



# **Euromedia'2011**

**SIXTEENTH ANNUAL SCIENTIFIC CONFERENCE ON  
WEB TECHNOLOGY, NEW MEDIA, COMMUNICATIONS AND  
TELEMATICS THEORY, METHODS, TOOLS AND APPLICATIONS**

**APRIL 18-20, 2011**

**BRITISH INSTITUTE OF  
TECHNOLOGY & E-COMMERCE  
LONDON U.K.**

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A PUBLICATION OF

**eurosis**



16<sup>TH</sup> ANNUAL EUROMEDIA CONFERENCE  
2011

LONDON, UNITED KINGDOM

APRIL 18-20, 2011

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EUROSIS is a Division of ETI Bvba, The European Technology Institute, Torhoutsesteenweg 162, Box 4, B-8400 Ostend, Belgium

Printed in Belgium by Reproduct NV, Ghent, Belgium

Cover Design by Grafisch Bedrijf Lammaing, Ostend, Belgium

EUROSIS-ETI Publication

**ISBN: 978-90-77381-62-5**

**EAN : 978-90-77381-62-5**

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# AN APPROACH TO LEARNING-BY DOING THROUGH USER CREATION OF LEARNING CONTENT

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## KEYWORDS

CAI, learning-by-doing, semantic technologies

## ABSTRACT

The paper investigates the organisation of learning-by-doing activities through learner's authoring of analytical materials, considering some specifics of education in humanities. Semantic technologies are applied to guide and help the learner's actions in developing limited-sized dedicated collections of multimedia objects, adequate to pre-assigned learning tasks and then in comparing the selected objects for the needs of performed analysis. The discussed framework for a TEL environment targets concrete humanitarian domain - Bulgarian Iconography with educational uses in a set of disciplines like iconography, arts, history, culture studies, theology, etc. The paper contains an example with structured formulation of a given learning task, and its formalisation in form of queries for the environment to help in the collection development steps and in the evaluation of the adequacy of the selected by the learner representative subset of objects.

## INTRODUCTION

In the educational theory of constructivism (Driscoll, 2000) whose academic significance and practical value are generally acknowledged, it is universally recognized that the learner needs an active learning style, different from passive reading and memorizing. The learners have to participate actively in learning situations in order to "construct" their own understanding of the subject. In case of education in humanities a set of specific features have to be considered: a/ Big volumes of not explicitly structured knowledge; b/ Domain significant, yet differing theoretical models, which can not be generalized in a common framework; c/ Different, even contradictory interpretations of phenomena, which can not and should not be neglected in the learning process; d/ More significant impact of linguistic, cultural and subjective factors on the understanding and explanation of phenomena; e/ Conceptual theoretic frameworks, built on not fully defined concepts and notions, hampering the computer modelling.

The present paper investigates learning-by-doing through learner's authoring of analytical materials, facilitated by applying semantic technologies to support the learners in the access and filtration of necessary multimedia objects to be analysed during the authoring process, as well as in the materials evaluation. The presented work is organised

under current national research project SINUS "Semantic Technologies for Web Services and Technology Enhanced Learning" (Dochev and Agre 2009).

## LEARNING-BY-DOING THROUGH AUTHORIZING

### Learning setting and objectives

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 appropriate information objects (the structure is offered by domain ontology);
- writing of analytical materials on selected objects (with offered guidance by the system)

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

The project SINUS aims to a specialised learning environment, supporting the learners to create specific learning materials by intensive use of multimedia digital libraries /DL/. With these 'learning-by-authoring' activities the following learning goals are pursued: a/ Improving, making more precise, consolidating and extending learner's specific domain knowledge; b/ Developing the analytical skills of the learners and facilitating their application; c/ Mastering professional DL usage by the learners.

The SINUS environment supports specific learning tasks - development of educational scholarly essays/course theses/projects for pre-assigned by the teacher analyses of the objects under study. The result is a multimedia document combining a specific collection of DL multimedia objects, and textual analytical essay (e.g. analysis of certain object characteristics). The developed collection serves as a base for performing the necessary analysis and as an illustration of theses in the analytical essay. A project development consists of three steps: 1/ Constructing limited-sized dedicated multimedia collection by selecting appropriate material from DL with semantically annotated resources; 2/ Analysis of the selected collection by comparison and debate of certain objects characteristics. The analysis may require modification/enrichment of the developed collection. 3/ Development of the analytical essay as a multimedia document.

