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Online Exam Questions Distribution Technique based on Terminals Locations: The Case of Arab Open University

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Abstract

The Arab Open University provides many of its exams through their Learning Management System. The system works fine in most situations, however, once there are many students taking a specific exam at the same time, the probability of repeating the same questions for adjacent examinees represents a threat to online examination reliability. In fact, and according to "on-the-field" observations, there is a noticeable percentage of repeated questions among adjacent examinees, which may decrease system reliability and accuracy on the one hand, and increase students cheating probability on the other hand. This research provides a solution to detect examinees locations and distribute the questions randomly, however, taking into account the location of examinees to ensure that no adjacent students will receive similar questions.

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1 Introduction

E-Learning is prospering on a global and local levels. In Saudi Arabia, the government is giving attention to the education sector in general, and e-Learning in particular, to respond to the increasing number and growth rate of both male and female students enrolled in educational institutions. Many universities in Saudi Arabia have already implemented e-Learning systems and are offering distance learning courses and degrees.

E-Learning provides much enrichment to the educational process. In particular, e-Learning technologies offer a potential for high quality formative assessment. Online assessment provides dynamic visuals, sound, user interactivity, adaptation to individual learner and almost real-time score reporting that expands examination options beyond the limitations of traditional tests [12]. With no doubt, learner assessments are essential in the educational process. However, the introduction of such systems to the educational process requires people involved to have basic technical skills and to be aware of the benefits of such systems. Exams may inform the instructor whether student progress is satisfactory or not.

Online assessment systems provide instructors with many advantages; in particular, instructors can create online examination in little time, administer online exams from the computer, and monitor answers during the exam and access results after the exam without spending time on evaluation and correction, and trends of the examination can be obtained easily. In addition, online examinations –that might take different forms, either web-based or even using mobile devices [10]- provides benefits to learners, for instance, learners are not required to be physically present at a given location and results can be available to

learners immediately.

Trusted and secure online examination systems are essential for e-Learning success [1, 3]. Generally, in online examination, learners should enter their names and password or authenticated automatically and continuously in some systems [6, 9]. Then the exam will be generated from the test-bank according to the parameters sat by the instructor. Major questions types of online assessments are true/false and multiple choice questions, reordering/rearrangement (matching, categorization, ranking, etc.), completion, concept maps, and essay questions. Exam questions will appear on the screen and each learner will start answering through his/her computer. When the time of the exam is over, the exam will be stopped and the score will appear. The learner may receive test result immediately.

Reliability of exams refers to the consistency of the measurement [4, 5]: will all students be compared in an equitable way and would the result be the same if the test were to be remade? The validity of the test states whether the test provides information appropriate for making assumptions; does the test measure what it was intended to measure? The concepts of validity and reliability are directly linked to the fairness of assessment, referring to a subjective feeling of whether the assessment is just or not [2].

In short, researchers are studying online examination systems from different perspectives; exams validity, reliability [13], security [8], accuracy, fairness…etc. Online examination systems could be very helpful, but many factors should be considered and they should be implemented carefully to guarantee the successful adoption, fairness and reliability [7].

2 Online Examination Structure at AOU

Most modern online education uses web-based learning management systems such as WebCT [11], blackboard, or software customized or developed in-house.

In the context of the Arab Open University (AOU), online examinations are conducted through the open-source Learning Management System (Moodle). The generation of the online exam is carried out by selecting questions randomly from a predefined question bank. The problem is that there is a noticeable amount of adjacent students receiving similar questions, which may decrease system reliability and accuracy and increase probability of students cheating.

The system at AOU allows the corresponding instructor to generate an online exam by identifying a set of criteria. In particular the questions' types and the units covered in that exam. The students are asked to log in to their LMS accounts and then access the exam page which is enabled by the administrator on the exam date. Once the exam page is accessed, a secret password should be entered by a specific proctor.

At the exam lab, the terminals are located at close distances (approximately 60cm). Such short distances allow adjacent students to share their screens with each other. Figure 1 shows the terminals distribution structures implemented at AOU exam labs.

