WEB SERVICES AS HELP FOR TEST CONSTRUCTION AND VARIANTS GENERATION

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Abstract. The goal of this paper is to present the developed Web service for test variants generation. The method for test construction is based on the Bloom's taxonomy. Each test includes several sections of the curricula. Each section may contain a number of questions and these questions are ordered. The idea is that each test variant contains only one question for each section. The lecturer has to determine one definite question for each section for the first variant. The next variant is automatically built. The question for every section is determined as the next question in the ordered set of the section. The set of questions for each section must correlate with the appropriate level of the Bloom's taxonomy. The levels should be used according to the definite goals in education. In one discipline, the different sections of the curriculum could intend different cognitive levels. In the paper the keywords for the different cognitive levels have been cited because of their usage in the questions' formulation in the experiments. This Web service for test variants generation has been used for printing on paper of generated variants.

Keywords: education, testing, short answer questions, Bloom's taxonomy, Web services

1. Introduction

The usage of tests nowadays for knowledge and skills assessment in educational institutions (and not only) has been widely spread. Tests have been used for incoming and intermediate control as well as for final exam. In practice a lot of tests' types have been used and this variety mainly concerns the types of questions used in the test, the cognitive levels according the Bloom's taxonomy, the method used to order the set of questions in a test and so on.

The computer tests' applications are not something new. They have been developed, used, and improved for years. Still some requirements need new developments. The idea for SOA adoption in educational institutions demands the development of Web services as further improvement because of all listed advantages [1].

The conduction of a test could be performed on computer but sometimes it is required that the test should be conducted on paper.

The goal of the paper is to present the developed and implemented Web service for test construction, which would allow the usage of the cognitive levels of Bloom's taxonomy [2]. The questions of the test belong to a certain cognitive level. The questions also belong to a section of the curricula. A number of test variations is necessary to be prepared for printing. Each test variation should contain questions of every pointed section.

2. Idea for test construction
2.1. Question types

The widely used types of questions in the tests are [3]:

- Calculated Formula Questions;
- Calculated Numeric Answer Questions;
- Either/Or Questions;
- Fill in the Blank Questions;
- Multiple Answer Questions;
- Multiple Choice Questions;
- Short Answer Questions;
- Etc.

These are the most typical types of test questions. All of them have certain number of advantages and disadvantages [3]. They are the easiest and timesaving way for checking tests. They help the lecturer – once constructed the test would be used many times and the checking (on paper or on computer) is timesaving. The students often prefer these types of testing in comparison with oral exams.

However, the short answer type of questions combined with the paper type conduction of the test [4] would be the most appropriate way for the described way of testing. The short answer questions are from one side similar to essay but if the questions have been constructed in a clear form [5] and if they require a short answer – their checking would be much easier than essay. Such questions have to be constructed not only for the lowest but also for the upper levels of Bloom's taxonomy. As the praxis has proven the checking and proofing of such type of questions is timesaving.

2.2. Bloom's taxonomy

The Bloom's taxonomy [2] is very popular and widely used. Some criticizing opinions appear but the defined cognitive levels are still in use in education as shown bellow (Figure 1).

CATEGORY	KEY WORDS
KNOWLEDGE: Recall data or information.	defines, describes, identifies, knows, labels, lists, matches, names, outlines, recalls, recognizes, reproduces, selects, states.
COMPREHENSION: Understand the meaning, translation, interpolation, and interpretation of instructions and problems. State a problem in one's own words.	comprehends, converts, defends, distinguishes, estimates, explains, extends, generalizes, gives an example, infers, interprets, paraphrases, predicts, rewrites, summarizes, translates.
APPLICATION: Use a concept in a new situation or unprompted use of an abstraction. Applies what was learned in the classroom into novel situations in the work place.	applies, changes, computes, constructs, demonstrates, discovers, manipulates, modifies, operates, predicts, prepares, produces, relates, shows, solves, uses.
ANALYSIS: Separates material or concepts into component parts so that its organizational structure may be understood. Distinguishes between facts and inferences.	analyzes, breaks down, compares, contrasts, diagrams, deconstructs, differentiates, discriminates, distinguishes, identifies, illustrates, infers, outlines, relates, selects, separates.
SYNTHESIS: Builds a structure or pattern from diverse elements. Put parts together to form a whole, with emphasis on creating a new meaning or structure.	categorizes, combines, compiles, composes, creates, devises, designs, explains, generates, modifies, organizes, plans, rearranges, reconstructs, relates, reorganizes, revises, rewrites, summarizes, tells, writes.
EVALUATION: Make judgments about the value of ideas or materials.	appraises, compares, concludes, contrasts, criticizes, critiques, defends, describes, discriminates, evaluates, explains, interprets, justifies, relates, summarizes, supports.

