by the Rhetorical Structure Theory and how narrative principles and user interest are applied to these relations to generate coherent stories. Semantically organized events using primarily RST have been used in applications that present multimedia content, but most of them use only a very limited set of relations. Since rhetorically structured content was mainly used for organizational purposes, these applications do not deal with the narrative implications that rhetorical relations have in storytelling-like presentations.

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.

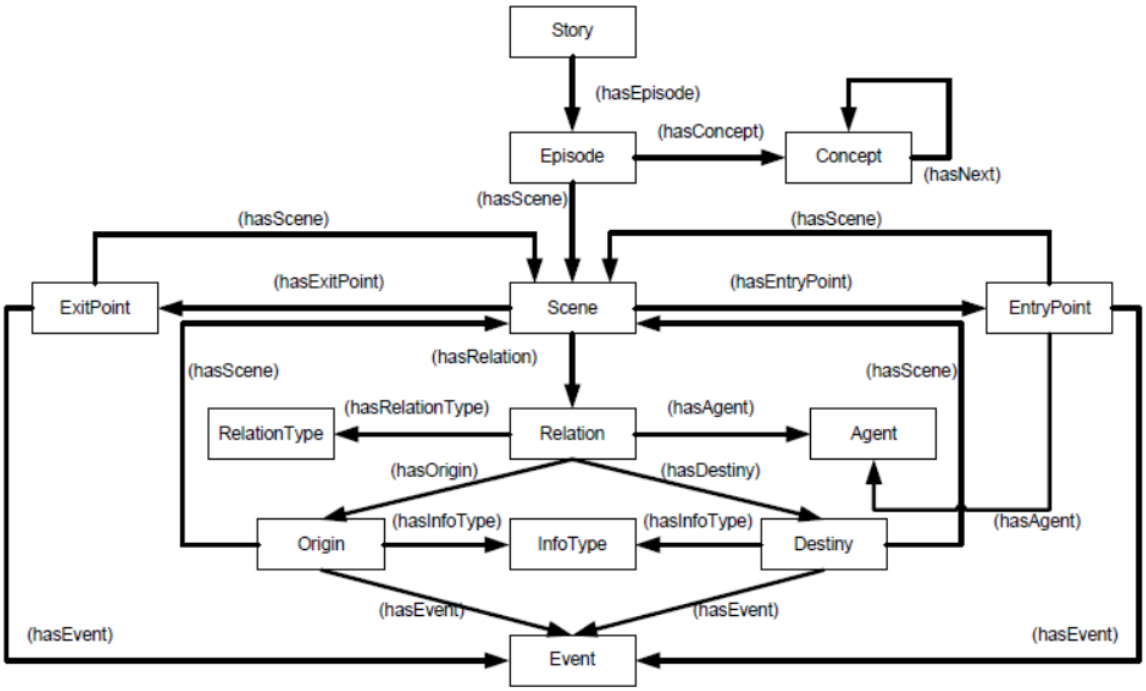


Figure 6.3 IRST Ontology Model

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 a conceptual model, as knowledge representation to support design and authoring of storytelling Learning Object.

6.2.1 Classes of Concept

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.

Table 6.2 Classes of Concept for storytelling modeling

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	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.
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.

In our model, a Topic is organized presentation 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 visual portrait's sequence and student'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.

6.2.2 Relations And Typologies

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:

Table 6.3 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 that can be used in our model like Not player character (NPC) model are:

Table 6.4 NPC useful for a better definition of a story

Questioning Role: The Agent will receive the information contained in the relation (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 favored 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)

Using a semantic representation of story a semantic checker can validate semantics of story in the automatic story generation system using ontology . Performance can be improved by extending the ontology with a higher number of concepts and attributes. Even though Ontology has the provision for extending with new concepts, Ontology alignment is also crucial for reusing the existing ontologies and for facilitating their interoperability. In future, the domain ontology has to be enhanced with widespread information and the reasoning should concentrate on deriving tacit knowledge from the axioms, which helps to improve the *semanticness* of the story.

6.3 Introduction to languages for expressing narrative structure

Studies on such interactive storytelling are gives a consideration to followings as essential components of interactive storytelling.

1) **Narrative Structure**: The essential elements for processing stories and the structure to express such elements are required.

2) **Script language** to embody narrative structure. - A system, where the narrative structure is expressed in the type of languages which authors or programmers can understand so that the computer can process it, needs to be arranged.

3) **Story generator** and authoring tool assisting in generation of story and narrative structure even without professional knowledge of programming languages.

The development environment, which allows story makers to create stories easily even if they do not have knowledge of script languages, should be supported. Astory generator interprets input information as narrative structure, converts it in script language, and then generates the story based on it.

The language for expressing narrative structure requires following characteristics.

First, the legibility should be good enough so that users can easily understand the meanings without any difficulty and add what they want. There would be no occasion to write codes, because the authoring tools are basically used. However, good legibility is necessary so that there would be no difficulties even in the case of writing codes directly.

Second, there should be good expressiveness. In the previously suggested structure, an actor or an action has subordinate constituents in complex form. In particular, the way the motion is defined demands information of properties necessary for the motion, actors who can perform the motion, and stages where the motion can occur. Each motion, however, has different number of such constituents.

The structures defined in the constraint declaration are combined by a relationship of 'AND' or 'OR' and demands a wildcard character, and a reference structure, thereby becoming more complex. The language should be able to express such structures that are defined as being complex and multilateral.

Third, the structure should be easy to deal with. It requires the operation of generating or parsing the codes written in the given language using an authoring tool or a story generator. The structure of the language should be easy to deal with, so that it would be easy to develop an authoring tool or a story generator that supports such a language.

Among various important elements constituting an interactive storytelling system, the narrative structure and the interactive storytelling script language based are suggested in this work. For this purpose, the existing script languages and their expression modes are described: a specific language, IMS LD, is suggested for the Storytelling Design Model (developed in this deliverable). This script language is fundamental to an interactive storytelling system and is used to develop story generator and authoring tools, making it possible to generate stories. A multi-story can be generated by the interactions of users in the interactive storytelling system. The basic environment and constituent required in the story are defined in the constituent declaration, and the constraint items holding the outline of overall direction of story are assigned in the constraint declaration. We suggest narrative structure and corresponding Storytelling Markup Language. Actor, Action, and Constraint are declared and programmed using interactive storytelling system which generates the stories. Generated stories can be transformed to multimedia formats which are texts, images, animations, and others.

