Invited Papers

Conversation-based Learning in the Social Semantic Web

Giuseppina Rita Mangione[1], Francesco Orciuoli[1], Matteo Gaeta[2], Saverio Salerno[2]

[1] CRMPA – Centro di Ricerca in Matematica Pura ed Applicata, Italy - {mangione, orciuoli}@crmpa.unisa.it
[2] DIEII – Università di Salerno, Italy - {mgaeta, salerno}@unisa.it

Keywords: instruction based conversation, social semantic web, workplace learning, adaptive learning, CSCL script

The collaborative approaches based on concepts of *Knowledge construction* and *knowledge creation* consider the learning as a direct function of processes of social participation and dynamic argumentative talk between peers. These approaches justify the Social Semantic Web' success as a theoretical and technological model which establishes a synergy between an Ontology-based approach to knowledge (suitable for defining, structuring and sharing knowledge) and collaborative software environments (utilized to create and share knowledge socially). The above mentioned approaches make reference to Semantic Web and Social Web respectively. If the Ontologies are an effective mechanism for the formal representation and sharing of knowledge, the social/collaborative activities adopt pedagogical theories of Social Constructivism. Recently, the scientific community has promoted the *Educational Social Semantic Web*, where activities and educational content are easily created, shared and used by teachers and students even without

for citations:
Mangione G. R., Orciuoli F., Gaeta M., Salerno S. (2012), *Conversation-based Learning in the Social Semantic Web,* Journal of e-Learning and Knowledge Society, v.8, n.2, 45-63. ISSN: 1826-6223, e-ISSN:1971-8829

possessing brilliant engineering knowledge skills or technological know-how. The purpose of this work is to model, according to Social Semantic Web's principles, an adaptive environment able to support Instruction-based Conversation learning processes in a work environment. In such an environment, the conversational process is guided by a collaborative script automatically generated basing on the explicit representation of a disciplinary domain, a knowledge goal to be achieved, as well as learner's characteristics (cognitive state) and corporate resources available at a given time. The environment maintains the learner's cognitive balance, minimizes the *extraneous processing*, appropriately manages the *essential processing* and maximizes the *generative processing*.

1 Introduction and Motivations

The *didactic* formats, distinctive of cooperative and collaborative learning, advocate dialogic educational modalities, considering them as *affordances* necessary to promote an active learning and development of *higher-order thinking skills* (Renshaw, 2004; Salomon & Perkins, 1998).

The importance of conversations in learning emerges from cognitive and learning studies (Vygotskij, 1978; Soller & Lesgold, 2005) that have highlighted a tight correlation between cultural context, language and thought processes, also observing strong effects that dialogue and dialogic social interaction may have on the way they stimulate processes of cognitive interiorization of an individual.

Studies on the dialogue, seen by an active perspective, point out that in a conversational activity different "ways" of discourse can be observed, that is *knowledge sharing*, *knowledge construction* and *knowledge creation*, which find their correspondence with three defined theoretical perspectives (Van Aalst, 2009). The *knowledge sharing* refers to the exchange of information between peers that occurs in a dialogue and has its grounds in the communication theory (Pea, 1994). The *knowledge construction* refers to cognitive processes being activated in a conversation, by which a learner compares received information with his/her *prior knowledge* and with the situation in which the learning need is urged (Paavola *et al*. 2004). At last the *knowledge creation*, overcoming the distinction between "knowledge-telling" and models of "knowledge-construction" based on the writing, refers to a process by which new ideas can be generated in a discourse (Bereiter & Scardamalia, 1987) thanks to a positioning into authentic practices and situations (Brown *et al.*, 1989; Hutchins, 1995; Lave & Wenger, 1991).

The cognitive perspective has strongly highlighted the fact that social interactions might have an impact on the creation of cognitive processes (Dekker *et al.*, 2004; O'Donnell & King, 1999). Dialogical functions such as *explaining*, *reasoning* and *asking questions* stimulate both explorative thought and knowledge development (Mercer, 2000; Wegerif *et al.*, 1999). The dialogue indeed can stimulate and go further beyond a simple level of "telling the knowledge"

(Bereiter & Scardamalia, 1987) and can emphasize reflection and investigation. In a dialogue, the participants explicitly debate and reason about cognitive and relational aspects occurring within a conversation, and enhance their learning process in this way.

The debate about what would it be the most suitable structuring level to start the conversational process and make it really work as a collaboration method, has been extremely profitable (Dillenbourg & Jermann, 2007). In particular, the *Cognitive Load* theory has brought forward the idea that behind the constructivism and the consequent wide decisional space, which collaborative methods offer to learners, there would be a sort of egocentric projection by which the learner is assigned skills that are more belonging to an expert user (Calvani, 2009). Such learning environments, said to be a derivation from constructivism, must be oriented to instructional design theories, which are prescriptive and more in line with cognitive architectures (Van Merrienboer & Pass, 2003).

The fallacy of a constructivist approach (Mayer, 2004) as well as the necessity to think of collaborative educational events able to mediate extraneous cognitive load with a relevant one, has recently led some researchers (Dillenbourg, 2002; Dillenbourg & Hong, 2008; Dillenbourg & Jermann, 2007; Kollar *et al.*, 2006; Weinberger *et al.*, 2004; Fisher *et al.*, 2007) to introduce the concept of *CSCL script*, i.e. more specific information, generally defined at a micro-design level, about structuring into phases, sequences and tasks specifying a collaborative method.

