Engaging e-learning for risk management: the ALICE experience in Italian schools

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***Abstract*—Learning to behave in case of natural disaster is one of the most urgent challenges in our modern society. The school plays a major role in the development of educational plans for disaster reduction, designing appropriate resources and selecting didactic methods able to guarantee the retention and progression of the learning process. The challenge for the educational institutions is to introduce new learning and teaching approaches to engage the *millennial students* overcoming the main issues of traditional learning experience such as lack of empowerment, exploration, participation and locus of control. In order to contribute to overcoming these limitations with respect to learners' engagement, we implemented ALICE, an innovative adaptive environment for the e-learning able to combine personalization, interaction, emotional aspects. The experimentation and validation activities reported in this paper confirms the instructional value of complex didactic resources and the impact on learning process in risk education setting.**

Keywords—risk education; adaptive learning; complex learning resource; learning engagement; emotions.

I. INTRODUCTION

The risk education has become a subject of main interest in teaching and learning science also due to an apparent increase on natural disasters in the last century. Learning to behave in case of natural disaster is one of the most urgent challenges for our modern society [1].

The misconceptions about natural disasters and incorrect beliefs are often the causes for misguided actions that lead to inefficient behaviors during earthquake phenomena [2].

Instructional plans for disaster reduction must become an integral part of any educational strategy aimed at promoting and creating sustainable societies.

School can play an important role in risk education [3] also because "*children are excellent emissaries between home and school for information and mitigation practices relative to natural hazards and they can contribute significantly to raising awareness and public understanding of disaster vulnerability and issues*" [4],[5].

Together with to these issues there is the need to respond effectively to the learning peculiarities of new millennium learners. The educator, by understanding the millennial students and how they learn, will be more successful in creating a learning centered environment.

The way Generation Y (Gen Y) learns has been called "mediated immersion", a way characterized by a greater fluency in the use of media, a more collective sharing and learning, and a cooperative design of learning experiences. Gen Y asks for a learning developed in more realistic contexts as well as in simulated environments and for the use of more non-linear texts. The literature precisely observes that Digital Age students express this need for more varied forms of communication and report, being easily bored with traditional learning methods. Net Genres need self-directed learning opportunities, interactive environments, multiple forms of peer feedback, and assignment choices that use diverse resources to create personally meaningful learning experiences. Educators need to provide a platform and mechanisms for the learning by effectively reaching the teaching experience using a variety of instructional delivery methods and activities to engage students within their own learning process.

The field of educational technology considers the research of new models and the experimentation of new methods as the major challenge for educational designers. How can educators reach the Millennial student and provide them with a productive learning environment?

Based on Howe and Strauss's [6] seven characteristics of Millennial students, we offer a few suggestions to assist with the instructional delivery. The challenge for the School is to introduce new learning and teaching approaches to engage the millennial students [7]. Although the pedagogical engineering develops new tools to improve user's experience and to effectively respond to the way in which the new generations conceptualize a learning experience, there are still some problems to overcome: issues that contribute to this lack of engagement can be seen in a poor interaction, unchallenging learning materials, lack of empowerment and poor social interaction offered by the current e-learning systems and tools.

In order to contribute to overcoming these limitations with respect to learners' engagement we implemented ALICE, an innovative adaptive environment for the e-learning able to combine personalization, interaction, emotional aspects with the aim to maximize the lesson learned in risk education.

The main results coming from ALICE with respect to these research themes have been discussed as well as the encouraging results coming from an experimentation made with real users in Italian schools. The experimentation and validation activities reported in this work consider complex didactic resources, their scientific aspects and the impact on risk education.

II. VISION AND INNOVATIVE DIDACTIC COMPONENTS

The literature confirms that the "European risk education landscape" is an emerging field of research. In terms of process of learning and teaching, innovative pedagogies are suggested in the risk education [8], [9]. A disaster education program requires that the teachers may use instructional methods (mini-lectures, debates, brainstorming exercises, presentations, games) able to teach what is more relevant to their needs and interests.

The ALICE project [10] focuses the attention on the construction of a "complex" learning experience that includes active resources and is based on explorative, social and intuitive approaches. These resources provide a complex internal adaptivity that can maximize the nonlinearity of paths, by using educational resources fit to the learner's preferences and needs.