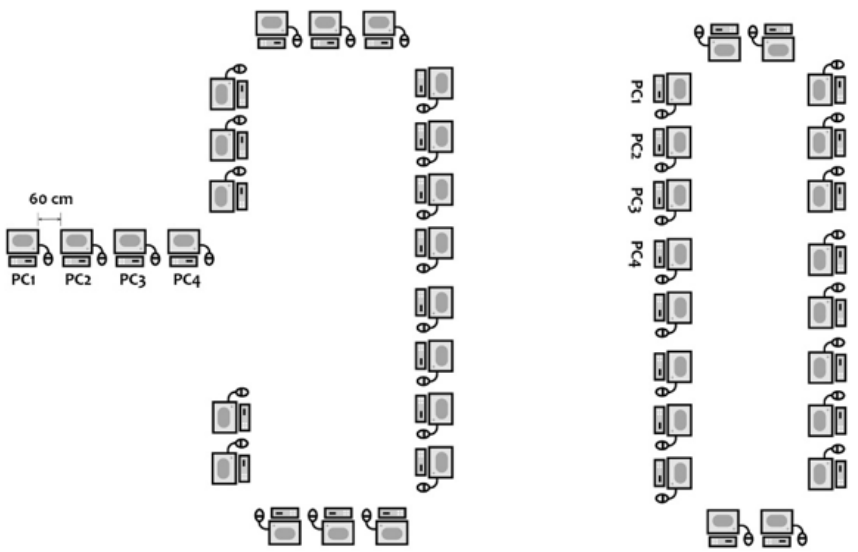

Figure 1: Two examples of terminals distribution structures at AOU exam lab

For the purpose of this research, each terminal is denoted by (a_i), where i represents the terminal ID in a particular exam lab. Adjacent terminals are expressed in Equation (1) as follows:

$$a_{i-1} \equiv_{\tau} a_i \equiv_{\tau} a_{i+1} \quad (1)$$

where ($\equiv_{\tau}$) denotes adjacent terminals of a distance that is less than (τ) cm. Currently, the test bank (β) of a particular course (C) denoted by (β_C) is linked with each terminal at the exam lab with no considerations on the terminal adjacency issues. The relation (denoted by $\approx$) between the test bank and the terminals is mathematically expressed in Equation (2) as follows:

$$\beta_C \approx a_i \quad (2)$$

The current examination schema considers choosing random questions from the test bank and send it to students' terminals. Therefore, adjacent students may receive the same set (or partial set) of exam questions. However, in the next section we introduce an alternative model which considers the adjacency issue when distributing the exam questions over the examinees.

3 Proposed Model

3.1 Overview

The proposed model consider choosing the exam questions randomly. However, taking into account the location of students' terminals to ensure that no adjacent students will receive similar questions, and at the same time, ensuring that all students receive the same type and difficulty of questions. Therefore, we found that a controller should be added to the relation link between the test bank and the student terminals. The new controller ∂ is expressed in Equation (3).

$$\beta_C \approx^{\partial} a_i \quad (3)$$

The task of the controller is to ensure that no adjacent students receive the

same set of questions in any given exam. Therefore, the controller is designed to control the questions selection process with respect to the location of the students' terminals. Figure 2 shows how the new controller is used to control the questions selection process. Practically, the controller is associated with each question (q_i) of the test bank. If q_i is chosen fo a_i, then neither terminals a_{i-1} nor a_{i+1} should receive the same q_i. The link between each q_i is formulated in Equation (4) and (5), where the formula in Equation (5) is activated after assigning q_i to a particular a_i in order to avoid assigning (removing the link $\approx^{\partial}$ between β_C and the adjacent terminals) the same question to terminals a_{i-1} and a_{i+1}.

$$q_i \in \beta_C \approx^{\partial} a_i \tag{4}$$

$$q_i \in \beta_C \approx^{\partial} \{a_{i-1}, a_{i+1}\} \tag{5}$$

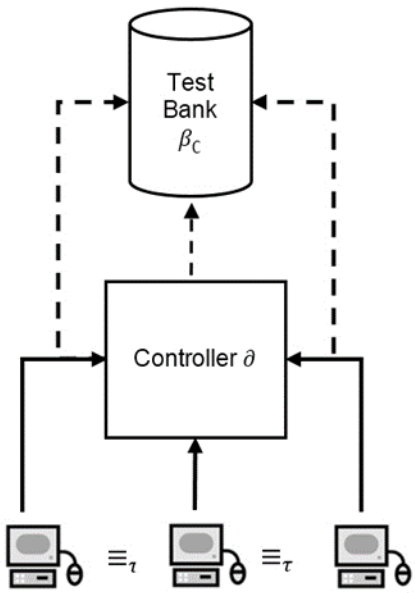

Figure 2: The interaction between examinee terminals and test bank through the controller

The network architecture of the online exam system consists of a set of

network clients (hosts) which are connected to one centralized server. The server is responsible for generating the exam questions after the client's names and password are entered. The network architecture used in this model is based on the assumption that the network clients are connected in a sequential form as shown by Figure 3.

