User Authoring in Learning-by-Doing Situations\textsuperscript{1}
Danail Dochev, Gennady Agre, Radoslav Pavlov

Abstract: The paper deals with learning-by-doing activities through learner’s authoring of analytical materials in well-defined learning situations, considering some specifics of education in humanities. These ‘learning-by-authoring’ activities are facilitated by Semantic Web techniques to support the learners in the access and filtration of necessary information objects to be analysed during the authoring process. The paper discusses a framework for Technology Enhanced Learning environment under experimental realisation for a concrete humanitarian domain - Bulgarian Iconography covered in a set of educational disciplines like iconography, arts, history, culture studies, theology, etc. The paper contains an example with structured formulation of a concrete learning task, used in the environment to help in the execution of the steps of collection development and in the evaluation of the adequacy of the selected representative subset of objects.

Key words: Learning-By-Doing, Learner’s Content Development, TEL Environments, Semantic Technologies.

INTRODUCTION
In the last decades it is universally recognized that to acquire given knowledge fragment the learner needs an active learning style, different from passive reading and memorizing. In the educational theory this is the basic principle of constructivism [3], whose academic significance and practical value are generally acknowledged. According to this principle, the learners have to be stimulated to engage directly with the subject under study, participating actively in learning situations in order to “construct” their own understanding of the subject – their own knowledge. From this viewpoint, the education is first of all social interactive undertaking, centred on the learners and supposing their active involvement.

This attitude to learning prevails in many contemporary research and development efforts in the area of Technology Enhanced Learning /TEL/, addressing the creation of different pre-defined learning situations to facilitate active learners’ participation. Active learning is relatively easy accomplished when learning facts, simple procedures and practical skills, even in natural daily situations. This becomes more complicated in case of more “artificial” academic education, concerning more theoretic, conceptual matters and connected with formation and interpretation of abstract concepts. This is the case when studying e.g. theoretical physics, mathematics, logics, philosophy etc. [4], [5]. This is valid to great extent also for education in humanities, irrespective of the significant volume of accompanying factual knowledge. The learners in such disciplines are often not engaged directly (or are engaged in lesser extent) with phenomena and perceptions from the real world (as in learning experimental sciences or technological disciplines), but have to work more with models – world representations as well as with digital objects. It seems natural this necessity to be supported adequately by TEL facilities due to the rich possibilities to present and apply models and digital cultural heritage objects by means of computer systems.

\textsuperscript{1} The work on this paper was funded partially by the Bulgarian NSF project D-002-189 SINUS “Semantic Technologies for Web Services and Technology Enhanced Learning"
In case of education in humanities, a set of additional specific features have to be considered:

- Big volumes of not explicitly structured (i.e. tacit) knowledge;
- Differing, but domain significant theoretical models, which cannot be generalized in a common framework;
- Existence of multiple different, even contradictory interpretations of phenomena, which cannot and should not be neglected when learning the subject;
- More significant impact of linguistic, cultural and subjective factors on the understanding and explanation of the domain processes and phenomena;
- Availability of conceptual theoretic frameworks, build on not fully defined concepts and notions, leading to difficulties in developing computer models.

Due to these specific features, the interpretative component of the learning is of a special importance for the education in humanities. From information viewpoint the interpretation concerns abilities to make associative links to independent information sources, to formulate assertions on their base and to make inferences from the available knowledge.

The present paper investigates the organisation of learning-by-doing activities through learner’s authoring of analytical materials in specific learning situations. These ‘learning-by-authoring’ activities are facilitated by semantic technologies, supporting learners’ access and filtering of necessary information objects to be analysed during the authoring process, as well as to some extent in the evaluation of the created materials. The work presented is organised under the current Bulgarian NSF project SINUS “Semantic Technologies for Web Services and Technology Enhanced Learning” [1] (http://sinus.iinf.bas.bg/). The paper is structured as follows: the learning setting for specific ‘learning-by-authoring’ activities is discussed in the next section; then steps for development and analysis of dedicated collections according to the pre-assigned learning tasks are briefly presented; an example of structured learning task is provided; at the end some points to future work follow.

PROJECT OBJECTIVES AND LEARNING CONTEXT

The investigations in the project SINUS aim to support the analytical and to a certain extent the interpretative skills of the learners in a given humanitarian field by developing an environment, permitting to build-up appropriate task-focused presentation of annotated digital resources to the users. These resources are intended for use in the authoring of analytical materials in defined learning situations. The participation of the learners in:

- semi-structured navigation on sets of interesting for the learning goals information objects (the structure is offered by domain ontology);
- writing of analytical materials on selected objects (with offered guidance)

will guarantee their active involvement in the learning process in constructivist sense.

