Enhancing educational experiences with re-mediation theory: the case of the FIBAC project

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***Abstract*—The paper reports the results related to the application of the FIBAC cultural re-mediation model for the development of an interactive educational experience. The FIBAC model remediates a cultural resource not only with regard to media and the ICT but mainly with regard to its meaning and associated knowledge generating, thus, knowledge paths able to add new meaning to a cultural resource. To contextualize this model for educational and scientific museums, we frame the re-mediation in a didactic model based on the Kolb learning cycle and Brousseau theory of didactic situations, namely the Virtual Scientific Experiment. We evaluated our results with a Proof-of-Concept based on a physic experiment exposed in a real Italian scientific museum.**

Keywords—Cultural Re-mediation; Digital Storytelling; Virtual Scientific Experiments; Didactic models

I. INTRODUCTION

The changes occurred in technology, learning, and learners' style are pushing for a rethinking of *museum education* [1], learning theories, and pedagogical approaches [2]. The literature underlines how the development of models and methods for the fruition of museums, if placed in an informational path designed to take multimedia changes into consideration, can offer opportunities to increase the critical explorative and reflexive knowledge experiences. An important learning theory useful to innovate in the *museum education* field is *connectivism*, a recent pedagogical framework that integrates the constructivist pedagogy whit the possibilities offered by emerging and disruptive technologies [3][4]. Connectivism bears some similarity with the *activity theory, situation learning theory* and *social learning theory*, but its characteristics are understandable by some core principles.

The first principle says that *learning and knowledge rests in diversity of opinions*. This principle considers the achievement of new knowledge (*similar* or *dissimilar* to prior knowledge of user) as a goal of a learning experience [5][6].

In the museum education perspective, the achievement of meanings using alternative and collective views or adaptive and personal learning paths is very important in order to maintain curiosity and level of engagement.

A second principle says that *learning is a process of connecting specialized nodes or information sources*. The network of concepts and resources plays a fundamental role in the definition of learning opportunities and favors the possibility of navigating in progressive and intuitive ways the cultural spaces [7].

The third principle asserted by Siemens is that *learning may reside in non-human appliances* assuming that the educational process can be supported by technologies and their "re-mediations" also because technologies plays a key role on "how people learn and how knowledge is shared" [8].

The fourth (*nurturing and maintaining connections is needed to facilitate continual learning*) and the fifth (*ability to see connections between fields, ideas, and concepts is a core skill*) principles of the connectivism focus on cultural change in the modern society. In the digital age a core skill is to find relevant connections between fields, ideas, and concepts, and the capacity of nurturing and maintaining connections. Continuous learning is essential for cultural heritage and educational museum.

The sixth principle of connectivism says that *currency (accurate, up-to-date knowledge) is the intent of all connectivist learning activities*. The ability to seek out current information and filtering secondary and extraneous information is an important skill for learning. [9]. Thus, meaning making is a learning process that drives the knowledge acquisition in museum context.

Starting from this learning approach a re-visitation of museum space can take place, enhancing its role as a producer of learning and knowledge opportunities for people.

The museum becomes a "self-transformational centre" [10] adapted to "catch and represent" the "social biography" of the material and immaterial heritage into a close relationship. The digital interfaces not only guarantee to visitors an access to the museum "behind the scenes" and to archives and databases, but also carry out a genuine "re-mediation" (an expression given by David Bolter and Richard Grusin [17]) of all museum contents [11] and cognitive processes activated in it.

FIBAC (Innovative Fruition of Artistic and Cultural Assets) is an Italian co-funded project on the valorization of cultural resources in real and virtual museums, and is

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contextualized in the frame of the above mentioned cultural re-mediation. FIBAC aims at developing a guide system able to establish a new way of mediation of the cultural heritage by combining knowledge based methods with approaches and techniques from creativity in order to generate knowledge paths able to add new meaning to a cultural resource.