6.4 Mark-up language for Storytelling

Languages that have been used in an interactive storytelling system so far can be largely divided into three types; natural language, logic programming language, and markup language derived from XML. A natural language is the most suitable language to narrate actions, characters, events, and other source of story because it expresses a human language as it is. Although using a natural language provides convenience for users and increases accessibility or legibility, there are many difficulties compared to processing the existing programming languages. In previous studies, such a natural language system was used in integration with a speech recognition system, which was the system that shows the final stories by processing natural language coming through the speech recognition system. Since logic programming languages use an artificial intelligence planning technique in the narrative structure of an interactive storytelling system, programming languages that are compatible with logic programming are used. For example, there are STRIPS (Stanford Research Institute Problem Solver) and languages derived from STRIPS. STRIP, which was introduced to solve problems of Al, is the most suitable for expressing a planning algorithm of narrative structure (Barros, Musse, 2005), thus it is used in an interactive storytelling system (Cavazza et al., 2002)

Lastly, there is XML (eXtensible Markup Language). HTML (Hyper-Text Markup Language), a subordinate concept of XML, is used as the standard output format of the World Wide Web all over the world, and many users, thus, know or can easily learn the format. Along with such an environmental factor, XML expresses all information in letter that users know, leading to high legibility. XML has been widely used as the standard to express information since proposed by W3c (World Wide Web Consortium), and it is even suggested that it might replace HTML. Many developing tools have already included the libraries dealing with XML and are continuously developing it. Accordingly, HTML has an advantage of being widely used. Most of all, XML, a language with the property of generality, can add various formats and express almost any imaginable formats.

With regard to XML-derived languages used in an interactive storytelling system, there are **MPML (Prendiger et al 2004)** (Multimodal Presentation Markup Language), **AIML**[13] (Artificial Intelligence Markup Language), **APML (DeCarolis et al, 2004)** (Affective Presentation Markup Language), **FML (Krenn, Sieber 2008)** (Functional Markup Language), **BML (Kopp et al 2006)** (Behavior Markup Language). **MPML** is a markup language suitable for controlling actions of characters similar to the real world. MPML is a powerful language which can provide the control for behavior of second dimensional characters, the presentation flow, and the integration of external objects. **FML** and **BML** are designed to unify representational framework for Embodied Conversational Agents to produce multimodal behaviours of computer-generated characters in a broad range of circumstances. **APML** is another attempting version for ECA able to generate context-adapted behaviours based on Mind-Body interface; Mind which represents the personality of an agent, and Body reflects its appearance and expressive behaviours. However, they have some shortcomings to be the script language for generating stories which this study aims at, because it is a language for controlling the agent.

In the VISTA (Virtual Interactive Story Telling Agents) project (Figa, Tarau 2003) , **AIML** was used to write programs. AIML is a XML style script language supporting for AI application program, and the Vista system used AIML interlocked with Prolog. AIML was used in the question answer relationship applied to stories, while Prolog was used to generate various action rules. With regard to AIML, however, all the questions and answers should be defined in advance, and it is hard to produce various results inferred from the various conditions. Besides, there is another difficulty that general users who are not familiar with programming should know Prolog. In addition to language to formalize narrative structure, authoring tools which assist to program the language and specify the information have been investigated and developed: INSCAPE (Zagalo et al 2006) and PRISM (Cheong et al 2008). In INSCAPE, an author writes an interactive story idea; prepares characters, props, and stages; and plan entire flow of story with those assets to achieve desired goals. It also adopted XML-style language, called **ICML** (Inscape Communication Mark-up Language) for underlying data model. It is designed to create interactive stories for edutainment, simulation, training, and other areas of nonlinear story. PRISM provides story maps to set up an interactive story in a similar way to INSCAPE and it adopts hybrid narrative structure combining “condition based branching narrative” and “planning” methods to generate an interactive story. Recently **SML** (Storytelling Markup language) are developed. SML is a script language that is fundamental to an interactive storytelling system and is used to develop story generator and authoring tools, making it possible to generate stories.

In the next section we focus major attention on specific mark up languages that present the best evidences in storytelling modeling.

6.4.1 ICML - INSCAPE Markup Language

Based on preliminary, long-term research in the field of story-based edutainment applications and DEGs, this paper introduces the conceptualization of Narrative, Game-based Learning Objects (NGLOBs) as the basis for Story-based DEGs. The main result represents a first version of a formalized model for NGLOBs composed by narrative, gaming and learning context. The model has been technically implemented in the form of an XML schema being used as extension for the ICML format and has been rudimentarily integrated into the StoryTec authoring environment and the 80Days run-time system.

[13] A.L.I.C.E. AI foundation, “Artificial Intelligence Markup Language (AIML),” *Technical Report* URL: http://alice.sunlitsurf.com/TR/2001/WD-aiml/

ICML (INSCAPE Markup Language) has been originated within the European research project INSCAPE and used and further cultivated in other projects such as U-CREATE (Figa, Tarau, 2003) or 80Days (Prendinger et al 2004) . In brief, the global aim of ICML is to provide a standardized comprehensive description language for Story-based DEGs and any kind of Interactive Storytelling application. The ICML format6.6 provides three top-level nodes: ICML_content, ICML_strategies and ICML_story. The model of NGLOBs is being integrated and serves as detailed annotation and specification of ICML_story parts (complex scenes, scenes micro missions and situations in 80Days or game levels/learning chapters and game situations/learning units in games/learning applications). In order to use NGLOBs in Story-based DEGs such as 80Days, StoryTec has been enhanced both in the authoring tool and run-time components. In the authoring tool, the Property Editor provides fields to enter context information of a NGLOB.

Figure *6.4. XML-based Schema for NGLOBs, being integrated within ICML_story*

The Condition Editor is used to enter application logic and define conditions for transitions among story units (sequencing of story units in Story-based DEGs).