Figure 1. Cognitive levels according to Bloom's taxonomy [2]

The levels should be used according to the definite goals in education. In one discipline, the different sections of the curriculum could be determined as corresponding to different cognitive levels.

2.3. Method for the test construction

This method for test construction requires that the discipline or the part of discipline on which test would be conducted have to be presented as a set of sections (Figure 2). On figure 2 the sections are named from Section 1i to Section Ni, where i depict the appropriate cognitive level.

Each section includes a number of questions over a part of the curricula. Every section corresponds to a certain cognitive level in Bloom's taxonomy. The questions to each section may refer to the lowest level in the taxonomy up to the level of the section.

Of course, it depends on the author of the test, but in such way, the students would be tested and assigned to the cognitive level, which correspond to their assessed knowledge and skills. The construction of a definite variant of the test should contain questions at different cognitive levels that

are equal or lower than the level of corresponding section.
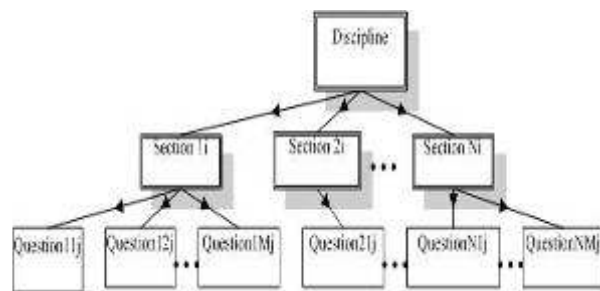
Legend:
i – cognitive level of the section
N – number of the section
M – number of the question in the section
j – cognitive level of the question
Figure 2. Test structure

3. Web service for test construction
3.1. Database structure

The required database structure for the Web service (Figure 3) contains three tables – "disciplines", "section" and "questions".

The table "disciplines" contains the fields: id – auto incremented integer number, primary key; name – name of the discipline, containing

characters; max_sections and max_questions – numbers, which show the maximum number of questions and sections for the current discipline.
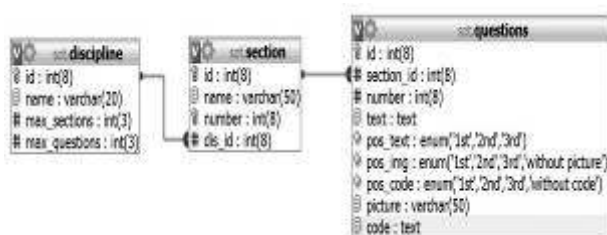

Figure 3. Database structure

The table "section" contains the fields: id – auto incremented integer number, primary key; name – name of the section; number – number of the section; dis_id – a foreign key containing the id of the discipline that the current section belongs to.

The table "questions" contains: id – auto incremented integer number, primary key; section_id – foreign key containing the id of the section the current question belongs to; number – the number of the question; text – the text of the question; pos_text, pos_img and pos_code – enumerable fields that have similar content. They help the user to make the order of appearance of the text, the code, and the picture; picture – text field, containing the path to the picture; code – text field, containing a source code.

The database has been created by the means of MySQL.

3.2. Interface of the service

The interface has been designed to be useful for the lecturers' needs and it is simple and nice-looking.

At the beginning, the user has to choose from the database a discipline (Figure 4), which the test will cover, the number of sections from this discipline and the number of different variants the test will consist of. The user's input is checked for correctness. If an error occurs the user is informed and asked to correct his input.
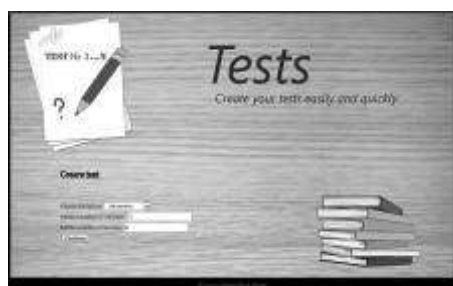

Figure 4. Selecting the discipline

On the next page, the user has to choose the sections. The idea is that later at the test construction the program picks up only one question from each section. Again, an error check will follow to verify that each chosen section is unique for the test.

