Disaster Education: a narrative-based approach to support learning, motivation and students' engagement

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Keywords: emergency in education, digital storytelling, cognitive process, affective learning, empirical evidences.

Over the last decade, the interest in disaster education has grown rapidly. Several studies demonstrate that effective results can be obtained in this field only with instructional methods able to motivate the learner and to support them in practicing skills by means of narrative situations. The narrative is a privileged method that can help developing cognitive skills, organize knowledge and support the construction of meaning. In this paper we present a novel adaptive storytelling model defined in the context of ALICE project and its contextualization in the field of disaster education. The defined model aims at maximizing learner's understanding and development of concepts fostering the "learning in action" and problem solving skills in natural disaster contexts by combining direct experience, observation, discovery and action. In particular the model arises motivation in the story

for citations:
Mangione G.R., Capuano N., Orciuoli F., Ritrovato P. (2013), *Disaster Education: a narrative-based approach to support learning, motivation and students' engagement,* Journal of e-Learning and Knowledge Society, v.9, n.2, 129-152. ISSN: 1826-6223, e-ISSN:1971-8829

and creatively engage learners in finding solutions to a problem and building personal responsibility. The experimentation results are encouraging and confirm that the storytelling offers higher engagement than the traditional practicing methods.

1 Teaching the emergencies: a new disciplinary domain

Disaster education, specific subfield of Education in Emergency (EiE - Wright, 2012) has become a main subject of interest in teaching and learning science also due to the apparent increase in natural disasters occurred over the last century (Figure 1). While the field of Education in Emergency has expanded in the last decade, research on education and natural disasters is still in its infancy (Tomlinson & Benefield, 2005).

Over the past decades, academics' and practitioners' interest in confronting challenges of educating children affected by emergencies, including both natural disasters (e.g. hurricanes, typhoons, floods) and human-made crisis (e.g. war, internal conflict and genocide) (Kagawa, 2005), has grown rapidly.

Chand, Joshi and Dabhi (2003) argue that emergencies caused by natural disasters are a secondary concern in research compared to conflict-triggered emergency education. Many evidences, in fact, demonstrate that, during a natural disaster, misconceptions as well as incorrect beliefs may lead to inadequate behaviour (Alexander, 2007; Sinclair, 2001; Tannsever, 2008).

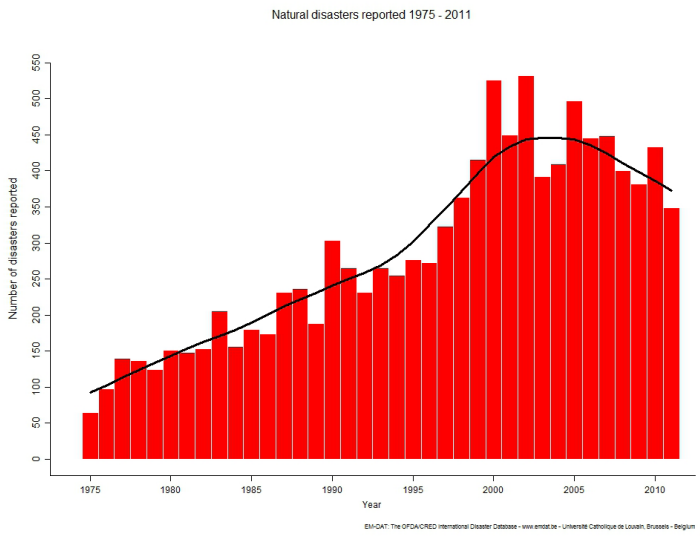

Fig. 1 - Natural disaster reported 1900-2011[1]

[1] http://www.emdat.be/natural-disasters-trends

UNESCO has identified training for natural disaster preparedness as a core issue to be addressed under the "*Decade of Education for Sustainable Development*" (DESD) in order to enable the learners to protect themselves and to behave correctly during such blasting events.

Several studies confirm that disaster and risk education should be part of the national primary and secondary school curricula and be included in several school subjects, such as geography, social sciences, biological sciences, forensics, physics, history, and domestic sciences. (Cardona, 2004; Stoltman, 2004). Also the literature endorses that the "*risk education landscape*" (Komac *et al.*, 2010) is far from uniformity and suggests that much has to be done in this field of research. (Tomlinson & Benefield, 2005)

The lack of uniformity is also demonstrated by the fact that several terms are used in different countries to describe the same field of Disaster Education like: emergency education, education in conflict, education and fragile states, education and crisis, education and post-crisis transition, education and natural disasters.

The data available in the sector of Disaster Education is primarily quantitative and focuses on the number of children attending school prior and post disasters. The qualitative component looks at developing education programs that focus on emergency preparedness. The disaster risk reduction education concerns building students' understanding of the causes, nature and effects of hazards while also fostering a range of competencies and skills to enable them to proactively contribute to prevention and mitigation of disaster. Both knowledge and skills in turn need to be informed by a framework of attitudes, dispositions and values that propel them to act pro-socially and responsibly.