Adaptivity is therefore the added value of the ALICE vision that is not deterministic but customized to the learner, dynamical to the interaction between learner and system, and guided by both cognitive and emotional-affective feedback. Each complex resource presents itself with a very specific architecture, but with a common layer designed (1) to promote adaptive internal engagement, as well as explicit and implicit assessment (both cognitive and emotional) that can encourage continuous feedback and, to (2) address student's needs by adapting location and structure. In the following sections, we also present the semantic layer developed in order to enhance the adaptive potential of IWT in terms of creating Contextualized Learning Experiences.

A. *Emotional component*

The classification of a learner's emotions is an essential step in building teaching experiences that are sensitive to the learner's emotions [11]. The ALICE project has defined an original model to handle emotions in the context of adaptive learning experiences: this model, integrated in Intelligent Web Teacher (IWT), is able to manage the emotional feedback and exploit it to adapt pedagogical strategies to keep students engaged, and to boost self-confidence, heighten interest, and maximize learning outcomes.

After the individuation of variables that may represent students' emotional characteristics related to learning content and exercises [12], the prediction of emotional states relies on a questionnaire-based explicit detection [13].

The decision to adopt a self-report technique (questionnaire) to measure the emotional state, although it is very different from other more non-intrusive methods [27], is tied to the need to obtain reliable data and, at the same time, to maximize the students' locus of control. That helps them understand how their emotional state could influence or be influenced by the learning process.

Our approach takes into consideration the dichotomy of emotional states and emotional traits [14]; yet in the ALICE project the research has been focused on the emotional state. This aspect has been perceived in a well-defined teaching path: to understand whether the failure to pass a test assessment, included in one's learning path, could be linked to a certain negative emotional state and act to improve the mood of a student.

We propose a methodology, easily applicable to learners, to detect affective states of students and manage these data in order to scaffold the learning process.

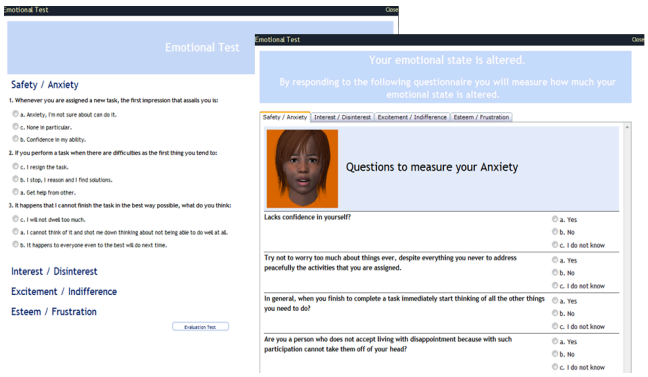

Figure 1. The pre-quantification and quantification tests

The assessment of a user's emotional state results from choices made by the user and is described at two levels: the state (pre-quantification) which gives Boolean feedback (yes/no) and the quantification of the state which is a real number between -1 and 1. The mechanism to activate the emotional assessment is linked to the cognitive assessment, thus it only starts if the user has not reached a fixed level of knowledge, i.e., if his/her learning curve differs from his/her class average learning curve [13] .

The existing version of the IWT Course module has been updated in order to interact with the Affective and Emotional module. The teacher will be able to /set different parameters of the Affective/Emotional Module while the feedback from the emotional assessment is sent directly to the tutor who is in charge of rebalancing altered emotional states through a direct intervention (e.g., through a discussion, by suggesting alternative learning resources, etc.) and it is used to adapt instructions and to intervene in the articulation and internal dynamics of each Complex Learning Object.

B. *Storytelling Complex Learning Object*

The ALICE Project considers a digital storytelling as an complex leaning resource characterized by its capability to support high-level learning processes thanks to a process of remediation of languages, strategies and roles. A Storytelling Design Model is defined, by using the most promising results of other research activities [15], [16], [17] in order to fill the lacks of existing storytelling models that use indications coming from adaptive instruction research [18] and to define a SCLO, a guided and explorative narrative structure,

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considered to be more suitable than simply transmitting the learned lessons about natural disaster. A SCLO is a complex educational resource characterized by a logic composition of various situations, based on phases of a Visual Story Portrait (VSP). Each situation is related to Bloom's hierarchy of transformation [19], that identifies intellectual changes in terms of six different levels of learning objectives, considered in increasing order of difficulty, from basic to higher levels of critical thinking skills.

