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Smart and Secure Exam Management System for Mobile Learning Environment

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Abstract: M-Learning has enhanced the e-learning by making the learning process learner-centered. However, enforcing exam security in open environments where each student has his/her own mobile/tablet device connected to a Wi-Fi network through which it is further connected to the Internet can be one of the most challenging tasks. In such environments, students can easily exchange information over the network during exam time. This paper aims to identify various vulnerabilities that may violate exam security in m-learning environments and to design the appropriate security services and countermeasures that can be put in place to ensure exam security. It also aims to integrate the resulting secure exam system with an existing, open source and widely accepted Learning Management System (LMS) and its service extension to the m-learning environment, namely "the Moodbile Project".

Key Terms: Access control, e-learning, exam engine, Learning Management System (LMS), m- learning.

1. INTRODUCTION

LEARNING has experienced such an extraordinary growth over the last years that its global industry market is estimated to be worth USD 91 billion [1]. Learning Management Systems (LMSs), due to being essential tools of e-learning, have been adopted by many organizations to establish and provide access to online learningservices. Nowadays, the success of LMSs is so great: 74%of the US corporations and educational institutions currentlyoffering e-learning employ LMSs in their trainingprograms [2]. Thus, LMSs must change to adapt to new user requirementsand technologies. For example, interaction withexternal applications, such as social networks and mobileapplications, must be incorporated in LMSs [9] to facilitatepersonal learning demands that happen anywhereand at any time.M-learning puts the control of the learning process inhands of the learner itself [10] and enhances collaborationand flexibility. It is concluded in [11] that having a mobile,accessible e-book is "perceived to benefit studentlearning due to the value placed on the affordance ofsituated study in everyday life." The students that participatedin this study expressed feelings of competence andhigh self-efficacy, and that they were able to learn moreusing their e-books. Moreover, among other technologicalfactors impacting the future of m-learning, Rao et al. [12]asserted that cloud computing would make mobile learningmore efficient in many ways, ultimately in time andcost. A web portal developed using Amazon's cloudcomputing service is presented in [13] whereby teacherswithout programming skills can implement interactivelearning processes. The materials developed can be usedwith mobile applications on Android and iOS based devices.

Some of the contributions of m-learning are:

1. It is learner-centered .
2. It is a new alternative for information delivery and
3. It enhances collaborative learning.

On the other hand, m-learning faces several challenges such as:

1. Lack of teacher confidence, training or technicaldifficulties with mobile devices.
2. Lack of institutional support.
3. Interoperability problems with LMSs.
4. Security and privacy issues.

One possible solution to overcome these challenges isthe integration of m-learning initiatives with LMSs. Fromstudents' point of view, m-learning could personalizetheir learning process as well as enable them to collaboratewith other students or teachers. From teachers' pointof view, they could continue to use LMSs as their workingplatform, leaving mobile devices for students. Theproblem, however, is that the integration between m-learningapplications and LMS is not an easy task. Indeed,LMSs do not generally contain interoperability standardsto communicate with external applications; they are usuallydesigned as monolithic or layered systems [9]

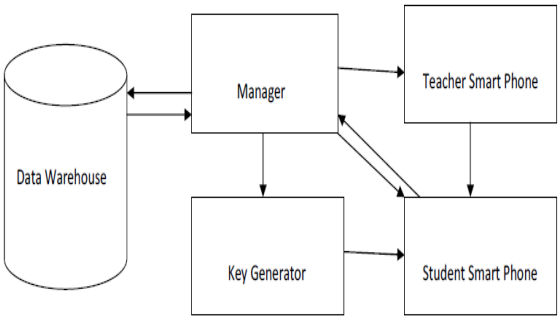

Figure: System Architecture

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The above figure 1 shows the system architecture of our proposed model. Where teacher and student should own a mobile device to participate in examination system. Key generator model is build with intention of generating keys for both teacher and student. Data warehouse is used to store all the information with respect to our proposed model.