Some of the Countries vulnerable to natural hazards such as Japan and USA, usually do *separated disaster education* approach. The Japanese school disaster education, for instance, only includes education for natural hazards. On the contrary, the British disaster education applies a "*holistic approach*". It includes all types of hazards, thus it should be better called risk education or safety education than disaster education (Shiroshita *et al.*, 2008)

Today, a number of examples around the world are beginning to reveal the power of formal education in disaster risk reduction, integrated into curricula for all age levels. A review of Disaster Risk Reduction (DRR) reveals a range of approaches to the inclusion of disaster risk reduction in school curricula (Petal & Izadkhah, 2008). The approach most frequently found includes *infusion* or *permeation* whereby DRR themes and topics appear within the curriculum of specific school subjects. A broad range of courses can be integrated or infused with disaster risk reduction. "*Disaster risk reduction content can and should also be appropriately be infused into social studies, physical health and safety education, language arts such as literature and composition, civics, and ma-*

thematics. The content distributed in this way, needs to be linked in order to be complementary and to make sense" (Petal & Izadkhah, 2008, pp. 3). This usually happens following a curriculum review whereby the curriculum is scrutinized for its DRR relevance and potential.

In terms of learning and teaching processes, innovative pedagogies are suggested. A disaster education program requires that teachers use instructional methods able to activate the learning which is more relevant with learners' needs and interests, and likely able to motivate them to learn more. "*A pedagogy that brings knowledge to life, practices skills, challenges attitudes and scrutinizes values is a pedagogy that is active, interactive, experiential and participatory*" (Selby & Kagawa, 2012, pp.29).

Knowledge to be also internalized needs to be contextualized within real situations. Similarly, skills need to be practised to be honed. Behaviour, Knowledge and Motivation are rethought through interactive dialogue, point of view sharing, and constructive debate.

Several case studies for Disaster Education have been presented in (Selby & Kagawa, 2012). The following learning modalities, listed in (Selby & Kagawa, 2012, p.39) are used to better engage students in disaster risk curriculum across the aforementioned case studies:

- ***Interactive Learning***: brainstorming; discussions in pairs, in small groups and with the whole group; interactive multi-media presentations.
- ***Affective learning***: sharing feelings about threats and disasters; empathetic exercises based upon those caught up in disasters.
- ***Inquiry Learning***: team case study research and analysis; Internet enquiries; project work.
- ***Surrogate Experiential Learning***: filmmaking, board games, role plays, drama (sketches, mime, puppetry), simulation gaming; school assemblies on disaster topics.
- ***Field Experiential Learning***: field trips to disaster support services; hazard mapping and vulnerability assessment in schools and in communities; community hazard transects; reviewing emergency plans; interviewing local community on hazard/disaster memories.
- ***Action Learning***: student community partnerships to raise hazard awareness, develop risk maps and risk reduction plans; poster campaigns; street theatre.

Basing on the above mentioned case studies, a technique likely to have good potential to be effective in teaching/training school children about emergency preparedness is **Storytelling**. The narrative, in this view, is a privileged instrument that can help develop cognitive skills and organize the knowledge and a powerful cognitive tool to support the learner during the meaning construction

(Bruner, 1992).

Teaching *emergency preparedness* may in fact involve many complex topics and, as shown by various studies, narrative strategies can be an effective method for teaching subjects that are intrinsically intricate (Hulya, 2010). Since nature (e.g., through natural hazards) is closely integrated with social and cultural development, it is important for the learning to refresh or preserve memories; for instance, through storytelling. In addition, the story is land of possible metaphors to help someone learn a concept. Recent studies in the field have emphasized the importance of working with conceptual and visual metaphors, identifying metaphors that the students mostly converge on when dealing with an earthquake (Kaya, 2010).

Moreover, during the narrative experience in risk education the metaphor can be a useful way of bringing implicit assumptions to awareness, encouraging reflection, finding contradictions, and fostering change in educational beliefs and practice (Cameron, 2003).

Stories can be both personal (real) and general (universal); the more the stories used in education are realistic and embodied in real life they are describing, the greater symbolic potential they carry out. An interesting example is the "Tsunami Story," (ADRC, 2005) based on a true story at the time of the Ansei-Nankai Tsunami (1854), which claimed about 3,000 lives in coastal areas of western Japan (Komac *et al.*, 2010). Since telling stories relies on the use of language, it is also beneficial in developing and expanding language skills. Using stories also enhances critical thinking and writing skills (Koki, 1998; Mello, 2001).

In addition, several models of protective behaviour describe the correlation among emotional state, motivation factors, risk reduction behaviours (Abraham *et al.*, 1998) and the intention to learn. For example it has been argued that earthquake anxiety may reduce the likelihood that people will prepare for earthquake (Duval & Mulilis, 1999; Lamontaigne & LaRochelle, 2000).

The presence of *affective learning* (Bevilacqua *et al.*, 2009) is very important but often disregarded by risk education strategies. "*This is both strange and understandable. It is strange given that consideration of both actual and potential hazards/disasters can elicit strong emotions in the learner: learning that a disaster once ravaged one's community and that there might be a recurrence can be frightening, if not nightmarish unless pre-emptive steps are taken*" (Selby & Kagawa, 2012, p.30)

The authors also assert that "*however, a low premium seems to be set on affective learning within disaster-related curriculum and pedagogical development so far. Moreover it is understandable given that the facilitation of emotional learning requires special skills that, are rarely developed as part of DRR-related teacher training and guidance*" (Selby & Kagawa, 2012 p.30).

