

## About Test Classification in E-Learning Environment

M. Sokolova, G. Totkov

**Abstract** Problems during the construction of an e-test are related to the lack of suitable classification of test assignments, limited number of types of test assignments realized in different e-Learning environments and the lack of realization of different assessment systems. In this work we offer a classification of the e-assignments (34 types), which is comparable to the classical taxonomy (of Ruter) and realization of dynamic tests. Experiments are carried out in the e-Learning environment PeU 2.0.

**Keywords:** Bloom's taxonomy, Ruter's taxonomy, e-test, e-Learning environment

### 1. Test taxonomies

**The classical test consists** of a set of test assignments and questions from concrete subject domain, related to an assessment system and offered for solving (accomplishment of certain activities).

Test assignments can be classified using different criteria – learning objectives, level of difficulty and psycho-physical peculiarities of the examinees, etc. The classical taxonomy of test questions and assignments is based on the way by which **examinees give their answers**. Test questions and assignments are divided into two groups: free-form responds (open type) – the examinees construct their answers themselves; questions and assignments with constructed answer (closed type) – examinees select the correct answer from a set of alternative answers. This classification is supported by R. Thorndraik, T. Ruter, M. Herbig [2], etc. There is another classification which is widely used, it is based on the way of **assessment of answers** to test assignments – subjective or objective. In each of these two basic groups, test assignments are classified according to the type of expected answer again. The classification of Ruter consists of three basic groups of test questions and assignments (according to the expected answer): opened, half-opened and closed.

A classification based on the **learning objectives** (of the corresponding test) is also widely used in test theory. Classifications of this type are often based on the taxonomy of B. Bloom, known as "Taxonomy of Learning Objectives" [4, 7]. Bloom's categories are related to cognitive domains like: Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation. All cognitive domains except the Application one are broken into subcategories. Bloom's taxonomy is shown in Table 1, the first column presents different categories and their subcategories, the second column – short description of cognitive objectives achieved at the relevant level. The classification of test assignments based on learning objectives is supported by B. Furman and A. Grasha [8]. Types of test assignments, which they offer for every separate category of Bloom's taxonomy, are presented in the third column of Table 1.

Table 1. Bloom's taxonomy

Category/Subcategory	Description	Types tests by Furman
<b>Knowledge</b>	Observation and recall of information; knowledge of dates, events, places; knowledge of major ideas; mastery of subject matter	Define, Describe, Identify, Label, List, Match, Name, Outline, Reproduce, Select, State
<i>Knowledge of: specifics, terminology, conventions, trends and sequences, classifications and categories, criteria, methodology, ways and means of dealing with specifics</i>		
<b>Comprehension</b>	Understanding information; grasp meaning; translate knowledge into new context; interpret facts, compare, contrast; order, group, infer causes; predict consequences	Convert, Defend, Distinguish, Estimate, Explain, Extend, Generalize, Give examples, Infer, Predict, Summarize
<i>Translation</i>		
<i>Interpretation</i>		
<i>Extrapolation</i>		
<b>Application</b>	Use information; use methods, concepts, theories in new situations; solve problems using required skills or knowledge	Demonstrate, Modify, Operate, Prepare, Produce, Relate, Show, Solve, Use
<b>Analysis</b>	Seeing patterns; organization of parts; recognition of hidden meanings; identification of components	Diagram, Differentiate, Distinguish, Illustrate, Infer, Point out, Relate, Select, Separate, Subdivide
<i>Analysis of elements</i>		
<i>Analysis of relationships</i>		
<i>Analysis of organizational principles</i>		
<b>Synthesis</b>	Use old ideas to create new ones; generalize from given facts; relate knowledge from several areas; predict, draw conclusions	Categorize, Combine, Compile, Devise, Design, Explain, Generate, Organize, Plan, Rearrange, Reconstruct, Revise, Tell
<i>Production of a unique communication</i>		
<i>Production of a plan, or proposed set of operations</i>		
<i>Derivation of a set of abstract relations</i>		
<b>Evaluation</b>	Compare and discriminate between ideas; assess value of theories, presentations; make choices based on reasoned argument; verify value of evidence; recognize subjectivity	Appraise, Compare, Conclude, Contrast, Criticize, Describe, Discriminate, Explain, Justify, Interpret, Support
<i>Evaluation in terms of internal evidence</i>		
<i>Judgments in terms of external criteria</i>		

## 2. E-tests and classification of e-assignments

One of the most important priorities of the automatic e-test assessment and organization is resource saving. Examination using e-Learning environments guarantees reliability, objective assessment and application of identical assessment criteria for each examinee. Once e-tests are created and standardized (after appropriate experiments and evaluation), they can be reused and exchanged and/or shared between different teachers and universities. Using e-tests teachers can check the knowledge and skills in much more domains compared to the classical form of examination. Moreover learners can see outcomes of their achievements and learning progress much faster compared to the time necessary for the classical way of examination.

