Trialogical E-Learning and Emergent Knowledge Artifacts

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Abstract. According to the recently emerged, *trialogical learning* (TL) paradigm, learners are collaboratively developing shared objects of activity in a systematic fashion. In this paper we propose a basic learning scenario according to the TL paradigm. With this scenario as gnomon, we elaborate the technical issues that are raised for supporting it and we propose a flexible novel method for defining various aspects of the group knowledge.

1 Introduction

Classical learning theories are based either on the *knowledge acquisition* metaphor (i.e. a learner facing a body of knowledge), or on the *social participation* metaphor (i.e. a group of learners collaborate to assimilate a body of knowledge). Although widely accepted, these theories do not provide sufficient models for capturing innovative practices of both learning and working with knowledge ("knowledge practices"). To address this problem, a novel theory emerged recently, called *Trialogical Learning* (TL) [6], that emphasizes on the collaborative knowledge creation process. According to TL, learners are *collaboratively* developing *shared objects* of activity in a *systematic fashion*. We could therefore consider as cornerstone of trialogical learning the notion of shared objects, a notion that is quite general and can capture a plethora of application scenarios. For instance, a video that records how group members carry out their tasks, could be considered as a shared knowledge artifact which the group could annotate (with free text or with respect to an ontology), analyze and further discuss (e.g. for capturing tacit group knowledge). Moreover, and more interestingly, a knowledge artifact could take a more formal substance as in the case of documents (e.g. a survey paper), conceptualizations (e.g. a data/knowledge base), or even software code exchanged within a group. Hereafter we shall use *knowledge artifact* to refer to what is being created and/or shared by a group of learners (and could be a set of words, documents, concept maps, ontologies, annotations, etc).

Models and techniques that allow diversification and flexible amalgamation of different world views are still in their infancy. In this paper, we investigate various ways to build emerging knowledge spaces within a "Trialogical Learning" scenario. In particular, we focus on the various methods to form the common knowledge of a group by combining the individual knowledge of its members. The provision of flexible methods for defining various aspects of the group knowledge is expected to foster TL knowledge creation processes and could lead to the development of tools that overcome the inelasticities of the current knowledge creation practices.

2 Motivating Scenario for *Trialogical* Learning

A set of N research papers, say $P = \{p_1, \ldots p_N\}$, is given to a set of K learners $A = \{a_1 \ldots a_K\}$ who could be students, researchers, or co-workers in a company. The goal of this group is to understand the topics discussed in these papers and to build an ontology, say O, that represents the main issues discussed in these papers. Moreover the group has to annotate these N papers according to the derived ontology, i.e. specify $d(p)$ for each $p \in P$ where $d(p)$ denotes the description of p with respect to O. We could also assume that there is an additional constraint saying that the ontology should not have more than C concepts. The learners, hereafter *actors*, have to collaborate (synchronously or asynchronously) in order to carry out this task.

Note that various combinations of (N, K, C) values describe different real-life scenarios. For instance, $(50, 1, 20)$ could describe what a MSc student should do in order to write the state-of-the-art of his MSc thesis. Of course, this scenario does not fall into trialogical learning, but is rather an instance of monological learning (acquisition metaphor). Values like $(150, 2, 50)$ might describe the collaboration between a professor and a graduate student for finding a topic for a PhD thesis. Values like $(100, 10, 10)$ may describe a group (comprising 10 members) of a research lab that is trying to join a research area by studying the 100 related papers that have been published the last 5 years and trying to identify the 10 main topics of the area (subsequently each member of the group would be responsible for one topic). Finally, big values for K, say 1000, could model the effort for developing an international standard.

A related rising question is whether the "quality" of the result of this collaboration (i.e. of O and $d(p)$'s) should be measured and if yes how. We can identify two broad cases. According to the first, there is an external (human or machine) observer who can grade the result, while according to the second there is not any external party. For instance, we may assume that there is a certain "solution" ontology (ideal or criterion), denoted $O^{(i)}$ that it is unknown for members of the group. For example, $O^{(i)}$ could have been provided by a tutor if there is one (or the tutor instead of one ontology he might have provided a set of admissible ontologies). Subsequently, appropriate metrics could be employed in order to measure the "distance" between $O^{(i)}$ and O_{s_i} and at every point in time (state s_i), so that the members of the group can judge if they progress or not.

Of course not only the group work but also the individual work could be graded. Recall that according to [7, 2], for effective collaborative learning, there must be "group goals" and "individual accountability". Based on the successful results of experiments reported in [2]: fifty percent of each student's individual grade was based on the average score (of the group members) while the remaining fifty percent of each student's grade was individual.

In the case where there is not any external party we could probably only measure the degree of agreement between the members of the group. If O_A expresses the knowledge that all members of A accept to be correct, then the bigger O_A is, the better the group goes (assuming there is not any other constraint like C in the previous scenario).

3 General Principles and Issues

This section discusses issues that are important for supporting the previous scenario. In particular, Section 3.1 introduces personal and shared knowledge artifacts and clarifies their relation, while Section 3.2 shows how a set of learners can interact on the basis of the shared knowledge artifacts. Finally Section 3.3 synoptically discusses additional issues.

3.1 Personal versus Shared Knowledge Artifacts

To abstract from representation details we shall hereafter use the term knowledge base (KB) to refer to an ontology or to an ontology-based information base (i.e. to a set of objects annotated with ontological descriptions).