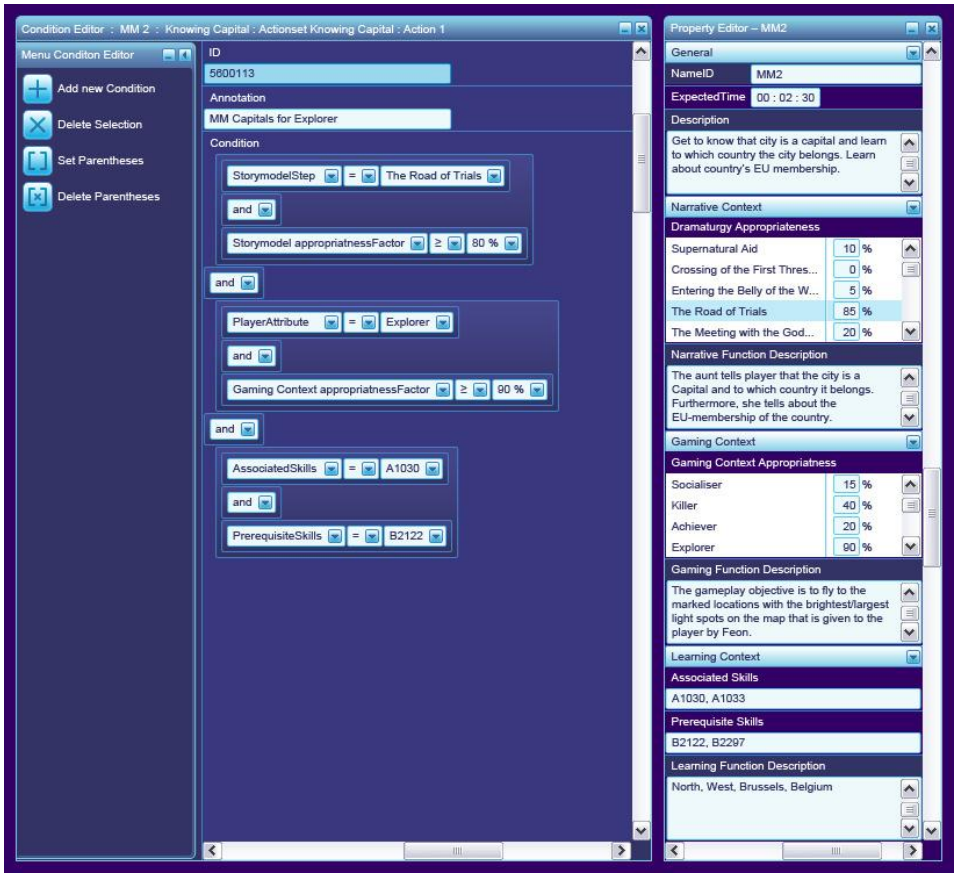


Figure 6.5 Condition Editor (left) and Property Editor (right).

The result of the authoring process are ICML-encoded stories. These ICML files are loaded into the run-time environment of the 80Days framework in form of an executable story graph in the Story Engine. Then, the story starts and unfolds according to the user/player/learners´ interactions, behavior, rules and application logic provided by the author, and context information.

6.4.2 AIML Story Specific Scripts and Question Answering

Virtual Interactive Story Telling Agents (VISTAs) are coded as a combination of AIML scripts (a subset of XML specialized to support AI applications) and rules in a Prolog knowledge base. An online chat transcript is used for establishing the AIML query/answer pat terns through an example driven learner implemented in Prolog. The query/answer correlations are used to generate an AIML script specific to the story, as well as a number of action rules in Prolog, allowing the agent to play the story over the Web or to retrieve and display specific sections of the transcript. AIML has good handling of individual patterns but has limited generalization and inference capabilities. We extend AIML-based pattern processing with a logic-based engine. The engine consists of a natural language parser, a common sense database, and a lexical disambiguation module, as well as a set of transformation rules mapping surface structures to semantic skeletons. The inference engine uses a dynamic knowledge base, which accumulates facts related to the context of the interaction. Such facts can be used for future inferences. This dynamic knowledge base works as a short-term memory similar to the one implicit in human dialogue and provides means to disambiguate anaphoric references.

6.4.3 SML (Storytelling Markup language)

The narrative structure with the purpose of an interactive storytelling was defined previously. However, the previously defined structure is simply a kind of an abstract data type. In order to generate stories, it is necessary to express above components in definite language so that the story generation engine can process them. When taking the structures of already existing languages into consideration, a XML (eXtensible Markup Language) format can be easily considered first. XML can be seen as a super-ordinate concept of HTML (Hyper-Text Markup Language). HTML is well known to many users because HTML is used as a standard output mode of World Wide Web. Many users, in turn, can read and write HTML. Thus, the XML mode can be considered to have quite excellent legibility. In addition, XML itself is a language that can add various formats freely, leading to fairly good expressiveness. Also, since XML is widely known and used, there are many related libraries. Since it is easy to deal with languages with help of libraries, the XML format is, in a sense, the 'easy-to-handle structure'. As described, XML satisfies all the conditions required as a language listed above. This study, thus, defines the previously defined narrative structure in the XML format, naming the language as SML (Storytelling Markup Language). The DTD (Document Type Definition) of SML is not included in a text, since the constituents and the constraint conditions of the previously presented narrative structure are large in quantity and complicated.

The story was generated through a story generator based on the algorithm suggested above, after the construction of The Lord of the Rings story was simplified and then expressed in SML defined above, Figure 6.6 is the currently realized authoring tool, and Figure 6.6 shows one example of created stories.

