UML in Defining the Conceptual Model for Distance Learning System Based on Dialogue

Bozidar Kovacic, Zoran Skocir*

University of Rijeka
Faculty of Philosophy
Omladinska 14, Rijeka, Croatia
Tel. 38551345046 Fax: 385051345207 E-mail:bkovacic@mapef.pefri.hr
*University of Zagreb
Faculty of Electrical Engineering and Computing
Unska 3, Zagreb, Croatia
Tel. 38516129831 Fax: 38516129616 E-mail:zoran.skocir@fer.hr

Abstract: **Development and implementation of new technologies are very valuable in education. The use of the Internet computer network and distance learning enabled the transfer of vast multimedial information and made education independent of the location and time. Quality of the students feedback from distance learning can be improved. Dialogue-based distance learning system is aimed at knowledge appraisal and is based on the analysis of the feedback, research of the defined structure of the teaching domain and generation of new learning contents. Object approach is the most suitable for developing such a system. The UML 'use case', package, class and state diagrams based on the UML notation define conceptual model of a Distance learning system based on a dialogue. The system is implemented by integration of database and WWW technologies.**

1. INTRODUCTION

Distance learning is very valuable in contemporary education. Development of communication technologies and especially the use of computers in communication, especially Internet, facilitated data transfer to great distances. They were powerfull grounds for the development of distance learning techniques. The advantages of electronic media enabled fast and relatively simple distribution of the learning material to great distances within a short period of time. Majority of the issues regarding data, information and knowledge transfer has been resolved. Currently, most of the efforts are focused on the organization of distance education so as to increase its performance [6]. Distance learning system based on a dialogue (DLSBD) can improve the results of such learning. Complexity of this system determines the object-oriented approach in development. This paper explains the use of the object oriented method UML in designing of the conceptual model for DLSBD. The UML 'use case', package, class and state diagrams define the conceptual model and explain implementation of a dialogue in distance learning. The diagrams include all elements relevant for distance learning and all elements that contribute to its improvement. The elements for distance learning improvement relate to distance learning control, which includes monitoring of the learning process, recording of important process characteristics, and process corrections. The diagrams include the elements necessary for realization of system's behavior based on continuous communication and exchange of information between the students and teachers. Permanent communication and exchange of information or a simple dialogue are necessary for monitoring and correction of a distance learning process. Main purpose of the system is to transfer knowledge, monitor the learning process and increase the effect of distance learning. The system is realized by integration of database and WWW technologies as a dynamic Web application. It can involve many students and teachers, irrespective of its venue and time.

Distance learning model explains basic principles [1,2,4]. Its elements are: knowledge base, delivery, learner, evaluation, record base and system control.

The system control employs a query index (defined by specific selection criteria) to deliver a request to knowledge base included in the learning contents (material with information presented to the student). Through the query index, knowledge base sends a locator index of the requested data in knowledge base to control system. The control system controls the transfer of the learning contents between knowledge base and computer for data transfer. Learning contents are transferred to the student who generates the reaction in the form of behavior, important for evaluation of the learning process and appraisal of the student. Evaluation data are sent to the system control that decides about additional activities necessary to accomplish the learning process. The student appraisal data are also sent to the record base to update the learning process data. The record base stores important data about the completed learning process that are then analyzed for the improvement of the additional learning. The control system uses many student appraisal data related to the ongoing learning process and the record base. They are needed to define the selection criteria for the learning contents necessary for process continuation. The control system places various queries to the record base about current and previous learning processes. With its answers the

system control influences further learning course. It changes future learning processes by upgrading knowledge base through recognition of the completed learning processes.

Basic advantages of the system are its capability to analyze a distance learning process and change the ongoing and future distance learning. The system must be able to record the contents and store them in the record base for subsequent conclusions about the quality of the completed distance education. Based on these information, the system control performs self-education and improves distance learning cognition.

Requirements and algorithms for DLSBD are shown in Section II. Conceptual model for DLSBD is shown in Section III. Implementation of DLSBD is shown in Section IV. Conclusion in Section V is followed by the reference list.

