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DEVELOPMENT OF DATABASE STRUCTURE FOR THE EXPERT SYSTEM OF TEACHING MATERIALS EVALUATION

The paper describes some approaches to realization of the database structure for the problem of building the system for teaching materials quality evaluation. The analysis of the subject area has been conducted; corresponding UML models of the system operation have been developed. The proposed database structure is presented.

***Key words**: database, distant learning, quality criteria, web material quality, course material, distant learning system, quality expertise.*

Introduction

The problem of quality of information, used in the education process, has always been important. Current trends of the distant learning implementation, the results of the Internet-aided self-education, broad usage of the global computer network facilities – all this has been gradually shifting the emphasis of the problem towards the evaluation of electronic publications quality. Means for the analysis of electronic materials quality were proposed by the researchers from different countries of the world [1]. In the paper a new conception is proposed for evaluation of the distant learning materials directly in the distant learning system environment [2]. The distinguishing feature of the method for evaluation of the expert estimate formation consists in it being determined by the estimates of any user and not only by those of individual experts.

The analysis and selection of the main quality criteria for education materials evaluation, considered in [2], give the possibility to solve the problem of optimal database structure development that would take into account all the entities taken for consideration, their interconnections, results of the materials evaluation by experts and the results of processing the data arrays accumulated by the expert system. This paper presents the solution of this structure development problem.

Modeling of the expert evaluation system precedents

At the initial stage of the problem solution UML-model system is constructed. It includes the evaluation process precedents and corresponding actors having definite characteristics. On the basis of the model analysis the requirements to the developed database will be elaborated. Main attention will be given to the precedents description, to the activity models and to the sequence of the system actions [3], which enables the analysis of information flows in the system already at the design stage.

Precedents define variants of the system application or those of its part and constitute conceptual designation of the set of such sequential actions, performed in the system by the actor, which lead to a definite result [3]. *Actor* is a role played by the user, by the external system or its separate part in the system operation.

In the system being developed each precedent corresponds to the definite sequence of actions performed by the expert system in its interaction with the user. E. g., in the interaction of *Student* actor with *Material* actor one of the possible precedents occurs – evaluation according to the *Value* criterion, which includes saving of the definite estimate value, pointed by the *Student* actor, in the developed database.

Let's consider the precedents model in more detail (fig. 1). It should be pointed that in this case research object is represented by education materials (built on the basis of HTML format) of the university distant learning system. In accordance with the known methodology of UML models elaboration [4], main system entities are defined:

Man – a person registered in the distant learning system, any actual user of the system. The attributes of this entity are the most generalized ones and they must not have highly detailed information about the system user.

Student – a person who processes the material and evaluates it according to definite criteria. In fact, any system user having access to definite education materials can act as a *Student. Student* is a more detailed entity than *Man.* On the diagram it is presented as a subclass that inherits the parent class properties. The attributes of this entity are the obligatory characteristics of the developed expert

system and are discussed in more detail in [2].

Teacher – a person that creates the course material, fills it with interactive material. The attributes of this entity have considerable influence on the initial values for the evaluation system. This entity also inherits some of its attributes from the parent class M*an*

Material is a key actor in the developed system and is the object of processing and evaluation. Each item of the *Material* class is formed by the *Teacher* actor with participation of *Distant Learning system (DLS)* actor. The *Material* attributes determine the values of initial estimates.

DLS is responsible for the creation, storage and representation of *Material*. Representation may include changes of the M*aterial* design, but not of its content.

Expert system is responsible for statistical data collection and includes mathematical apparatus for data processing and establishing of the course material estimates.

Main precedents of the system operation include *Representation* estimate; *Volume* estimate; *Authority* estimate; *Value* estimate; determination of *Orientation*; *Value* constraint; *Authority* constraint; Statistical data collection; Formation of the estimate; Creation and designing of the material; Creation, displaying and storing of the material.