The project SINUS targets the development of specialized e-learning facilities, allowing learning by-doing through learners’ authoring of specific learning materials by intensive use of multimedia digital libraries /DL/. With these ‘learning-by-authoring’ activities the following learning goals are pursued:

- Helping the learners to improve, make more precise, consolidate and extend their specific domain knowledge;
- Supporting the development of the learners’ analytical skills and facilitating their application;
- Mastering professional DL usage by the learners.

The SINUS environment is focused on pro-active achievement of these goals by learners’ own actions, supported by the built-in domain and pedagogical knowledge. The environment supports specific learning task: development by the learners of educational scholarly essays/course theses/projects for pre-assigned by the teacher analyses (e.g. analysis of certain object characteristics, presenting selected aspects of the domain under
study). The result is multimedia document, authored by the learner according to the pre-assigned task and combining specific collection of information objects from the DL and textual analytical essay, answering to the given task. The developed specific collection of multimedia objects serves as a base for the analysis, as well as illustration of the theses in the analytical essay. Thus the development of a project consists of three steps:

1. Constructing limited-sized task-focused multimedia collection of DL objects by selection of appropriate illustrative material from RDF repositories with semantically annotated digital resources.

2. Analysis of the selected collection by comparison and pondering over certain objects characteristics. The analysis may reveal the necessity to extend/enrich the developed collection.

3. Development of the project (analytical essay) as a multimedia document (text + links to collection objects). An optional step is the possible formation of the result (approved by the teacher) as reusable learning material, annotated with semantic metadata (and/or with folksonomic markers) and stored in dedicated repository.

The environment guides and consults the learners for the assigned tasks on the base of its built-in knowledge (implemented by use of Semantic Web techniques):

- Domain knowledge about the subject under study, presenting its concepts and relations, significant from the viewpoint of the learning process. It is organized in a set of domain ontologies for annotating the information and learning materials.
- Pedagogical knowledge, reflecting the teacher/expert mental picture about the content and structure of good analytical essays, based on sufficiently rich and various illustrative materials, as well as about the possible steps to create such essays.

The use of both types of knowledge in the environment to guide and help the learners has to consider the normal shortage, inaccuracy and even incorrectness of the initial learners’ knowledge for the domain and also for the accessible materials and available information support.

INFORMATION SUPPORT DURING COLLECTION DEVELOPMENT

From the learners’ viewpoint the development of a specialised collection of multimedia objects from DL is a cyclic process of two steps:

- Formulation of a search, describing certain desired characteristics of the collection;
- Selection of representative objects from the set of objects, satisfying search criteria.

From the environment side this is a cyclic process of the following functions:

- Finding a set of objects, satisfying the current query;
- Sorting the result according to implicit or explicit criteria;
- Visualisation of sorted objects according to implicit or explicit criteria;
- Storing the user choice (subset of the search results) for further processing.

The information support of the environment aims to facilitate the learner’s actions by intelligent (i.e. guided by additional built-in knowledge) execution of system functions, listed above. The built-in knowledge is in a sense pedagogic knowledge and determines concrete criteria (parameters) for the system functions. It permits to control the correctness of the learners’ actions when performing the sequence of operations to solve the task. The SINUS environment applies this knowledge for the following purposes:

- To help the learner to formulate concrete query by ontological terms with explanations of some unknown/unclear terms and their relations with familiar concepts;
- To check the correctness of query results (e.g. by comparison against an exemplary query for given task);
- To facilitate the student’s selection of representative objects (by different modes of visualization);
To check the adequacy of the selected representative objects against criteria, set by the teacher (number, authors, variety, area coverage etc.).

Many learning tasks can be achieved by following several, often very distinct, paths through the space of learning resources. Different paths can be triggered by associations that happen to be useful at a particular moment. In reality the relationship between tasks and paths is many to many – one task can be achieved by following several paths, and vice versa. These reflections have been considered in the SINUS environment by allowing the student to perform the assigned learning task with the system help in 3 modes:

- Independently from the plan offered by the teacher, using only the semantic search and explanation facilities of the environment.
- Considering the teacher’s recommendations and the system help. In this mode the environment does not monitor the execution steps, but only evaluates the adequacy of the developed collection against the pre-assigned learning task.
- Using step-by-step recommendations of the plan and full system help, including monitoring and evaluation of queries with feedback to the learner at each step.