In the context of the FIBAC project, we adopted the main principles of the connectivism adapting them into a new interactive learning resource, the so called Virtual Scientific Experiment, to propose a new way to enhance educational experiences with the cultural re-mediation theory.

The rest of the paper is as follows. Section II introduces in detail the framework of cultural re-mediation in FIBAC. Section III gives an overview of the Virtual Scientific Experiment. Section IV presents a scenario, based on a Proof-of-Concept development, of the application of the FIBAC re-mediation methodology within a virtual scientific experiment. Finally, Section IV provides some insight with respect to future works in terms of implementation and testing of the framework in the context of the project.

II. OVERVIEW OF THE FIBAC METHODOLOGY OF RE-MEDIATION

The convergence of different media [15] is at the core of the cultural re-mediation theory [17]. FIBAC provides an additional perspective that is based on the convergence of different type of *knowledge*, i.e. factual and user generated (social), and on the recognized value of cross-fertilization among domains, i.e. cultural and not cultural. A cultural resource in FIBAC is re-mediated not only with regard to media and the ICT but mainly with regard to its meaning and associated knowledge.

The figure 1 gives an overview of the methodology defined in the project that leverages on knowledge based techniques developed in another project [11] and on ontology matching [16]. At the left-hand side of the figure there is a conceptual scenario related to the Leonardo's Virgin of the Rocks while at the right-hand side two possible re-mediated scenarios are depicted.

The conceptual scenario presents the factual knowledge (e.g. events, actors, time and space) on a cultural resource. This scenario is built on: i) domain knowledge about the resource, ii) preferences and knowledge background of the user, iii) environment (real or virtual museum) and technical contexts (e.g. kind of devices).

After the delivery of this scenario, the methodology provides an assessment according to cognitive and emotional perspectives. Affective and emotional approaches are combined with traditional cognitive assessment in order to evaluate the user engagement and cognitive growth. In figure 1, we have oversimplified the results of the assessment with two types, I like and I do not like, that can lead to different strategies to produce a re-mediated scenario. Indeed the results of the assessment can be a combination of levels of engagement and cognitive growth (figure 2).