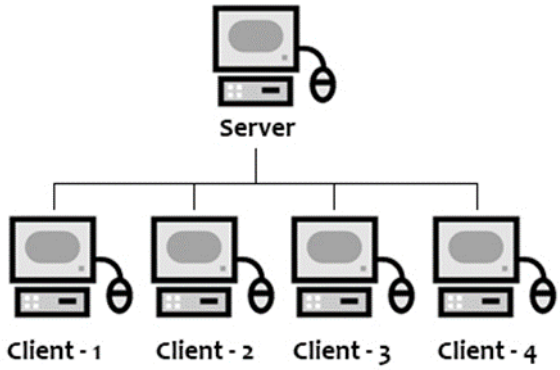

Figure 3: Network Architecture of the Online Exam System

With respect to the configuration of Local Area Network (LAN), each Personal Computer (PC) is assigned a unique Media Access Control (MAC) address and an Internet Protocol (IP) address by the Dynamic Host Configuration Protocol (DHCP) server. One the important characteristic of the later address is that it does not stay permanent. As soon as a PC is rebooted, a new IP address is assigned to it by the DHCP server from the pool of available IP addresses. Therefore the mechanism of identification of adjacent PCs cannot rely on IP address.

Alternatively, the MAC addresses are hardcoded inside the network card, and they never change during the life time of the corresponding network card. Therefore the MAC address is considered as the best alternative for identifying the adjacent PCs in any given lab structure.

3.2 Test Bank Controller (∂)

To ensure distributing unique set of questions to adjacent PCs, the first prerequisite is to identify the maximum number of possible adjacent PCs to any PC. In the given situation, illustrated in Figure 1 (left), none of the PCs from PC1 to PC4 is adjacent to any of the PCs on the other side, but they are close to each other. The same situation is applied for the other lab structure shown in Figure 1 (right). With respect to Figure 1, adjacent PCs are illustrated in Table 1 as follows. Obviously (referring to Table 1), there are only two maximum adjacent PCs to any PC in the given configuration. Therefore, there should be at least two sets of unique questions (for each course) available in the test bank β_C. It would be better if more unique lists can be generated out of the available pool of questions. For instance, if each exam is formed by 10 questions, there should be at least 20 questions available, out of which two lists of 10 questions can be created. Figure 4 presents the internal structure of β to serve our purpose of having two sets of exams that are composed of n questions for each course β_C.