The success of collaborative didactic experiences of dialogical type, is associated with the chance to evaluate the learner's self-governance/autonomy and with finding a right balance between two opposites (prescription vs. self-governance/autonomy) adopting an internal adaptivity able to suitably integrate scaffolding and fading methodologies (Brown *et al.*, 1989). The *scaffolding* supports the dialogic process through appropriate structures under the shape of directions on how to proceed or schemes or models to follow when producing the required artifacts. The *fading* consists in reducing (fade-out) or augmenting (fade-in) the *scaffolding* as the learners demonstrate they can go ahead more autonomously.

The conversational approach considers the negotiation process of viewpoints on concepts to be learnt, as a fundamental matter to govern the individual's perceptions in point. The social dialogical mediation, revised in terms of instructional environments and solutions, may become an essential instrument to valorize work practices and to transform them into meaningful experience inside a professional activity. The need for a *continuous learning* in *lean enterprises* (Knuf, 2000) underlines the importance of learning in a workplace (*workplace learning*) and the recall to active pedagogical methods, capable of anchoring training moments in a work situation, fostering reflection and examination of specific issues in a perspective that links together work productivity and operations with social and cultural purposes of the educational process. The dialogue is a cognitive artifact in which the interaction between a plurality of knowledge and the adaptation of the conversational flow can contribute to improving work practices.

The communicative aspect represents a fundamental indicator that helps understand work practices and relevant schemes of the professional activity. The dialogue, by supporting the development of assumptions, inferences and consolidation of conversational routines through reflection and progressive investigation, becomes a central point to innovation and learning inside the organizations (Mengis & Eppler, 2005).

This specific social space of conversational type, presents itself as a fertile context where to activate learning processes with a different formality level, characterized by a virtuous knowledge transformation.

The scope of this work is to model, according to the Social Semantic Web's principles, an adaptive environment able to support Instructional-Based Conversation learning processes in a workplace, by optimizing generative cognitive processes and balancing by means of instructional scripts the prescriptive aspect with flexibility and self-governance.

2 Social Semantic Web as Learning Platform

The Social Semantic Web (Bresling *et al.*, 2011) can be defined as the network connecting Collaboration Services and Collective Knowledge System (Gruber, 2007), in which the more the individuals interact and contribute to "semanticized" information (i.e. enriched by machine-understandable metadata) through flexible and shared structures, the more the value grows. Online identities can therefore be correlated (semantically) to relevant content and contributions provided by other users, enabling a user's experience which is empowered and executed in an environment implemented by the interconnection of social applications. The Social Semantic Web makes use of a synergic application of complementary technologies and methodologies, belonging to research areas of Web 2.0 (Social Web) and Semantic Web (which exploits results deriving from the Linked Open Data initiative), and overcoming their limits. In particular, the inclusion of the Semantic Web approach into social applications, allows to connect contents generated by users in a more effective way, and to improve skills of correlation and research (in terms of *precision* and *recall*).

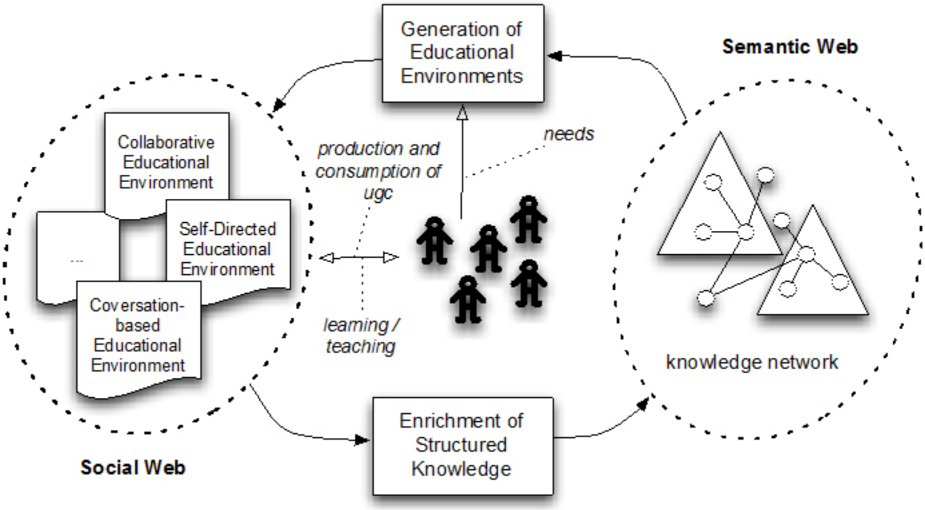

Fig. 1 - Social Semantic Web as Learning Platform

The Semantic Web provides languages, schemes and technologies that assist the definition of metadata and ontological structures able to organize and annotate the content and activate inference / querying operations and applicative interoperability. Social Web and Social Networking applications indeed, can significantly help the Semantic Web, by using metadata under the shape of annotations, tags, rating, blogroll links, etc., produced by numerous user communities associated with the above said applications.

The figure describes the synergic application of Semantic Web and Social Web made possible through the generation and execution of Educational Environments. Specifically, the Semantic Web is seen as a Knowledge Network that connects contents, services, people, events etc., represented and managed by languages such as RDF, RDFS, OWL and OWL2[1], through specific schemes such as FOAF[2] and SIOC[3] according to a Linked Open Data approach[4].