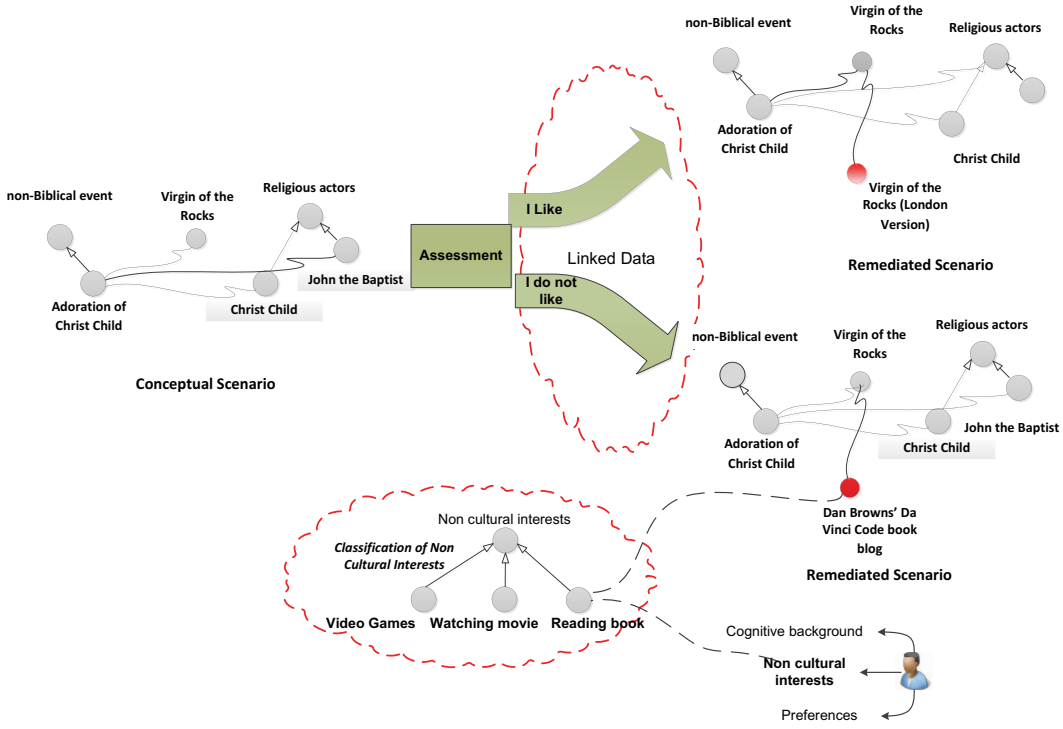

Figure 1: The FIBAC methodology

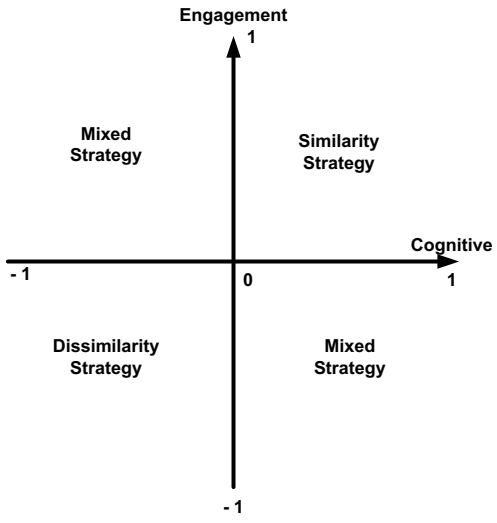

Figure 2: Assessment

On the basis of the assessment, FIBAC decides the appropriate strategy to adapt the experience in the re-mediated scenario. A re-mediated scenario has the objective of making more proficient and engaging the delivery experience by adding new meaning to the delivered resource providing additional contents on "similar" or "dissimilar" resources.

In case of positive assessment (e.g. high engagement and cognitive growth in the Figure 2) we exploit a similarity strategy maintaining the same context of the conceptual scenario. In this case, in general, the objective of the re-mediated scenario is to provide additional meaning to a resource such to improve the cognitive growth of the user. Additional meaning is offered by provision of knowledge about similar event, actors, etc. (e.g. relating knowledge about the Virgin of the Rocks of Paris with knowledge about the Virgin of the Rocks of London).

From a technical point of view, FIBAC leverages on semantic technologies and inference rules to discover correlations between two resources, in order to assign them additional "meaning" not evidenced in the conceptual scenario. We extract a set of features from the contents of the conceptual scenario (e.g. in the case of figure 1 with a feature extraction function we could extract a set of terms such as "Museum", "Leonardo", "Virgin of the Rocks", "Christ", etc.) and use the extracted feature terms to perform a search of the external dataset. This step can return dataset such as Europeana Linked Open Data or DBPedia.

Once identified the appropriate external dataset, the next problem is to identify relevant classes inside the selected datasets containing matching individuals (e.g. the London Version of the Virgin of the Rocks) in the dataset. To this purpose we use ontology matching techniques.

In case of negative assessment (e.g. low engagement and cognitive growth in the Figure 2) a dissimilarity strategy is exploited to mix the cultural context with "not cultural" one. Analyzing linked data, social network posts, and other user generated content FIBAC is able to correlate knowledge on the cultural resources with knowledge available on the web filtered according to the "not cultural" interests of the user (e.g. hobbies such as sports, music). The idea of connecting different contexts that are not immediately obvious is at the base of the so-called lateral thinking that the project uses to provide a new meaning to a cultural resource.