A set of instructional events (advancer events, learning event, and reflection, assessment event) are repeated for each situation; during the assessment event the story proposes an assignment to learners, to measure if the cognitive transformation has occurred.

Figure 2. Advancer event

The assessment results support the story plot and suggest alternative routes taking into account the level of knowledge achieved by the learner. Different remedial paths are defined. The first level of the remedial path is defined according to learning style strategies, and is based on the idea that the most effective learning occurs when learning activities closely match the learners' preferred learning style. According to the situated learning strategy, the second level of the remedial path presents the events a learner has passed through but in a different scenario. The role taking is the next specific level of micro-adaptivity, defined according to a novel approach where a perspective of a specific character (with a specific role) taking part in an action is taken into account [20], [21].

An authoring tool has been developed, and allows to build interactive e-books that can be played both on a PC through a Web browser or on a tablet with iOS Operating Systems.

C. *Serious Game Complex Learning Object*

The purpose of using serious games is to support an educational program around the area of civil defense, and specifically evacuation management. Evacuation training is characterized by a need to change learners behavior , rather than to simply transfer the knowledge. A serious game blended with the IWT system is then exploited to provide learners with both immediate in-game feedback, and long-term feedback through the LCMS system.

The game itself builds upon the approach used in other evacuation simulators [22], [23], [24] of placing learners in a 3D environment during an emergency and demanding they follow correct principles for safe evacuation. A simple experiential model of learning [25] is implemented, coupled with a requirement for analogical transfer to real-world situations [26].

The game is developed in the Unity [27] and extensively reuses existing simulative assets, including a detailed 3D model of a school building, and procedurally generated city backdrop. The engine provides for advanced effects such as GPU-based physics simulation, deferred lighting, occlusion culling, and advanced texturing. Interactivity is supported through a first person viewpoint similar to that in many entertainment games, allowing for an immediately recognizable interface to players who are used to entertainment gaming.

Figure 3. A kind of feedback in a Serious Game

The game contains elements of crowd simulation within evacuation scenarios, effectively placing the player within the building and monitoring their actions as they evacuate. Hence, by providing feedback and assessment, the game identifies in a correct way key actions that may indicate correct and incorrect behaviors. This is achieved through the implementation of virtual "checkpoints" within each scenario and recording players' time and state as they pass within a radius of a single point. This allows for a number of metrics of performance. The total evacuation time can be assessed in terms of time from the starting checkpoint to checkpoints at the building's exits. By comparing this to the expected values, the overall behavior can be inferred, e.g., a very fast evacuation may indicate the player has run to the exit and feedback should note the importance of evacuating in a calm and controlled manner.

III. EXPERIMENTATION AND VALIDATION

The goal of the experimentation was to demonstrate the added-value of having a CLOs resource embedded in an active learning environment and enriched by an emotional detection module.

Thus, a specific learning course about the management of risks has been structured. The learning course aims at teaching

the right behavior to be acquired in the event of natural a phenomenon such as an earthquake in an amusement park or the evacuation of a building due to a fire.

The course is composed of two CLOs, a storytelling and a Serious Game, and an emotional component for testing the emotional state of the learner attending the course.

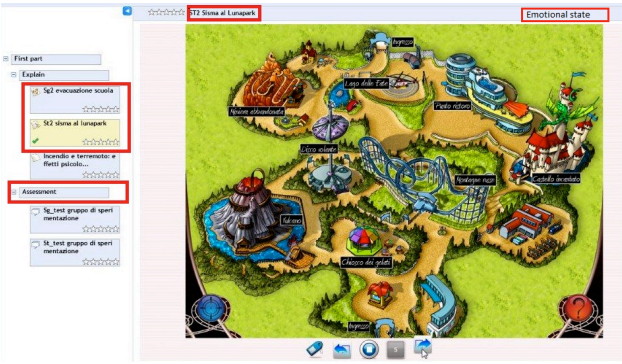

Figure 4. Overview of the learning course

Figure 4 shows an overview of the learning course that includes the two CLOs on the left and the emotional module on the right.