Although trialogical learning focuses on shared artifacts, learners should be able to construct and evolve their own models. Let KB_a denote the knowledge base of an actor a. Now let KB_A denote the "shared" (or common) knowledge base of a set of actors A. The important issue here is the relation between KB_A and KB_a (for $a \in A$). Below we identify three broad cases:

- *UNION-case.* Here KB_A is obtained by taking the union of the KBs of all participants, i.e.: $KB_A = \cup\{\ KB_a \mid a \in A\}$. Note that KB_A could be inconsistent if there is a notion of consistency. For example, if the task is to annotate a video with argumentative maps, then consistency is not a very strict issue. If on the other hand the task is to develop an ontology (for subsequently building a bibliographic database) or a software module, then consistency is a very important issue.
- *INTERSECTION-case.* Here KB_A is obtained by taking the intersection of the KBs of all participants, i.e.: $KB_A = \cap\{\ KB_a \mid a \in A\}$, so it comprises statements "accepted" by every participant.
- *QUANTITATIVE-case.* Here KB_A is defined by a quantitative method, e.g. it may comprise all sentences that are accepted by at least a percentage of the actors. Obviously, UNION and INTERSECTION are special cases of this case.

3.2 Interaction through Knowledge Artifacts

Suppose that we want to design and develop an application for supporting various forms of collaboration (e.g. asynchronous and synchronous) and supports private and shared knowledge artifacts. Figure 1 sketches a possible UI for that application that could serve as a proof of concept and as a gnomon for identifying and analyzing the associated technical requirements and challenges.

The UI is divided in two main areas: the left area allows managing the personal space, while the right area allows managing the group space. In the left area each learner is free to do whatever she wants, so everything is editable in that area. The right area shows the shared artifacts and this area is the key point for collaboration and for supporting trialogical e-learning. For instance, and assuming the scenario described earlier, each user may develop her own ontology at the left area, while the right window shows the group ontology O (according to the method that O is derived from the personal ontologies).

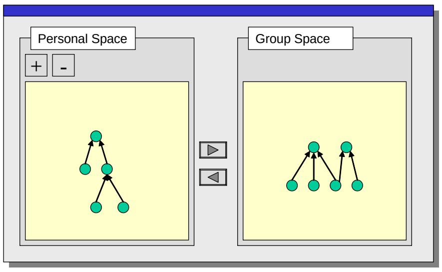

Fig. 1. An indicative UI for trialogical E-learning

The relationship between personal space and group space is very important. The button labeled by "$\rightarrow$" allows a user to copy the desired parts from her ontology to the group space. The button labeled by "$\leftarrow$" allows a user to copy the desired parts from the group ontology to her personal space.

An option that keeps the button "$\rightarrow$" permanently pressed would allow synchronous collaboration in the sense that every change at a learner's ontology is immediately reflected (propagated) to the group ontology (e.g. blackboard-based collaboration). Symmetrically, an option that keeps the button "$\leftarrow$" permanently pressed would propagate the changes on O to the personal space. This is not reasonable if O is defined by union, but it could be reasonable if O is defined by intersection or quantitatively. Deletions are handled analogously.

3.3 Auxiliary Functionalities

Above we have sketched the basics of a trialogical e-learning scenario. Of course, the scenario (and the UI) can be enriched with a plethora of auxiliary functionalities. Below we identify the most important ones according to our opinion:

- The *group space* view could be *customizable*, e.g. instead of showing the group ontology, one participant may want to see the ontology derived by considering the ontologies of only a *subset* of the participants. In general, the shared knowledge base could be defined with a set theoretic expression over subsets of A. For example, $K_{(\{a_1\}\cap\{a_2\})\cup(\{a_3\}\cap\{a_4\})}$ could capture the scenario where two groups (a_1, a_2) and (a_3, a_4) collaborate in the sense that the joint work of each group is integrated. Moreover, the group space could be *optionally managed* by a person whose role would be to accept or reject the changes that the participants forward to the group ontology.

- The *provenance* of every statement should be saved and be available at any time (e.g. this link was added by learner a_2). Moreover, the participants should be able to *annotate* every element of their personal or group space. The annotations could be textual or ontology-based.
- *Usability* is always a very important issue. For instance, by placing the mouse on top of an element of the group ontology, a balloon should open showing who provided this info (or what percent of the actors agree with this). Moreover the *visualization* of knowledge artifacts is a very important, challenging and open issue (some related issues are discussed in brief in [4, 8]).
- The UI could be enriched with *teleconferencing* services allowing the participants to discuss in real-time while using the system.

4 Concluding Remarks

This paper described a specific scenario for collaborative knowledge creation in the spirit of the trialogical learning paradigm. According to this scenario the group knowledge base is formed by combining the KBs of the participants according to various methods. The provision of flexible methods for defining various aspects of the group knowledge is expected to enhance synergy in the knowledge creation process and could lead to the development of tools that overcome the inelasticities of the current knowledge creation practices. An indicative UI was sketched enabling us to scent the most important issues that are raised for its realization.

We plan to further investigate and experiment with these issues in the context of the Knowledge Practices Laboratory (KP-Lab) project (co-funded by the IST programme of the EU 6) and on the basis of the RDF Suite [1, 3, 5].

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