Towards Enhancing Supportive E-Learning Courses using Smart Tags

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***Abstract*—E-learning management systems have emerged as a method of education development in many universities in the Arab world. E-learning management system tools provide a basic environment for interaction between faculty members and students, and these tools require information technology to obtain the most benefit. This paper proposes a method for enhancing the delivery of supportive e-learning courses using smart tags, such as NFC technique. The study sample comprises students at a supportive E-learning course in King Khaled University. This study aims to propose a technique to enhance the delivery of E-learning courses using these tags, which enable teachers and students to interact with the educational material and track their academic performance. The conducted experiments used receiver operating characteristic (ROC) prediction quality measurements to evaluate the proposed technique.**

Keywords*—Learning Management System (LMS); Supportive courses; Blended courses; Online Courses; Quality Matters

I. Introduction

Educational technology is a necessity to ensure the success of educational systems. Hence, educators always take advantage of new technologies that could enhance teaching and learning processes that increase performance efficiency.

The number of creative people in a community is not attributable to distinguished mental capabilities or educational systems. Traditional education systems do not evolve creative minds, but the creative student in the framework of the traditional education system is considered creative when he/she overcomes the limitations and determinants of the traditional education system. Modern education systems drive the evolution of the brain and motivate authors by establishing the principle that the primary goal of education is to raise the ability of students to think, innovate, and search for information until they acquire knowledge [1].

Universities in the Kingdom of Saudi Arabia have experienced outstanding achievements in the use of E-learning by adopting the "Blackboard" E-learning management system. E-learning is one of the modes of education that use the Internet and other technologies to provide scientific technology courses to students and provide communication and interaction between them as well as the faculty and the learning resources.

Usually, E-learning systems offer three main levels using blackboard system, which are as follows:

- Supportive E-learning (traditional): At this level, the educational process applies in a classroom, and the E-learning systems and tools facilitate and support the learning process [1].
- Blended or hybrid E-learning: This method replaces the face-to-face classroom sessions with electronic activities on the site and use tools of the E-learning system [1].
- Online (Full) E-learning: This method replaces all the courses and face-to-face classroom sessions with electronic activities on the course site by using the tools of an E-learning system, with the exception of the final exam and limited face-to-face sessions decided by the faculty members [1].

The NFC tag is a wireless smart technology used to transfer data, such as text or numbers between two NFC enabled devices. One of them is an NFC tag, such as a sticker. The tag contains small microchips and an antenna, which store a small amount of information, such as URL. The second is the NFC device, such as a smartphone [2].

In this paper, the authors propose a method to enhance supportive E-learning courses at the King Khalid University through the use of NFC smart tags. The proposed method has been applied on a sample of 1000 students in the Introduction to Computer course (Hal 101). The practical part of the course uses E-learning. The next section discusses related studies to this paper. The third section presents detailed information on the adopted dataset. The fourth section explains the structure of the proposed methodology, and fifth section presents the experiments and results. Finally, the sixth section presents the conclusions.

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II. Related Work

Saparkhojayev and Guvercin [3] proposed the use of the radio-frequency identification (RFID) system based on RFID Tags to identify automatically the presence or absence of students in Suleyman Demirel University, Kazakhstan. All classes are provided with personal computers (PC) connected to a web camera and RFID reader. These PCs and their peripherals are connected to the main server. The system uses a database. The instructor has to input his/her ID and password to the system to start verifying whether the students who had attended the lecture are the enrolled students in the course. This manual verification is considered one of the main flaws in their system [3]. Nainan, Parekh, and Shah [4] presented the components of RFID systems, emphasized scalability and security of the systems, and tested the feasibility and practicality. Soliman and Guizan [5] investigated the enhancement of E-learning system usage of learner profiles through mobile learning. They argued that proper understanding of the learner is crucial and achieved through the availability of learner profiles for mobile learning environments. Therefore, they applied RFID with smart tags to identify and extract the data/profile of learners. Their study concluded that learner profiles are personalization-enablers for e-learning systems and identification cards for learners to explore different learning environments. The system also provides the context and location-awareness services to learners [5].

Hamid [6] presents two major problems facing universities. The first one is wasting time in recording attendance for students and the second is losing part of the power for the operation of devices with little or no educational institutional benefit. HANISAH was introduced as solution to these problems through the use of RFID technology. Frequency identification radio (FIR), which is an automatic identification method, relies on storing and retrieving data using devices that deal with posting and reception from a distance. The system has been building applications using the Internet to monitor attendance records of students. Information technology through existing attendance management system on the computer RFID aims to solve everyday problems and assist faculty members in accessing the system easily via the Internet. The system could be equipped to create reports and provide valuable information on student commitments to attend lectures in real time [6].