Basing on the above considerations, our opinion is that disaster education need to develop more imaginative and innovative forms of assessment of student learning under DRR curricula. If knowledge, skills, attitudinal/dispositional and behavioural learning outcomes matter, then appropriate assessment forms need to be considered in order to illuminate the actual extent of the realization of these outcomes.

The educators are asked to provide a variety of instructional methods and activities (do, connect, play, share) to engage the Millennials (Mangione & Caballè, 2012) in a risk education process basing on learning technologies as an important driver of pedagogical change (Barnes *et al.*, 2007). In this context, the ALICE Project introduces new opportunities for supporting students' skills of problem solving and learning in a specific emergency domain (Capuano *et al.*, 2012) combining direct experience, observation, discovery, and action into an inseparable whole (Kolb, 1984). The purpose of this paper is to present findings obtained within Alice's framework.

The paper is structured as follows: the next section presents the Adaptive Storytelling Model defined in ALICE in order to maximize the learning achievements in specific risk domain and to focus the attention on story structure, learning situations and role taking based on emotions. The third section presents the developed prototypes and content generated by means of them. Furthermore, the forth section reports results obtained after the experimentation phase. The last section provides conclusions and future works planned.

2 The Adaptive Storytelling Model for Disaster Education

This section is purposed to describe the theoretical model defined for the design and the execution of a storytelling learning resource for disaster education within the ALICE project. The model is aimed at maximizing learner's understanding and development of concepts and also at arising motivation in the story and creatively engage learners in finding solutions to a problem and building personal responsibility.

To increase the levels of motivation, the model we have defined, coherently with the socio-cognitive perspective, implies the following developmental learning process: motivating the learners to be prepared, facilitating the formation and promoting the conversion of intentions to preparedness. This Model addresses both affective (emotional) and cognitive (informational) treatments, tailoring a natural disaster context.

2.1 The theoretical model

The Storytelling Design Model (SDM) is based on the notion of Visual Portrait of Story (VPS) defined by (Ohler & Raymond, 2008) able to guide the development of story-based didactic resources. The defined SDM exploits the concept of *transformation formations* (Ohler & Raymond, *op. cit.*) considering the *intellectual transformations* as changes in terms of learning objectives. At this level of transformation, the learners (who lead the characters) are asked to use intellectual abilities in order to solve a problem.

We proposes an extension to the association between Bloom's Taxonomy and character transformations in order to map each transformation with a specific phase of the Visual Portrait of Story (*Beginning*, *Call to the adventure, Problem, Middle transformation, Solution, Closure*).

In our SDM, the learning situations, based on the phases of VPS have been related to the six different levels of learning objectives, which are considered by an increasing order of difficulty, from basic to higher levels, of critical thinking skills (Mangione *et al.*, 2011).The learners know about risks, understand the ideas of vulnerability and resilience and can apply them to specific potential hazards.

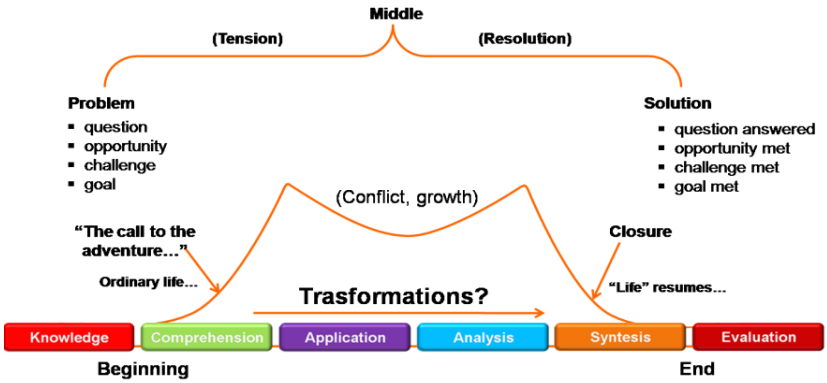

Fig. 2 - Storytelling Portrait

In order to ensure the achievement of the assigned learning objectives, each situation presents itself as a composition of *instructional events* (advancer, learning, reflection and assessment) whose structure facilitates the development of organization, selection and integration of information carried out by the learners in order to maximize the results for a specific learning objective, associated with a specific level of knowledge.

The following events are repeated for each VPS situation:

- **advancer event**, that is designed to activate the student's prior knowledge and ensure their initial involvement in the situation;
- **learning event**, that supports the learner's understanding of topic goal and is based on a guided approach;
- **reflection event**, that is designed to help the learner reflect on learned concepts and to allow them to consolidate the acquired knowledge;
- **assessment event**, that submits learners to testing (with respect to a specific VPS situation the learner may be involved in) for evaluating the type of transformation occurred.

The combination of these "instructional events" for each situation has the objective to enhance the desired learning level and to support the learners' cognitive transformation into domain contexts focused on the safety management in an Amusement Park (figure 3).