Test questions and assignments, which are included in a concrete e-test can be chosen on the basis of different principles and rules. Opinions of different authors expressed in the literature, are very contradictory. Some authors consider that the test assignments must be chosen according to their type (according to the appropriate classification), and others think that they must be chosen according to their content (including relationship with the subject domain) and/or cognitive objectives of the learning process.

Despite of the fact that contemporary information technologies provide a lot of functional and interactive possibilities [13], great part of the e-Learning environments provide few types of test questions and assignments: 3 types in *ClassBuilder* [5], *Black Box Testing Course* [3] and *Advanced e-Learning Builder* [1]; 4 – in *MicroTest III* [9] and *CQuest Assessment Software* [6]; 6 – in *Respondus* [10]; 8 – in *Riva e-test* [11]; 9 in – *StudyMate* [12].

This paper offers a classification of test questions and assignments covering the classical classification of Ruter and appropriate for computer realization. The realization and experiments are carried out in the *PeU 2.0* e-Learning environment [13, 14]. For comparison to other e-learning environments, the test module of the system supports 37 types of e-test assignments. We must point out that Bloom's classification based on the semantic content of test assignments, is not appropriate for computer realization. The new taxonomy of e-assignments compared to Ruter's classical classification is presented in Table 2.

Each e-assignment in *PeU 2.0* consists of a precondition (which defines what is required in the e-assignment), base (may contain blank space for filling), alternative (with which the blank spaces in the base can be filled) and a set of characteristics – subject domain (SD), concepts related to the SD and a list {<resources, value of resources>} (time, price, difficulty etc.). E-assignments are classified not only according to the cognitive objectives, but also according to the form used for filling/submitting/saving the content of assignments in the database (DB). According to the way of visualization, e-assignment types differ not only in respect to the form of filling/submitting/saving the content, but also in respect to the alternative type. The alternative may be constructed using different visual components: text fields, text areas, labels, radio-buttons, multiple-choice buttons and different elements for import (text fields, pictures, multimedia, etc.).

## 3. Realization

Elements and characteristics of each e-assignment are saved in the system DB. The computer realization of each type of e-assignment requires relevant functions for **insertion** in DB; **visualization** (for preview during editing); **editing**; **saving the responses** of the examinee, and **assessment**. In the e-assignments of type “condition taken from a file and answer sent to a file or textarea”, the condition of assignments is presented by file, which is uploaded by the author and contains condition of the e-assignment (including instructions, directions and explanations). Types of files which are uploaded can be: txt, doc, jpg, jpeg, gif, png, bmp, avi, mp3, ppt, etc. Using this type of e-assignment, tests from different subject domains can be realized.

**Table 2.** Comparison of e-assignment types with Ruter classification

<b>E-assignment types</b>	<b>Ruter types</b>
Matching texts, images and mixed Arrangement by sense	Full correspondence; Partial correspondence Successive association
Fill in blanks	Multiple association; Free-form, combined answer; Simple assignments; Additive associative response; Simple, multiple, successive addition; Successive replacement; Additive answer for completion; Simple assignments using substitution; Additive substitution; Transformation using: completion, reduction
Multiple choice (of texts or images)	Simple identification; Simple alternative answers; Assignments with 3 answers – one of them being correct; Simple association; Simple substitution; Common substitution; Simple extension
Fill in blanks with alternatives	Additive associative answer; Simple, additive substitution; Simple, multiple completion
Fill in blanks with images	Simple completion; multiple completion; Common substitution
Free-form response (response in text field or file); Condition taken from a file (response in text area or file)	Free writing; Simple, multiple or additive association; Successive answers; Additive answer; Common answer; Simple assignments; Successive association; Additive associative response; Additive answer for completion; Simple substitution assignments; Multiple, successive, additive substitution; Associative construction; Construction using: substitution, reduction; Transformation using: completion, substitution, reduction, new solution; Multiple identification; Questions for interpretation; Successive association
Image description	Multiple association; Successive association; Additive association
Multiple answer (using texts or images)	Multiple identification; Homogeneous multiple alternative answers; Assignments with five answers and two of them – correct; Multiple association
Multiple answer with multiple choice	Multiple association; Multiple completion
Image arrangement	Associative transformation; Direct transformation
True or false with/without proofs	Simple identification or association; Simple alternative answers; simple substitution
Text editing	Conversion using substitution
Arrangement after multiple choice	Multiple identification; Successive association; Choice transformation
Finding words in a table	Construction using substitution or reduction; Associative or direct transformation
Table reconstruction; Crossword	Simple substitution
Table arrangement	Simple substitution; Direct conversion
Image area(s)	Successive association; Associative conversion
Group description, disappearing image	Additive association
Group of thematically related questions	Successive answers; Multiple association/substitution; Several questions with common answer