This component represents an important aspect since it allows to rebalance the course by using alternative learning resources in case of a negative result coming from the emotional component.

For this purpose, two experimentations were performed at the MOMA's school network, involving 6 schools, 100 students and 6 teachers in all.

In the following section, we will show the principal results obtained from the experimentation.

A. Storytelling Complex Learning Object

Could the use of a digital storytelling improve the correct behavior to take in risk situations and optimize the transmission of lesson learnt? Concerning the methodology effectiveness, the students evaluated this new methodology positively, specifically showing a positive interest in navigation, and exploring different learning paths characterizing the storytelling structure.

The students were asked to assess the work through the following questions:

- While using a storytelling resource, were you asked to navigate autonomously and to explore possible ways presented by the story?
- Have the suggested reflection moments given you a key to understand the objective?
- Have the assessment events, distributed within diverse key situations, allowed you to delve into learned concepts before moving forward?
- You had the chance to assess your emotional state at some given points in the story. Was it helpful for you to understand whether your emotional state may influence your interaction with the story?
- Is the storytelling's interface easily usable?
- Were visual and auditory stimuli opportunely defined so to allow you to follow the story events and focus on the most important ones?

Figure 5 indicates the average values for the six questions submitted to the students to test the effectiveness of the methodology and the corresponding competence levels they acquired.

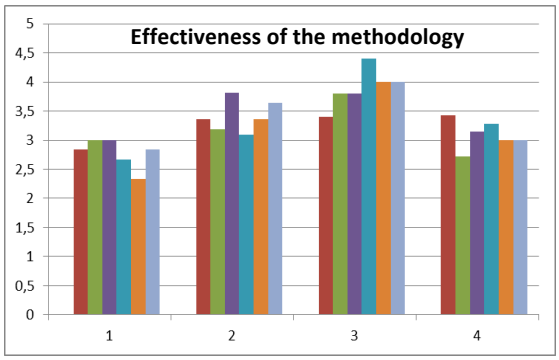

Figure 5. Evaluation of the Storytelling activity

It was found that the storytelling learning resource can offer more variations than the traditional practicing methods. The students appreciated the combination of activity and reflection for each situation. The assessment events have contributed to stimulate their critical judgment with respect to what they were supposed to learn before encountering new difficulties and challenges in the story in terms of knowledge and skills to be deployed. Very appreciated was the opportunity to evaluate the emotional state at a given point of the story that indirectly influenced the continuation of the story itself. The analysis of averages for each question reinforces the data previously reported, and partially validates the SCLO as a way to change and renew the educational experience of digital natives. The experimentations confirm that this innovative and interactive didactic component is more oriented to a student-centered educational approach and is able to involve emotionally, providing guidance and making the reflection easier. The storytelling resource can guide the student to the understanding of specific concepts and also resorting to alternative paths. Finally, from the point of view of a cognitive transformation, the experiment have also confirmed the efficacy of the storytelling, considering the average competences obtained through the delivery of the itself resource (M=5.72): the obtained value indeed is over the minimal threshold fixed by the teachers (equal to 5). The teachers participated in a survey that helped validate the Storytelling resource from the instructor's point of view. In particular, they agreed that the resource provided the students with the opportunity to express their native style, characterized by a progressive exploration of knowledge in a guided and structured context.

B. Serious Game

Could the use of Serious Game resources contribute to improve motivation and learning of students with a natural predisposition to the experiential learning?

Concerning the methodology effectiveness , students were asked to assess the work through the following questions:

- How responsive was the game to actions that you initiated (or performed)?
- How much did the visual aspects of the game involve you?
- How compelling was your sense of the game moving through space?
- How much did the visual display quality interfere or distract you from performing the assigned tasks?
- How completely were your senses engaged in this experience?
- To what extent did external events distract from your experience of the game?
- How easily did you adjust to the control devices used to interact with the game?
- Was the information provided through different senses in the game (e.g., vision, hearing, touch) consistent?

A large number of students appreciated the immersive reality of the game and the sense of engagement in the experience.