This paper aims to design a Secure Exam ManagementSystem (SEMS) that meets the distinct security requirements of m-learning environments and to integrate it with the current Moodle/Moodbile platform. This willresult in a complete LMS that is both equipped with secure exam services and suitable for m-learning. Our intentionof integrating SEMS with a well-known LMS suchas Moodle is so to get the benefits of Moodle's readymadeservices in other learning aspects such as coursematerial administration, documentation, etc. which havebeen experienced and appreciated for the last 15 years.However, the proposed SEMS can also work as astandalone secure exam management system for mlearningenvironments without integration with Moodle.

Although the proposed SEMS design is platform independent,the paper presentation adopts Android platformas a case-study for the following reasons:

1. Android devices are more affordable for students.
2. According to IDC, Android dominated the marketwith a 78% in the first quarter of 2015 [38].
3. Android is supported by many enterprises such asGoogle, HTC, Sony, Intel, LG, and Samsung [39].
4. For better compatibility with Fatih Project [40], theTurkish government project that seeks to integratecomputer technology into Turkey's public educationsystem. It will be fully developed on Android.

2. SEMS EXAM ENGINE CORE SERVICES ANDFUNCTIONALITIES

The Quiz Engine embedded in Moodle is not builtbased on Service Oriented Architecture. It is implementedas a bulk of PHP code which has to be accessed throughstandard web browsers that are a bit slow on mobile devicesand cannot address the exam security issues that exist in m learning environment. Moodbile services extensionto Moodle does not touch the Moodle's Quiz Engine.Thus, we need to develop a new Quiz Engine thatcan be deployed as a service oriented application, so thatits services can be consumed by a mobile applicationdesigned to cater to m-learning specific security requirements.As well, it should be integratable with Moodle/Moodbile in order to have a complete LMS whichsuites the m-learning environment and addresses all of its security issues. The core services of the proposed ExamEngine are discussed below.

2.1 Secure and Random Distribution of Exam Questions

This service provides the following functionalities:
1. Enabling the teacher to define a bank of examquestions and to link them to his/her subjectthrough an appropriate interface (Subject's QuestionBank Interface). In case of objective kind of questions, each question may have a set of options.The teacher has to provide those options throughthe same interface and specify the correct choicesamong them to enable the exam engine to autoevaluatestudents' answers. In case of descriptivekind of questions, a text box (or probably a sketchingcanvas) will appear below each question at thestudent device screen to allow him/her towrite/draw the question's answer; those answerswill be saved at server side to be further reviewedand evaluated by the teacher. In addition, eachquestion will have a property to specify its difficulty"level" (let's say: A, B, C, D, and E).

2. Enabling the teacher to specify a subject's exampropertiessuch as: Date and Time, Duration, Percentageof level A, level B, and level C questions inthe exam paper, etc. through an appropriate interface(Subject's Exam Setup Interface).

3.Securely authenticating and enrolling students,using any of the well-known secure authenticationmechanisms, into exams at the pre-defined dateand time through the Exam Enrollment Interface.Multifactor authentication can be adopted forstronger security as explained in Section 2.4.

4. Creating exam instances by random distributionof exam questionsto the enrolled students' mobile/tablet devices according to the predefined examproperties such as percentage of each questionlevel. This means that questions are not going toreach students in the same order. Moreover, themulti-choices of each question, in case of objectivequestions, will be flipped randomly and delivereddifferently to each student. The Exam Server associatesthe exam questions with a message digestsigned by its private key to ensure data integrity.The Exam Server also has to memorize the way ithas distributed the questions to each student to beable to evaluate the correct answers once the studentssubmit their answers back to the Exam Server.This process, illustrated in Fig. 2, guaranteesthat each student gets different questions orderand makes cheating by "hand-signals" impossible.The prepared questions bank is reusable. Teacherscan always enrich their courses' questions bank byadding new questions or upgrading old ones duringthe semester. At the exam time, it is the responsibilityof the Exam Server to create exam instancesout of the questions bank. Incorporatingthe "question level" concept helps the Exam Serverto prepare a moderate kind of questions whileselecting them out of the questions bank.