A special type of e-assignment is the so-called “dynamic assignment”. The author of the dynamic test automatically generates the content – a list of e-assignments with tools for DB query containing e-assignments, giving parameters like: type, subject domain, concepts, difficulty, time, etc. The author defines the number (N) of elementary e-assignments, which will be chosen from the generated set and will be proposed for solving to each learner. The concrete test examinations, which consist of N assignments, are randomly shown in the dynamic test, and different learners are given different sets of e-assignments.

Users can choose the type of e-assignments with friendly interface tools (Fig. 1.) using different criteria. For example authors of tests can choose the type of e-assignment according to the new classification offered or according to the classification of Ruter. If a type of e-assignment (from the new classification) is chosen, the author is offered a relevant template for entering/editing the content of the assignment. In case of entering a Ruter type, the author will be offered a new list, including types of e-assignments (some of the 37 possible types) suitable for the case.

Software realization and experiments are carried out in the e-Learning environment PeU 2.0. One of the newest tools for web-based software development is used for the realization. The realization is based to the so-called client-server technology, and the program language PHP is used together with the Apache web-server. The DB managing system MySQL is used for the realization of the DB.

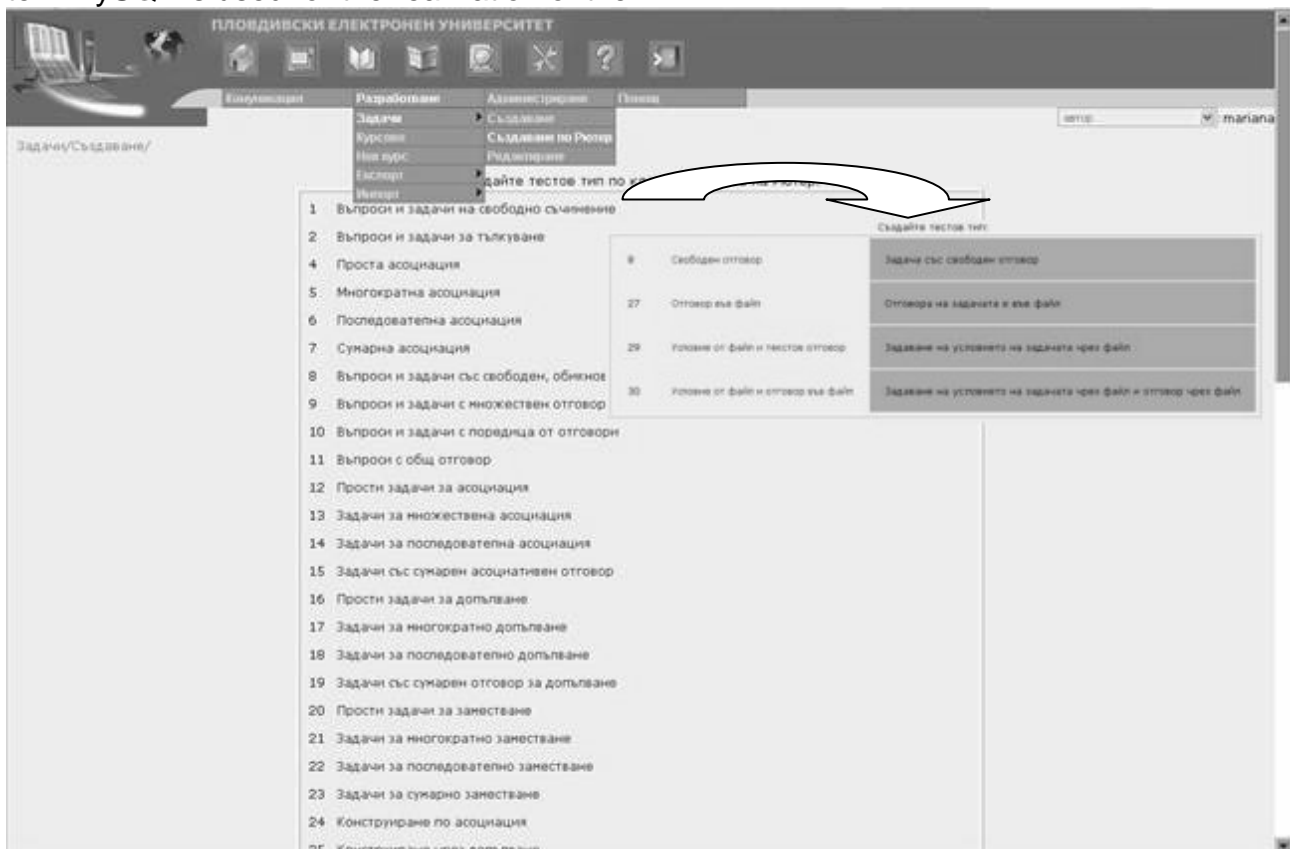


Figure 1. Selection of e-assignment type using Ruter’s classification

#### 4. Conclusion

Means and facilities providing a wide range of e-assignment types, related to classical types of test assignments are offered in the research. Experiments with the following elements are carried out in the e-Learning environment:

- **classification of test assignments and questions, appropriate for computer realization** (all 34 types, 24 of which can be automatically assessed);
- **computer realization of e-assignment types** in e-Learning environment;

- in addition **3 more types e-assignments** are realized: compound e-test – a list of e-assignments, which are saved into the DB; current e-test – a list of e-assignments, created at the moment (are saved in the DB) and **dynamic e-assignment** – a list of e-assignments in the DB, and the author defines the number of test assignments offered to each learner. Compound assignments can be assessed automatically or by the teacher;
