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## **THE DESIGN OF A SECURE QUIZ EXTENSION FOR MOODBILE**

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**ABSTRACT:** E-learning has been adopted broadly by various institutions all over the world. However, the expansion of mobile devices creates a new form of E-learning, called m-learning. M-learning encompasses all learning delivered via mobile devices. It helps to make the learning process learner-centered by promoting “Bring Your Own Device” (BYOD) model of learning technology. Despite ever increasing demand for it among students, m-learning lacks teachers and/or institutions confidence who are accustomed to use e-learning systems such as LMSs. Moodbile project was the first attempt to find a moderate solution between the two parties by the integration of m-learning initiatives with LMSs. On the other hand, M-learning has unique security requirements especially for conducting exams. For that, we have designed a Secure Exam Management System (SEMS) as a service extension to Moodbile. SEMS enables mobile exams to be conducted securely (as cheat-free as possible). This paper discusses the design principles of SEMS. It also presents the results of a survey about students/teachers acceptance and confidence to adopt such exam systems.

**Key words:** Learning management system (LMS), m-learning, e-learning, exam engine, access control

### **INTRODUCTION**

The LMS has become a centerpiece of the digital strategy of most educational institutions. In addition to offering a virtual space for the classroom and the usual set of tools (noticeboards, forums, assignments, wikis, quizzes, SCORM, PDF and other contents), the LMS has articulated the digitalization management of studies and curriculums. With support for advanced gradebooks, groups within courses, meta-courses, competences, roles and integration via web services, the LMS has a lot of information about what is going on in the educational institution, and is often a key part of the business processes that take place inside it. With the transition to new ways of using technology for learning, such as mobile devices and MOOCS, one could suppose that the established LMSs (Blackboard, Moodle, Sakai and the one: Canvas) have long been ripe to be replaced by new ones that are more tuned to the new trends in the field.

However, in the last 15 years the educational institutions have invested heavily in technology, information systems integration, training and reorganization around the LMS. And, it is hard, if not impossible, to find a big organization considering replacing a large LMS system for a new one [1, 2]. Thus the established LMS is the starting point towards the new trends of technology in education. Particularly in the field of mobile-learning, we can see how all platforms are moving towards it. There are two main approaches. One is to enable mobile friendly web interfaces. In the Polytechnic University of Catalonia, the Moodle installation experienced an increase in usage from mobile devices from 7% to 28% of the total accesses, just by changing the CSS templates. The other one is to develop mobile apps. The Moodle community published a mobile Moodle connected to the web services, as proposed by the Moodbile project back in 2010 [3].

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Nevertheless, as Moodle founder Martin Dougiamas admitted, when receiving his Honoris Causa doctorate in Catalonia in Spring 2016, going mobile means to rethink deeply the workflows of the LMS tools, and it will mean a heavy redesign and recoding. Quizzes are not an exception. Moodbile project never addresses the security and privacy issues related to conducting exams in m-learning environment, and neither does the Moodle Quiz Engine which emphasizes only on the learning process not on securing the examination process. Other e-exam systems developed based on mobile platforms with wireless access [4], [5] lack proper security considerations and exam management functions as well.

This paper aims to briefly discuss the design principles of SEMS [6]. SEMS is designed to meet the distinct security requirements of m-learning environments and to be integratable with Moodbile. The paper is organized as follows: Section 2 presents SEMS Exam Engine. Section 3 discusses how SEMS enforces exam security and controls network communication during an exam. Finally, Section 4 presents a survey conducted about SEMS.

### **Sems Exam Engine**

The Quiz Engine in Moodle can only be accessed through standard web browsers that are slow on mobile devices and that cannot address m-learning exam security issues. Thus, we need to develop a new Quiz Engine integratable with Moodle/Moodbile in order to have a complete LMS whose services can be consumed by mobile applications, to cater m-learning specific security requirements. The core features of the proposed Exam Engine are discussed below.