2. REQUIREMENTS AND ALGORITHMS FOR DISTANCE LEARNING SYSTEM BASED ON A DIALOGUE

Implementation of such a model starts with the estimate of the learning process and definition of the ways to correct and improve it [3]. All relevant elements for estimation of the learning process must be carefully analyzed. The next step is to consider particularity related to acceptance of technologies for distance learning. It includes storage of knowledge, its distribution to students, distance estimate and the possibility to correct the process.

The first step in designing of DLSBD is defining knowledge domain presentation [4]. The concepts and relations between them define knowledge domain that enables its structural organization. The experts define the concepts and every expert defines his/her relevant learning material comprising the text, pictures, audio, video and multimedia. Also, every concept is linked to three types of questions (checking, training and examination). Checking of the questions is aimed at defining student's acceptance of a concept through two answers: correct or false. A training question is used for student's training and checking of the adoption level of the learning material. The examination question is aimed at final check before the exam. Knowledge matrix stores information about students' knowledge (Table 1.). Matrix's rows are associated with students and the columns with concepts. Intersection of row i and column j stores variable V_{ij} to present knowledge of the student U_i about the concept X_j. The student's answer is recorded in the knowledge matrix

Table 1. Knowledge matrix.

	X_1	X_2	X_3	.	.	X_m
U_1	V_{12}	V_{13}	V_{14}	.	.	V_{1m}
U_2	V_{21}	V_{22}	V_{23}			V_{2m}
.						
U_n	V_{11}					V_{nm}

used for V_{ij} in the knowledge matrix. False answer lowers the score of the student's knowledge. Correct answer of the student U_j to the question about the concept X_i raises the value V_{ij}. The expert at the beginning defines the value of every V_{ij} in the knowledge matrix.

By using the concept structure a student can choose the concept to learn. The learning material is presented to him/her and a question to check every concept related to the learning concept too. If his/her answer to any question is false, the adoption of the concept is unsatisfactory and he/she is instructed to learn it. Then the check up questions are repeated. Every answer is recorded in the knowledge matrix by the changed value of the learned concept and it defines current adoption of the learned concepts. The limit denoting satisfactory level of the student's adoption of the X_j concept is defined for every value V_{ij} in the knowledge matrix. If the student reaches it a check up question is avoided every time it has to be presented for checking of the student's adoption of the X_j concept. Consequently, the student is checked only for the concepts insufficiently well adopted, so that learning of the well-known concepts is avoided as unnecessary. The achievement of every concept's characteristics relevant for estimation of the student's knowledge the student's skills, because the concepts that correspond to the skills are very well adopted. It is, therefore, possible to determine the level of student's knowledge and its structure. By comparing several students' values from the knowledge matrix we can analyze their structure and the overall quality of the learning process.

When concept's structure and knowledge matrix are defined, the algorithms for presentation of the activities during learning process are created [4]. The algorithms define the steps for avoidance of further processes:
- defining concept structure,
- making entries of the learning materials,
- defining concept sequence,
- making entries of questions,
- selecting criteria for examination,
- learning process,
- repeating,
- examination,
- analysis of the learning results.

Next step in designing of DLSBD is defining of the elements and their relations needed for implementation of previous algorithms. These elements and their relations are presented by the conceptual model for DLSBD.