In response to the need expressed by a user, it is possible to access the Knowledge Network through standard languages as for instance SPARQL1.1[5]. The results from the query can be, in turn, analyzed and reformulated so to create a Web-based Educational Environment capable of meeting the need expressed by the user and of respecting some bounds like experts and /or

[1] http://www.w3.org/TR/owl2-overview/

[2] http://www.foaf-project.org/

[3] http://sioc-project.org/

[4] http://linkeddata.org/

[5] http://www.w3.org/TR/sparql11-query/

contents availability inside the Knowledge Network, the user's cognitive state who expressed the need or his/her learning preferences.

The generated Educational Environment will be based on tools of Web 2.0 and in particular the Social Web, opportunely empowered by semanticized contents. This will allow to use, for example, Instant Messaging tools in case of dialogical environments or Semantic Wikis in case of self-directed environments.

Once the Educational Environment has been generated, the involved users will be able to interact with it, accessing contents, dialoguing with peers, with experts or tutors, and doing so, activating learning and teaching processes. Such Environments will be made adaptable to any behaviour expressed by users, newly using information deriving from the Knowledge Network. The contents generated by users in these Environments, will be first analyzed and afterwards correlated to Knowledge Network elements, actually increasing the knowledge already structured and represented, in order to support new and richer experiences of Learning/Teaching.

The Educational Environments generated basing on the Knowledge Network, allow to enhance the learning process since they are based on a semantic representation of contents, services and people that enables three actions (Mayer, 2010) considered to be crucial to assure meaningful learning processes:

- Minimizing the *extraneous processing* (required by the presence of extraneous overload, i.e. material that is not relevant to the learning objective). The capability of executing complex research queries that improve result accuracy, and, as a consequence, reduce the percentage of non relevant contents to the expressed user's need and so to the learning goal. The possibility of pointing out the organization of proposed contents through Knowledge Network links, is an additional element to reduce the extraneous load.
- Properly managing the *essential processing*. The capability of providing contents with an adequate granularity, being the same contents annotated with taxonomies, controlled dictionaries and topic map that conceptualize the learning domain adequately. This conceptualization allows to preliminary access a sort of pre-training about names and characteristics of key concepts of a learning experience.
- Increasing the *generative processing*. The capability of constantly linking current learning object with user's prior knowledge, fostering their learning supposing that they may better learn when new educational contents are associated with their knowledge asset.

The same Educational Environments allow the users to enrich the Knowledge Network, in terms of contents and connections not yet elicited, helping not only views related to a given knowledge but also practical instructions about how to use it.

3 Conversation-based Educational Environment

The following sections describe the approach proposed for the generation and execution of an Educational Environment based on conversations able to exploit mechanisms typical of the Social Semantic Web.

3.1 Generating the Environment

The educational environment based on conversations is generated taking into account the analysis of learning need expressed by a learner; it therefore sets out as a tool for the execution of informal-intentional learning experiences. In a context of Workplace Learning (Tynjälä & Häkkinen, 2005) the learner is a worker who is assigned a task with a specific competence or part of competence as a prerequisite. In Figure 2 it is possible to observe how a learning goal (highlighted in the layer of disciplinary domains conceptualization) can be correlated to competences, and specifically to knowledge and skills (shown in the layer of light ontologies and knowledge modeling). The conversation will take place between learners through an Instant Messaging tool. The environment envisages an engine to execute a conversational script (as described in the previous sections) and adapt the learning experience.

Knowledge Network and Selection of Resources

As previously described, the Knowledge Network defined by means of a Semantic Web technological stack, is used to generate Educational Environments. The Knowledge Network here proposed is therefore structured in three ontological layers:

- Semantic description of *key concepts*. The first layer is defined using and extending ontological schemes such as, for instance, FOAF and SIOC and is utilized to model and semantically represent the knowledge, being represented by contents, people (their competence and relations) events, etc.
- Classification of instances. The second layer is defined through the use of SKOS[6] for the modeling of structures which include controlled dictionaries, thesauri and taxonomies useful to organize and classify instances of the key concepts defined in the first layer.
- Conceptualization of disciplinary domains. The third layer is composed of light ontology structures able to model and represent disciplinary do-

[6] http://www.w3.org/2004/02/skos/

mains which serve the scope to organize contents and activities related to learning experiences.

Figure 2 shows the way the three layers of the Knowledge Network can be instantiated and correlated among them so to support research operations through complex queries (De Maio *et al.*, 2012). In particular, to generate an Educational Environment based on conversations it needs to search for a person (*peer, expert peer, tutor*, etc.), within the Knowledge Network, with whom the learner may activate a dialogical process.

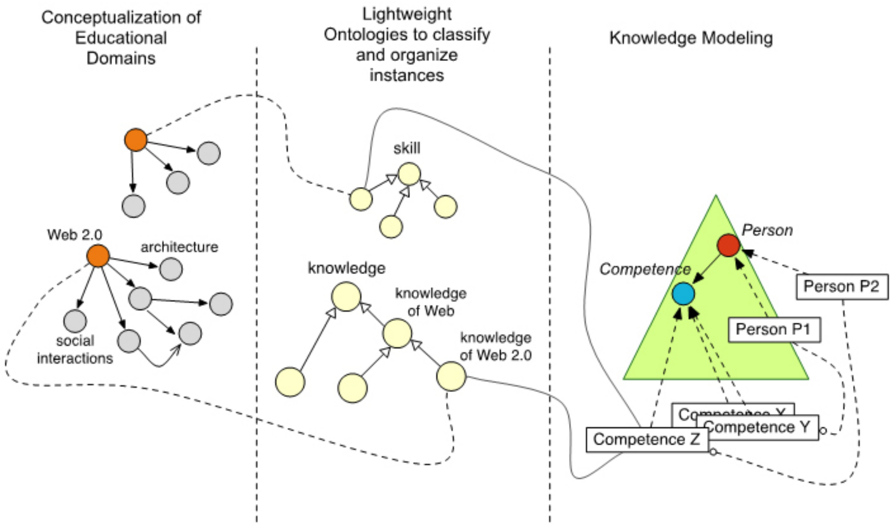

Fig. 2 - A sample instance of the knowledge network

The above research can be associated with a SPARQL1.1 query in order to find out instances of class *FOAF:Person* that own those competences (instances in Class *Competence*) and that can be associated with the learning goal (Mangione *et al.*, 2009; Gaeta *et al.*, 2011).