### **Secure and Random Distribution of Exam Questions**

The following functionalities are provided in this context:

- Enabling the teacher to define a bank of exam questions and linking them to his/her subject.
- Enabling the teacher to specify subjects' exam properties such as: Date and Time, Duration, Percentage of questions at various difficulty levels, etc.
- Securely authenticating and enrolling students, using any of the well-known secure and multifactor authentication mechanisms, into the exam at the predefined date and time.
- Creating exam instances by random distribution of exam questions and multi-choices of answers to the enrolled students' mobile devices according to the predefined exam properties such as percentage of each question level.
- Allowing students to answer the exam questions through the Exam Client and then submitting the answers to the Exam Server.
- Allowing students to request interaction with the teacher during an exam. If a student has a doubt about one of the questions, he/she can click a button that causes the teacher version of the software to raise an alert about the question, the student who is asking, and the room that he/she is attending the exam from. The teacher will be further able to edit the question in case he/she finds a mistake or an ambiguity in it. Students who have got the same question will be alerted with the change.
- Processing students' answers to determine their grades.
- Generating a set of reports to enrich the assessment process, by providing statistical information about a particular exam, a student, or a teacher.

The Quiz Engine proposed herein also includes a Turbo-mode Assessment Service for conducting arbitrary quizzes during class time rapidly. According to the student's answers it increases or decreases the difficulty level of the questions in a reactive manner. As a result, student's level can be determined using fewer questions and in a shorter time. Also the software has to be supported with a special theme for students with special needs (for example, a theme with a big font for students with short vision).

### **Following the Widely Accepted Industrial Standards**

SEMS Exam Engine must conform to a well-known and widely-adopted set of standards and specifications developed by IMS Global Learning Consortium (IMS-GLC) [7]. IMS-GLC is a specification authoring organization comprised of distributed computer learning system vendors, publishers, digital content vendors, government agencies, universities, training organizations, and other interested parties. It is a global and non-profit member organization supported by over 190 of the world's leaders in educational and learning technology. It has approved and published some 20 standards that are the most widely used learning technology standards in higher education around the globe. These include meta-data, content packaging, enterprise services, question & test, competencies, tools interoperability, sharable state persistence, vocabulary definition, and learning design. All IMS-GLC standards are available free of charge via the IMS GLC web site and can be used without royalty. The IMS Question & Test Interoperability (QTI) specification enables the exchange of item, test and results data

between authoring tools, item banks, test constructional tools, learning systems and assessment delivery systems. QTI specification is defined in XML to promote the widest possible adoption.

### Enforcing Exam Security

In m-learning environments, students' tablet/mobile devices are connected to a Wi-Fi network through which they can exchange information during an exam. Applying simple policies, such as turning the network down, does not work out as students from different classes do not have their exams simultaneously. We have to introduce an appropriate mechanism to address this point in a practical manner.

In such an environment, a dynamic network access policy has to be generated and applied on each student's tablet according to predefined conditions. For example, if the student has no exam, then all the intranet communication, including the Bluetooth communications, are allowed. However, during exam time, Bluetooth and all other network communications have to be blocked except the main connection to the Exam Server through which the student is going to download the questions and submit their answers.

To enforce such policies, we introduce **SEMS Security Agent**. It is an agent software installed on students' mobile devices and is responsible for downloading the dynamic network access policies from the Exam Server and enforcing them on each student device respectively. This agent is connected to the Exam Server via a predefined secure channel through which it is going to download the dynamic access policy. To ensure that students are not going to shut this agent down in order to break the access control policy, the Security Agent will keep sending a periodic heart-beat signal through the same secure channel to the Exam Server as illustrated in Figure 1. In case the Exam Server stops receiving this signal for a predefined period, it has to log this event and send an immediate alert to the proctor's device who is associated with the running exam to investigate the issue.