Riahi [7] describes the ways to benefit from the environment of cloud computing to build sustainable and widely used E-learning systems. Cloud computing is considered by Riahi [7] as a suitable infrastructure for building large-scale E-learning systems. He presents five main layers of E-learning, namely, hardware and software resource layers, resource management, server, and business application.

According to Dominikus and Schmidt [8], “The Internet of Things (IoT) is an upcoming topic as things are getting smarter and are able to connect themselves with each other.” The study describes a method that applies concepts from Mobile Internet Protocol (MPI v6) to enable a two-way end-to-end communication with passive RFID tags into the Internet. Furthermore, they apply concepts from MIPv6 where tags do not require IPv6 functionality themselves, but communicate with readers using their standard RFID communication protocol. The readers provide MIPv6 functionality and act as a gateway between the Internet and the tags. They concluded that MIPv6 allows full integration of passive RFID tags via the IoT [8].

The study of [9] highlights the omitting factors in E-learning environment, which reflects the illegal behavior of students. The authors studied a sample of 150 students and 15 instructors for several online courses by using questionnaires. The experiment results indicated that the Learning Management System (LMS) supported academic institutions, but issues are missing legal development. The study recommended the use of a new model that could integrate society members in the LMS of an academic institution. The proposed model was evaluated based on statistical measurements. The results showed the effectiveness of the proposed model.

Peters [10] explained that mobile technology is implicitly used in formal education. Millions of sites are linked with mobiles used by students because they all search for information even though they may not be in the official records of the training course.

Many educational institutes recognize the importance and benefits of using mobile learning, but these benefits are limited by several factors. The most important limitations include age of teachers and trainers, their ability, cost of providing mobile devices, and infrastructure necessary for operation and connectivity.

The increasing growth of the functionality of mobiles as smart devices appears to have a clear place in training and education. Management of m-learning is very important for learners as they shift teachers from indoctrination process to guidance, as well as help learners to get instantly limited skills for the knowledge economy. The proposed system enhances the interaction among three main partners, including students, teachers, and parents of students, in one account [10].

III. Dataset of the Study Sample: Supportive E-Learning

King Khalid University applies supportive E-learning for all courses that students should attend in the classrooms. The curriculum should be presented by using the learning management system (Blackboard), and the lecturer assigns the subject area, assignments, and forum discussions [11].

Each supportive E-learning course must contain

- platform of the curriculum and information on the lecturer,
- scientific material of the course (not required to cover all course materials, but is preferable),
- link to course-related announcements, and
- link to hold discussions with the students.

The practical component of the Introduction to Computer course (Hal 101) is regularly taught at King Khalid University under the direct supervision of the Department of Computer

Science at the Faculty of Computer Science, and the component uses supporting E-learning level [12]. The study sample consists of 1000 students from the main university campus, includes supportive e-learning requirements, and considers international quality standards. Quality Matters (QM) was applied after obtaining approval from the Deanship of E-learning at the University of King Khalid for the two courses [13].

The respondents were asked if they have smart phones and internet connections. Approximately 95% of the respondents have this technology, and this figure sufficiently covers the limitation of 5% of the author sample. King Khalid University provides Internet services over wireless networks to all students and faculty members. As for the students who do not have smart phones, the Deanship of E-learning at the King Khalid University provided iPad devices to support the activities of E-learning at the university [11].

IV. Methodology

The proposed methodology consists of the following phases:

1) The authors developed a mobile application utilizing the NFC technique.

2) The lecturer is responsible for creating various related links available to students on the E-learning system and controlling accessibility by using the secure browser (LockDown Browser) [14].

3) Authors have two main types of NFC tags. The first type is used for student attendance system, in which every student has a tag containing the students' information (student ID). Once the student enters the classroom, a special reader attached to the main door will read the student's information and register students who attend the lecture.

4) The second type of NFC tag is a sticker found on the worksheet given once during the semester.

5) The lecturer includes these links in the class worksheets using tiny URL, which is stored in the second NFC tag in the worksheet as a sticker. The advantage of using tiny URL is to use the same NFC during the whole semester. Moreover, the lecturer could change the content of the tiny URL without changing the NFC sticker. The students use their smartphones as an NFC tag scanner to search for the specific URL.