In the example of Figure 2, the learning goal is "Web 2.0", the relevant competence is "Competence Z", while "Person P2" is a potential participant in the conversation. The scheme OPO[7] (Online Presence Ontology) can be used to allow the workers to declare their online status and, possible, their willingness to take part into a conversational experience in order to support their partner's learning process. OPO natively integrates itself with FOAF and SIOC.

Similarly, it is possible to search for any other answer (e.g. documents, discussion thread, messages, posts, Web pages, Wiki papers, etc.) to support

[7] http://online-presence.net/

the learning environment.

Being the Knowledge Network a sort of *collective knowledge* of the organization, basing on Semantic Web components, this structure could be used to represent every worker's prior knowledge, as well as results and information on project tasks of the organization itself.

Definition of Conversational Scripts

In order to maximize learning possibilities during a conversation, the generated Educational Environment is required to generate conversational scripts that led and also re-balanced the conversational process. In the proposed approach, a conversational script is composed of a *learning path* automatically generated from a sequence of ontological structures used for the conceptualization of disciplinary domains. The *learning path* is an ordered sequence of topics (concepts of the ontological structures) to be treated in a conversation (Capuano *et al*., 2009).

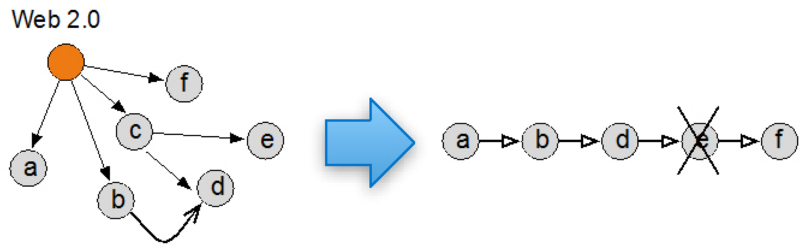

Fig. 3 - Conversational script generation

Figure 3 shows how to obtain, starting from the conceptualization of a disciplinary domain, the *learning path* composed of leaf concept that are needed for the achievement of the learning goal (in this case "Web 2.0"). To make the learning experience more effective and minimize the *extraneous processing* (as described in the previous sections), all the concepts already known by the learner are deleted from the *learning path*.

It is worth mentioning that the right choice of concept granularity within the conceptualization of a disciplinary domain allows to support and manage the *essential processing* at the best, that will be described in detail in the following sections.

Use of SIOC to model conversations

For the purpose of modeling and representing conversations using the Semantic Web stack to enable applicative interoperability and correlation capabilities with the Knowledge Network, the choice has fallen on the ontological scheme called SIOC (Semantically-Interlinked Online Communities), widely used among the communities of the Social Semantic Web.

SIOC aims at correlating contents generated by online communities in different platforms such as blog, forum, wiki, instant messaging, and providing a light ontology able to describe the structure of activities performed in the above said applications. The ability to correlate SIOC to other ontologies, such and FOAF (social networks and user profiles) and SKOS, offers the possibility to annotate single messages and whole conversations with taxonomies, and controlled dictionaries (but also folksonomies) to transform messages, groups of messages and whole conversations into reusable contents, so to be able to insert new Educational Environments and new learning/teaching experiences.

Figure 4 describes a part of the SIOC ontology and some extensions (*ChatChannel* and *InstantMessage* subclasses of *Forum* and *Post*) which allow to model other main elements of a conversation session (occurred through an Instant Messaging tool).

The properties *topic* and *content* are used respectively to annotate a specific message to a topic, possibly represented by a SKOS concept (*SKOS:Concept*), and to add textual content to the message.

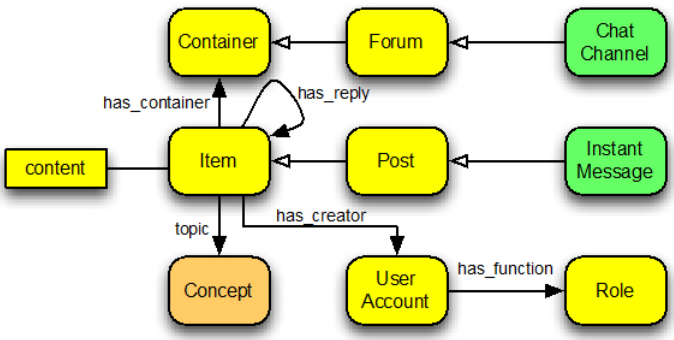

Fig. 4 - Modeling conversation data using SIOC

The property *topic* enables the correlation between a conversation message and one or more concepts belonging to the second or third layer of the Knowledge Network.