Fig. 3 - Example of storytelling learning event in Amusement Park

The Amusement Park can be seen as a critical infrastructure of interest because it is an area containing advanced electro-mechanical infrastructures in motion and because parks are areas with a high population density. This situation's structure articulated in educational events suggests that adjustment can be better understood by moving from a focus on the behaviour background and metaphors developed about "earthquake" (in this case related to "risk perception") to the cognitive process that underpins the knowledge and behavioural

change and its maintenance over time.

2.2 Changing the role basing on emotions

The assessment event presents a selection of assessment modes. Through the arrangement of a variety of tests and items with different levels of interactivity and complexity, it is intended to detect the learners' levels of knowledge during the storytelling. The result, in terms of measurement of knowledge they have acquired, should determine a remodelling of the story path, or the entire personalized learning experience where the learning resource is inserted, with the aim of facilitating, supporting and motivating the learner in reaching their learning goals.

In particular, if the assessed learner's knowledge level (with respect to a given situation) is insufficient (comparing it to a given threshold) the learner takes a new role by which he re-lives the previous situation in order to get a different viewpoint on the story.

Role taking is a specific level of micro-adaptivity. This level is defined according to a novel approach based on the concept of *Point of View* (PoV) in a story, where the perspective of a specific character (with a specified role) taking part in an action is regarded to (Vaz & Paiva, 2006; 2005).

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 (Mangione *et al.*, 2012).

Then, we have reasoned about how beneficial such archetypes are to balance the emotional state of a student when altered (i.e. non-functional or discordant with the one required for learning in a specific emergency situation of the story path). For this purpose, we firstly defined the emotional state as a vector on a hyperspace composed by four principal axes: A) **resilience** (safety vs. anxiety), B) **curiosity** (interest vs. disinterest), C) **engagement** (excitement vs. indifference), and D) **self-confidence** (esteem vs. frustration) (Arroyo, 2009).

Going back to the study conducted on various models, employed to describe the roles' personalities in narrative stories and their behaviours or main activities, we also imagined to map them using the emotional model lexicon in order to describe personalities and understand some archetypes able to guide the story design and the re-addressing of role micro-adaptivity.

Once the roles had been identified together with the emotional axes, we defined a role taxonomy for each archetype useful to rebalance the emotion in a new branch of the story (see table 1).

As an example, when disinterest emotion it is detected, the system can address the student to a different perspective that may let him/her understand the damage resulting from a lack of knowledge or the ability to act in a given context (e.g. hero, innocent, etc.). If these emotional axis indicate a negative value and therefore a student's interest but with insufficient learning results, it is needs to re-address him/her to active roles of greater relevance (e.g. hero, helper, etc.).When the emotion detection indicates a state that is 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).

Table 1
NARRATIVE ARCHETYPES, ROLES AND EMOTIONAL AXES

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*)

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 (e.g. wise, ruler). The figure 4 shows the scene through which it is possible

to change the student role in "helper" according to the detected cognitive and affective state.

Our study also takes care of the emergency education theories postulating that high prominence should be given to affective learning because a key component of learning, self-esteem building, is vital for developing responsible, responsive and active citizen. The affective dimension, according to risk education studies, should not be disregarded also because of an high correlation between the sense of personal self-worth and the level of altruism and willingness to take action for the good of peers.

Fig. 4 - Role taking in storytelling

3 The Developed prototype

In order to build and experiment a serious game for disaster education based on the defined model, either a specific editor or a player, embedded in an existing e-learning system have been developed.

The editor being obtained by customizing the Microsoft Workflow Foundation v3.5 designer and by connecting externally built content to the workflow activities. Within the editor, a simple and clear editing layout and various content editing functions enable authors to make creative contents of story and publications quickly (see figure 5). It also allows the authors to include in each activity specialized interactive multimedia elements like textboxes, images, video, audio and flash files. The storytelling editor also allows the creation of testing activities and the management of different flows inside the story. A *table of rules* must be defined by the designer. Rules guarantee that checks are executed in every assessment cycle: if the score overcomes a given threshold, the story flow proceeds to the next narrative situation otherwise the cycle is restarted.

The table of rules also includes facilities to check and change the role of the learner. In fact, after an assessment, if the result is too low, the user role must

be changed taking into account emotional data captured by a set of emotional tests made in accordance to subscale able to measure state-aspects of emotivity (Mangione *et al., op. cit.*). The emotional data are used to identify the best narrative *archetype traits*, which are useful to re-balance the emotional states and to select the new role to be assigned to the learner.