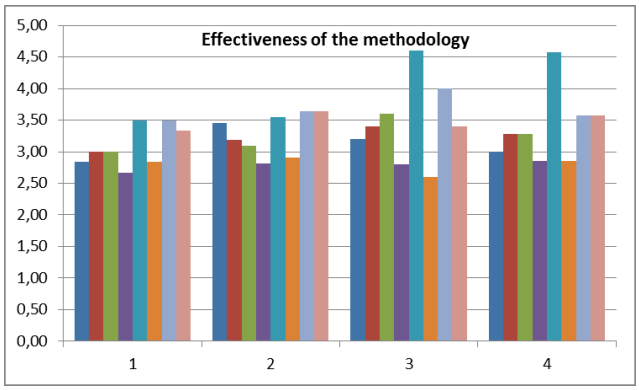

Figure 6. Evaluation of the SG activity

The interaction with the game by using control devices, shows that the students have not encountered particular problems with the new device. The information obtained

through different senses of the game, as vision, hearing, touch, caught the students' attention.

Data set shows that the SG resource includes an appreciable auto-assessment (M= 3.47) that allows the student to obtain specific skills related to management risk. Finally, by analyzing the survey submitted to the teachers, all of them agreed upon the use of SG learning resources as an improvement for students' understanding of key concepts.

C. Affective and emotional module

Is the use of emotional component able to recognize and evaluate the affective/emotional state of a learner for supporting him and improving its learning?

Concerning the methodology effectiveness, students were asked to assess the work through the following questions:

- Does the recognition of your emotional state make you feel like being the centre of attention during the learning path?
- Do you think the emotional test is clear and easily understandable?
- Do you think the emotional test is representative of your emotional state?
- Do you think the emotional/affective state may have a great impact on the results of your educational experience?
- Does the display of your emotional and affective state lead you to improve your performance levels?
- Do you think the data collected can be used to provide additional activities useful for recovering the emotional balance?
- Do you think the emotional test should be made visible to peers in order to trigger a social support?
- Would you like to share your state only with a small group of students selected by you?

Students although appreciated the consideration of their emotional state during the learning experience and think that this factor allows to arrange corrective activities in order to bring the students into affective equilibrium conditions.

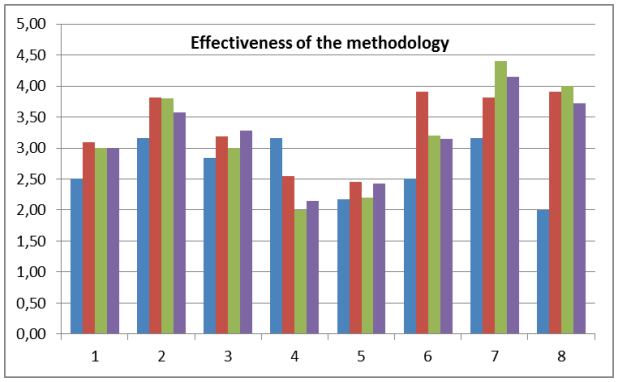

Figure 7. Evaluation of the Emotional tool activity

All students agreed upon the possibility to share their emotions with others because sharing could help them overcome critical situations. The use the Emotional tool may help the instructional designer or the teacher differentiate the

learning path taking into account different students learning styles.

IV. CONCLUSIONS

The main results coming from the ALICE Project with respect to these research themes in the context of civil emergency have been discussed as well as the encouraging results coming from an experimentation made with real users in Italian school. The experimentation has demonstrated how different complex didactic methods, revised in a proper way, are more suitable for the transmission of specific lessons learnt. Finally, it is worth mentioning that the teachers participated in a survey that helped validate the complex resources from the instructor's point of view. In particular, they agreed that the complex resources provided the students with the opportunity to express their native style characterized by a progressive exploration of knowledge in a guided and structured context. A relevant result was the use the Emotional tool which resulted to be more useful for teachers than for students as it may help the instructional designer or the teacher to differentiate the learning path taking into account the different students learning styles. The experimentations confirm that these innovative and interactive didactic elements are more oriented to a student-cantered educational approach and are able to involve emotionally, providing guidance and making easier the reflection on natural disasters in educational contexts.

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