6) The technique features (variables) are then extracted.

7) The hypotheses are stated.

8) The proposed technique using receiver operating characteristic (ROC) prediction quality measurements is evaluated.

V. Experiments and Results

The proposed method was tested on 1000 students in the Introduction to Computer course (practical) at the supportive E-learning level. The authors prepared the links using the LockDown Browser in the blackboard system [14].

The Secure Browser (LockDown Browser) refers to an application designed to open various tests and links over the Internet and can be integrated easily with E-learning management systems, such as Blackboard [14].

The LockDown Browser application prevents the student from copying or pasting answers to questions or taking screen shots, as well as from opening other browser windows. Hence, the system guarantees specific academic use.

The Eighth General Standards of Quality Matters must consider special needs, accessibility to links, and different manners [13]. In the proposed technique, blind students could point their smart phones to the NFC tags, which will identify the blind student and link them directly to the audio lectures. In the Hal 101 course, the authors used the link of the course in the Blackboard system with one link or divided the activities to generate many NFC tags. The authors followed the guidelines below for their supportive E-learning courses:

1) They established NFC tags (Figure (1)) for the attendance activity. The reader at the main door reads the student tags. The NFC reader will retrieve the student name and ID, and send the data to the registration database in the university server. This step will save time because checking of the attendance has been done. Hence, classroom time is fully utilized for the lecture.

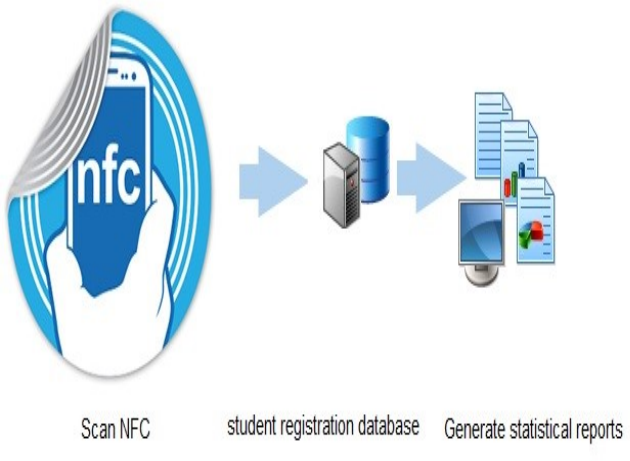

Fig. 1. NFC for student attendance

2) Another tag will be in the hard copy (course sheet), which contains a link to the lectures on the Blackboard system. Thus, students could review lectures as a type of asynchronous learning, as shown in Figure 2.

3) The lecturers placed another tag for the quizzes and discussion boards in the last part of the worksheet. Appropriate links using NFC tags would enable the students to participate in the forum, and students could avoid the barriers of fear through e-participation.

Fig. 2. NFC on student worksheets

To evaluate the proposed method, a questionnaire was designed for 1000 students. The questionnaire asked about the benefits of the proposed method and the authors extracted possible features (variables).

The authors have two types of variables (i.e., dependent and independent). Dependent variables refer to variable results computed in reference to other variables, whereas independent variables are not based on other variables [15].

In this study, independent variables are as follows:

1) Student Academic Level (SAL)
2) Field of studies (FS)

TABLE I. DEPENDENT VARIABLES

Variable	Description
FT	Flexible Technique
IT	Inexpensive Technique
ST	Safe Technique
QT	Quick Technique

The null hypothesis indicates that the independent variables did not participate in computing the dependent variables. The alternate hypothesis explores the relation between dependent and independent variables [15]. The hypotheses are presented in Table 2.

TABLE II. HYPOTHESES

1. The proposed technique explores inexpensive environment of learning delivery.
2. The proposed technique prevents copy/paste and cheating cases and offers a safe environment.
3. The proposed technique presents flexible learning environment and saves the time for feedback, assessment, and monitoring.
4. The proposed technique enhances student results.
H_0: Independent variables do not participate.
H_1: Independent variables participate.

The authors used Statistical Package for the Social Sciences (SPSS) [16] to accept or reject the alternative hypothesis. Alternative hypotheses are acceptable when P value< 0.05.

Table 3 presents the decision results for the hypothesis.