The environment guides and consults the learners on the base of its built-in knowledge (implemented by use of semantic technologies): A/ 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. The information and learning materials in the repositories are semantically annotated in the terms of these ontologies. B/ Pedagogical knowledge, reflecting the teacher/expert mental picture about the content, structure and steps to create good analytical essays, based on sufficiently rich and various illustrative materials.

Both types of knowledge have 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.

### Development of a collection

From the learners' viewpoint the development of a multimedia collection is a cyclic process of two steps: 1/ Formulation of a query, describing certain desired characteristics of the collection; 2/ Selection of representative objects from the set satisfying the query. From the environment side this is a cyclic process of performing the following functions: a/ Finding a set of objects, satisfying the query; b/ Sorting the result according implicit or explicit criteria; c/ Visualisation of sorted objects with different descriptive details according implicit or explicit criteria; d/ Storing the user choice (subset of the search results) in appropriate form for further processing.

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 additional 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. This type of knowledge may be used to:

- Help the student to formulate concrete query, by using friendly interface with appropriate ontological terms;
- Explain some unknown/unclear terms and their relations with familiar concepts;
- Check the query result correctness (e.g. by comparison against an exemplary query for given task);
- Facilitate the student's selection of representative objects (by different modes of visualization);
- Check the adequacy of the selected objects against teacher's criteria— number, variety, area coverage etc.

In reality the relationship between learning tasks and possible paths through the space of learning resources is 'many to many': one task can be achieved by following several paths and vice versa. SINUS environment considers this by allowing the student to perform the assigned learning task with the system help in 3 modes: 1/ Independently from the offered plan by the teacher, using only the semantic search and explanation facilities of the environment. 2/ Using the recommendations in the teacher's

plan and the system help. The environment does not monitor the execution steps, but only evaluates the adequacy of the developed collection against the learning task. 3/ 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.

### Collection analysis

The collection analysis begins with comparison of given collection objects in order to determine their common or differing characteristics. The following operations will contribute to this comparison:

- Grouping of the collection elements according to given value/s of their characteristic/s;
- Partitioning on subgroups according to given characteristic or set of characteristics;
- Finding partitioning according to common value/s of characteristic/s (the values are not pre-defined);
- Ordering objects according a characteristic value (e.g. chronologically);
- Registering similarities and differences of the selected elements according pre-defined characteristics.

To obtain information support during the initial steps of collection analysis the learner should formulate correct queries to the environment and register the observations on the results. To ensure this support in addition to sorting and visualisation functions the learning environment has to execute commands like Group, Order, Compare, Register. The specific pedagogic-type knowledge should determine parameters for the internal functions, realising the commands.

In SINUS environment the 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 (reflected in the built-in knowledge). The environment may evaluate if the developed task-focused collection of multimedia objects contains sufficiently rich illustrative material to back-up the analyses (e.g. checking minimal number of objects, sufficient coverage of: iconographic schools, time periods, diversity of analysed characteristics etc.).

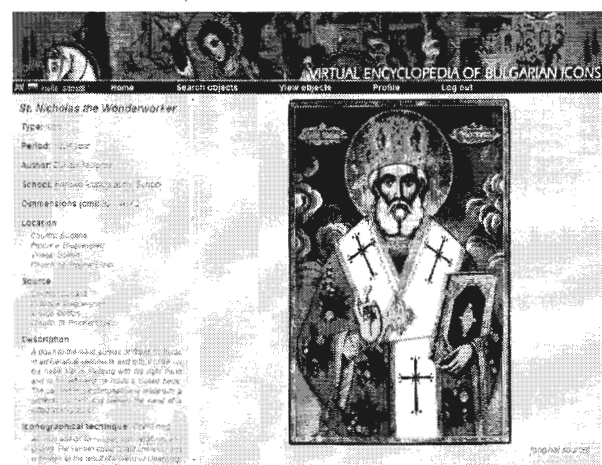


Figure 1: An object from the "Virtual Encyclopaedia of the Bulgarian Iconography"

### AN APPLICATION EXAMPLE

The discussed framework for a TEL environment, facilitating learning-by-authoring in specific learning settings, is under experimental realisation for a concrete humanitarian domain - Bulgarian Iconography, which has educational uses in a set of disciplines like iconography, arts, history, culture studies, theology, etc. It is experimented on source materials from the multimedia digital library "Virtual Encyclopaedia of the Bulgarian Iconography" (Figure 1) (Pavlova-Draganova et al. 2007). The semantic annotation and search of digital objects is based on the domain Ontology for Bulgarian Iconographic Objects (Staykova and Dochev 2009).