Table 1: Adjacent PCs in AOU Lab Structure

PC	Adjacent PCs
PC1	{PC2}
PC2	{PC1, PC3}
PC3	{PC2, PC4}
PC4	{PC3}

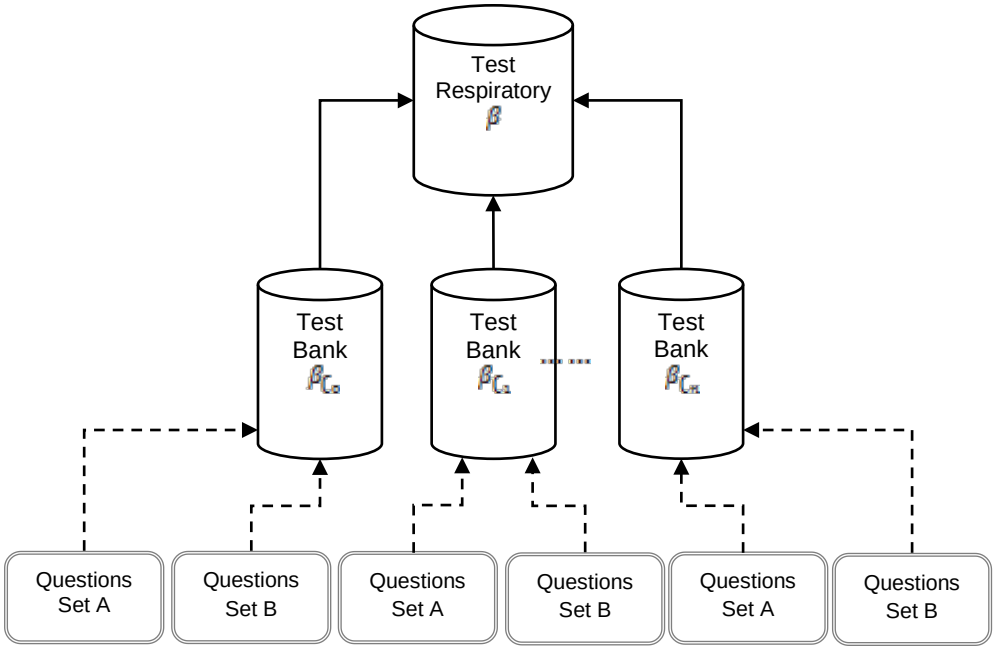

Figure 4: Internal Structure of test respiratory β composed of multiple courses β_{C_1}

Table 2: MAC list

PC Serial No.	PC Name	PC MAC Address
1	PC1	$0x_1$-$0x_1$-$0x_1$-$0x_1$-$0x_1$-$0x_1$
2	PC2	$0x_2$-$0x_2$-$0x_2$-$0x_2$-$0x_2$-$0x_2$
3	PC3	$0x_3$-$0x_3$-$0x_3$-$0x_3$-$0x_3$-$0x_3$
4	PC4	$0x_4$-$0x_4$-$0x_4$-$0x_4$-$0x_4$-$0x_4$

To distribute the questions list over PCs, the test bank controller (∂) identify the MAC address of each PC through the MAC list. The MAC list should be

prepared such that it starts storing the MAC address of each PC from one end of the Lab till the last PC, sequentially. However, the MAC addresses list need to be created as shown in Table 2.

Based on the pre-defined MAC list, each PC receives either **Set A** or **Set B** from the test bank. This would ensure that no two adjacent students get the same set of questions. With this arrangement, *odd* PCs receives Set A while *even* PCs receives Set B questions. Consequently, the exam controller assigns each exam sets to the corresponding PCs as shown in Table 3.

Table 3: Associating exam sets with PCs

Exam Set	**PC MAC Address**
Set A	$0x_1$-$0x_1$-$0x_1$-$0x_1$-$0x_1$-$0x_1$
Set B	$0x_2$-$0x_2$-$0x_2$-$0x_2$-$0x_2$-$0x_2$
Set A	$0x_3$-$0x_3$-$0x_3$-$0x_3$-$0x_3$-$0x_3$
Set B	$0x_4$-$0x_4$-$0x_4$-$0x_4$-$0x_4$-$0x_4$

4 Discussion

This section discusses the impact of the proposed model on the performance and security of online examination. The current examination system implemented in AOU depends on selecting random questions from the test bank. The random selection scheme generates random numbers that is associated with a unique question in the test bank. In term of performance, generating random numbers for selecting random questions consumes more time if compared to our proposed selection scheme.

To proof the performance efficiency of our model, assume that an exam is composed of q questions. Generating a random number for selecting one exam question requires the time *t*. Therefore the total time needed for selecting the questions (q_{ti}) is computed as follows:

$$\sum_{i=1}^{n} q_{ti} \tag{6}$$

In the case of our model, the process of selecting the questions is restricted to two sets of questions that are previously identified. Therefore, the maximum number of selections made for choosing exam questions for each student is one. On the other hand, the overhead for retrieving the MAC address of each PC from the MAC address lists is considered acceptable as for the purpose of preventing two PCs from receiving the same set of exam questions. As a result, our model can assure better performance compared to the traditional random questions selections.

5 Conclusion

This paper presented an alternative approach for preventing two adjacent PCs of sharing the same set of exam questions in AOU. The proposed approach is based on identifying each PC through its MAC address. Each time the examinee access its exam, the system will identify its adjacent PCs and choose the exam questions' set accordingly. This approach ensures that adjacent examinees will not share the same set of exam questions. In term of the performance, our approach is found efficient as it reduces the random generation processes that are carried out for selecting each exam question from the test bank.

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