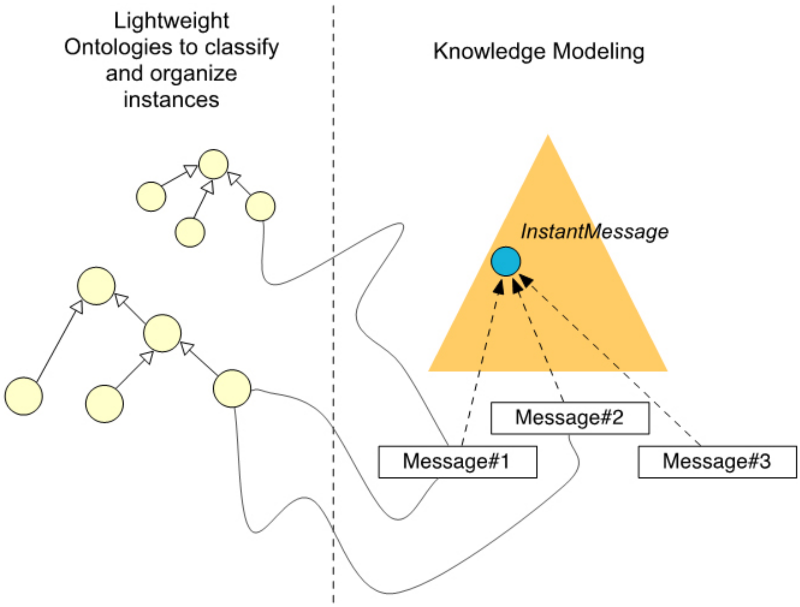

Fig. 5 - Using messages to elicit semantic correlations

As reported in Figure 5, through the three ontological layers, and particularly through the modeling of messages produced in the conversations, it is possible to elicit semantic correlations of two types.

The first type can be seen when, for instance, two messages are linked to the same element of a taxonomy. In this case, a semantic correlation is elicited between two messages. The second type occurs when the same message is linked to more elements of one or more taxonomies. In this case, the message itself correlates two concepts eliciting new knowledge. These correlations, being made explicit "manually" by participants in conversations or automatically by algorithms of Computational Intelligence, allow to increase the Knowledge Network and to enable the generation of new and richer learning experiences.

The mentioned mechanism applies not only to messages but also to other types of entities including documents and learning objects.

3.2 Execution of Learning Experience

Once the educational environment has been created and a contact with the second participant in the conversation is activated, it is possible to start the session and the execution of the conversational script.

Conversational Process

The script (as presented in the previous sections) is used to schedule the ordering of topics to deal with in the conversation, and to guide the two participants towards the achievement of their learning goal.

The script is divided into modules. Each module is followed by an assessment activity which, using a specific tool, allows to assess the learning process of both learners (*learner* and *partner*) involved in the conversation. They may evaluate their learning with reference to every topic studied in their current module. The Figure 6 shows the script subdivided into modules and assessment moments graphically. For instance, the first module in Figure 6 contains the set of concepts

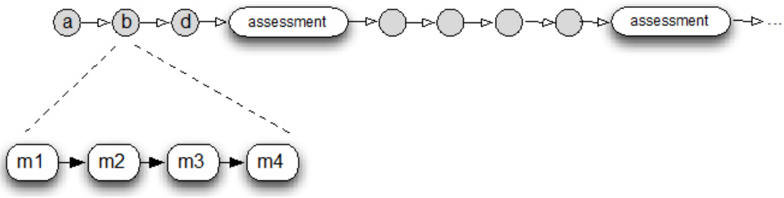

Fig. 6 - Script segmentation in modules

For any c_i concept of the script, the two participants (*learner* and *partner*) will exchange an M_i set of messages (modeled by SIOC as indicated before) having an $n=|M_i|$ cardinality. The discourse structure depends on many factors including, for instance, partner's competences. In case of *peer* or *expert peer* partner, the learner would start the conversation with a request for a thorough discussion. In case of a *tutor* partner, who owns specific teaching competence, the conversation could be activated by this latter through a direct question to the learner about the *learning path* current topic. The *learner*, at this stage, will try to formulate an answer, which will be followed by a *tutor*'s feedback. All n messages in the M_i set will be therefore aggregated into a learning object linked to the c_i concept saved in a repository and retrieved during other educational paths. Of course, the quality of a learning object generated basing on a conversation between *leaner* and *tutor*, will have a greater probability to reach a higher qualitative level than the learning objects generated by conversations between *learner* and *peer* (or *expert peer*). This mechanism enables a phase of enhancement of the structured knowledge (Figure 1) within the Social Semantic Web.

During the conversation, *learner* and *partner* will exploit the Knowledge Network to graphically visualize correlations between their *prior knowled-*

ge and part of *collective knowledge* of interest with concepts of the *learning path*. As an example, in Figure 7, shows how the Knowledge Network can correlate a concept in a learning path (extracted from the conceptualization of a disciplinary domain) with an annotated document, during the organization's knowledge modeling.