3. CONCEPTUAL MODEL FOR DISTANCE LEARNING SYSTEM BASED ON A DIALOGUE

The object-oriented method UML is used for designing the conceptual model of DLSBD. The UML 'use case', package, UML class and UML state diagrams are used [5]. The UML 'use case' diagram is used for defining the actors in the
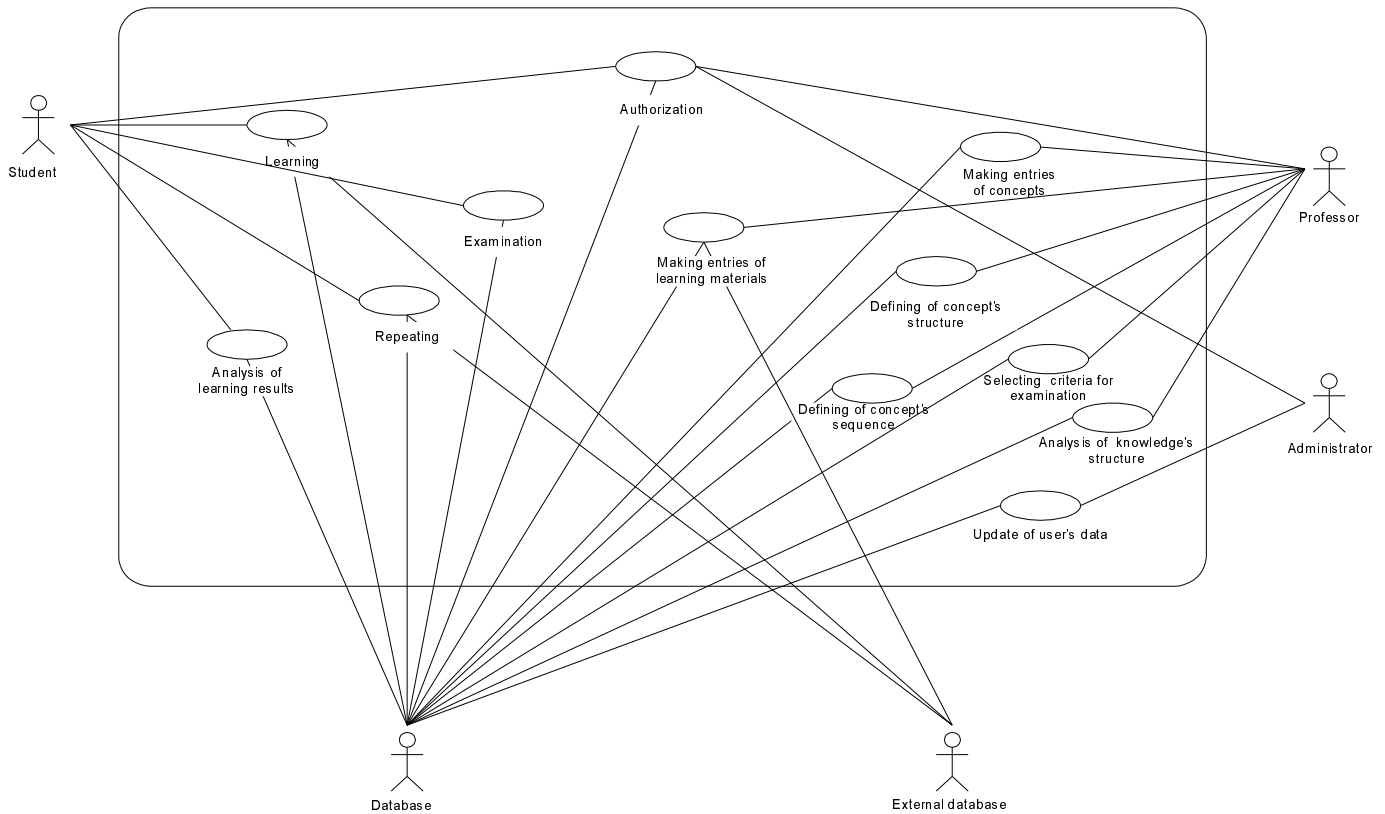
Figure 1. 'Use case' diagram

system and their interaction and processes for data exchange (figure 1.). We are presenting the commonbook workspace rather than every 'use case' separately because of the limited space. The actors are the student, teacher, database administrator, database and external database. The student and teachers use database and external database during learning processes. Table 2. defines the connections between the actors and their activities. Package diagram is presented in figure 2. Complexity of connections between the element do not allow defining of more than one package. The UML class diagram and the UML state diagram define every process between the actors in the 'use case' diagram. The UML state diagrams explain changing of the object state during learning. The UML class diagrams define the classes and relations between them. Every class is defined by the attributes and operations. Conceptual model of distance learning system based on a dialogue consists the following UML diagrams: defining relations between the concepts; connecting questions to concepts; connecting learning materials to concepts; defining concepts flow; selecting the examination criteria; learning process; repeating process; examination process and analysis of the learning results. Explanation of every UML class and UML state diagram cannot be presented on paper. However, the UML class