The purpose is twofold: i) to raise the interest of the user in the cultural resource via the provision of correlated content matching her/his preferences, and ii) to offer a new, different and un-conventional meaning of a cultural resource by provision of contents about non-cultural objects (e.g. relating a description of the Virgin of the Rocks with an entry in a blog commenting the Da Vinci Code book). A side effect of a scenario re-mediated according to a dissimilar strategy is to open the mind of the user offering additional and not obvious perspectives about a cultural resource.

From a technical point of view, features extracted from the user profile about not cultural interests are used to identify external datasets, while feature set extracted from the cultural resource are used in the matching phase to identify in the selected dataset the appropriate instances. In the case of the example provided in figure 1, if the user is interested in book, the first step of such strategy can result in the identification of datasets such as, for instance, OpenLibrary and the second in the identification of a review or a particular blog about the Da Vinci's Code book.

In summary, by combining traditional cultural re-mediation ICT based [17] with the additional one knowledge based, we can obtain experiences characterized by the combination of immediacy-hypermediacy and similarity-dissimilarity, as in the figure 3.

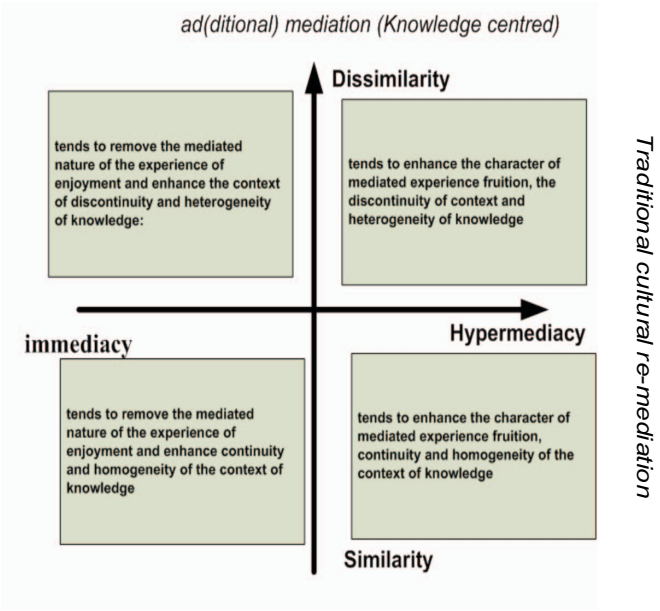

Figure 3: FIBAC experiences

III. THE VIRTUAL SCIENTIFIC EXPERIMENTS

Virtual Scientific Experiments (VSE) have been seen as particular "implication" scenario for a learning experience. They fit some fundamental aspects within a cognitivist and constructivist vision: the importance of the situated learning (thus the specific context), the collaborative learning, the experiential learning, implementing thus some principles of connectivism.

From these considerations, a model has been defined, by combining the Kolb's approach [13] with the Theory of Didactic Situations by Brousseau [14]. Such pedagogical approach foresees to move from a concrete experience (Practical Situation) to a more abstract experience (Abstract Situation) and it is composed by four principal phases as shown in figure 4:

- **Presentation**: it provides a description of the didactic experience that the student is about to start;
- **Practical Situation**: it represents the phase in which the learner lives the concrete experience that we want to analyze;
- **Abstract Situation**: it extrapolates an abstract model from the previously analyzed context;
- **Institutionalization**: it constitutes the passage from the intuitive knowledge and spontaneous concepts to more evolved forms of thought organization.

Each situation is modelled according to *active involvement* (the learner will be able to move and manipulate the objects at his/her disposal so to make his/her own conjectures and/or to foresee and verify the system behaviour under his/her action), *collaborative learning* (discussion or work with other learners may let the conjectures arisen in the previous phase become statement with suitable proof), *assessment* (in order to verify the achievement of the didactical objectives) and *addressed situation* (a more simplified and guided situation to help the learner to recover some misunderstanding respect to the didactical objectives).