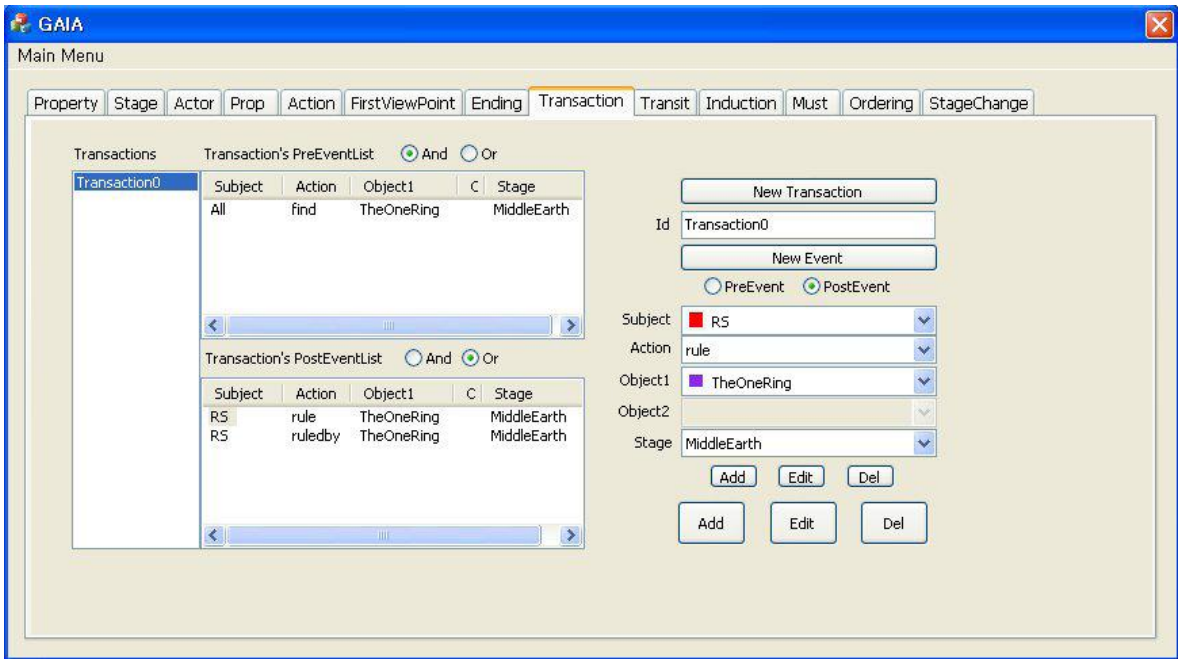


Figure 6.6 Interactive storytelling authoring tool

6.4.4 IMS-LD in story for children

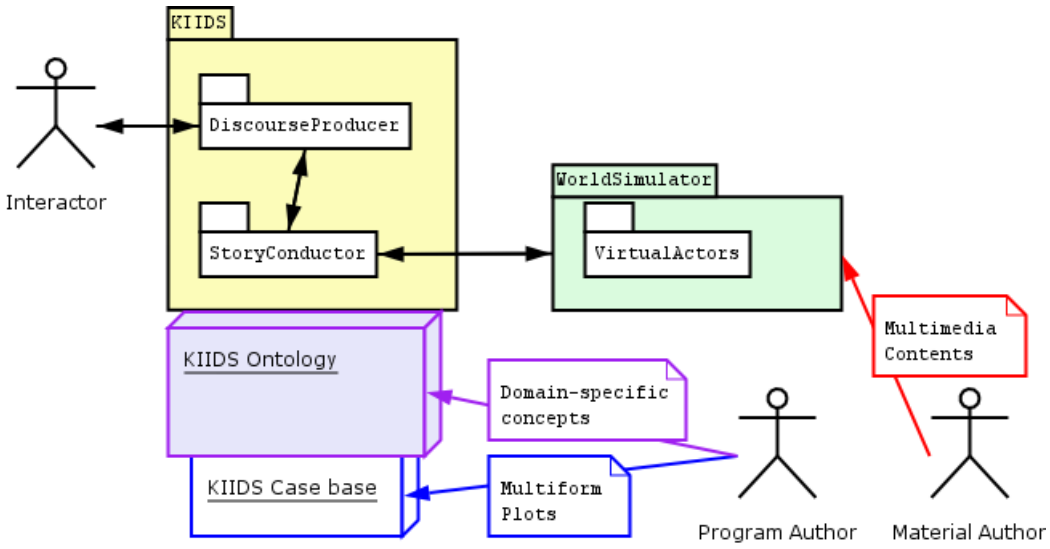
IMS Learning Design (IMS LD) is an open e-learning specification released by the IMS Global Learning Consortium[14] in 2003 . IMS LD includes a binding specification that defines precisely how

[14] IMS Global Learning Consortium, "IMS Learning Design Information Model. Version 1.0 Final Specification," Retrieved

learning designs are represented in XML. IMS LD derived from two developments in the area of e-learning specifications: Firstly, IMS LD is based upon the Educational Modeling Language (EML), which was developed by Rob Koper (Koper, 2001) from the Open University of the Netherlands (OUNL). The motivation behind EML was to show that many, if not all pedagogical approaches can be described in a meta-language, the core of which accounts for various activities for one or several learner roles and staff roles in a certain order. IMS LD incorporates and extends the general approach of EML. It provides an elaborated notation to specify learning and teaching activities which is pedagogically neutral and implementation independent. Secondly, IMS LD integrates other IMS specifications like content packaging[15], meta data[16] and simple sequencing[17]. IMS-LD considers a Learning Design as a process that orders and coordinates the execution of a variety of activities by different participants in the learning process. The highest-level component of the structure is the Play, built as a sequence of Acts. During each Act, the different Actors (learners, tutors, etc.) perform a number of Activities organized in different Activity Structures. An Activity takes place in a determined Environment, simultaneously or sequentially with other Activities.

IMS-LD specification proposes a rich and complex structure consisting of three increasing levels of complexity support, each built on top of the previous one. Level A includes the aforementioned elements and yields complete learning designs with different paths between the Activities. Level B adds the notion of Conditions and thus introduces the possibility of altering the flow of the course depending on the result of certain Activities. Finally, Level C adds Notification mechanisms that allow communications triggered by the results of the Activities.

Following the parallelism between the elements of a Learning Design and the elements of an Activity Diagram (Martinez et al 2005) , in our proposal we interpret each element of a Learning Design in terms of interactive storytelling. We can thus use IMS-LD as a modeling language for the global interactivity model of the system.



January 15, 2007 from http://www.imsglobal.org/learningdesign/ldv1p0/imsld infov1p0.html

[15] IMS Global Learning Consortium, "IMS Content Packaging Specification, Version 1.1.3 ," Retrieved January 15, 2007 from http://www.imsglobal.org/content/packaging/

[16] IMS Learning Resource Meta-data Specification, Version 1.3 – Final Specification," Retrieved January 15, 2007 from http://www.imsglobal.org/metadata/index.html

[17] IMS Simple Sequencing Specification, Version 1.3 – Final Specification," Retrieved January 15, 2007 from http://www.imsglobal.org/simplesequencing/index.html

Figure 6.7 KIIDS architecture overview. The Case Base stores plots and plot variations following a specific ontology.

Therefore, the first step in the process is to formalize the pedagogue's plot and goals for the application following well-known Narratological approaches and the IMS Learning Design specification. Once this has been achieved, we must add that new layer of complexity that will provide the feeling on authenticity. Following the parallelism between the elements of a Learning Design and the elements of an Activity Diagram , in our proposal we interpret each element of a Learning Design in terms of interactive storytelling. We can thus use IMS-LD as a modeling language for the global interactivity model of the system. KIIDS (Knowledge-Intensive Interactive Digital Storytelling) system is an AI tool that provides meaningful interactive storytelling with a general architecture. It provides a narrative layer dedicated to the management of the plot. This layer of the system represents the restrictions for the Story Conductor (Gervas et al 2004) that creates each part of the story . Actually, the Story Conductor is a Case-Based Reasoning (CBR) process, a problem-solving method based on a four-stages cycle. More details about this process can be found in (Peinado et al 2004).
There is a long way to go before the full implementation of a complete environment built over a fully functional system supporting IMS Learning Design Level C for Interactive Pedagogical Storytelling, but this paper presents a first approach of what seems to be an AI-based solution for the complex issue of "edutainment".