Table 2. Interaction of role with 'use cases'

| Use case	Student	Teacher	Administrator	Database	External database
Authorization	✓	✓	✓	✓	
Learning	✓			✓	✓
Repeating	✓			✓	✓
Examination	✓			✓	
Analysis of the learning results	✓			✓	
Making entries of the concepts		✓		✓	
Making entries of the learning materials		✓		✓	✓
Defining concept structure		✓		✓	
Defining concept sequence		✓		✓	
Selecting criteria for examination		✓		✓	
Analysis of knowledge structure		✓		✓	
Update of user data			✓	✓	

»System«

Distance learning system
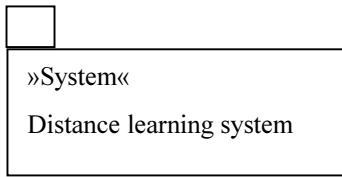
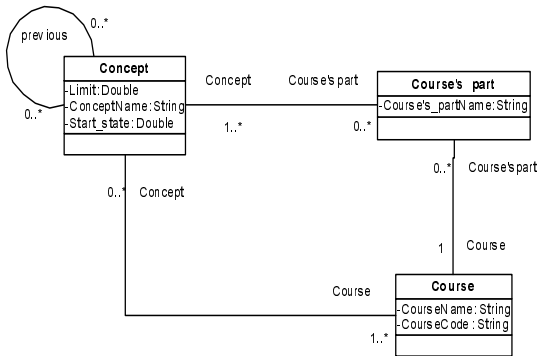*Figure 2. Package Distance Learning System*

*Figure 3. UML classs diagram of defining relation
between concepts*

diagram for defining the relation between the concepts (figure 3.) and state diagram for defining the relations between the concepts (figure 4.) are presented together with the most important UML class diagram for learning process (figure 5.).

The UML class diagram for defining the relations between the concepts has the following classes: Concept, Course and Course part. The UML class diagram of the learning process has the following classes: Student; Learning; Concept; LearningConcept; Question; ReferencedConcept; LearningConceptQuestion and Knowledge. Class attributes, with the exclusion of the class operations (for simplicity of a diagram), are presented in figure 5. For example, the methods for class Question are:

- AddQuestion(question:Question);
- DelQuestion(question:Question);
- SelectQuestion():Iterator;
- AddAnswer(answer:Answer);
- DelAnswer(answer:Answer);
- SelectAnswer():Iterator

One student performs one or more learnings, while learning can be performed by one student. The concept selected for learning is presented by class LearningConcept. The connected Class Concept has a recursive binary association because every concept can be connected without any or with more concepts, which enables defining of the concept structure. Question included in learning of the selected concept is presented by class LearningConceptQuestion. Class ReferencedConcept presents the concepts referenced by the selected learning concept derived from the concept structure. Every referenced concept is checked during the learning process, so that ReferencedConcept is connected

