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Enhancement of Testing Process in Learning Management System Moodle

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ABSTRACT

The study describes the process of implementing a Learning Management System (LMS) Moodle in training activities. The principle of organization of e-learning based on open source Moodle was described. It illustrates the process of creating courses, download lectures, testing in selected Learning Management System Moodle. Adaptation of Moodle to information resources of educational activity is carried out. The study also discusses the modernization of the learning process in the Learning Management System Moodle, allowing partially automate the process of learning by creating tests for the control of knowledge. Creation module of questions that gives teachers a tool that can be used based on the lecture material introduced into the Learning Management System Moodle, to programmatically generate a certain kind of questions and answers to them.

Key words: Learning management system, e-learning, academic performance control, testing

INTRODUCTION

The analysis of the development of university education in the world shows that under the influence of modern computer and telecommunication technologies, as well as in the process of development in the field of education market relations formed a new university model. E-learning integrates existing teaching methods and gives them a new level. The basic idea of modern methods of e-learning systems is to create educational information environment, including computer-based information sources, digital libraries, video and audio library, books and tutorials (http://moodle.org/; Ostroukh, 2011; Krasnynskiy *et al*., 2012; Barinov *et al*., 2012; Ostroukh and Nikolaev, 2013a, b; Ostroukh *et al*., 2012a, b, 2013a, b, 2014; Ostroukh and Surkova, 2011; Ostroukh and Vladimorov, 2012; Ismoilov *et al*., 2013). Component of such educational environment are both students and teachers, which interaction is carried out with the help of modern telecommunications.

The first stage included the analysis of existing distance learning systems and the choice of the most viable one according to the following criteria:

- Openness, simplicity and user-friendliness
- Stability of work in an average group (60 people)

- Possibility of questions random choice from different categories of a common base
- Ruling out the possibility of repeated questions in student testing
- Possibility of viewing test statistics according to a student group or an individual student
- Possibility of using different question types, comments to correct and incorrect answer and to question in general
- Testing being carried out in a safe window (no possibility of copying and text search)

After the thorough analysis, the Moodle learning management system with open code was chosen.

Moodle (http://moodle.org/) is a distance-learning environment, designed for development of high-quality distance courses. The software is used by universities, schools, companies and independent teachers in more than 100 countries over the world. According to its functionality, Moodle can stand the comparison with well-known commercial learning management systems, at the same time having the advantage they are devoid of, i.e., being distributed with open source code.

There is a possibility of statistical analysis of completed test assignments (Ferguson, 2012).

The following question types are supported:

- **Multiple choices:** There is a possibility to choose one or more variants in a closed form. The teacher can make comments to each variant, which can be shown to a student after answering
- **Short answer:** In response to a question the student types a short word or a phrase. There may be several possible correct answers with different grades
- **Numerical:** From the student perspective, a numerical question looks just like a short-answer question. The difference is that numerical answers are allowed to have an accepted error, i.e., a fixed range of answers can be evaluated as one answer. For example, if the answer is 30 with an accepted error of 5, then any number between 25 and 35 will be accepted as correct. Numerical questions can also have non case sensitive non-numerical values as answers. That can be useful if the answer to a numerical question is something of the following kind: N/A, sin, cos etc
- **Calculated:** The question is built as a pattern with a certain set of values for automatic substitution. The given formula and the set of values determine the correct answer. Thus, for each student the question with specific numerical values and consequently with a specific correct answer will be shown
- **Matching:** After a short introduction the student is offered several questions and the corresponding number of answers. There is only one correct answer for each question. The student has to choose a corresponding answer for each question. Each question is automatically equally weighted
- **Random matching:** After a short introduction the student is offered several questions and a corresponding number of answers. There is only one correct answer for each question. The students have to choose the corresponding answer for each question. Each question is automatically equally weighted. The distinction from the "Matching" type is that question is randomly chosen from the "Short answer" set of the given category. By each testing different questions are used. The number of questions can be controlled