The FIBAC re-mediation methodology, anyway, can support the VSE model in several ways. Besides Presentation and Institutionalization phases, where the re-mediation method can enhance the phases providing additional similar and dissimilar contents, we see an added value in the Practical and Abstract situations. In these phases the FIBAC methodology can improve the so-called *addressed situation* that can be represented by a guided situation, built on the basis of similar or dissimilar contents presented with different type of media. In other words, an addressed situation can be one of the four re-mediated experiences depicted in Figure 3.

In the following section, we describe a case study based on a Proof-of-Concept of the VSE enhanced with the FIBAC re-mediation methodology.

For the assessment phase, in order to consider the user engagement, we expanded on ALICE results related to the computational model for managing emotions and affections [18]. In ALICE we identified four axes characterizing the emotional sphere: resilience (safety vs. anxiety), curiosity (interest vs. disinterest), engagement (excitement vs. indifference) and self-confidence (self-esteem vs. frustration).

The assessments of an emotional state drive a remedial path able to sustain the knowledge acquisition. The assessment of a user's emotional state results from choices made by the user and is described at two levels: the pre-quantification state which gives Boolean feedback (yes/no) and the quantification state which is a real number between 0 and 1. The mechanism to activate the emotional assessment is linked to the cognitive assessment and guide different type of re-mediation path during learning experience optimizing engagement and knowledge acquisition.

IV. THE CASE STUDY

In this section we describe Proof-of-Concept developed in order to validate the application of the FIBAC cultural re-mediation methodology to a physic experiment, the **Fermat's principle**, exposed in a real Italian scientific museum.

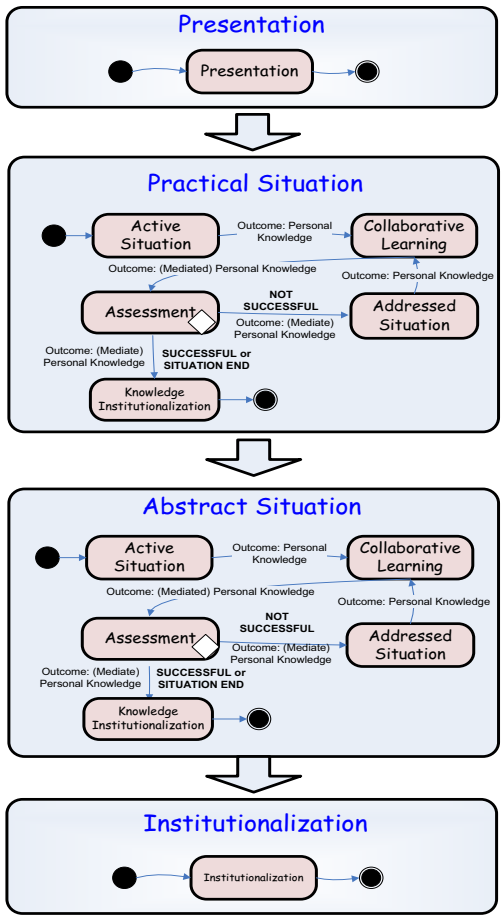

Figure 4: The VSE Learning Model

The VSE aims at explaining the Fermat's principle, by the analysis of the path that a light source follows from one medium to another (for example air and water). For each phase of the VSE model, it is explained, where possible, the mapping with the phases of the FIBAC model (similarity-dissimilarity; immediacy-hypermediacy).

The experiment has been delivered to two kinds of high school students: a student enthusiast about the physical topics and a student that has not particular tilt about the mathematics.

We put more attention to the *Practical Situation* and, in particular, to the active and addressed situations where the FIBAC re-mediation model can provide added value. After a brief description of the Presentation's phase, we analyze the Practical Situation for the two students and close our Proof of Concept with a brief description for the eventual Institutionalization's Phase.

Phase I: Presentation

The objective of the experiment is to study the behavior taken by a light to move from a point A to a point B located in two media characterized by different propagation velocity. When crossing the separation surface, the light rays are deflected in general. Which among the infinite possible paths the light tends to choose?