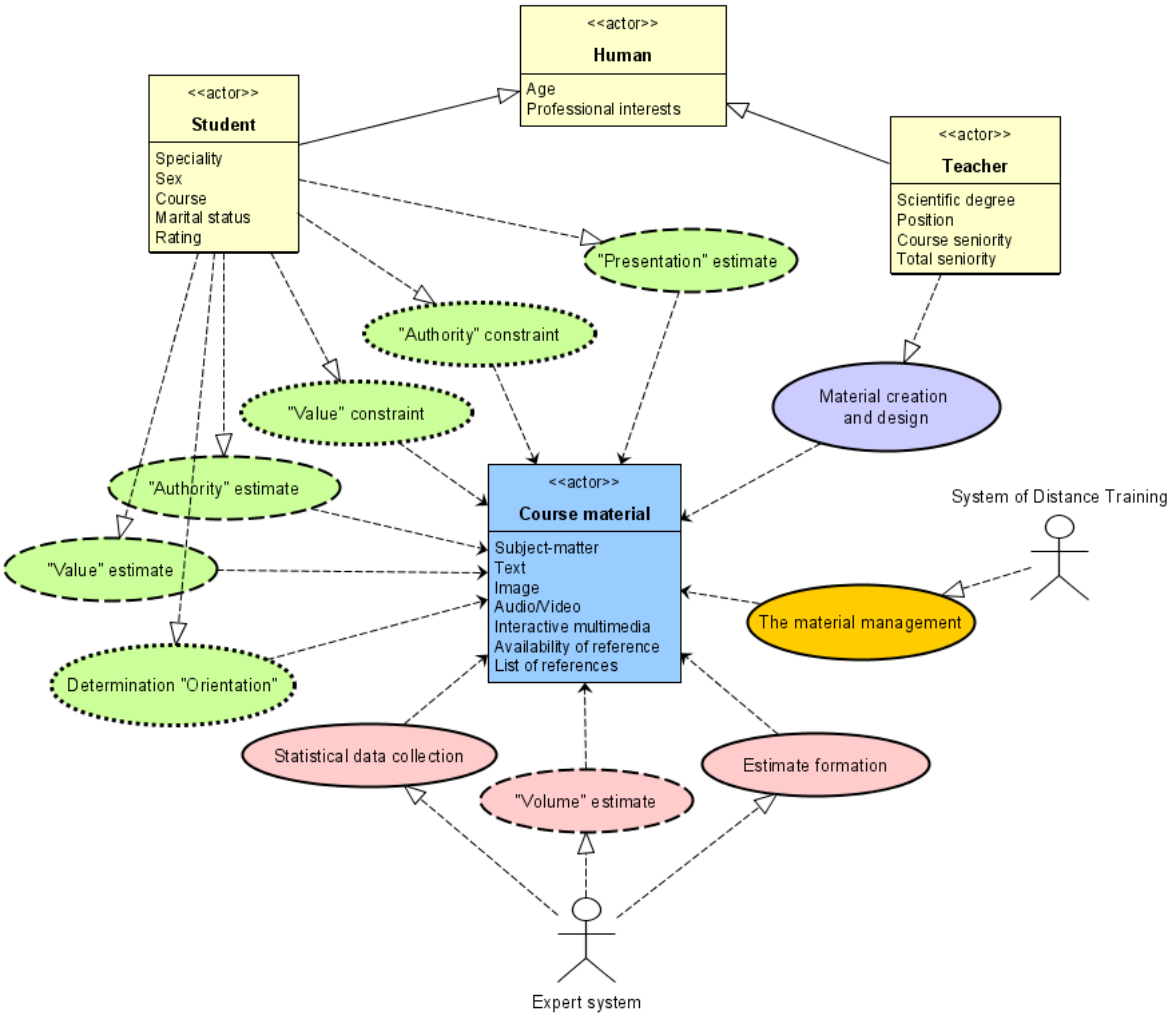

Fig. 1. UML-diagram of the evaluation process precedents

The system precedents

Each of the distinguished actors has its own functionality, described by the precedents, as well as connections with other actors.

Student actor interacts with *Material actor*, evaluating it according to the proposed criteria, determines subject-matter of the material that is being developed. In this way he indirectly interacts with *Teacher* actor, who is creating the material. For *Student* actor the following functioning variants are distinguished:

'Representation' estimate – Student determines the estimate of practical subjective value of the presented material and of the quality of information contained in it.

'Value' estimate – Student determines the estimate of practical subjective value of the presented information.

'*Authority' estimate – Student* evaluates current importance of the presented material both for himself and for other potential users of the material.

Determination of *'Orientation', 'Value'* constraint, *'Authority'* constraint – these precedents play a secondary part in general functioning of the system. They are intended for defining the boundaries of the *Student* actor parameters where the estimate of the given *Student* could be rather weighty.