- **True/False:** The student chooses between "True" and "False". If the "Comment answers" option is on, the student will see the comment after completing the test. Moreover, if he is mistaken, he will see the comment to the wrong answer
- **Essay:** Supposes student's text answer in a free format. It is assessed by the teacher
- **Embedded answers:** Question contains fields for the student to enter or choose the answer:
  - Questions are stored in the database according to certain topics (categories) and can be used in several courses or between courses. For passing a test several attempts can be set. Each attempt is automatically registered and the teacher can choose to make a comment or show correct answers
  - The possibility of adaptive control has been implemented, i.e., after the student fulfills a certain assignment, the next question is chosen depending on the correctness of the previous answer. If the answer was correct, a more difficult question is chosen and vice versa. In other words, there is a feedback between the students and the test. From our perspective, the LMS Moodle algorithm for adaptive control implementation has the following disadvantages:
    - The algorithm doesn't adapt to each individual student
    - Discrete grading system
    - Rigid connections between the questions
    - Varying number of questions

LMS MOODLE ADJUSTMENT TO THE DEPARTMENT INFORMATION RESOURCE

At the second stage, work has been carried out to adapt LMS Moodle to MGUPI information recourse and creation of a system allowing students testing in five subjects has been attempted. The developers have been facing the following challenges (Skvortsova, 2009; Skvortsova and Pyl'neva, 2010):

- Creation of question database
- Development of testing process
- Results processing and statistical representation

As a result, question database of five categories has been set. Each category includes about two hundred questions for one subject. The test consisted of 25 questions, 5 random questions from each category, with time limit of 20 min.

At the third stage, an experimental testing has been carried out. The experiment was supposed to determine the adequacy of difficulty of prepared questions in relation to the time limit for answers.

The following question types have been used in testing:

- Yes/no
- Multiple choices
- Short answer
- One from many

To determine the optimal balance of question types for obtained knowledge assessment with standard LMS Moodle tools, the percentage of correct answers in relation to the question type has been specified.

Automatic processing of testing results shows that the questions suggesting the choice of the correct answer from many variants and "Short answer" turned out to be the most difficult for the students.

The further analysis carried out by teachers and connected with their subjective information concerning students level of competence could not precisely determine the proportion of different question types in an examination paper. It is obvious that more data is needed for the final conclusion concerning the proportion of suggested question types.

With LMS Moodle standard tools the analysis of correctness of answers in the following subjects has been carried out:

- System modeling
- Network technology
- Real-time computing
- ACTF (automatic control theoretical fundamentals)
- Databases

The results of the analysis are illustrated in Fig. 1:

- The Fig. 1 reflects the proportion of correct answers to the whole number of questions
- It vividly shows which subject causes students most difficulties
- The third stage resulted in a corrected questions database, which can be further used for examination in the considered subjects
- The further introduction of the LMS in MGUPI will consist of lecture material preparation and the following deployment of LMS Moodle at the IT faculty as a distance learning system