Phase II: Practical Situation - CASE I

For the student enthusiast about the physical topics, the experiment starts with the statement of the Fermat's principle "*The path taken between two points by a ray of light is the one that is crossed in the shortest time"*

This situation is associated to the **immediacy**'s phase of the FIBAC model: the user is lowered into the simulation. In order to test his knowledge, the student is transposed in an assessment phase. In case of the output of this phase is negative, the student passes in an addressed situation composed by several steps: initially we introduce a new description of the parameters involved by using the parametrical representation (so we have a first phase of similarity-hypermediacy of the FIBAC model).

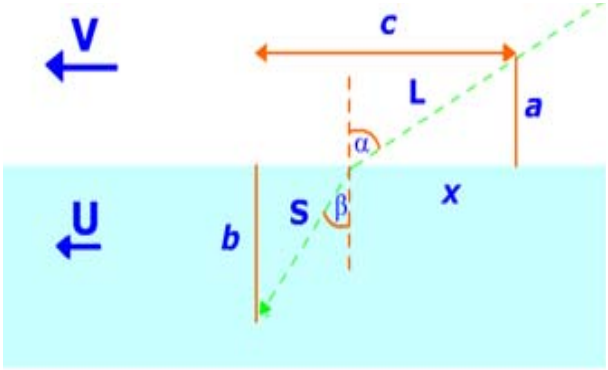

Figure 5: The Practical Situation

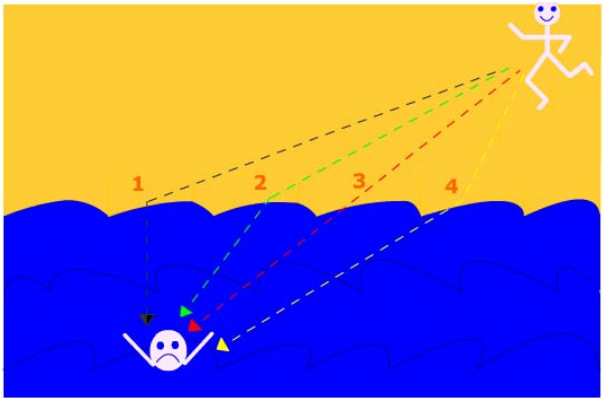

Figure 6: The Abstract Situation

If the student fails with the assessment, for a second time, a second step is shown, stressing the axis of the similarity and adding more hypermediacy to the experiment. That is obtained adding to the experiment information about the light travel time for the two materials (air and water). The figure 5 shows a situation providing additional information to the student.

Phase II: Practical Situation - CASE II

For the student that has not particular tilt about the mathematics, the active situation is represented within a dissimilarity context: the student is immersed in a real context, represented by the selection of the right path useful to a lifeguard for rescuing a shipwrecked in the shortest possible time ().

If the attempts fail, the user will be dropped in the addressed situation, where through the **hypermediacy** modality, new visual aids help him to choice the correct path. The Figure 7 shows an instrument (video) that provides additional information to the user.

Figure 7: The hypermediacy modality

Phase IV: Institutionalization

This is the phase in which we highlight the knowledge that the virtual scientific experiment should transfer: the Fermat's principle. The principle affirms: "*Fermat discovered ' in 1600 that the light changed direction so as to arrive at their destination in the shortest possible time, in other way among all the possible paths between the start and the finish, the light chooses the fastest."*

This phase is associable to the **dissimilarity** modality that involves the acquisition of new events, justified by the application of Fermat's principle, as may be the sunset of the sun.

So we pass from a situation where the user is drawn into the role of "lifeguard" in order to be involved in its virtual experience of the concepts' acquisition about the light's path, to a situation contextually different (nature) of application of immersive virtual reality; in this situation the user is itself the protagonist of the phenomenon (the sunset), and therefore has a direct and immediate perception of the phenomenon.