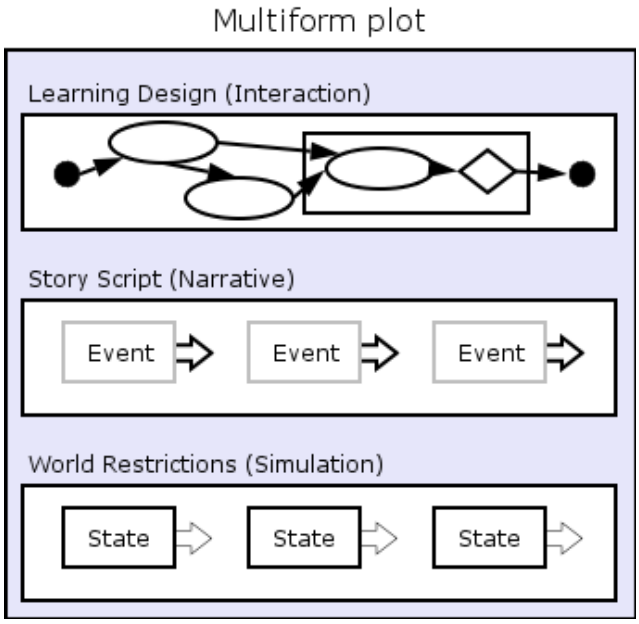


Figure 6.8 Three-layer structure of multiform plots: The KIIDS system interactively builds a story over the pre-defined Learning Design.

6.5 Mapping of Storytelling Design Model whit IMS-LD

As examined previously, several script languages have been used in interactive storytelling systems. Although these languages are specialized for storytelling, in this document we would like to investigate the use of IMS-LD to model storytelling experiences following the Storytelling Design Model (SDM) proposed in Alice Project that aims to enhance the pedagogical aspects of the storytelling approach. In this scenario, IMS-LD is the only language to model educational scenarios enabled by a wide range of pedagogical approaches and it seems to be the right choice for the investigations of this section.

IMS-LD is a standard, therefore we could create a storytelling resource compliant with this specification and execute it in an external IMS-LD player. The objective of the IMS Learning Design specification is to define a set of elements able to represent every type of learning process and formalize it inside a Unit of Learning.Within a Unit of Learning, it must be possible to:

- integrate activities belonging to different types of roles;
- integrate resources and services during the learning process;
- support a wide range of learning approaches;
- support the blended as well as the pure online learning.

In the SDM:

- a learner plays a role when he/she embodies a character living a story from its specific viewpoint (role playing);
- the learning resources are used in the various learning activities but also some services can be foreseen by teachers;
- we can use individual and collaborative approach;

In the following paragraphs a mapping between SDM concepts and IMS-LD constructs is shown.

6.5.1 IMS-LD Constructs

A learning scenario in IMS-LD is organized like a theatrical play in which the actors, the party or the role they assume in individual acts and the scene in which each takes place are defined.
The specification can be decomposed into two parts. The first one describes the dynamic aspects of the scenario. The second one describes the structural aspects of the scenario.
The first part provides a *play* object in which the flow of the learning process is represented, the activities that individuals roles play in the various acts and in what order. According to this view a *play* provides one or more *acts* to be performed necessarily in sequence as well as the *Situations* (*Beginning, The call to adventure, Problem, Middle, Solution and Closure*) of the SDM. As in a theatrical play, an *act* includes one or more *role-parts*, which are “on stage” at the same time. A *role-part* object has two reference links, the first one is used to link a *role* (and consequently one or more users) and the second one is used to link the specification of the *learning activity* to be executed by the users associated to that *role*.
The *learning activities* assigned to different *roles* must be performed in parallel, the *acts* represent the synchronization point of the activities of the different *roles* involved. This means that if a *role* ends before another, his next *act* will be made available only when the others *roles* have completed. However, although IMS-LD supports models that involve multiple learners, it can be used also for models involving single learners. Used in this way, it is possible to use IMS-LD to implement programmed learning, just as easily as collaborative and multi-user scenarios. This is the case of the SDM: in which a collaborative learning activity exists (i.e. a co-writing Wiki) but it is optional, in other words the learning process is intended as an individual moment and the synchronisation with the other users is not mandatory.A *learning activity*, referenced by the *role-part* object, can contain others sub-activities; the *activity-structure* element is used to represent this case. An *activity-structure* can be a *sequence* or a *selection*. *Sequences* organize the *activities* in a given order, then they have to be made available to a user only in that order. In contrast, the *selections* organize the activities without giving a specific order, then it will be decided by the user. The *activities,* executed in sequence by a *role,* recall to the *Events* (*advancer, learning, reflection and assessment*) of a *Situation* in the SDM.
The *activities* constituting an *activity-structure* are described through an *activity-description* and an *environment* element. The *environment* contains the *learning objects* to be enjoyed by the learners and the *learning services* to use within an *activity* as well as the scenes of an *Event* of the SDM.
Hence, we have a perfect correspondence between the SDM elements and the IMS-LD elements. Furthermore it is also possible to describe the workflow that take place in the SDM, in fact here, “*the*

assessment points support the mechanism of branching logic in the story plot. The model allows to link the alternative routes to the level of knowledge achieved by a learner". This behaviour can be represented using the Level B of the IMS-LD specification.
Level B adds *properties* and *conditions*. *Properties* enable information about learner, *roles* and the state of the learning design itself to be maintained, hence can be used for our sake to maintain the level of knowledge achieved by a learner. *Conditions* provide the capability to define rules as to what should happen when certain *Events* take place. Rules can be triggered when an *activity* or *activity-structure*, a *role-part*, an *act*, the *play* or even the *UoL* (as a whole) has completed. Another common *Event* that can be evaluated by a rule is the changing of a property value. This can be used for our sake, in fact when the last activity of an act (the *assessment event*) will change the *level-of-knowledge* property, an event will be triggered and a rule executed (as shown in Figure 6.9).
A rule can hide or show *learning objects* and *learning services*, *environments*, *activities*, *activity-structures* or *plays*.
In the SDM a micro-adaptivity branch is an event (in the same situation) that is re-lived by the learner in a different scenario (namely using different media). This situation therefore can be reproduced in IMS-LD showing a new environment with different *learning objects* or *learning services*. Note that it is not possible through a rule to show or hide *acts* or *role-parts*, this means that the level C micro-adaptivity can't be done changing the *role-part*, but simulating the change of *role* using different *learning objects* or directly changing the *activity-structure* (as shown in Figure 6.9). We can resume the mapping identified above, between the SDM and the IMS-LD, through the following table:

Table 5 Mapping between SDM and IMS-LD

SDM element	**IMS-LD Level B**
Storytelling resource (an instance of the SDM run by a specific role)	Play
Situation	Act (containing only a *role-part* object referencing an *activity-structure* of *Sequence* type)
Situation event	Activity
Event scene	Environment
Event multimedia objects	Learning objects
Event collaborative service	Learning service
Role	Role
SDM execution	**Play execution**
Workflow variables	Properties
Micro-adaptivity and branching logic	Condition rule

The following Figure 6.9 illustrates practically this mapping with an example of IMS-LD Play.