- there are possibilities for interactive facilities, by **including multimedia elements** in e-assignments (audio, video, images, etc.).

Other development of the PeU test subsystem can be in the following areas:

- management of test examination using **resources limitation**;
- **realization of a common e-assignment template**, by which the author would be able to choose the type and the number of necessary visual components (text fields, textareas, buttons, radio-buttons, files, etc.), and in this way he/she would be able to create his/her own e-assignments types;
- realization of functions for automatic **assessment and checking** of open type test questions, etc.

### Bibliography

1. Advanced eLearning Builder: ([www.eduiq.com/elearning.htm](http://www.eduiq.com/elearning.htm))
2. Bijkov, G. *Methods of pedagogical investigations*, Asconi-izdat, Sofia, 1995, 123-154. (in Bulgarian)
3. Black Box Testing Course: <http://www.testingeducation.org/BBST/index.html>
4. Bloom, B. S. (ed.). *Taxonomy of Educational Objectives. Vol. 1: Cognitive Domain*. New York: McKay, 1956.
5. ClassBuilder (<http://www.classbuilder.com/info1.htm>)
6. CQuest Assessment Software (<http://www.cquestsoftware.com/>)
7. Crooks, T. J. "The Impact of Classroom Evaluation Practices on Students." *Review of Educational Research*, 1988, 58(4), 438-481
8. Fuhrmann, B. S., and Grasha, A. F. *A Practical Handbook for College Teachers*. Boston: Little, Brown, 1983.
9. MicroTest III (<http://www.chariot.com/microtest/index.asp>)
10. Respondus (<http://www.respondus.com/>)
11. Riva e-test (<http://www.riva.com/etest/features.asp>)
12. StudyMate 1.1 (<http://www.respondus.com/products/studymate.shtml>)
13. Totkov G. Virtual Learning Environments: Towards New Generations. Proceedings of the Intern. Conf. of Computer Systems and Technologies (e-learning), CompSys-Tech'2003, Sofia, Bulgaria, 19-20 June, 2003, P.2-1 – P.2-9.
14. Totkov G., E. Somova, M. Sokolova. Test assessment in the e-Learning environment, Computer Systems and Technologies, October 2003, Veliko Turnovo, 192-198.

### ABOUT THE AUTHORS

**Mariana Sokolova**, PU "Paisii Hilendarski", tel.: 032 772 000, e-mail:

mariana\_sokolova@yahoo.com

**Assoc. Prof. Dr. George Totkov**, PU "Paisii Hilendarski", dept. "Computer Science", tel.: 032 628 672, e-mail: totkov@pu.acad.bg