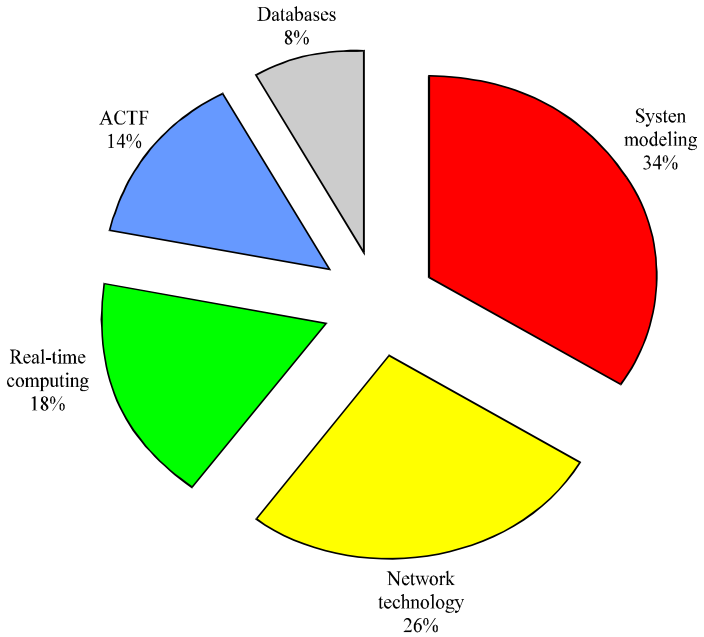

Fig. 1: Difficulty of questions according to subjects

ACADEMIC PERFORMANCE CONTROL

Academic performance control in LMS Moodle is primarily represented by tests. Tests help lecturers to monitor students activity and academic performance. Besides, supplementary statistics of students course attendance, reading lectures etc. is performed in the LMS.

The work at a test in LMS Moodle involves the following stages:

- Test creation and specification of setting up parameters
- Adding questions to a test
- Test editing
- Test completion by students
- Test assessment and analysis of results

Academic performance control by means of tests has a variety of advantages but there are also a number of drawbacks. The main drawback is the time spent for the creation of a question bank large enough for effective assessment of students knowledge. All tests are created manually in a text document and then are uploaded into the system. The stage of test creation is the slowest one and partially undermining all the advantages of academic performance control by means of tests, as it supposes considerable labour costs for creation of a question bank large enough for effective assessment of students knowledge.

There is no such tool in LMS Moodle facilitating adding questions to a test.

One of the ways to deal with the problem is to partially hand over question creation to ECM. That means to implement the block of question creation, which would allow facilitating teacher's work by automatic generation of questions to the input lecture.

The efforts have been made enabling us to partly automate the process of question creation basing on the input data, i.e., lectures.

Learning management system of LMS in MGUPI is built according to the module principal. Each module has input and output parameters. Inner data of the module is localized from the others, thus modernization of each of them does not have a dramatic impact on the others. A variant of such structure is schematically shown in Fig. 2.

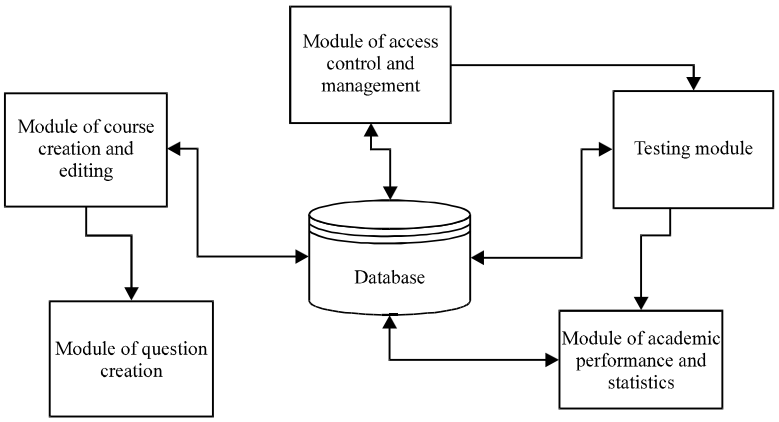

Fig. 2: General structure of learning management system moodle

The LMS of the scheme in question has been operating at the department for about four years.

Database contains the principal information about academic performance control and the attendant data:

- Students data (information about the students, year of studying, time/results of testing, lectures read and so on)
- Subjects data (information about all subjects for academic performance control to be performed)
- Information about test creators (surname, given name, patronymic, education, subjects he gives lectures in, educational institution and so on)
- Tests data (lists of questions and answers to them, as well as time and grading standards necessary for passing the test)
- Course data (contains all the necessary information for completing courses)

The module of course creation and editing provides a teacher with an opportunity of creating and editing a course of study.