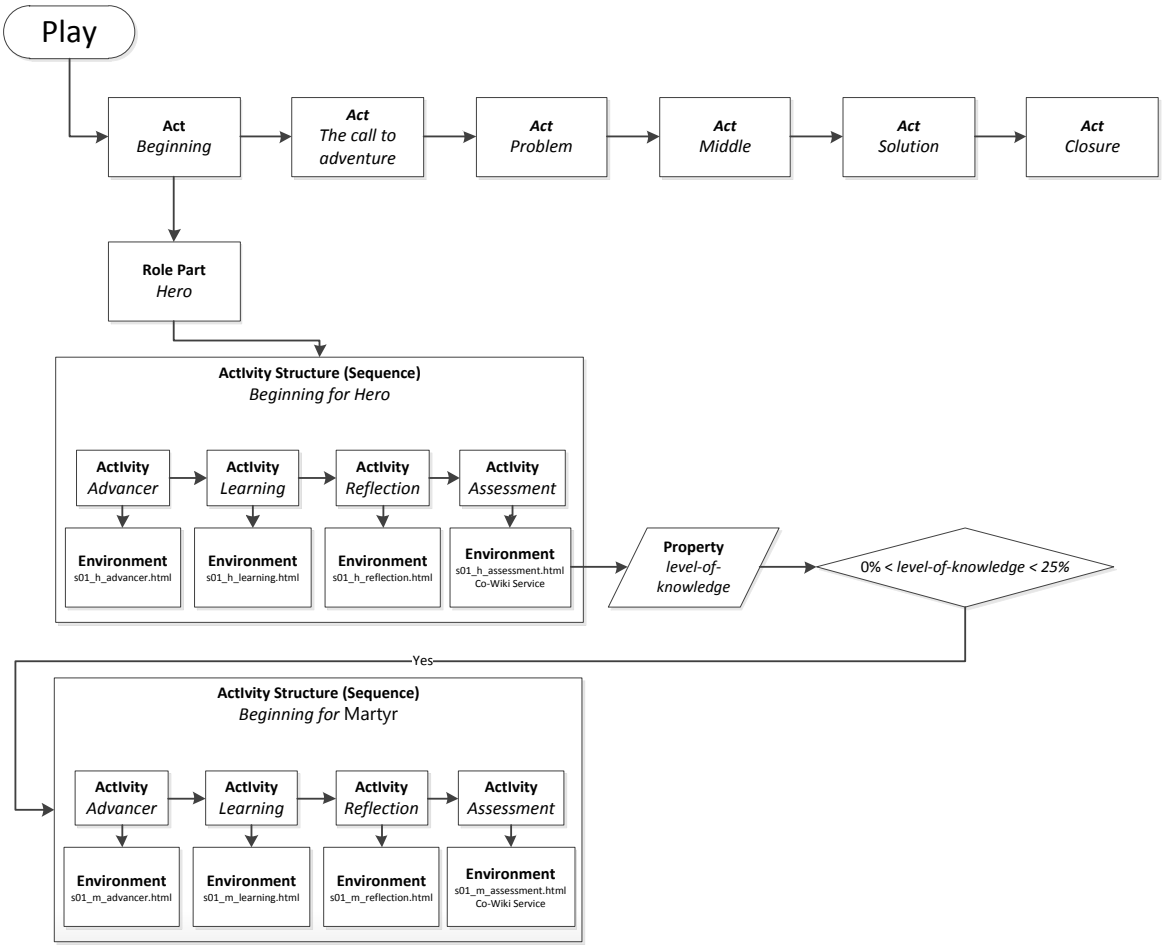


Figure 6.9 - Sample of a Storytelling Play represented in IMS-LD

7. Metadata Viewpoint: Educational Needs of CLO and SCLO

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 Intelligent Web Teacher (IWT) is a e-learning platform allowing the definition and execution of personalized e-learning experiences tailored on the basis on learners' cognitive status and learning preferences. IWT is based on three main models (Capuano et al, 2009) : knowledge model, learner model and didactic model. The first one is based on the definition of ontologies used to model the knowledge of the didactic domain of interest.