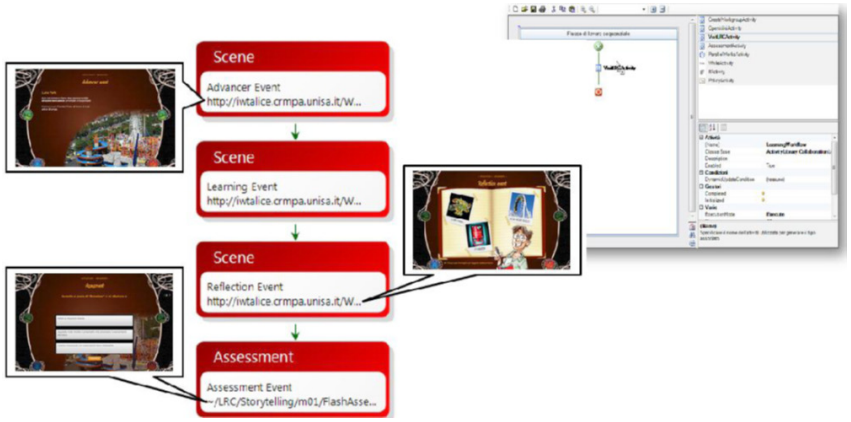

Fig. 5 - The storytelling editor

The player is included within the IWT platform, an intelligent learning system (Gaeta *et al.*, 2012) able to build personalized learning experiences (Capuano *et al.*, 2009b). Within IWT the student can access the story and following the experience (figure 6).

The player being an application that allows learners to follow and to get engaged in a story. It is a Silverlight application that can run inside a Web page and that allows a user to choose, load and play a storytelling learning resource from a repository of previously created objects.

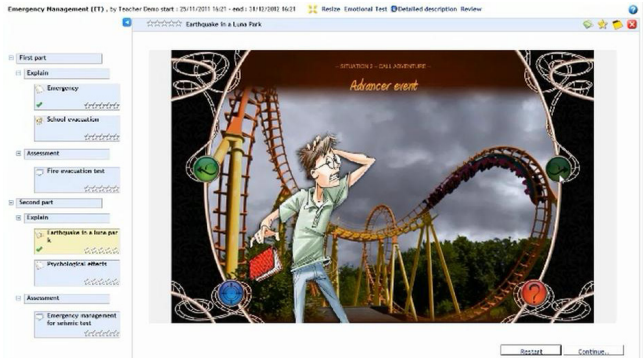

Fig. 6 - Example of storytelling events in risk education context scenes

4 Experimentation and Validation in Italian secondary schools

In order to evaluate if a learning resource that combines guided, objective-oriented and emotional adaptive processes for contributing to better learning and engagement in disaster education, four Italian schools were involved in an experimentation. Specifically, an experimental group, composed of 2 teachers and 29 students had the chance to access an educational experience suitably created to meet learning topics related to emergency management through the use of Storytelling.

Thus, a specific learning course about the management of risks was structured. The learning course aimed at teaching the right behavior to be acquired in the event of a natural phenomenon such as an earthquake in an amusement park or the evacuation of a building due to an alarm.

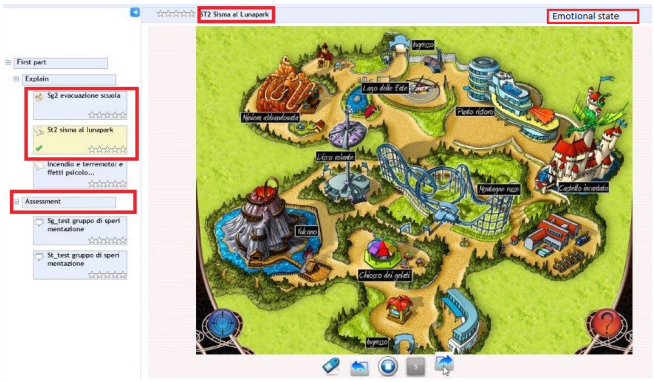

Fig. 7 - Overview of the learning course

All students were supervised by a tutor during the experiment. At the end of the course, a qualitative and quantitative survey was given in order to test efficacy of the storytelling.

4.1 Qualitative Analysis

The quantitative analysis was based on a questionnaire composed of six open-ended questions to the experimental group. This has enabled us to obtain a judgment about the effectiveness of the proposed learning resource, its originality and innovation compared to the disaster education sector and in terms of ability of the resource to drive towards the achievement of specific knowledge.

The first fact that emerges from the analysis of the questionnaire is the storytelling ability to meet the new navigational and exploratory style of students. The answers to question 1: "*While using a storytelling resource, were*

you asked to navigate autonomously and to explore possible ways presented by the story?" suggest that storytelling and its various reading levels have given students the opportunity to explore in a guided manner several angles of situations through a progressive learning of scenes and have allowed them to achieve their learning objectives by overcoming trials.

Game "reiterations" were particularly appreciated as it clearly emerges from answer to question 2:" *Have the suggested reflection moments given you a key to understand the objective?*" The guidance of the intrinsic structure of each situation and the reflection phase have helped give learners a higher level view of the key concepts and of the their relationships, allowing them to accomplish their final goal. This confirms the validity of the storytelling as a teaching resource which can counteract one of the risk factors of the new generation of apprentices, characterized by a short-term memory and a loss of noble skills.

With respect to question 3: "*Have the assessment events, distributed within diverse key situations, allowed you to delve into learned concepts before moving forward?*" students consider the assessment events very important to improve their capability for critical judgment with respect to the knowledge to be acquired. The feedback that accompanies the detected performance during the assessment, promotes an adjustment capability and a greater predisposition to follow alternative events aimed at recovering the found knowledge gaps.