The tool of course development takes into account the possibility of dividing courses into categories. Its principal goal is creation of the course shell: Course name, time period of availability (course starting and course ending date), course general settings, number of topics, description, editing of a part of a course, adding and deleting of elements and so on. The connection between the course and corresponding tests is also established here.

Module of access control and management provides compartmented access to the environment as well as system administration (Blinova, 2013; Morozova *et al*., 2013):

- Users registration
- Access control of teachers and students
- Security tools for system and data

Module of academic performance and statistics includes the necessary tools for creation, structuring and analysis of statistical performance reports for an individual student as well as a group of students.

Module of question creation allows automating the process of creating questions to lectures, thus facilitating the process of tests preparation for academic performance control. Exactly this module, being the result of performed work, has been included in LMS. The structure of the module is reflected in Fig. 3.

TRAINING SUBSYSTEM

There is a lecture processed by a morphological analyzer (MCR library is used) at the input of training subsystem. From the words absent in colloquial vocabulary a list is being built, after that either new terms dictionary are created or the old ones are enriched with the words found in the lecture. The following requirements have been set for a training subsystem during its development:

- Morphological analysis of each sentence
- Filling of terms database for qualitative analysis of a text

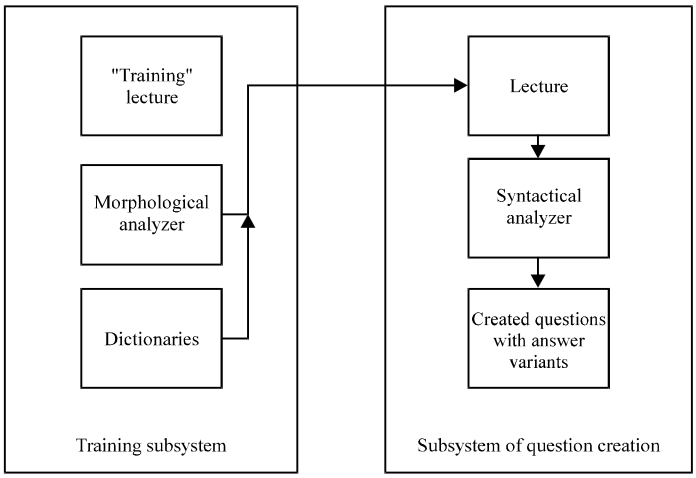

Fig. 3: Structure of question creation module

By morphological analysis each word is identified for containing only Cyrillic characters. Further on, all the words are going through the following stage of processing.

For Cyrillic characters: The belonging of a word to colloquial vocabulary is checked (the dictionary by Zaliznyak (2008) containing around 100 thousand common words is used) and if the answer is negative, the word is defined as unknown and goes to the list of unknown terms (Zaliznyak, 2008).

For non-Cyrillic characters: If a word is a numeral, it is added to the list of unknown words. Otherwise, it is checked whether there is another non-Cyrillic word. If there is, it is considered possible for the two words to be a complex term and both are added to the list of unknown words. The completely built list can be shown at the screen to specify permanent and variable grammatical characteristics of the words, their meaning and dictionary to put them in. After that, either new terms dictionaries are created or already made ones are enriched with corresponding terms.

STRUCTURE OF TRAINING SUBSYSTEM DICTIONARIES

Figure 4 illustrates the structure of dictionaries and subjects registered in the system. In the folder "Dictionaries" the "General Vocabulary" dictionary is stored as well as all registered subjects (subjects are named as "Subject 1", "Subject 2" and so on). There can be any number of subjects. The subject folder contains subject-related dictionaries in Cyrillic (dictionaries are named "Dictionary 1", "Dictionary 2" etc.), as well as "non-Cyrillic" folder containing consequently dictionaries in non-Cyrillic. There can be unlimited number of dictionaries. Subjects and dictionaries should be given correct and logical names to avoid any confusion by further expansion of the base.