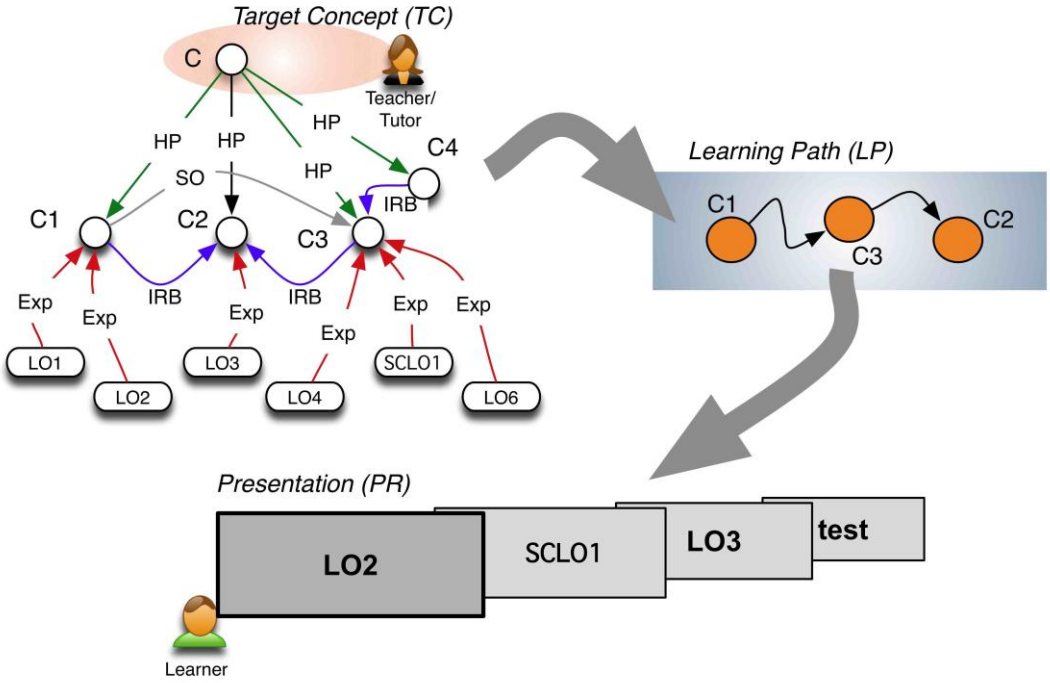


Figure 7.1 IWT: personalized e-learning experience generation process

These ontologies are used to organize the learning objects that are the building blocks exploited to realize the personalized e-learning experiences. The second one defines the rules by which a learner is profiled within the system. In the end, the third one defines the rules (basing on the most suitable learning strategy) by which the learning process happens and the knowledge is acquired by the learners.

The personalizes e-learning experience generation process is illustrated in the Figure 7.1. In particular, the aforementioned process can be decomposed in the following steps:

1. The teacher defines a learning objective or target concept (TC) by selecting a concept on the educational ontology of interest;

2. A learning path (LP) is automatically extracted from the ontology. The LP represents the sequence of concepts (piece of knowledge) learners have to acquire in order

to achieve the learning objective;

3. The LP is personalized for a learner by cutting all the concepts already known by this learner;
4. The learning experience or presentation (PR) is automatically constructed by binding learning objects
5. (coming from the IWT repository) with the concepts in the LP; Learning objects are selected in order to accomplish learners' preferences and to optimize the presentation.

In IWT, learning objects are annotate with IEEE LOM[18]. This metadata allows the link between a learning object and one or more concepts of an educational ontology. A learning object is linked to a concept if it can be used by learners in order to acquire knowledge about the aforementioned concept. The SDM guides authors to define Storytelling Complex Learning Objects (SCLO) by using the IWT authoring tools opportunely enhanced (in the context of ALICE project) to support the requirements of defined model. A SCLO is treated in IWT in the same way of a simple learning object. By exploiting IWT mechanism it is possible to insert a SCLO within a personalized e-learning experience in order to deal with specific concepts requiring a more sophisticated didactic method. Furthermore, IWT enables a macro-adaptation process. It consists in (automatically) support the generation of personalized remedial work on the basis of assessment results.

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

[18] http://ltsc.ieee.org/wg12/files/LOM 1484 12 1 v1 Final Draft.pdf

for studies that analyze educational metadata according to the Alice project and SDM pedagogical viewpoint. 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 SCLO in particular. The characteristic feature 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.

7.1 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:

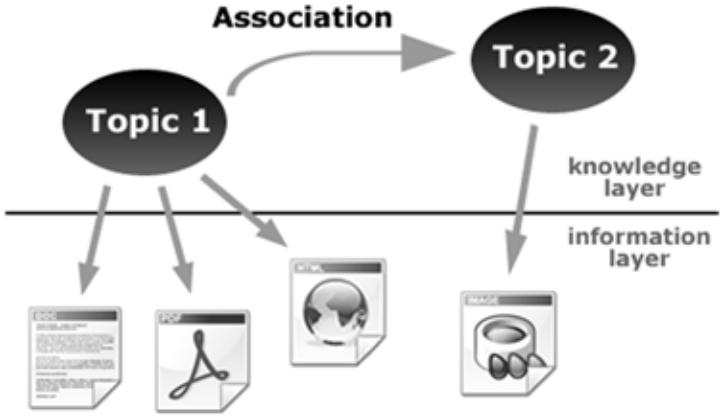


Figure 7.2 mapping between target concept sandlot

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.