with class Question. Class Knowledge represents the record of a knowledge matrix. It connects the students with concepts and contains variable V_{ij} for recording the change in student's knowledge. Class LearningConceptQueestion and ReferancedConcept change the value of a variable V_{ij} because their attributes contain information about the correctness of the student's answers. The presented UML class diagram defines the class included in the learning process, their relations and attributes for storage of all relevant data about the learning process. The analysis of the results of the learning process is performed using data recorded during the learning process in the class attributes. The UML 'use case', UML package, UML class and UML state diagrams present a conceptual model for a DSLBD.
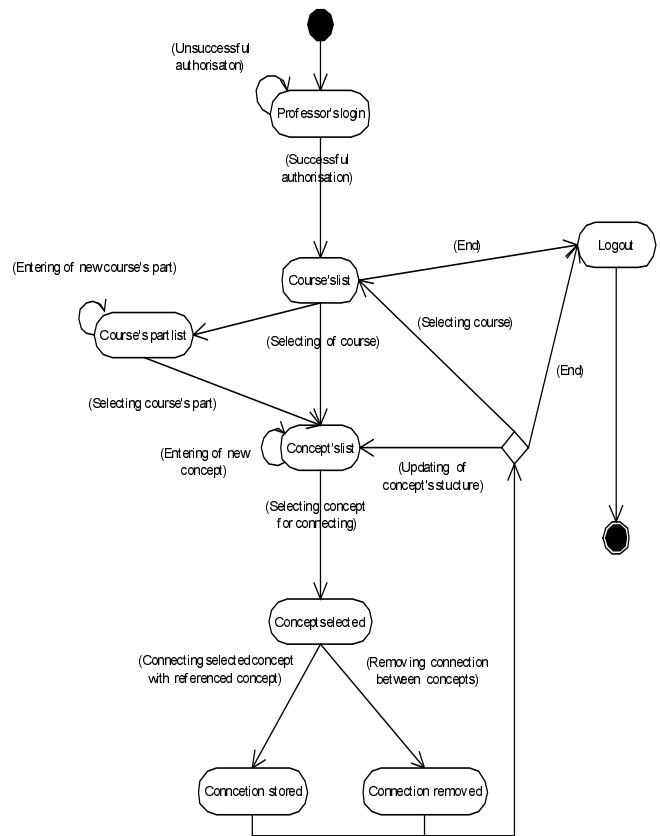

*Figure 4. UML state diagram of defining the relation
between the concepts*

4. IMPLEMENTATION OF DISTANCE LEARNING SYSTEM BASED ON A DIALOGUE

DLSBD is realized as the WWW application based on the integration of database and WWW technologies [6,7]. The system connects the end user (student or teacher) with the data stored in a database by middle tier presented by the
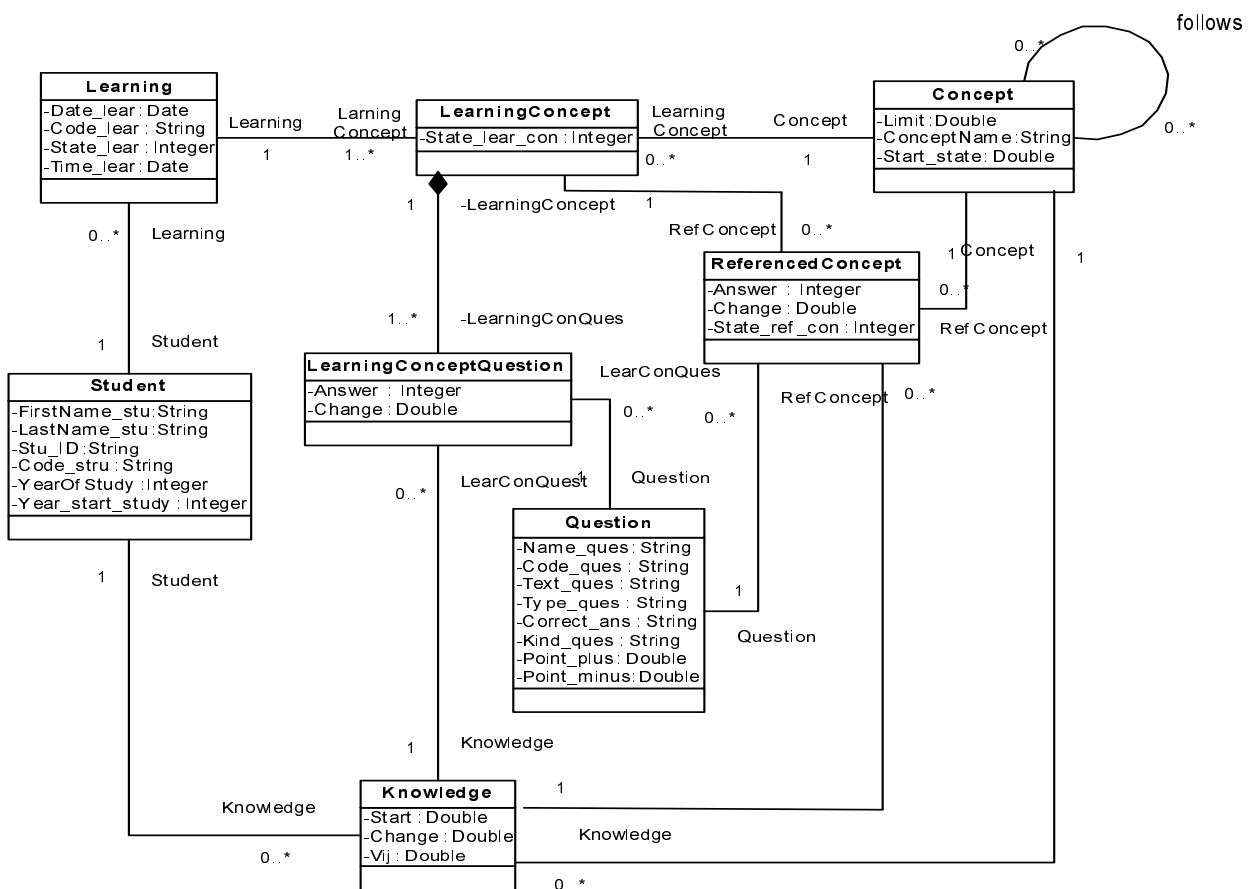
Figure 5. UML class diagram of learning process