In order to provide a preliminary evaluation of our result, from a qualitative point of view, at the end of the experiment an open questionnaire has been submitted to the students that have cognitive style similar to the student considered in the case II quoted above.

The output of the interview, obtained through the evaluation of the open questionnaire, has shown that the re-mediation model has helped them to choose the learning material more compliant with the learning objectives. They have more appreciated the dissimilarity context related to the transposition of mathematical law in a real context. Indeed the dissimilarity phase has allowed to improve the individual competences by using other learning contexts.

V. CONCLUSION AND FUTURE WORK

The purpose of this paper was to validate the capability of the FIBAC re-mediation methodology of leveraging on similar and dissimilar contents and on different kinds of media in order to improve the addressed situation. To do that we defined and validated a VSE model via the development of a Proof-of-Concept related to a physic experiment.

Future work will be devoted to better understand how to enhance other situations of the VSE model and to provide a deeper evaluation and validation in a pilot.

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REFERENCES

[1] Hein, G. E. (2006). Museum education. A companion to museum studies, 340-352.

[2] Hooper-Greenhill, E. (2007). Museums and education: Purpose, pedagogy, performance. Routledge.

[3] Heinemann, M. H., & Estep Jr, J. R. (2012). EDUCATIONAL THEORY AND ONLINE EDUCATION. Best Practices of Online Education: A Guide for Christian Higher Education, 13.

[4] Verhagen, P. (2006). Connectivism: A new learning theory. Surf e-learning themasite, 11, 2006.

[5] Wegerif, R. (2013). Dialogic: Education for the internet age. Routledge.

[6] Ravenscroft, A. (2011). Dialogue and Connectivism: A New Approach to Understanding and Promoting Dialogue-Rich Networked Learning. International Review of Research in Open & Distance Learning, 12(3).

[7] Siemens, G. (2005). Connectivism: A learning theory for the digital age. International journal of instructional technology and distance learning, 2(1), 3-10.

[8] Bell, F. (2011). Connectivism: Its Place in Theory-Informed Research and Innovation in Technology-Enabled Learning. International Review of Research in Open & Distance Learning, 12(3).

[9] Kop, R., & Hill, A. (2008). Connectivism: Learning theory of the future or vestige of the past?. International Review of Research in Open & Distance Learning, 9(3).

[10] Remotti, F. (Ed.). (2000). Memoria, terreni, musei: contributi di antropologia, archeologia, geografia (Vol. 2). Edizioni dell'Orso.

[11] Gaeta, A., Gaeta, M., Piciocchi, P., Vollero, A., Ritrovato, P. (2012) Exploiting semantic models and techniques to evaluate relevance of human resources in knowledge intensive organizations. Proceedings of 8th International Conference on Signal Image Technology and Internet Based Systems, SITIS 2012r, pp. 960-966

[12] Macdonald, S. (Ed.). (2011). *A companion to museum studies* (Vol. 39). John Wiley & Sons.

[13] Kolb D. A., (1984). Experiential Learning, Englewood Cliffs, NJ.: Prentice Hall.

[14] Brousseau G., (1997). Theory of didactic situations in mathematics. Kluwer Academics Publisher.

[15] McLuhan, M.(1964): Understanding Media. The extensions of man. New York: Mentor

[16] Fenza, G., Loia, V., Senatore, S. (2009). Local semantic context analysis for automatic ontology matching. Proceeding of International Fuzzy Systems Association World Congress and 2009 European Society for Fuzzy Logic and Technology Conference, IFSA-EUSFLAT 2009, pp. 1315-1320

[17] Bolter, J. D. and Grusin, R. (1999) Re-mediation. Understanding new media, Cambridge, MIT Press

[18] G.R. Mangione, A. Pierri, N. Capuano (2014) Emotion-based digital storytelling for risk education: Empirical evidences from the ALICE project. International Journal of Continuing Engineering Education and Life-Long Learning, Inderscience Publishers, 24(2), 184-211.