TABLE III. HYPOTHESIS RESULTS

Hypothesis	*P*-value	Result
First Hypothesis	0.0011	Accept the alternative.
Second Hypothesis	0.0020	Accept the alternative.
Third Hypothesis	0.0084	Accept the alternative.
Fourth Hypothesis	0.0091	Accept the alternative.

The following Receiver Operating Characteristic (ROC) prediction quality measurements were used to evaluate the proposed method: Accuracy, Precision, Recall, and *F*-measure (*F-M*) [17]

$$Accuracy_i = \frac{TP + TN}{TP + FP + TN + FN} \quad \text{..... (1)}$$

$$Recall_i = \frac{TP}{TP + FN} \quad \text{..... (2)}$$

$$Precision_i = \frac{TP}{TP + FP} \quad \text{.....(3)}$$

$$F - measure = \frac{(2 \times TP)}{(2 \times TP) + FP + FN} \quad \text{.....(4)}$$

where *TP* is True Positive, *TN* is True Negative, *FP* is False Positive, and *FN* is False Negative.

1) Accuracy: This characteristic indicates the closeness of computations to the true values.

2) Kappa statistic (KS): This value finds the error reduction percent, which is compared to all errors in the sample. Kappa values are between 0 and 1. A KS value close to 1 presents better value than 1 near 0 [12].

3) Mean Absolute Error (MAE): MAE computes the average of errors that appear in the set of the estimation, which explores the relative values to the actual outcomes [13].

Table 4 summarizes the evaluation results.

TABLE IV. EVALUATION RESULTS

Accuracy	Precision	Recall	F-measure
80.4%	0.805	0.804	0.823

The proposed application has an accuracy of 80.4%. The effectiveness measurement results of the application are *KS*, *MAE*, Root Mean Squared Error (*RMSE*), Relative Absolute Error (*RAE*), and Root Relative Squared Error (*RRSE*). The calculated values are shown in Table 5.

TABLE V. EFFECTIVENESS MEASURE RESULTS OF SVM CLASSIFIER

Author`s application	KS	MAE	RMSE	RAE	RRSE
	0.6493	0.2679	0.346	71.71%	80.07%

Table 5 shows the effectiveness of the proposed application with probability of occurrence of several error rates.

Table 6 summarizes the results of the comparison between the present study and previous studies using different measurements.

TABLE VI. COMPARISON OF DIFFERENT TECHNIQUES

Study	Technique	Purpose	Covered range	Evaluation
Present study	NFC	1. Allow secured tests 2. Facilitate access of blind students to audio lectures 3. Automate student attendance record 4. Interact easily with E-learning materials	1. Short range (up to 10 cm). 2. Sufficient for the target of this study	1. Effective by saving time 2. Enhances student results 3. Prevents cheating 4. Flexible learning environment for feedback, assessment, and monitoring 5. Low possibility of error occurrence in reading proposed tags
Study [3]	RFID	Automate student attendance	Longer distance (several meters)	Flexible, which may be extended by adding more modules
Study [4]	RFID	1. Identify individual students based on their unique tag identifiers 2. Generate reports 3. Detect errors in tag 4. Integrates data storage	Longer distance (10–100 meters)	Saves the time and improves operation efficiency
Study [5]	RFID	1. Automate student attendance 2. Get education resources	N/A	Proposed implementation without evaluation
Study [6]	RFID	Automate student attendance.	Longer distance (10–100 meters).	Provide context-awareness for educational process

VI. CONCLUSION

E-learning in universities in Saudi Arabia has become the most important source of knowledge for application. The wide environment that contains a huge amount of digital information is ranked and seeded reliably and accurately in line with the needs of learners of different courses at the university. In the supportive E-learning courses, information technologies are neccessary to activate learning management system tools in this type of course.

This paper proposed a method for the development of supportive E-learning courses at the King Khalid University using NFC. The study sample consisted of 1000 students in a supportive E-learning course. The main results are as follows. First, the technology must apply main quality standards, which refer to e-learning being accessible to all students without any considerations. Second, the technology must be safe and inexpensive, as well as contribute to relieving the burdens of the curriculum through the use of electronic tools to access lectures, assignments, and discussions. The proposed technique should enable students to receive educational resources and monitor their academic performance (such as registering to attend classes and running tests). The manner should be commensurate with the abilities of students and provide access to the student community and interactive product. The experiments were evaluated using SPSS, and the results showed that the proposed technique is safe, flexible, inexpensive, and enhances student grades. The proposed method was evaluated using ROC prediction quality measurements. The conducted results indicate the effectiveness of the proposed technique.

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