ANALYSIS OF ALGORITHMS FOR GENERATING TEST QUESTIONS IN E-TESTING SYSTEMS

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Abstract

The introduction and use of the electronic test not only as a means of verifying knowledge but also as a means of self-learning has led to the need to generate multiple training tests. Besides the well-known learning management systems (LMS), a lot of applications have been created in the space that offers the generation of training tests. Each one offers a set of algorithms to generate different types of test questions. In addition, each system offers a specific random selection mechanism for both the answers to a question and the order of the test questions in the final test. We make analysis and after that, it was found that different systems (LMS or specialized test systems) have, besides similar and specific ones, the algorithms themselves, but in each one of this system, the question is created/generated one by one. This takes a significant amount of time for teachers to create their own questions and then upload them into their chosen system. This article analyses which of the existing systems offers the best opportunity to prepare test exams individually for each learner. For this purpose, the capabilities of well-known LMSs and less used test system ones have been examined and analysed. This analysis will be the basis for preparing a model for the accelerated generation of test questions and grouping them into individual tests that save time for teachers.

Keywords: test, algorithms, LMS, analyses.

1 INTRODUCTION

Today's challenge is to constantly make efforts, learn and improve skills and competencies. There are a variety of training courses available on the market, both in-house and/or online, where people can improve their knowledge.[6] The emergence and use of the electronic test not only as a means of verifying knowledge but also as a means of self-learning has made it a preferred tool for verifying knowledge upon completion of many training courses. This has led to the need to generate multiple training tests. In addition to the well-known training systems (LMS), a number of applications have been created on the web to offer the generation of training tests. [2, 5] The use of electronic tests and the introduction of automation in the process of completing and checking, save time for trainers. In addition, the processing time and analysis of the results of the exams are significantly accelerated. Computer off-line and online tests, which are filled in with a mouse click, provide feedback as soon as students respond. [4] On the one hand, learners can immediately understand their results and the mistakes they have made and focus on the appropriate literature to help them catch up with missing knowledge. On the other hand, appraisers have the opportunity to learn immediately about the testing and its results.

Developed test software gives a variety of statistics after testing, both locally on a particular computer and a web-based application. In use are the many and varied products and programs offering electronic tests. These are systems such as CMS Moodle [8], CMS Joomla with its AriQuiz [1], Google Forms application, programs like MyTest [9], TEXAHM [12] and others [7, 11].

Examples of online test systems are Easy Test Maker, iSpring Quizmaker, HotPotatoes, Testmoz, ProProfs, QuizMaker, SurveyMonkey, Wufoo and others.

Any e-learning system (ATutor, Moodle [8], ILIAS, 7 Sakai, Google Classroom, PeU 2.0, eLSe, etc.) also has the ability to generate tests. There is an option in which such a system can be located even on an FPGA-based device that provides access via LAN or Wi-Fi [3].

Each of the listed systems offers certain capabilities and algorithms for generating electronic tests with different types of test questions. Each of the listed systems includes basic (general) algorithms and specific ones. The teachers must make a decision what system to use for the preparation of training tests so as to provide them with an easy, quick and convenient way to create multiple and different tests.

2   METHODOLOGY

This paper discusses several e-testing systems and makes a comparative analysis of which one offers the best opportunity to prepare test exams individually for each learner. Two categories of e-test generation systems are considered:

- specialized - dealing solely with the generation of tests, dissemination and subsequent processing of the results.
- e-test systems that are part of the LMS (like Moodle, ILIAS)

The benchmarking is based on a number of indicators such as:

- how to access the tests,
- accessibility from a mobile application,
- How to create a test question
- Ability to shift the position of the question in its order in the final test
- How to set answers
- Ability to shift the position of the answer to each question
- Ability to import from a file
- Database Storage (DB)
- Retrieving ready questions from the database
- Automatic check
- Supporting results statistics

In addition, a comparative analysis of the set algorithms for generating test questions has been made. The main types of test questions and their realization in five randomly selected e-tests have been discussed. A review of the features of each type of test item has been made.

3   RESULTS

In order to optimize the process of preparing individual training tests, 5 of the most popular e-test systems have been selected. These are LMS Moodle, LMS ILIAS, CMS Joomla with AriQuiz, Google Forms, TCEXAM (Table 1). The first two are part of the LMS, while the others are only specialized in generating tests.

A comparison is made between them on the basis of indicators facilitating the rapid preparation of various individual tests. Indicators analysing the listed systems on 2 levels are as follows:

- At test generation level
- At test question level

3.1   Analysis of E-Test Generation Systems at test generation level

The preparation of individual tests is important for the objective assessment of learners. From this point of view, it is important to choose an appropriate application to easily generate as many test variants as possible for learners. Each application offers a variety of capabilities while trying to stick to simple work and maximum functionality.

For each application, it's important how to access it. Whether it is installed locally or in the local network or is freely available. Using a mobile version of the application is preferred by the learners.

It is also important how each question is created - whether it is created one by one or the system offers some accelerated generating mechanism. Most modern test generation systems use databases to store them, but there are still ones that do not use them.