WEB server. Implementation of a DLSBD is realized by:
- implementation of the object model data by using ORDBMS *ORACLE 8*,
- design of dynamical Web application,
- data entry and testing of the system's behaviour.

JSP technologies are applied in designing a dynamical WEB application. JSP pages present the extension of HTML pages with part of the JAVA code. A dynamic WEB application stores all relevant data about performed learning processesin a database, making the base for evaluation of the quantity and quality parameters about the learning process.

5. CONCLUSION

A distance learning system based on a dialogue can improve the results of distance learning. This paper describes the use of the UML in defining a conceptual model for distance learning system based on a dialogue. The analysis of the student's process defines the actors, their interaction and parameters for appraisal of the learning process in a distance learning system based on a dialogue. 'Use case' diagram, package diagram, class diagram and state diagram based on the UML notation define a conceptual model of a distance learning system based on a dialogue. The information

system is implemented by using the object-relational database ORDBMS ORACLE 8 and JSP technology in generating dynamic Web application. Distance learning system based on a dialogue is a modern tool in the teaching process that improves the quality of distance learning.

REFERENCES

[1] http://ltsc.ieee.org/ppt/ltsa_overview/
[2] B. Kovacic, "Distance learning model based on dialogue", Proceedings of the Conference MIPRO 2000, section CE, Rijeka, Croatia, 2000. pp. 29-32.
[3] I. Lavrnja, "Chapters from didactics", (in Croatian) Faculty of Philospofy, Rijeka, 1998.
[4] B. Kovacic, Z. Skocir: "Formal Model for Distance Learning System Based on Dialogue", Proceedings of the Conference ICT 2001, Volume 1, Bucharest, Romania, 2001., pp. 231-236.
[5] R.J.Muller: "Database Design for Smarties – Using UML for Data modeling", Academic Press, 1999.
[6] C. Chou, "Constructing a Computer-Asisted Testing and Evaluating System on the World Wide Web – The CATES Experience", IEEE Transaction of Education, vol. 43, no. 3, pp. 267-272. 2000.
[7] S-C. Yang, "Information Display Interface in Hypermedia Design", IEEE Transaction of Education, vol. 43, no. 3, pp.293-299, 2000.