Text in dictionaries is stored in text format, so called plain text. Each symbol from the used set is coded with one byte.

Text data can be divided in lines. Division in lines is coded by a couple of control characters with codes 13 and 10 (carriage return and end of the line). Table 1-3 show coding variants of permanent grammatical characteristics for words in Cyrillic.

In Table 4-6 coding variants of variable grammatical characteristics for non-Cyrillic words are demonstrated.

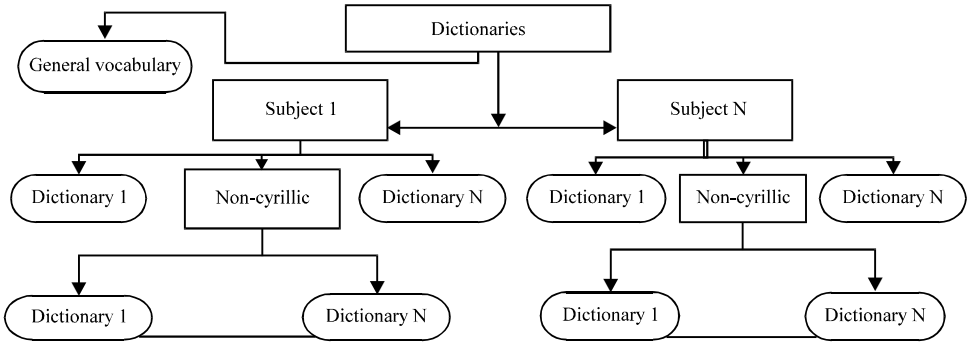

Fig. 4: Structure of dictionaries and subjects registered in the system

Table 1: Noun, permanent characteristics (Cyrillic)

Permanent identifier	Description
1	Masculine noun (inanimate)
2	Masculine noun (animate)
3	Feminine noun (inanimate)
4	Feminine noun (animate)
5	Neuter noun (inanimate)
6	Neuter noun (animate)

Table 2: Adjective, permanent characteristics (Cyrillic)

Permanent identifier	Description
20	Adjective

Table 3: Numeral, permanent characteristics (Cyrillic)

Permanent identifier	Description
25	Numeral

Table 4: Noun, variable characteristics (Cyrillic)

Variable identifier	Description
1	Singular, nominative case
2	Singular, genitive case
3	Singular, dative case
4	Singular, accusative case
5	Singular, instrumental case
6	Singular, prepositional case
7	Plural, nominative case
8	Plural, genitive case
9	Plural, dative case
10	Plural, accusative case
11	Plural, instrumental case
12	Plural, prepositional case

In Russian lectures and other text materials, different forms of words and numerals are not provided for (for example, word Ethernet or number 15). For words of the kind an individual morphological analyzer is used with simplified structure of words representation in dictionaries; there is no necessity for variable characteristics coding. Table 7-9 show coding variants of permanent grammatical characteristics for non-cyrillic words.

Table 5: Adjective, variable characteristics (Cyrillic)

Variable identifier	Description
1	Nominative case, masculine, singular
2	Genitive case, masculine, singular
3	Dative case, masculine, singular
4	Accusative case, masculine, singular
5	Instrumental case, masculine, singular
6	Prepositional case, masculine, singular
7	Nominative case, feminine, singular
8	Genitive case, feminine, singular
9	Dative case, feminine, singular
10	Accusative case, feminine, singular
11	Instrumental case, feminine, singular
12	Prepositional case, feminine, singular
13	Nominative case, neuter, singular
14	Genitive case, neuter, singular
15	Dative case, neuter, singular
16	Accusative case, neuter, singular
17	Instrumental case, neuter, singular
18	Prepositional case, neuter, singular
19	Nominative case, plural
20	Genitive case, plural
21	Dative case, plural
22	Accusative case, plural
23	Instrumental case, plural
24	Prepositional case, plural

Table 6: Numeral, variable characteristics (Cyrillic)