After the sections' definition, the user has to point the question's number for each section that will appear in the first variant of the test. The questions are given with their recorded (ordered) numbers (Figure 5) and texts in the database.
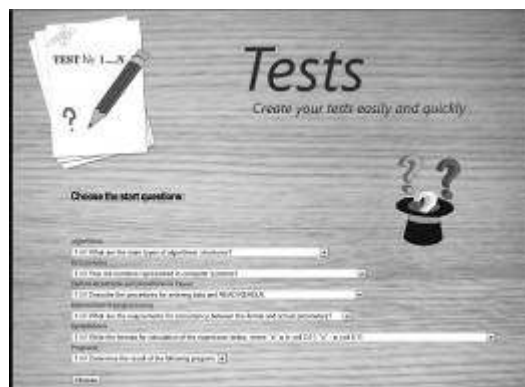

Figure 5. Selecting the containing questions

After the user has defined this first variant there is no need to choose the structure and content of the other variants.

The algorithm for creating the variants does this automatically.

3.3. Algorithm of the generation of the variants

The idea is that each section corresponds to a certain cognitive level in Bloom's taxonomy. The questions in the section must refer to the lowest level in the taxonomy up to the level of the section. For each subsequent variant, the next question will be taken. When all questions are used the first question comes again. The source code is given below.

```
$array=$_SESSION['temp_questions'];

if (isset($_POST['questions_section1']))
        {
                $_SESSION['temp_post']=$_POST;
        }
else
        {
                $_POST=$_SESSION['temp_post'];
        }

$i=0;
foreach ($array as $v)
{
        foreach ($v as $kk=>$vv)
        {
                if
```

```
($_POST['questions_section'.($i+1)]==$vv)
                    $j[$i]=$kk;

        }
        $i++;

}
for ($a=0;$a<$_SESSION['br_var'];$a++)
{
        if (($a+1)==$page)
                echo "<h1>Variant".($page)."</h1>
<br>";

        for ($i=0;$i<$_SESSION['br_razd'];$i++)
            {
                    $j[$i]++;
            if  (!isset($array[$i][$j[$i]]))

                    $j[$i]=0;
                    $query="SELECT    *    FROM
questions WHERE id=".$array[$i][$j[$i]];

        $temp=mysql_fetch_assoc(mysql_query($que
ry));

                    if (($a+1)==$page)
                    {
                            echo
"<b>Question:".($i+1)."</b>";

        print_question_content($temp, $i);
                    }
            }
        if (($a+1)==$page)
                echo "<hr> <br><br><br>";
}
```

The algorithm uses a temporary array with the id-s of all the questions from the chosen section. It goes through the elements of the array and checks if the id of the chosen question from previous page matches with an id from the temporary array. If they match, the id is set as key for an array, which will help us select the correct id. Then the questions are chosen by the user on the previous page as variant one and use a function for displaying their content. Next, a loop is used, which creates .as many variants as the user has chosen. For every variant, a question is selected from the array with questions' key, which every time is increased. It must be noted that if there is no element with such key, the key is reset to zero. After this check, the content of the current question is displayed.

The output of the Web service is presented by browser like html page or pdf file, which can be saved on the user's computer or directly printed (Figure 6).
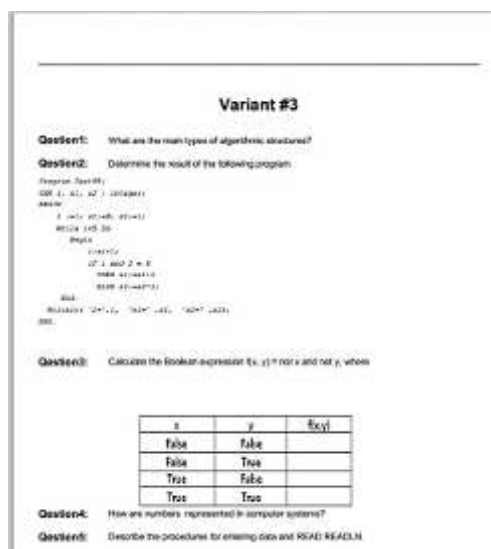

Figure 6. Final result of the Web service

The developed Web service has been tested with one discipline in one faculty. The future development should include online testing and other different types of questions.

References

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