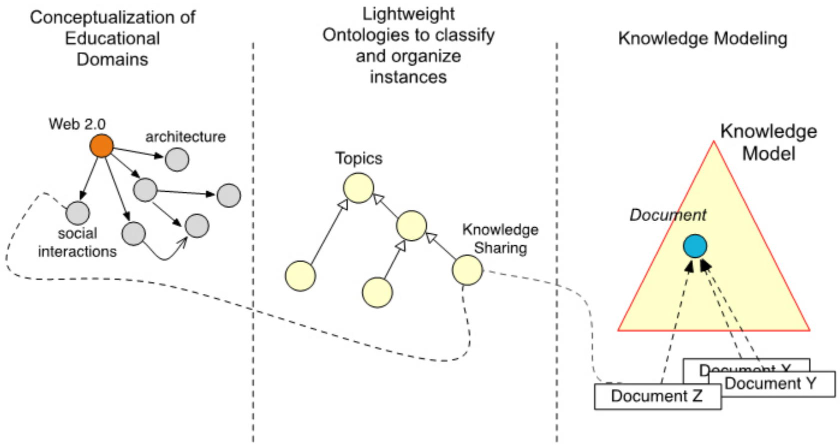

Fig. 7 - Semantic correlations between educational domains and collective knowledge

This mechanism allows *learner* and *partner* to activate, during the conversation, mechanisms referable to the *generative processing* described in the previous sections.

Assessment and macro-adaptation phase

As described before, at the end of the dialogue related to a specific module, *learner* and *partner* will be asked to assess their educational process with regard to learning (by the learner) of the set of concepts $Ci = \{c_1^{(i)}, c_2^{(i)}, ..., c_n^{(i)}\}$ available in the module, using a fixed value scale (from 1 to 10). The *learner*'s assessment feedback on $c_j^{(i)}$ concept will be $L(c_j^{(i)})$, while the *partner*'s one will be $P(c_j^{(i)})$. The final assessment for $c_j^{(i)}$ concept will be therefore defined as follows:

$$F(C_i) = \frac{w_L L(C_i) + w_P P(C_i)}{w_L + w_P}$$

The coefficients w_L and w_P represent respectively the weights of *learner* and partner assessment relevance. Such weights can likely vary according to partner's competences. $F(c_j^{(i)})$ is the final assessment of the $c_j^{(i)}$ concept learning. If $F(c_j^{(i)})$ is higher or equal to a threshold value (e.g. threshold = 6) then the $c_j^{(i)}$ concept is considered to be learnt, otherwise it will need a remedial path.

R_i represents the $c_j^{(i)}$ set whose $F(c_j^{(i)})$ results to be slightly lower than the fixed threshold.

At the end of the execution of the module and the related assessment phase, the R_i set, corresponding to a *remedial path*, that is the sequence of concepts whose learning experience needs to be repeated or integrated, is calculated. For the conversation related to the *remedial path* it is possible to increase or decrease the *social/peer scaffolding* level by selecting a new partner:

TABLE 1
Scaffolding & Fading rules

Rule	State of Experience	Start Level of Scaffold	End Level of Scaffold
1.1	End of the assessment phase with a training gap (percentage of concepts with insufficient feedback) > α	Peer	Expert Peer
1.2		Expert Peer	Tutor
1.3		Tutor	Tutor
2.1	End of the assessment phase with a training gap (percentage of concepts with insufficient feedback ≤ α	Peer	Peer
2.2		Expert Peer	Expert Peer
2.3		Tutor	Tutor
3.1	End of the assessment phase with a training gap (percentage of concepts with insufficient feedback = 0	Peer	Peer
3.2		Expert Peer	Peer
3.3		Tutor	Expert Peer

The *scaffolding* & *fading* rules reported in Table 1, aim at optimizing the use of resources within the organization, trying to select resources with teaching competence and expert resources only if strictly needed. In particular, the rules 1.x are used when the learning level is unsatisfactory and requires a more structured intervention. The rules 2.x keep the situation unvaried when the learning level is insufficient. The rules 3.x try to reduce the scaffolding level when the learning is completely satisfactory. The threshold indicated by α can be calculated experimentally.

Once the conversation related to the *remedial path* has ended, a new assessment phase is activated, which if results to be positive brings the script to the following module, and on the contrary, if negative activates a new remedial path.

Semantic Links and maximization of conversation skill reuse

Given a set of *M* messages related to a specific *C* concept, it is possible to make an analysis and determine the conversation topics. The same ability to annotate messages with tags related to the used conversational patterns, enables new and more effective ways of reusing.

3.3 Topic Modeling

As for what concerns the first aspect, the extracted topics can be used to elicit semantic correlations between messages and the second layer of the Knowledge Network, that is light Ontologies for the classification and organization of instances. This will allow to annotate more in detail the messages within the corporate Knowledge Network and to elicit new possible correlations within the network itself. The topic elicitation, basing on a conversation, occurs by means of *Topic Modeling*, which in its turn consists of two tasks: *Topic Segmentation* and *Topic Labeling*. The *Topic Segmentation* decomposes a conversation into segments which discuss about the same topic. The *Topic Labeling* instead, assigns an informative label to topics identified in a conversation segment. The most promising approaches to *Topic Modeling* are probabilistic, since they model the set of messages as a stochastic process. Among these approaches, Latent Dirichlet Allocation (LDA) is, at present, the most effective one (Blei & Lafferty, 2009). Once obtained a set of T_c topic from the analyzed messages, it is possible to apply algorithms of *Link Discovery* (Voltz *et al*., 2009) to connect topics with SLOS concepts already available in the Knowledge Network. The T_c topic are represented using the property *SKOS:topic* (Figure 4). The identification of topics and semantic links to the existing Knowledge Network, allows to increase reusability of conversations and to represent in a more formal and accessible way, through standard query languages (e.g. SPARQL1.1), constructed knowledge (knowledge construction) and created knowledge (knowledge creation) during the conversation, thanks to the messages (knowledge sharing).