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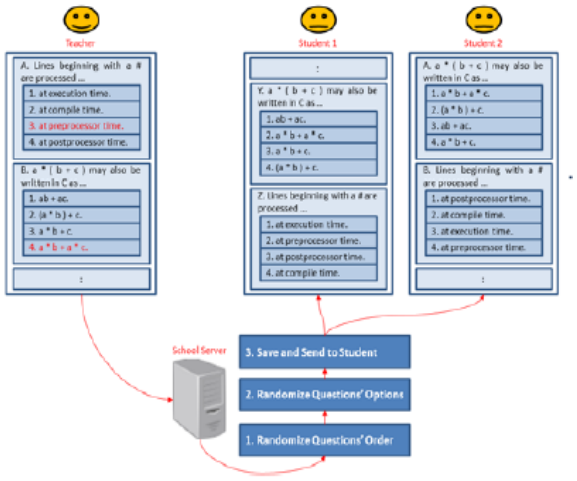

Fig. 2. Secure distribution of exam questions

2.2. Preventing the "Unattended Exam" Issue

In a Wi-Fi based network, we cannot guarantee that eachstudent is going to attend an exam from a dedicatedclassroom. A student can simply sit in a nearby room and log in to the exam system through the Wi-Fi network.He/she can subsequently open his/her course notes anduse it to answer the questions illegally. To encounter thisissue, we propose the following strategies.

2.3 Preventing Students from Exchanging Mobile/Tablet Devices during an Exam

Beyond all the enforced security mechanisms discussedearlier and those which are going to be discussed later onin this paper, students might still attempt to cheat bysimply exchanging their mobile/tablet devices after theyget authenticated by the Exam Server. To prevent thisissue, ECS tries to re-authenticate the students biometricallyby asking them to represent their faces in front ofthe mobile camera on a random basis. With this mechanism,students cannot exchange their devices during anexam after getting authenticated as the system at anypoint of time can ask them to represent their identity.Moreover, the proctor software will have the functionality to force a particular student attending an exam to getre-authenticated by the system in case any suspicious caseoccurs. It can simply signal the corresponding student'sECS to re-initiate the authentication process. ECS willalways respond to this signal coming from the exam'sregistered proctor device.

3. SEMS SECURITY AGENT

Students' mobile/tablet devices are connected to theschool's Wi-Fi network through which they may illegallyexchange information during an exam. Applying simplepolicies, such as turning the network down during examsto cut off any possible communication between students,is not a practical solution as students in different classesmay not take their exams at the same time. Moreover, thenetwork has to be up during exams in order to be able tosubmit students' answers to the Exam Server. A dynamicnetwork access policy has to be generated and applied oneach student's device according to predefined conditions.Employing an identity based firewall with dynamic accesspolicy seems to be a good solution to be adopted insuch a scenario. However, it has the following limitations:

1. It is a centralized software which cannot block Adhoc Bluetooth communications between students'mobile/tablet devices, neither can it block the regularcellular communications.

2. It cannot address certain issues such as the "**unattendedexam**" issue discussed in Section 2.3. Forsuch special issues we need a protocol specificallydesigned for m-learning environments.
3. It cannot prevent the students from opening offlinePDF files, which have been previously downloadedinto students' mobile devices and can beaccessed offline without the need for a networkapproval.

3.1Online Exam Strategy

In this strategy, students attend the exam through a secureand online channel established with the Exam Server.This strategy has more advantages over the offlineone. For example, it allows students to access a sharedlibrary of e-books or a set of related websites prespecifiedby the teacher for an open-book exam scenario.

On the other hand, enforcing exam security becomes a challenge in such an open environment.In this case, the system has to adopt a dynamic networkaccess control through which it can create and enforcedifferent policies for different cases. For example, ifthe student has no exam, then all kinds of communications,including the cellular, Bluetooth, and Wi-Fi communications,are allowed. During exam time, however, cellular, Bluetooth, and Wi-Fi communications have to beblocked except the main connection to the Server throughwhich the student is to submit answers to questions oraccess the exam's shared library.

4. CONCLUSION

This paper proposes the design of a Secure Exam ManagementSystem (SEMS) to mitigate the unique examsecurity threats that exist in m-learning environments.SEMS offers many exam services such as: secure andrandom distribution of exam questions, turbo-modeassessment, prevention of the "unattended exam" issue,biometric-based authentication service for antiimpersonation,preventing students from exchangingtheir devices during an exam, conducting exam securelythrough online or offline strategies, and auditing.

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