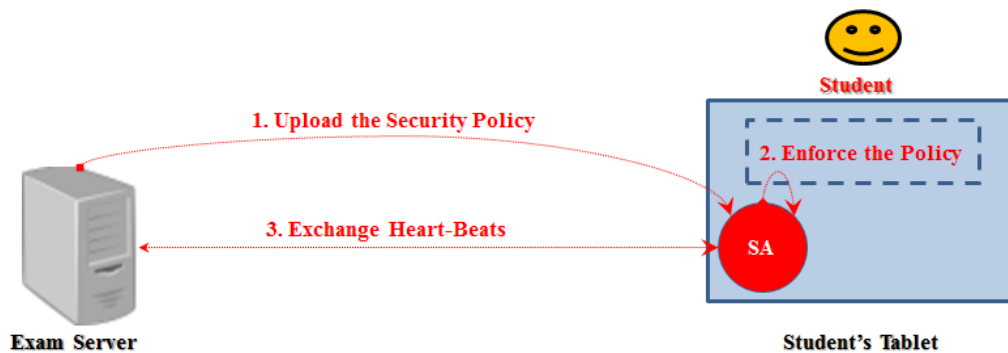


Figure 1: Student Monitor Agent

In case of an open-book exam, teacher has to upload a set of exam eBooks to the Server. The dynamic access policy allows students to browse the eBooks associated with their open exam. This mechanism controls the access to materials rather than opening the entire network resources which can be misused by the students. SEMS design also adopts a mechanism for anti-impersonation. Students' mobile devices' cameras can be used for a biometric-based login to the Exam Server by implementing any well-known face-recognition algorithm. In a Wi-Fi based connection, we cannot guarantee that each student is going to attend the exam from the dedicated class room. A student can simply sit in a nearby room, log in to the Exam Server through the Wi-Fi network, illegally open a textbook, and use it to answer the questions. To encounter this issue, SEMS design offers three strategies: the Proctor Approval based Strategy, the QR-Code based Strategy, and the NFC based Strategy. Each strategy suits a particular scenario.

Students might still attempt to cheat by simply exchanging their mobile/tablet devices after they get authenticated by the Exam Server. To prevent this issue, SA may re-authenticate the students biometrically by asking them to represent their faces in front of the mobile camera on a random basis. Moreover, SEMS design handles various network issues such as: network overload and occasional failures, the use of alternative mobile devices to exchange information during an exam, and the use of a Wi-Fi jammer to bring the Wi-Fi network down. On the other hand, the Security Agent has an optional auditing service that helps to monitor students' activities on their tablet/mobile devices such as: Internet browsing, playing games, reading course electronic materials, etc. This can help to analyze the efforts being done by the students and give suggestions to their parents in order to encourage them to improve their efforts so they can accomplish better results.

## RESULTS

The proposed Secure Exam Management System design principles were validated by conducting a survey at three different universities. The number of students participated in the survey was 322. The opinions of a total of 72 lecturers were also taken. Two of the institutions are private universities, the other is a state university, and the success levels of students at the entrance exam are almost the same. The lecturers were presented 7 questions related to adaptation of SEMS system in their exam evaluation process (Table 1). On the other hand, the students were asked to answer 5 question to expose their attitudes towards SEMS system (Table 2). Both of the surveys were prepared using a 5 point Likert-type scale i.e. (1) strongly disagree – (5) strongly agree.

The feedback from the both surveys shows that the attitudes of the students and the teachers towards adopting SEMS in conducting exam process are positive. The response from students shows that they 51.6% either “strongly agree” or “agree” on this statement. On the other hand, responses of the lecturers show positive and neutral tendencies. Out of 72 lecturers, 38.9% of them either “strongly agree” or “agree” on this statement, 36.1% are neutral while the minority of 25% disagree with the statement. The results show that the stakeholders’ attitude towards SEMS is acceptable. The exposure of the students to new high-tech devices is the main reason why the students’ feedback is more positive compared to the lecturers’.