3.4 Dialogue Act Modeling

Concerning the analysis of conversation structures, it is possible to use algorithms of *machine learning* to classify single messages by type. Table 2 reports some *dialogue acts* described in the paper (Boyer *et al*., 2011). At this stage, it is possible to extract dialogical patterns from the conversation. Sets of messages, being part of the same dialogical pattern, will be annotated to support and improve research and reuse capability, in the light of complex mechanisms of Social Semantic Web systems.

There are in literature different semi-supervised approaches to annotate turns of conversation with a label describing its type (Venkataraman *et al.*, 2002). Recently instead, other not-supervised approaches have been proposed, based on HMM (Hidden Markov Model) (Ritter *et al.*, 2010) or on CRFs (Conditional Random Fields) (Sutton & McCallum, 2011).

TABLE 2
Classification of dialogue acts

Tipe of Dialogue Act	Description
Statement	A statement related to a concept or a task to be performed
Question	A question related to a concept or a task to be performed
Assessing Question	A request for feedback on a task or part of conversation related to a concept
Positive Feedback	Positive assessment related to a performed task or part of conversation
Positive Content Feedback	Positive assessment, with explanation, related to a performed task or part of conversation
Negative Feedback	Negative assessment related to a performed task or part of conversation
Negative Content Feedback	Positive assessment, with explanation, related to a performed task or part of conversation

The classification of *dialogue acts* can be used, combined with the *Topic Modeling*, to adapt the conversation at a micro level, providing suggestions to *learner* and *partner* in order to improve the learning/teaching process.

Final Remarks

This work sets out the conceptual design of a learning platform based on Social Semantic Web's principles. In particular, the above mentioned platform has been instantiated with the purpose to define an adaptive environment for the learning, based on conversations. The environment supports a *learner* and his/her *partner* in the conversation (that can be a peer, an expert peer or a tutor) proposing a conversational script composed of an ordered sequence of concepts (*learning path*). The *learning path* is automatically extracted (basing on the learning goal) from "light" ontology structures, used for the conceptualization of disciplinary domains. The learning experience is further improved by exploiting the original correlation model here proposed. The messages produces during the conversations are semantically enriched by languages and schemes of the Semantic Web and linked to the existing Knowledge Network. Algorithms of *Topic Modeling*, *Link Discovery* and *Dialogue Act Modeling* are used for the elicitation of semantic correlations which are hidden in the Knowledge Network, also exploiting conversations and fostering capabilities of discovery and reuse of the conversations themselves in new learning experiences.

A further phase of prototype development, experimentation and assessment of this work is also envisaged in the context of the EU FP7 ARISTOTELE project. In particular, as for the assessment, the phase will follow two directions. First of all, verifying the effectiveness of the conversational environment, by the assessment of knowledge and skills acquired by the learner. Secondly, verifying the effectiveness of the environment with regard to its capability to semantically annotate the conversations to support their reuse into new experiences.

Acknowledgement

This research is partially supported by the EC under the Project ARISTOTELE "Personalised Learning & Collaborative Working Environments Fostering So cial Creativity and Innovations Inside the Organisations", VII FP, Theme ICT- 2009.4.2 (Technology-Enhanced Learning), Grant Agreement n. 257886.

REFERENCES

Aalst J.V. (2009), *Distinguishing knowledge-sharing, knowledge-construction, and knowledge-creation discourses*. I. J. Computer-Supported Collaborative Learning(2009) 259-287

Bereiter C., Scardamalia M. (1987), *The psychology of written composition*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Blei D., Lafferty J. (2009) *Topic Models*. In A. Srivastava and M. Sahami, editors, Text Mining: Classification, Clustering, and Applications. Chapman & Hall/CRC Data Mining and Knowledge Discovery Series.

Boyer KE., Phillips R., Ingram A., Ha E., Wallis MD.,Vouk M., Lester J. (2011), *Investigating the Relationship Between Dialogue Structure and Tutoring Effectiveness: A Hidden Markov Modeling Approach*. I. J. Artificial Intelligence in Education 21(1-2): 65-81.

Bouyias Y., Demetriadis S. (2010), *Cognitive Processes Induced from Fading-out of the Collaboration Script During Argumentation*. incos, pp.24-31, 2010 International Conference on Intelligent Networking and Collaborative Systems.

Breslin J.G., Passant A., Vrandecic D. (2011), *Social Semantic Web*, Handbook of Semantic Web Technologies, J. Domingue, D. Fensel, J.A. Hendler (Editors), Springer, ISBN 9783540929123, 24 June 2011

Brown J. S., Collins A., Duguid P. (1989), *Situated cognition and the culture of learning*. Educational Researcher, 18(1), 32–42.

Calvani A. (2009), *Teorie dell'istruzione e carico cognitivo. Modelli per una scuola* *efficace*. Trento: Erickson, p. 1-146.

Capuano A., Gaeta M., Marengo A., Miranda S., Orciuoli F., Ritrovato P. (2009), *LIA: an Intelligent Advisor for e-Learning. Interactive Learning Environments*, Taylor & Francis, vol. 17, no. 3, pp. 221-239, September 2009.

De Maio C., Fenza G., Gaeta M., Loia V., Orciuoli F., Senatore S. (2012), *RSS-based e-learning recommendations exploiting fuzzy FCA for Knowledge Modeling*, Applied Soft Computing journal, Elsevier, Vol. 12, No. 1, 113-124.