Answers to question 4: "*Was it helpful for you to understand whether your emotional state may influence your interaction with the story?*" show the appreciation of students for an experience that took into account their emotional state and the understanding of how this state affected in some way the continuation of the story (by a suitable change of role) improving the acquisition of a sense of accountability and a better governance of high-risk situations and improving their skills and knowledge in relation to the procedures for rescuing and evacuation of seismic zones.

The multimedia component, with particular attention to the visual one, was able to engage students and motivate them to learn the rules of conduct to be taken in case of emergency. The question 5: "*Were visual and auditory stimuli opportunely defined so to allow you to follow the story events and focus on the most important ones?*" attributes to the storytelling resource the ability to keep the student's attention high and to call him/her to responsibility and risk analysis.

Finally, the results obtained from question 6: "*Do you think that the teacher should use the information about the emotional state experienced by the class to arrange alternative activities?*" reach a quite high average. This testifies that students think that teachers should be in charge of taking into account the individual emotional states detected by the system to provide alternative activities (including corrective and scaffolding ones), finalized to bring students in a equilibrium state that is functional to learning.

The Figure 8 shows the average of the students' evaluation with respect to the storytelling activities. In the x axis, answers to questions (coloured columns) are shown for each experimental class. In the y axis the average score is reported in a *likert* scale ranging from 0 to 5.

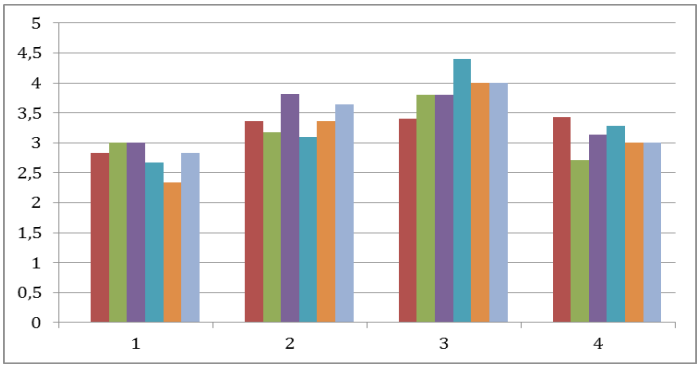

Fig. 8 - Average's answers to opened questions

This analysis of the averages for each question valids the storytelling as a possibility to change and renew the learning experience in risk education taking into account an instructive architecture for which the assessment and reflective events have obtained the most successful.

To investigate about the students' emotional state while using the storytelling tool, we added a section concerning "emotional aspects", which included 12 items of the Computer Emotion Scale (CES) that measure emotions related to narrative experience (Kay, 2008).

As reported in figure 9 the most interesting figures are related to the presence of anxiety (41%) and sadness (48%) feelings.

These emotional expressions highlight a full student's involvement in the educational context and the capability of the chosen narrative structure to generate tension spikes during the problem progression. This let the students empathize with the dramatic situation, thus maintaining a constant level of anxiety and tension useful to overcome the various assessment scenes

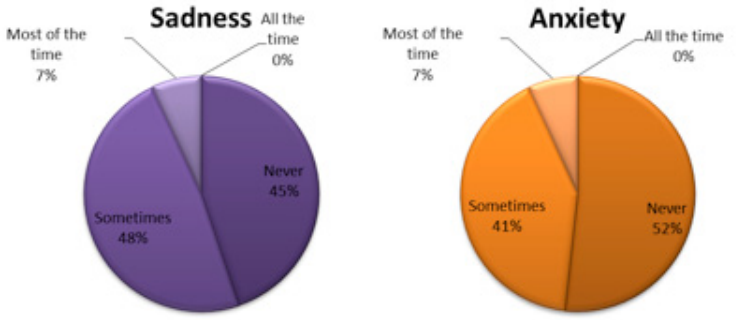

Fig. 9 - Results of emotion measurements during the game.

4.2 Quantitative Analysis

In addition to a qualitative analysis, the experimental data were analysed from a quantitative point of view in order to validate the teaching experience as well as the effectiveness of the storytelling as a learning resource. The number of accesses to that resource for the experimental classes appears to be satisfactory: all students (29/29) have benefited from the resource, even using multiple accesses with the ability to keep the student profile and to suspend and re-enter the resource with respect to individual learning pace and needs.

Figure 10 shows a suitable number of accesses (the x axis presents an average number of accesses per student equal to 1) showing a continued approach in the use of the storytelling resource and also cases of multiple accesses (up to 4 accesses per student) arising from the need for longer time to sediment key concepts before continuing the narrative path.