Can the system offer a specific random selection mechanism of the order of the test questions in the final test? And can the answers to each question be randomly rearranged? Is it possible to insert files from a folder or not? Table 1 looks at these indicators as well as indicators for automatic verification and statistics of the results of the tests.

Table 1 Comparative analysis of test generation systems.

Indicators	Included in LMS		Specialized		
	LMS Moodle	LMS ILIAS	CMS Joomla with AriQuiz	Google Forms	TCEXAM
Access	Online	Online	Online	Online	Online
Accessibility from a mobile application	Yes	No	No	Yes	No
Creating a test question	Question by question	Question by question	Question by question	Question by question	Question by question
Ability to shift the position of the question in its order in the final test	Yes	Yes	Yes	No	Yes
Way to set answers	One by one	One by one	One by one	One by one	One by one
Ability to shift the position of the answer to each question	Yes	Yes	Yes	No	Yes
Ability to import from a file	Yes	Yes	Yes	No	Yes
Storing in a database (DB)	Yes	Yes	Yes	No	Yes
Re-retrieve completed questions from the database	Yes	Yes	Yes	No	Yes
Automatic checking	Yes	Yes	Yes	Yes	Yes
Results statistics	Yes	Yes	Yes	Yes	Yes

Table 1 shows that in all examined systems the test questions were introduced one by one, as well as the answers to each question. Most of them have the ability to insert the questions from a file, but there are still others who do not have this option. The same applies to the use of DB for the storage of questions – not all systems use DB. This means that for each subsequent test, the questions need to be re-introduced.

As for automatic checking – all systems support that, as well as support statistics on learner results.

3.2 Analysis (Mapping) algorithms contained in the systems for generating tests by the type of questions

Each test is a set of test questions. For generating individual tests, it is **also** important what types of test questions can be used. Each application uses a set of algorithms to generate different types of test questions: closed-ended questions, open-ended questions, calculation questions, essay questions, linking questions, etc. Each type of question is better suited to a particular area of knowledge.

Table 2 provides an analysis of the main types of test questions and you use them in the systems to generate tests.

Table 2. Analysis (Mapping) algorithms contained in the systems for generating tests by the type of questions.

Type of test question	Included in LMS		Specialized		
	LMS Moodle	LMS ILIAS	CMS Joomla with AriQuiz	Google Forms	TCEXAM
Question with a closed answer	Multiple choice	Single Question	Single Question	Multiple choice	Multiple Choice Single Answer
		Closed-ended question	Multiple Question	Checkboxes	Multiple Choice Multiple Answers
		Multiple-answer question	Multiple Summing Question	Multiple-choice grid	
				Tick box grid	

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Question with open answer	Short Answer	Short answer	Free Text Question	Short Answer	Free-answer questions
		Long answer	Multiple Free Text Question	Paragraph	Short-answer questions
Question of the type „true/false"	True/False				
Question for connecting/match	Matching	Questions with connectivity answer	Correlation Question	Drop-down	
	Random short-answer matching		Drag and Drop correlation Question		
	Embedded answers (Cloze)		Multiple Drop-Down Question		
Question for complementation	Drag and Drop into text	Questions with answers to fill			subjective questions
	Drag and Drop markers				
	Select missing words				
Essay	Essay Question	Essay	Essay Question		Essay Questions
Calculated question	Numerical question	Numerical question			
	Calculated question				
	Calculated simple question				
	Calculated multichoice				
Others		Questions about wrong text	Hot-Spot Question	File upload	
		Question with image		Date	
		Questions to Answer arrangement			
		Questions to Answer arrangement (horizontal)		Time	
		Question to be uploaded to a file			
		Flash applet question			
		Java applet question			

Based on the analysis in Table 2, it appears that each of the listed systems tends to support the generation of questions from almost all types. Algorithms to generate test questions invested as part of the LMS offers several different algorithms to generate any type of test questions. In specialized test generation systems, the input algorithms are less than the LMC. Some systems, such as Joomla with AriQuiz or Google Forms, even lack algorithms to generate calculation questions. The most comprehensive set of algorithms is offered by LMS ILIAS, followed by LMS Moodle. There is no algorithm for working with a programming code in any programming language anywhere.

4 CONCLUSIONS

Over the last 5 years, a large number of electronic systems have been created on the world market and on the Internet to generate training tests, and the test has become a preferred form of assessment. The question is how teachers can quickly and easily generate multiple test variants to use in their training. After analysing 5 of the most commonly used test generation systems, we can see from the point of view of the possibility of generating a test whether we will use an LMS or a specialized application - most applications offer roughly the same test generation capabilities.

From the point of view of nested algorithms, a wider set of algorithms for generating test questions offers the generation of tests in LMS, compared to specialized applications.

In that examined systems, there are many algorithms for the realization of the generation of test questions like "create one by one", or insertion from a file. There is no algorithm to rapid and accelerated the generation of test questions. There is not an algorithm for generating test questions with a program code.

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