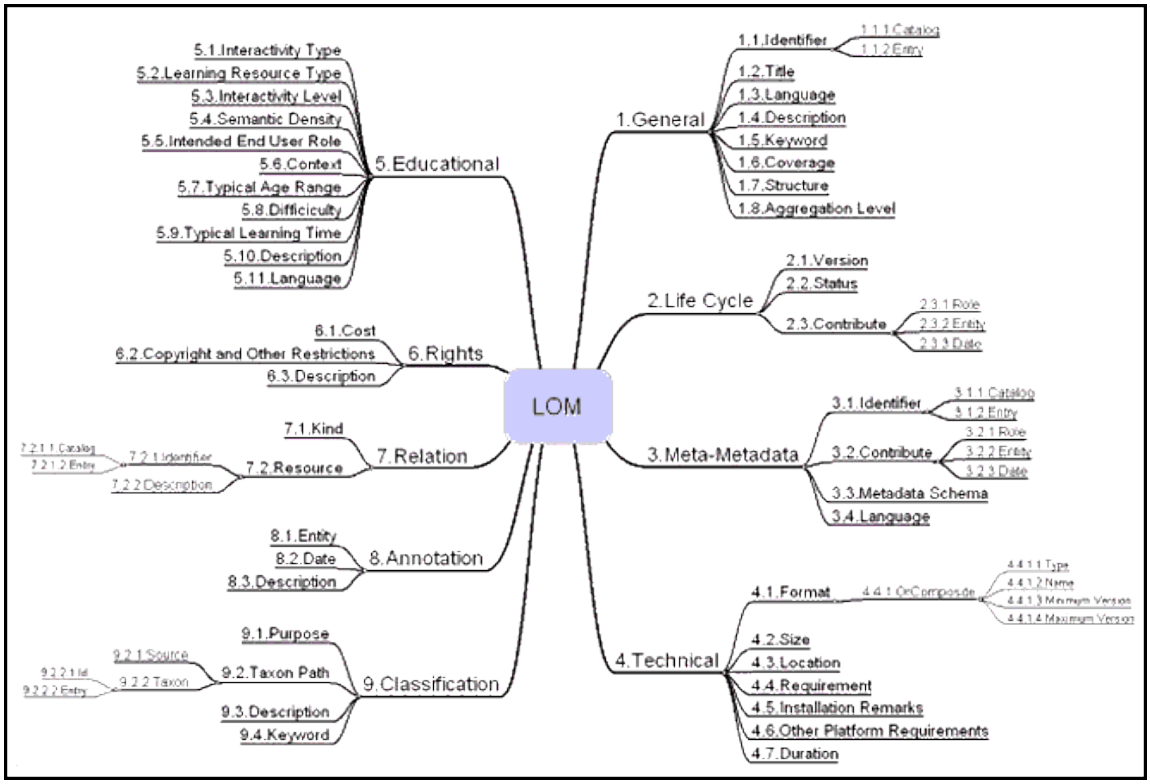


Figure 7.3 IEEE LOM

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***
Interactivity Type	Active, Expositive, Mixed	Interactivity Type		Active, Expositive, Social, Mixed.
Learning Resource Type	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 SCLO)	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.
Interactivity Level	Very Low, Low, Medium, High, Very High.	Interactivity Level	Level	Very Low, Low, Medium, High, Very High.
			Synchronization Type	Time Based Scheduling, Event Based Scheduling.
			Guidance Type	Individual, Social
			GamingRoleType	Role Playing, Role Taking, Role Making.

			Emotional axes	*Resilience (safety/anxiety), Curiosity (interest/disinterest), Engagement(excitement/indifference), Self-confidence (self esteem/frustration).*
Semantic Density	Very Low, Low, Medium, High, Very High.	Resource Complexity Level	LearningResourceConnections	*References to other LOs or CLOs.*
			Semantic Density	Very Low, Low, Medium, High, Very High.
			Difficulty	Very Easy, Easy, Medium, Difficult, Very Difficult.
IntendedEndUserRole	Teacher, Author, Learner, Manager.	Learning Audience	IntendedEndUserRole	Teacher, Author, Learner, Manager.
			Context	School, Higher Education, Training, Other.
			Language	EN, DE, IT, …
			User Age	"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 Learning Audience*		
Typical Age Range	"7-9", "0-5", "15", "18-", …	*See sub-field User Age of Learning Audience*		
Difficulty	Very Easy, Easy,	*See sub-field Difficulty of*		

	Medium, Difficult, Very Difficult.	*Resource Complexity Level*		
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, Implicit, Collaborative
			AssessmentType	Cognitive, Emotional.
			FeedbackType	Evaluative, Interpretive, Supportive, Probing, Understanding Form.
		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 6: 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 modeled 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 ***Learning Audience*** 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 ***Learning Audience. 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 (modeling 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*** (w*eb-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).

7.2 SCLO and emotional tagging

The SCLOs, as we have already underlined in the previous sections, must be annotated with metadata in order to be exploited in the IWT personalization process.

In the proposed approach the IEEE LOM scheme is extended in order to incorporate some information, called emotional metadata, about the emotions that the SCLO could arouse in the learner. The emotional metadata, defined by the learning object authors in the annotation (metadata) phase, is used to guide the personalization process with respect to the emotional dimension that sustain the learning process. Furthermore, the proposed approach also foresees a social refinement phase of the emotional metadata by exploiting the social tagging technique [Eda 2009].

In particular, a tag cloud is prepared by using emotional labels coming from the OCC Model [Alepis 2009]. The selected emotional labels are: hope, pride, distress, fear, satisfaction and gratification. Every time that a SCLO is tagged, a triple < SCLO; EmotionalLabel; Learner > is generated.

The set of all triples can be used to build a tag cloud for each SCLO, where the size of the font of an emotional label (tag) is given by the popularity of the tag for that SCLO. The popularity of the emotional labels can be used to generate feedback to the author of a specific SCLO when the most popular emotional labels for this SCLO do not correspond to the emotional metadata used to annotate it. This process is a bottom-up validation of the intention of the SCLO with respect to the emotions it would like to induce and increase.

8. Conclusions

The systematic research activity conducted in the first and second year of the project about Interactive Storytelling allowed us to confirm the value of storytelling educational strategy, to identify and classify different approaches for managing digital storytelling, to summarize several challenges and pedagogical issues. After this analytic research focusing on existing storytelling map, a pedagogical Storytelling Design Model has been identified and specific educational processes (needed to guarantee the learning achievement in storytelling flow).

In the second year of project, the research focused on the possibility to use learners' emotions to adapt the role in a story and to capture implicit assessment data in order to provide a more comprehensive evaluation of the learner and to suggest new instructional treatments coherently to a micro adaptive educational approach. Furthermore, in order to promote the social dimension a collaborative story construction has-been defined to foster the role making functional to develop the meaning making process.

The pedagogical output of research has allowed to update the Storytelling Design Model (SDM), defining a narrative learning process able to:

- enhance the character-based approach by improving the role taking and making strategies in order to support re-telling and re-living in the storytelling. In particular in the final model:
- improve the learning achievement process by exploiting emotion analysis in order to refine the micro-adaptivity mechanism enabling the emotion-based role taking;
- sustain the cognitive transformations by exploiting collaborative learning activities, based on a StoryWiki, in order to maximize the role making strategy;
- define the instructional guidance (machine and human based) by providing implicit assessment in order to track, collect and analyze learner's interactions with the storytelling interface;
- substain the digital native learning styles defining a guided and explorative narrative structure more suitable than transmitting learnt lessons if used to represent Memorial Stories related to big risk events.

This SDM is an original composition between story visual portrait, educational processes and learning outcomes useful to create a SCLO in civil emergency characterized by a story path that is not deterministic but customized on the learner, dynamical to the interaction between the learner and the story actions and guided by both cognitive and emotional-affective feedback.

9. 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 (SCLO, 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 COMPLEX LEARNING OBJECT (SCLO): 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

EVENTS IN SITUATION: components of singular situation whose structure favours the development of the organization, selection and integration of information carried out by the learners in order to maximize the results for a specific learning objective that identifies a specific level of knowledge

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.

MACROADAPTIVITY: approach that assumes that learners primarily differ on their learning rate and that adaptive instruction exists in permitting learners to move through the course at a speed according to their ability and other demands upon their time (go-at-your-own-pace feature); Intelligent Tutoring Systems (ITSs) are examples of adaptive systems, using artificial intelligence techniques in order to provide tailored and on-time instruction to the learner

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 (e.g. more compelling), a different user's role, and generally to choose a better following situation in the story.

IMPLICIT ASSESSMENT: The implicit assessment is based on the interpretation of learner´s actions and interactions (behavioral indicators) within the virtual environment

GROUP STORYTELLING: Group storytelling is a technique that involves the construction and retrieval of stories in which more than one person contributes, synchronous or asynchronous, locally or in a distributed manner, through one or more media and making one or more roles.

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).

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