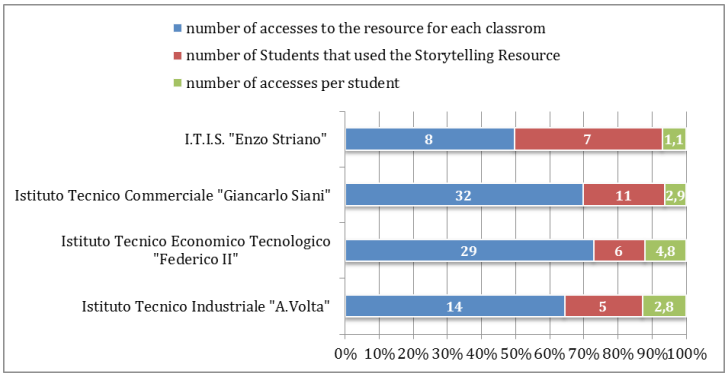

Fig. 10 - Accesses to the storytelling learning resource

The attractiveness of the storytelling is further confirmed by the tracking data that show an increase in the number of accesses to the resource directly proportional to the navigation time spent on each game situation. The students of experimental classes have in fact explored the communication levels of the narrative experience and, as shown in Figure 11 have navigated through the storytelling resource for an average time deemed sufficient to complete all the educational events and support the various assessment steps arising from the narrative situations.

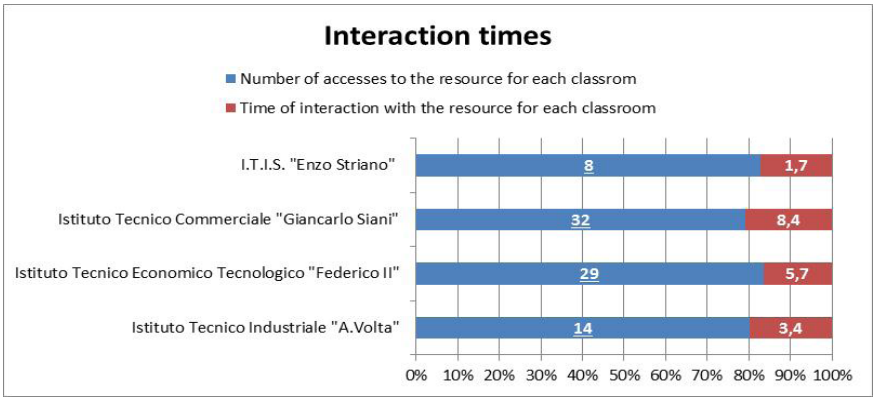

Fig. 11 - Interaction times with the storytelling learning resource.

A detailed analysis shows us the navigation time for each narrative situation. This data is very important to validate the structure of teaching situations and their association with the level of knowledge coming from the Bloom's taxonomy. From the graph presented in Figure 12 you can see that the navigation time (in seconds) is proportional to levels and types of knowledge to be acquired in each narrative situation.

As the Bloom's taxonomy is spanned, the student should pay more attention to situations and events gradually increasing the levels of permanence on the various educational events. During the first 3 situations (Beginning, Call to Adventure and Problem) the average time of navigation, exploration and permanence is around 30/45 minutes. In situations 4, 5 and 6 (Middle, Solution, Closure) the timing of exploration, navigation and permanence increases reaching an average time per situation that goes from 50 to 70 minutes.

From the situation 4, the protagonist of the story is called several times for the purpose of better defining the problem, for understanding the type of action that he is expected to act and solving the problem. This entails the need

for students to return several times on key concepts that must be used to act in the best way and that, for this reason, require longer time for reflection. The situation 5 presents higher average times related to a climax peak in the story structure also because it includes a possible role change, and allows to overcame knowledge gaps.

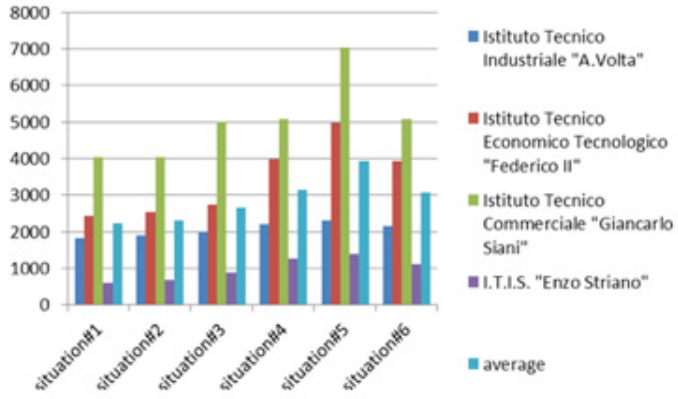

Fig. 12 - Navigation time w.r.t. different situations.

A measure of the user involvement, with respect to course themes, was obtained by comparing noting activities (i.e. comments, notes, tags) during narrative scenes with the navigation time.

The combination of these two factors, presented in Figure 13 provides a measure of the level of "pacing" i.e. of the concentration shown by the student and of his work as a "note taker" during the experience. The data shows a good relationship between the average usage time and the time spent in noting activities. On average, the students made a comment every 10 minutes. This figure rises in situations requiring more activities, a greater reflection and responsibility (situation 5 in particular).