Teacher actor forms, systematizes and prepares the information for its usage in the system where it is represented in the role of the *Material* actor. The *Material* may contain both the main text and additional materials: references to the information sources, images, video or audio comments and other multimedia content.

For the *Teacher* actor the following precedents are distinguished:

Material creation and design – the process of turning the information, available to the teacher, into the material of a distant learning course.

Distant Learning System (DLS) actor determines the interface of working with the *Material;* it is responsible for convenient presentation of the information, its design, storage, the ability of its viewing and navigation, including the information search. For *DLS* actor the following precedents are distinguished:

Material management – material allocation, storage, systematization and control.

Expert system actor is responsible for the material evaluation mechanism representation as well as for accumulation and storage of the evaluation results. This actor is also responsible for the estimate formation according to the *Volume* criterion and for establishing the integrated estimate of the material after all the required information about the material has been accumulated. Information collection continues for each new pair of *Student – Material* actors.

To *Expert System* actor the following precedents are assigned:

Statistical data collection – collection of the estimate values, established by the *Student* for the corresponding *Material*.

'Volume" estimate – calculating the volumes of the textual, illustrative and multimedia information in the *Material* that is being evaluated.

Establishing of the estimate – establishing of the integral estimate on the basis of information, collected about the material.

Transition to the relational model

On the basis of UML-models of the actors and precedents one can make the transition to relational DB, intended for storing the data required for functioning of the education materials evaluation processes.

All the proposed entities can be divided into three abstract classes:

1) A *Man*, comprising the classes of *Teacher* and *Student* actors and their general parameters;

2) *DLS*, a basic class for *Materials* actors;

3) *Estimate* determines all the required parameters of the process of material evaluation by the *Student* actor.

Each abstract class is realized by the entities of relational DB with corresponding internal

connections. The relational DB model is presented in fig. 2.

The *Man* class is realized by the following entities:

The *Teachers* table contains the following information about the author: initials, scientific degree, position, period of teaching the course, general length of service, professional interests, department, connection with the *Materials* table;

The *Student* table contains the student's first, second and family name, sex, speciality, age, marital status, professional interests, rating data, connection with the *Materials* table;

The auxiliary table *Departments* – names of the departments;

The auxiliary table *Scientific degree* – the scientific degree name;

The auxiliary table *Position* – the position name;

For DLS class the following complementary entities are distinguished:

The *Materials* table – subject-matter, text, the number of images, the number audio files, the number of video files, the number of multimedia files, availability of references, тthe list of literature, connection with the *Estimates* table, connection with the *Authors* table.

The *Estimate* class is represented by the following entities:

The *Criteria* table – the criterion name, its weight, connection with the *Estimates* table;

The *Materials evaluation* table – the student's unique number, the unique number of the material, the unique number of the criterion, numerical value of the estimate;

The *Authors – Materials* auxiliary table – the unique number of the material, the unique number of the author.