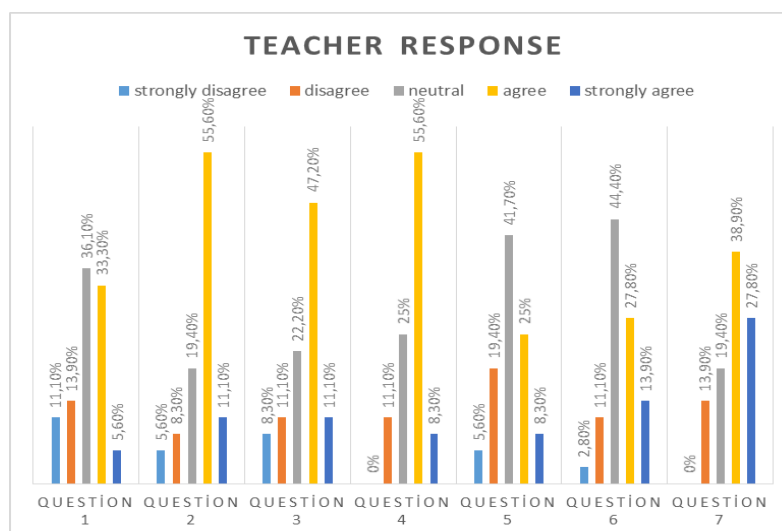
In general, the confidence level among the lecturers of using the system and getting benefit out of it is extremely high as seen in Figure 2; for Q2, 66.7% of the lecturers and for Q3, 58.3% of lecturers either “strongly agree” or “agree” on this statement, respectively. A similar tendency among students is evident on being comfortable with using SEMS (Figure 3). 64.6% of the students either “strongly agree” or “agree” on this statement regarding Q2 in the students’ survey. They also believe that SEMS would be fairer in grading. The opinion for the respective question is 49.1% being either “strongly agree” or “agree” on this statement. Although 22.9% of students either “strongly disagree” or “disagree” on this statement, the general attitude is comparably positive. Only %18.7 of the students did not think that SEMS would help to improve the teaching process via instant quizzes. The results are indicative of highly positive general view of the stake-holders on using SEMS in m-learning environments.

**Table 1. Questions to Teachers**

Q1 SEMS is more preferable over a paper-based exam.
Q2. Exams would be conducted easily and effectively using SEMS.
Q3. An enhanced evaluation process would be obtained using SEMS.
Q4. The user-friendly interfaces of SEMS design would help adaptation of new technologies in classrooms.
Q5. I don’t expect to have any difficulties in conducting exam using SEMS once it is implemented.
Q6. Students’ attitudes towards SEMS system would be definitely positive.
Q7. Face recognition as an extra security-check would increase the confidence.

**Table 2. Questions to Students**

Q1. SEMS is more preferable over classic type paper-based exam.
Q2. As a generation acquainted with high-tech devices we would be more comfortable with using SEMS.
Q3. SEMS would be more fair and unbiased in grading my knowledge.
Q4. As a system with latest technology SEMS would prevent cheating more efficiently.
Q5. Instant quizzes help to increase our success and to identify our levels quickly and regularly.



**Figure 2: Teachers’ Responses**

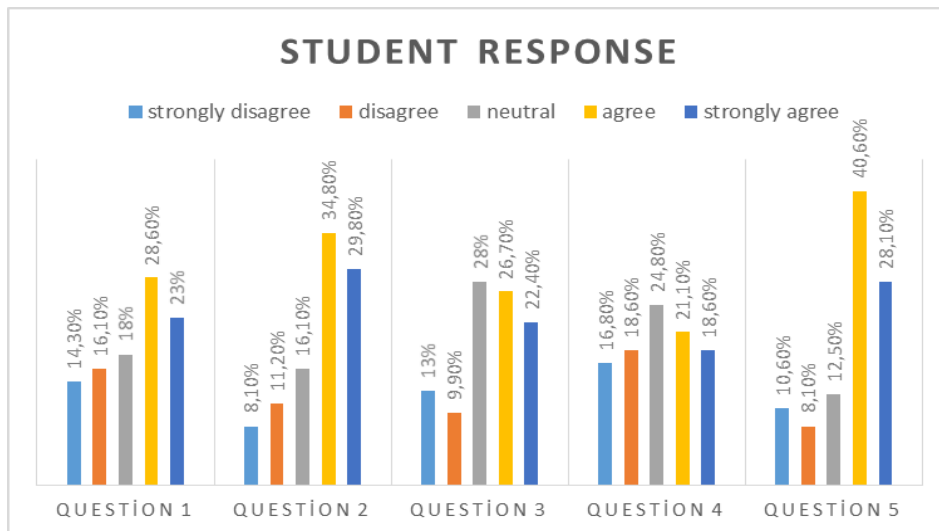


Figure 3: Students' Responses

## CONCLUSION

This paper proposes the design of Secure Exam Management System (SEMS) to mitigate exam security threats that exist in m-learning environments. SEMS offers many efficient exam services such as: secure and random distribution of exam questions, biometric based authentication mechanism for anti-impersonation, conducting exams securely, and auditing services. SEMS is integratable with Moodle and its service extension Moodbile. The resulted design is a complete LMS with secure exam services that can be consumed by legacy systems through web browsers and by m-learning systems.

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