Variables	Description
9	Masculine/Neuter, nominative case
10	Masculine/Neuter, genitive case
11	Masculine/Neuter, dative case
12	Masculine/Neuter, accusative case
14	Masculine/Neuter, instrumental case
15	Masculine/Neuter, prepositional case
16	Feminine, nominative case
17	Feminine, genitive case
18	Feminine, dative case
19	Feminine, accusative case
21	Feminine, instrumental case
22	Feminine, prepositional case

Table 7: Noun, permanent characteristics (non-Cyrillic)

Permanent identifier	Description
11	Masculine, inanimate
12	Masculine, animate
13	Feminine, inanimate
14	Feminine, animate
15	Neuter, inanimate
16	Neuter, animate

Table 8: Adjective, permanent characteristics (non-Cyrillic)

Permanent identifier	Description
21	Masculine
22	Feminine
23	Neuter

Table 9: Numeral, permanent characteristics (non-Cyrillic)

Permanent identifier	Description
31	Masculine
32	Feminine
33	Neuter

SUBSYSTEM OF QUESTION CREATION

A lecture is inputted into the subsystem of question creation. It is analyzed by morphological analyzer (MCR library is used) with the use of dictionaries entries added at the stage of training subsystem operating. The text obtained after the analysis including supplementary information about morphological characteristics as well as the terms peculiar for the lecture in question goes through syntactic analysis. At this stage, subordinate constituents are singled out and dependencies are built. Further on questions are built basing on the obtained information. The following requirements were imposed on the subsystem of question creation:

- Morphological analysis of each sentence
- Syntactic analysis of each sentence with singling out of subordinate constituents
- Elimination of potentially inaccurate questions
- Possibility of editing of sentences list and created questions
- Generating of questions to the lectures that has been put to the training system

The functioning of the subsystem in question is illustrated in more detail in Fig. 5. Concerning its inner structure subsystem of question creation is a multilayer converter. There are two levels of text phrase representation; morphological and syntactic. Each of the levels is maintained by the corresponding model constituent; set of the rules and a certain dictionary or dictionaries. On each level, a sentence has a formal representation hereafter called its structure; morphological (MorphS) and syntactic (SyntS).

Adding of other variants from dictionaries; morphological structure is defined as a consequence of words composing analyzed sentence with indication of their part of speech and morphological characteristics (case, number, gender, animacy, tense, aspect etc.).

Syntactic structure is defined as a dependency tree with words of the natural language at the vertices with parts of speech and grammatical characteristics being indicated and arcs correspond to the relation of syntactic subordination specific for the considered natural language.

For each sentence, subsystem operation will include seven stages (Blinova and Skvortsova, 2011):

- Subject identification
- Morphological analysis

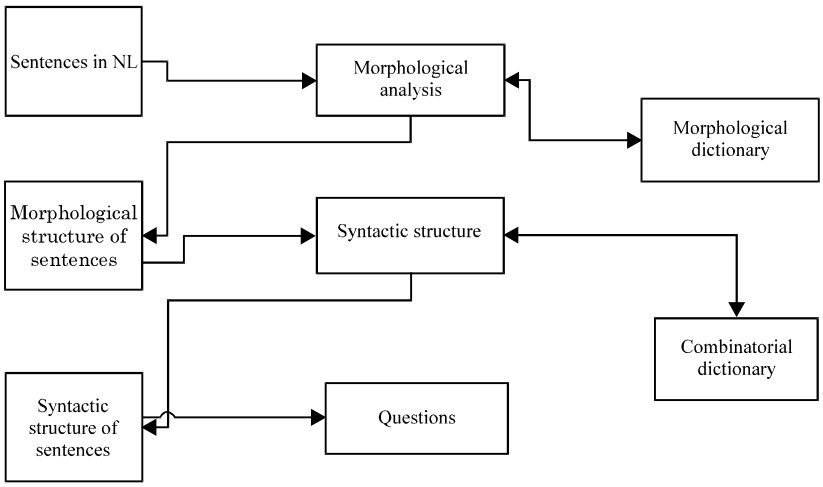

Fig. 5: Structural scheme of question creation subsystem

- Building of syntactic structure
- Question formulation
- Specification of the correct answer
- Adding other variants by means of changing letters in already existing ones