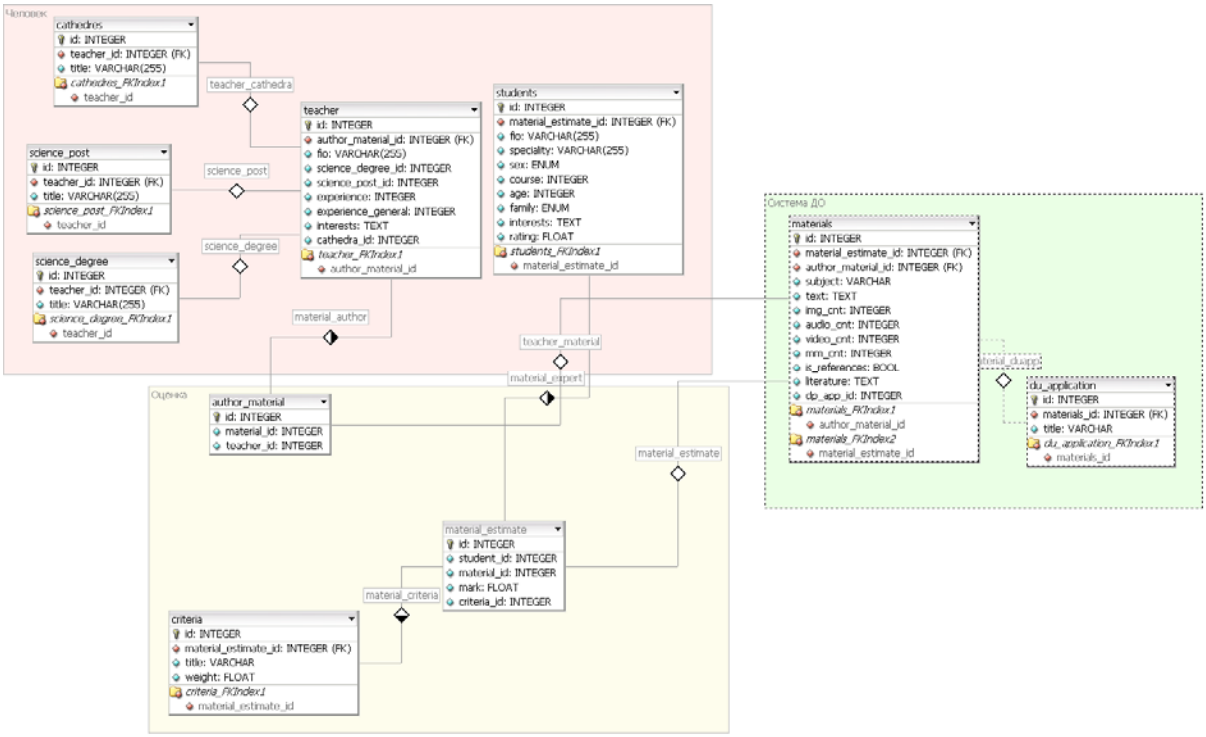

Fig. 2. Relational model of the evaluation system database

Database structure optimality criteria

Let's consider the optimality criteria for the proposed database in terms of functioning of electronic teaching materials evaluation system. Among the three known types of the optimality criteria identification [5] the most characteristic one consists in the choice of the best variant of actions that provides for achieving the definite, i. e. pre-set result, with minimum resources.

The first criterion is the database tables normalization excluding the excessiveness that may cause structural and logical problems while accessing or changing the data. All the tables must correspond to the at least third normal form [6].

The minimal number of requests that influences the system response and the server loading is adopted as the second optimality criterion.

The developed database structure is optimal in accordance with the adopted criteria. Each of the proposed tables is normalized and и brought to the third normal form. While accessing the statistical database, only one request per sampling is possible for one actor (*Student, Teacher, Material*). E. g. for representation of the materials estimates the following request is used:

```
SELECT Title, cBegin, cEnd, Status, orientation, presentation, size,
worth, authority, LastName, FirstName, Login FROM courses RIGHT JOIN
estimate_materials ON courses.CID =    estimate_materials.cid LEFT JOIN
people ON estimate_materials.student_id = people.MID
```

Conclusions

UML model of the entities behavior and responses is proposed for the system of electronic teaching materials quality evaluation. On the UML diagram of precedents the entities interconnections and potential reactions during the interaction process are presented. On the basis of the proposed model, optimal DB for the system data collection, storage and processing has been developed. The database is implemented in MySQL DBMS and integrated into the distant learning system of Distant Education Center of Vinnytsia National Technical University.

REFERENCES

1. An evaluation of Information quality frameworks for the World Wide Web : 8th Annual Conference on WWW Applications, 6-8th September 2006 y. / Parker M. B., Moleshe V., De la Harpe R., Wills G. B. / Bloemfontein, South Africa.

2. Боцула М. П., Моргун І. А. Про проблему експертизи якості матеріалів дистанційних курсів // Наукові праці ВНТУ. – 2008. – № 4. – Режим доступу до журн.: http://www.nbuv.gov.ua/e-journals/VNTU/2008-4/2008-4.files/uk/08mpbcme_uk.pdf

3. Буч Г. Язык UML Руководство пользователя. / Буч Г., Рамбо Д., Джекобсон А. – Питер, 2004. – 430 с.

4. Эрик Дж. Нейбург. Проектирование БД с помощью UML. / Эрик Дж. Нейбург, Максимчук Р. А. – Вильямс, 2002. – 288 с.

5. Пугачев В. Ф. Оптимизация планирования (теоретические проблемы). – М.: Экономика, 1968. – 171 с;

6. Дейт К. Дж. Введение в системы баз данных, 8-е издание.: Пер. с англ. – М.: Издательский дом "Вильяме", 2005. – 1328 с.: ил.

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