**INFORMATION SUPPORT DURING COLLECTION ANALYSIS**

In general, the collection analysis begins with comparison of given collection objects in order to determine their common or differing characteristics. This may be facilitated by the following environment operations: a/ Grouping of the collection elements according to given characteristic/s; b/ Partitioning the collection elements to subgroups according to common characteristic/s or common values of given characteristics; c/ Ordering objects according to a characteristic value (e.g. chronologically); d/ Registering similarities and differences of the selected collection objects with respect to the pre-defined characteristics. In order to obtain information support during the initial step of collection analysis the learner has to formulate correct queries to the environment and to register her/his observations on the results. To ensure this support the environment has to execute commands like Group, Order, Compare, Register. Pedagogic-type knowledge, useful to facilitate the learners in these comparisons, should determine parameters for the internal functions, realising the mentioned commands.

The evaluation of analytical materials created by the learners is a challenging task. Learning environments may help in this with the internal knowledge models, describing the authoring process. They reflect the teachers’ requirements towards the analyzed objects,
structure and characteristics of the results. In the design work on SINUS environment the attention to evaluation of intermediate and final results is focused not on assessment phases, but on monitoring the process and helping the learners to create projects according to teachers’ mental picture what is a good analytical essay. The environment may evaluate if the developed dedicated task-focused collections of multimedia objects contain sufficiently rich and various illustrative material to back-up the analyses (e.g. checking the number of selected objects and if they give sufficient coverage of: authors, iconographic schools, time periods, diversity of desired characteristics etc.). Further work in this direction will investigate in more details the models of actions when performing collection analysis, which may lead e.g. to necessity of modification/enrichment of the analyzed collection in order to cover more diverse illustrative material for better argumentation. Some manageable checks may be examined even in the evaluation of the structure and balance of final analytical essay (e.g. data mining techniques may check the availability of necessary basic concepts in the text, and the possibilities they are semantically related).

**EXPERIMENTAL APPLICATION**

The discussed framework for a TEL environment, facilitating learning-by-authoring activities, is under experimental realisation for a concrete humanitarian domain - Bulgarian Iconography covered in a set of educational disciplines (e.g. iconography, history, arts, culture studies, theology, etc). It is experimented on source materials from the multimedia DL.

<table>
<thead>
<tr>
<th>Table 1. Representation of a learning task and recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Task</strong></td>
</tr>
<tr>
<td><strong>Step</strong></td>
</tr>
<tr>
<td><strong>Recommendations</strong></td>
</tr>
<tr>
<td><strong>Basic:</strong></td>
</tr>
<tr>
<td><strong>Optional:</strong></td>
</tr>
<tr>
<td><strong>Step</strong></td>
</tr>
<tr>
<td><strong>Recommendations</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Step</strong></td>
</tr>
<tr>
<td><strong>Recommendations</strong></td>
</tr>
</tbody>
</table>

“Virtual Encyclopaedia of the Bulgarian Iconography” (Fig. 1) [6]. The domain Ontology for Bulgarian Iconographic Objects supports the semantic annotation and search of digital objects. Table 1 [2] presents formulation of a concrete learning task, extracted from the SINUS project use-case scenarios [7]. In the environment the users express their criteria for search, grouping, visualization etc. by queries in the terms of ontological concepts according to the given learning task. They are formed through user-friendly interface, realising convenient consecutive guidance through a system of menu.
CONCLUSIONS AND FUTURE WORK

The discussion in the paper is focused on the current work to reveal (and embed by semantic techniques) the necessary knowledge to guide and help the learner’s in developing limited-sized dedicated collections of multimedia objects, adequate to the pre-assigned learning tasks and then in comparing specific characteristics of the selected objects for the needs of performed analysis. The current investigations and experiments led to the following possible future work directions:

- Creation of multilingual ontology-backed terminological lexicons for formulating the semantic search queries.
- Use of text processing and data mining techniques to formalise learning task descriptions.
- Development and experimentation of more detailed procedures for monitoring collection development, based on the formalised task descriptions. By analysing the intermediate results of the incremental collection development against the pre-formulated teachers’ criteria the procedures should help the learner by warnings about errors and shortages.
- Use of text processing and data mining techniques to monitor and support the phase of analytical essays preparation, aiming at essays with rich enough illustrative material and appropriate argumentation.

REFERENCES


ABOUT THE AUTHORS

Assoc. Prof. Danail Dochev, PhD; Assoc. Prof. Gennady Agre, PhD; Institute of Information and Communication Technologies - BAS, Phone: +359 2 9792915, E-mail: dochev@iinf.bas.bg, agre@iinf.bas.bg. Assoc. Prof. Radoslav Pavlov, PhD; Institute of Mathematics and Informatics - BAS, Phone: +359 2 9793831, E-mail: radko@cc.bas.bg