Dillenbourg P. (2002), *Over-scripting CSCL: The risks of blending collaborative learning with instructional design*. In P. A. Kirschner (Ed.), Three worlds of CSCL. Can we support CSCL, (pp. 61-91), Heerlen, NL: Open Universiteit Nederland.

Dillenbourg P., Hong F. (2008), *The Mechanics of Macro Scripts*, International Journal of Computer-Supported Collaborative Learning, 3 (1), 5-23.

Dillenbourg P., Jermann P. (2007), *Designing interactive scripts*. In F. Fischer, I. Kollar, H. Mandl, & J. Haake (Eds.), Scripting computer-supported collaborative learning: Cognitive, computational and educational perspectives, (pp. 276-301), New York: Springer.

Fischer F., Kollar I., Mandl H., Haake J.M. (Eds.) (2007), *Scripting computer-supported collaborative learning – cognitive, computational, and educational perspectives*. New York: Springer.

Gaeta M., Orciuoli F., Paolozzi S., Salerno S. (2011), *Ontology Extraction For Knowledge Reuse The e-Learning Perspective*, IEEE Transactions on Systems, Man, and Cybernetics, Part A: Systems and Humans journal, Vol. 41, No. 4, 798-809.

Gruber T. (2007), *Collective Knowledge Systems: Where the Social Web meets the Semantic Web*. Journal of Web Semantics.

Knuf J. (2000), *Benchmarking the lean enterprise: Organizational learning at work*. Journal of Management in Engineering, 16(4), 59–71.

Kollar I., Fischer F., Hesse F. W. (2006), *Computer-supported collaboration scripts - a conceptual analysis*. Educational Psychology Review, 18(2), 159-185.

Kollar I., Fischer F., Slotta J. D. (2005), *Internal and external collaboration scripts in webbased science learning at schools*. Computer supported collaborative learning 2005: The next 10 Year!,LEA, Mahwah, NJ, pp 331-340.

Mayer R. E. (2010), *Applying the science of learning*. Upper Saddle River, NJ: Pearson.

Mangione G.R., Orciuoli F., Pierri A., Salerno S. (2009), *Competence management in e-learning systems: a possible approach*, Journal of e-Learning and Knowledge Society, Vol 5, No 3, 2009.

Mengis J. Eppler M.J. (2005), *Understanding and managing knowledge-intensive conversations*, in: Proceedings of the 2005 KMAP Knowledge Management Asian Pacific Conference, 2005. Nominated for Best Paper Award.

Mercer N. (2000), *Words and Minds: how we use language to think together*. London: Routledge.

Paavola S., Lipponen L., Hakkarainen K. (2004), *Models of innovative knowledge* *communities and three metaphors of learning*. Review of Educational Research, 74, 557–576.

Pea R. D. (1994), *Seeing what we build together: distributed multimedia learning environments for transformative communities*. The Journal of the Learning Sciences, 3, 285–299.

Renshaw P. (2004), *Dialogic learning, teaching and instruction: Theoretical roots and analytical frameworks*. In J. van der Linden, & P. Renshaw (Eds.), Dialogic learning (pp. 1-15). Dordrecht, The Netherlands: Kluwer.

Ritter A., Cherry C., Dolan B. (2010), *Unsupervised modeling of Twitter conversations*. HCT-NAACL.

Salomon G., Perkins D. N. (1998), *Individual and social aspects of learning*. Review of Research in Education, 23, 1-24.

Soller A., Lesgold A. (2003), *A computational approach to analyzing online knowledge sharing interaction*. In: Proceedings of Artificial Intelligence in Education 2003, Sydney, Australia, pp. 253–260.

Sutton C., McCallum A. (2011), *An Introduction to Conditional Random Fields*, Foundations and Trends in Machine Learning.

Ten Dam G., Volman M., Wardekker W. (2004), *Making sense through participation: social differences in learning and identity development*. In J. Van der Linden & P. Renshaw (eds.), Dialogic learning (pp. 63-85). Dordrecht: Kluwer.

Tynjälä P., Häkkinen P. (2005), *E-learning at work: Theoretical underpinnings and pedagogical challenges*, Journal of Workplace Learning 17 (5/6), 318-336.

van Merriënboer J.G., Pass F. (2003), *Powerful learning and the many faces of instructional design: Toward a framework for the design of powerful learning environments*, in E. De Corte, L. Verschaffel, N. Entwistle and J.G. van Merriënboer (Eds), Powerful Learning Environments: Unraveling Basic Components and Dimensions, Amsterdam, Pergamon, p. 3-20.

Venkataraman A., *et al*. (2002), *Automatic Dialog Act Labeling with Minimal Supervision*, Proc. 9th Australian International Conference on Speech Science and Technology, Melbourne, Australia.

Vygotsky L. (1978), *Mind in Society: The development of higher psychological processes*. Harvard University Press. Cambridge, MA.

Volz J., Bizer C., Gaedke M., Kobilarov G. (2009), *Discovering and Maintaining Links on the Web of Data*. International Semantic Web Conference 2009: 650-665

Wegerif N., Mercer N., Dawes L. (1999), *From social interaction to individual reasoning: an empirical investigation of a possible socio-cultural model of cognitive development*. Learning and Instruction, Vol. 9, No. 6

Weinberger A., Ertl B., Fisher F., Mandl H. (2004), *Cooperation scripts for learning via web-based discussion boards and videoconferencing*, EARLI SIM 2004, Retrieved April 10, 2010, from http://www.cs.uu.nl/docs/vakken/b3elg/literatuur_files/weinberg.pdf