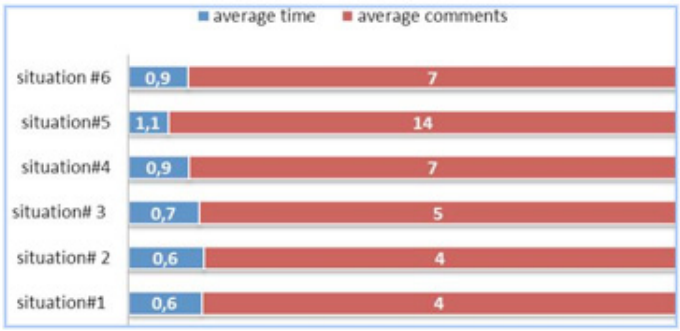

Fig. 13 - Results of note taking activity.

4.3 Analysis of Outcomes

The effectiveness of the teaching architecture of the storytelling resource is linked to the level of expertise gained during the use of the resource itself. To objectively validate the time quality spent on the resource as well as the guided exploratory approach, we analysed the average results obtained by the diverse experimental classes during the tests included within the narrative situations

Figure 14 shows how, in general, the first situations gave less problems to students also due to the type of knowledge to be acquired. It can be seen in fact that the average scores of the knowledge levels are quite good, placing themselves around 50-60. As the students moved to the other 3 situations, including scenes related to the higher part of Bloom's taxonomy, the mean values decreased, with a gradual increase in the navigation time. Specifically, in situation 5 we tested the quality of role adaptivity based on the emotional state: 12 out of 29 students were directed to a change of role allowing them to bridge the detected knowledge gap (situation of 5/1).

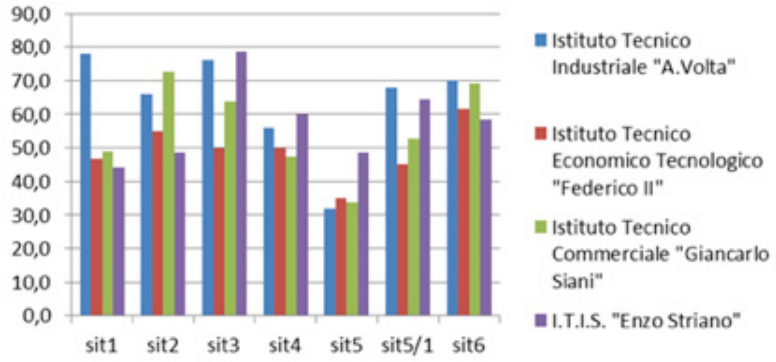

Fig. 14 - Average percentages of assessment results for each situation

A further analysis was carried out for the measurement of attention and motivation of the student during the storytelling. The graph in Figure 15 relates the number of times that students left the study session (but remained within the educational class) with the level of achieved learning. The data allows us to understand whether the student used the time out to individually explore some of the concepts or simply abandoned the resource suffering, when coming back to the resource, of a loss of context leading to the occurrence of knowledge gaps.

The analysis of the graph shows that the students, including groups for which more movements in terms of stop and go were recognized, maintained a high level of motivation and attention, enabling them to build solid conceptual links being stored in the long term memory.

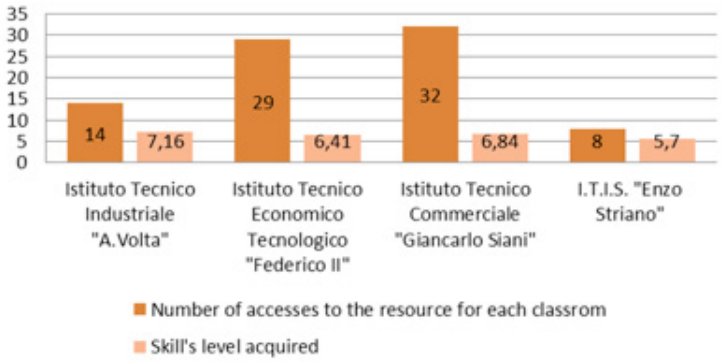

Fig. 15 - Motivation and Attention during storytelling

Final Remarks

This work provides an overview on the storytelling approach defined in the context of emergency in education. A novel storytelling model is also proposed in order to provide a pedagogical guide to the design and delivery of template-based storytelling resources.

A learning resource based on the storytelling to improve the preparedness in disaster education was designed and experimented among students of Italian schools. The experimentation results are encouraging and confirm that the storytelling offers higher engagement in risk education for millennial student.. It is an interactive didactic element, more oriented to a student-centred educational approach and able to involve students emotionally, providing guidance and making the reflection easier. Future works will focus on *somatic learning* in storytelling as a new form of experiential learning where the learner becomes an active participant in the knowledge acquisition process from his bodily experience (Amann, 2003; Horst, 2008). Participating in building or creating activities in the storytelling that require the body engagement and the making in action of specific motor skills also provides a *kinaesthetic* experience able to support the knowledge acquisition. Given the multiple ways to include somatic learning in the learning environment, we will try to identify and understand if new paradigms of Human Machine Interaction can be a tool for reclaiming body in digital storytelling and how such an integration can foster the transformative learning in our storytelling model.

Acknowledgement

This research has been partially supported by the European Commission under the Collaborative Project "Adaptive Learning via an Intuitive, interactive, Collaborative, Emotional system", ALICE, VII Framework Program, Theme ICT-2009.4.2, Grant Agreement n. 257639.

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