- **First stage:** The subject the sentence belongs to be determined
- **Second stage:** The morphological analyzer in two passes processes each sentence in natural language
  - **First pass:** Only Cyrillic dictionaries concerning the subject are used (obtained at the stage of training system operation). If a word from the dictionaries comes in the sentence, then it belongs to the terminology of the subject. This word will be implied in the question
  - **Second pass:** Only non-Cyrillic dictionaries concerning the subject are used (obtained at the stage of training system operation). As well as during the first pass, if a word from dictionaries is present in the sentence, then it belongs to the terminology of the subject. This word will be implied in the question
- **Third stage:** Deriving of syntactic structure. After determination of the word that will be implied in the question, other words of its nearest context are analyzed. If a word (an adjective, a noun or a numeral) adjoins to a preposition (from entries of the combinatorial dictionary), then it is marked as dependent on the word and will be included in the question being built. If the word implied in the question is a noun, then the near (after a space or a conjunction (from entries of the combinatorial dictionary)) presence of an adjective is checked. If an adjective is found, it is marked as dependent on the noun
- **Fourth stage:** Based on the data obtained during the previous stages the question to the word is formulated depending on its part of speech, its variable and permanent grammatical characteristics as well as on the fact whether there is a preposition near and what kind of preposition it is. All the words depending on the one implied in the question are excluded from the built question sentence

- **Fifth stage:** The word implied in question is added to the variants of answers. It is the correct answer
- **Sixth stage:** From the dictionary the word implicated in question belongs to other words of the same permanent and variable grammatical characteristics (part of speech, gender, case etc.) are retrieved. The words are added to the variants of answer for the question. They are wrong answers
- **Seventh stage:** According to the teachers demand (for example, if the number of answer variants is small) words derived from already existing answers by changing a letter are added to the variants ("Moscow"- "Moskow", "1985" - "1986" etc.)

The question with answer variants has been built and can be stored along with other questions according to the teacher's wish.

CONCLUSION

Automatic processing of testing results shows that the questions suggesting the choice of the correct answer from many variants and "short answer" turned out to be the most difficult for the students.

The further analysis carried out by teachers and connected with their subjective information concerning students level of competence could not precisely determine the proportion of different question types in an examination paper. It is obvious that more data is needed for the final conclusion concerning the proportion of suggested question types.

The developed module for test questions generation enables us to partly hand over the task of producing questions to ECM and thus to facilitate teacher's work by automatic generation of questions to the input lecture. The module in question can be applied in any learning management system.

In the course of work were analyzed various systems of automatic text processing such as MARGIE, Dialing, POLIText, FRAP and the algorithms on which these systems are based, their capabilities and limitations. In case of Dialing system can be noted that this system uses only one dictionary of the Russian language by Ozhegov (1988) and this dictionary is poorly structured within the system. The MARGIE system only works with English language and is not intended for semantic analysis of texts in Russian language. In the basis of this system lies the view of the meaning of the phrases in natural language and in terms of a theory of conceptual dependencies that is being built notions united by certain relationships between them. System FRAP contains a full chain of semantic analysis of the text, which was implemented partially. System POLIText was focused on the analysis of official documents in Russian.

System of morphological analysis that is developed by us, allows creating questions by the system without human intervention. This system uses not only dictionary of the Russian language by Ozhegov (1988) but also the grammatical dictionary of Russian language (Zaliznyak, 2008).

In further, plans to expand the system by the use of an English dictionary. Also of particular interest is a module of questions for the lectures in the languages of the Asian group.

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