The example below presents structured formulation of a concrete learning task, extracted from the SINUS project use-case scenarios (Table 1).

Table 1: Text representation of a learning task and recommendations

Task	Make critical art analysis of the chronological development of the iconographic image of Jesus Christ in the Bulgarian iconographic schools.
Step	<b>1. Select collection of objects for the analysis.</b>
Recommendations	The selected objects have to satisfy the following criteria:
Basic:	Select at least 6 iconographical objects with the person of Jesus Christ in compositions with one main figure. All iconographical objects have to be in good current condition.
Optional:	At least one object from eminent author or founder of iconographic school. At least one primitive iconographical object and at least one iconographical object from the period of Bulgarian renaissance.
Step	<b>2. Make analysis of the collection.</b>
Recommendations	Examine the selected objects, comparing: <ul style="list-style-type: none"> <li>the cloths, gestures, proportions of the person of Jesus Christ;</li> <li>objects, other persons, Christian symbols;</li> <li>background, other elements around the image of Jesus Christ.</li> </ul> Search for changes – appearance or lack of elements (objects, symbols, persons), changes in background, clothes etc.
Step	<b>3. Register the results of the critical art analysis as a project.</b>
Recommendations	The project to be formed as multimedia document containing the selected iconographic images together with explanatory text before/after each image.

The formulation is further formalised in form of internal queries (presented in pseudo-language) for the environment to help in the collection development and evaluation of the adequacy of the selected by the learner representative subset of objects for comparison of their significant characteristics.

1. Query for search in the digital library according the recommendations (main criterion):

```

FIND all ?Objects On_criterion:
    class_of(?Objects)= iconographic_object
AND contains_person(?Objects)=
    Jesus_Christ
AND participates(Jesus_Christ) =
    ?Composition
AND class_of(?Composition) =
    one_figure_composition

```

```

AND current_status(?Objects) = good

```

2. Query for sorting the selected objects:

```

ORDER ?Objects On_criterion:
    iconographic_school(?Objects) =
        ?Iconographic_school
AND author(?Objects) = ?Author
AND (school_founder(?Author) = yes
    OR eminent_author(?Author) = yes)

```

3. Query for visualisation:

```

PRESENT ?Objects On_criterion:
    composition(?Objects) =
        ?Composition
AND class_of(?Composition) =
    one_figure_composition
AND iconographic_school(?Objects) =
    ?Iconographic_school
AND school_founder(?Author) = yes
AND eminent_author(?Author) = yes
AND primitive(?Object) = yes
AND renaissance_object(?Object) = yes

```

4. Query for evaluation the adequacy of the selected by the learner representative subset of objects:

```

EVALUATE ?Selected_objects =
    part_of(?Objects) On_criterion:
/* criterion for search */
class_of(?Selected_objects) =
    iconographic_object
AND contains_person(?Selected_objects)
    = Jesus_Christ
AND participates(Jesus_Christ) =
    ?Composition
AND class_of(?Composition) =
    one_figure_composition
AND current_status(?Selected_objects)
    = good
/* criterion for selection */
AND ?Quantity(?Selected_objects) ≥ 6
AND exists(?Object1) =
    part_of(?Selected_objects)
AND author(?Object1) = ?Author
AND (school_founder(?Author) = yes
    OR eminent_author(?Author) = yes)
AND ?Quantity(?Object1) ≥ 1
AND exists(?Object2) =
    part_of(?Selected_objects)
AND primitive(?Object2) = yes
AND renaissance_object(?Object2) = yes
AND ?Quantity(?Object2) ≥ 1
AND exists(?Object3) =
    part_of(?Selected_objects)
AND renaissance_object(?Object3) = yes
AND ?Quantity(?Object3) ≥ 1

```

## CONCLUSIONS

An experimental learning environment for learning-by-doing activities through learners' authoring of analytical materials in specific learning settings is under development. It concerns the area of Bulgarian iconography, studied in a set of humanitarian disciplines. The current investigations and experiments led to the following possible future work directions: facilitating the semantic search queries by use of multilingual ontology-backed terminological lexicons; use of text processing and data mining techniques in formalisation of learning task descriptions to monitor and support collection development with rich enough illustrative material; use of similar techniques to monitor and support the preparation of analytical essays with appropriate argumentation. (e.g. checking the availability of necessary basic concepts in the text and the possibilities that they are semantically related).



## ACKNOWLEDGEMENTS

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”.

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