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ORIGINAL RESEARCH ARTICLE

A Token-based Attendance Management System: A Cheaper and Alternative Means to Managing Records of Lecture Attendance

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ABSTRACT

Keeping track of students' lecture attendance is important as it provides the basis for enforcing the policy of having prerequisite minimum attendance to qualify for examinations. It is equally important to the parents/guardian of the students as they will be in the know of whether or not their wards have been attending lectures or not. However, taking accurate records of student attendance, manually, can be tedious. Similarly, deploying attendance machines can be costly. To this end, this paper proposes the design and implementation of a token-based attendance management system as an affordable and an alternative approach of managing students' attendance. In the new system, a lecturer simply counts the number of students present in a lecture session and hands them tokens. The students use the tokens to mark their presence. The system was implemented using Hypertext Markup Language, Twitter Bootstrap, JavaScript, Hypertext Pre-processors, and MySQL. The system was deployed and put to use at Al-Qalam University Katsina. The implication to practice is that the software can be replicated, deployed and used in any academic institution.

ARTICLE HISTORY

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KEYWORDS

Token based attendance information system, Lecture attendance system, affordable automated attendance

INTRODUCTION

Attendance, in the context of educational settings, is the presence of a student during a teaching session. It provides the student with the opportunity to learn, keep track of course delivery, socialized, and be mentored (Pani & Kishore, 2016). Studies have shown that regular attendance has a positive correlation with student performance(Schmulian & Coetzee, 2012).

Traditionally, a means of getting records of students' attendance is through a sheet of paper(s) containing the list of all students that have been present during a particular learning session. That is, a lecturer or a class representative hand a sheet of paper to the students to enter the registration number, name, and signature. Although it is very cheap to implement the paper-based attendance system, the approach has several flaws. Some students tend to fill the attendance of their friends that are not present during the learning session. As such, the attendance records may be adulterated with entries that were completely cooked up. In that case, if a lecturer wants genuine attendance records, the lecturer has to resort to names calling at the end of the class, which is usually hectic and time-consuming. In addition, storing and compilation of the filled papers can be daunting. For example, in a class of 50 students with 12 learning sessions in a semester, the lecturer will have to spend productive time trying to compile the attendance report. There is also the possibility of human error during compilation as the students' handwriting can sometimes be illegible.

Over the years there have been many inventions to replace the traditional paper-based attendance with a digital attendance record system using variety of technologies. These include Radio Frequency Identification (RFID) attendance system(Koppikar *et al.*, 2019; Patel *et al.*, 2012), barcode-based attendance system(Noor *et al.*, 2016; Saheed *et al.*, 2016), and Quick Response (QR) code attendance system (Nuhi *et al.*, 2020). In the RFID-based attendance system, a student simply scans a tagged-identification card with an RFID reader to mark attendance. Similarly, in the QR-based attendance system, the student's relevant information is encoded as a QR code attached to the identification card.

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A program can also be developed that allows the lecturer to generate a QR Code for the students to scan using their smart-phones instead of their identification cards. The QR Code changes each time the system detects the code was used (this is often implemented using real-time database). Hence, student attendance could easily be taken via scanning their ID Card with a QR code device integrated into the system.

The RFID-based and the QR-based attendance systems have no means of verifying if the holder of an identification card or tag is a bonafide student. Thus, the records of attendance using the approaches are prone to adulteration through impersonation. The systems may also be costly to deploy as well since they required each lecture venue to have devices to capture attendance. Similarly, other necessary network infrastructures to transmit attendance to the server have to be deployed.

To avoid the impersonation problem, biometric-based attendance systems that recognize the attendee's facial or fingerprint were also developed (Dhanalakshmi *et al.*, 2017). Thus, students mark their attendance by scanning their faces against the system or by placing their finger (usually index or thumb) on a fingerprint-capturing device that has been integrated into the attendance system. The above approaches address the impersonation problem. In other words, the biometric attendance system is an effective means of capturing genuine presence of students at learning sessions. However, biometric attendance systems are also costly to deploy at institutions with low budgets. In addition, the cost and reliability of power and the internet must be taken into consideration. In the absence of power and when the built-in chargeable batteries are depleted, the whole system becomes inoperable. The same applies when a computer network is absent.

Given the above, this paper proposes a token-based attendance system that can be favourable for universities in the developing world. Using the proposed system, a lecturer simply counts the number of students present in the venue and hands them tokens. These tokens can be generated before, during, or after the class. The students use the tokens to mark their presence.

RELATED WORKS

There have been efforts to ease the process of managing students' attendance using Radio Frequency Identification (RFID) technology (Koppikar *et al.*, 2019; Patel *et al.*, 2012). In an RFID-based attendance system, a student identification card is labeled with a smart tag that is identifiable by an RFID reader. To mark attendance, a student simply scans the identification card with a RFID reader. The information would then be passed to software logic that would mark the identified student as present during the specific lecture session. Similarly, barcode technology was also proposed to be used in managing students' attendance (Noor *et al.*, 2016; Saheed *et al.*, 2016). In this approach, rather than a RFID tag on students' identification cards, a barcode is used. Hence, student attendance is taken via scanning their identification card against a barcode device. Quick Response (QR) based attendance systems also work in similar manner to the barcode system (Nuhi *et al.*, 2020). The difference between the barcode and the QR code is that the latter is considered a superior technology as the QR code accommodates more information than the barcode (Narayanan, 2012; Tiwari, 2017).

The RFID, the barcode, and the QR code approaches have no means of identifying if the holder of an identification card or tag is a bonafide student. Thus, the approaches are prone to impersonation. In addition, the approaches can be costly, since each lecture venue has to have a device to capture the attendance and there has to be necessary network infrastructure to transmit attendance to the server.

To avoid impersonation problems, biometric-based attendance systems that recognize the attendee's facial or fingerprint were also proposed. In the fingerprint-based attendance system, a student marks attendance by placing his finger (usually index or thumb) on a fingerprint-capturing device that has been integrated into the attendance system (Dhanalakshmi *et al.*, 2017). Once the system identifies the student's fingerprint as a valid record in the system, the student is marked as present.

Recently, Machine learning approaches are gaining momentum in many areas of applications including the management of student attendance. For instance, a face recognition system based on deep machine learning techniques was proposed (Bhattacharya *et al.*, 2018; Harikrishnan *et al.*, 2019). The system uses a model that trains itself to identify the faces of registered students. Students mark their attendance by scanning their faces against the system. The system then predicts five possible student names with the scanned face, allowing a student to select his/her name from the prediction. However, since the prediction can be resource-intensive, the process may be slow which can lead to delays in attendance taking. In a similar approach, image processing techniques were used instead (Matilda & Shahin, 2019). Each student's image is captured several times to enhance the training of the prediction model, hence improving prediction accuracy. Students get their attendance signed by merely being scanned by a camera.

The above approaches address the impersonation problem. However, they can be costly to deploy due to the devices and infrastructure that need to be in place for the implementation. They may also be time consuming, occasionally, as there are chances that a prediction of student identity may go wrong.

MATERIALS AND METHOD

Use case

Use case is a diagram or model that describes software from the perspective of its users. The Use case of the

proposed system is depicted in Figure 1. As shown in Figure 1, the main actors (users) are the *Admin, Lecturer, and Student*. Admin is the staff responsible for managing the software and who would create other staff such as the head of departments and lecturers. The Lecturer is the staff that is teaching a particular course and who would be responsible for facilitating the recording of the students' attendance.

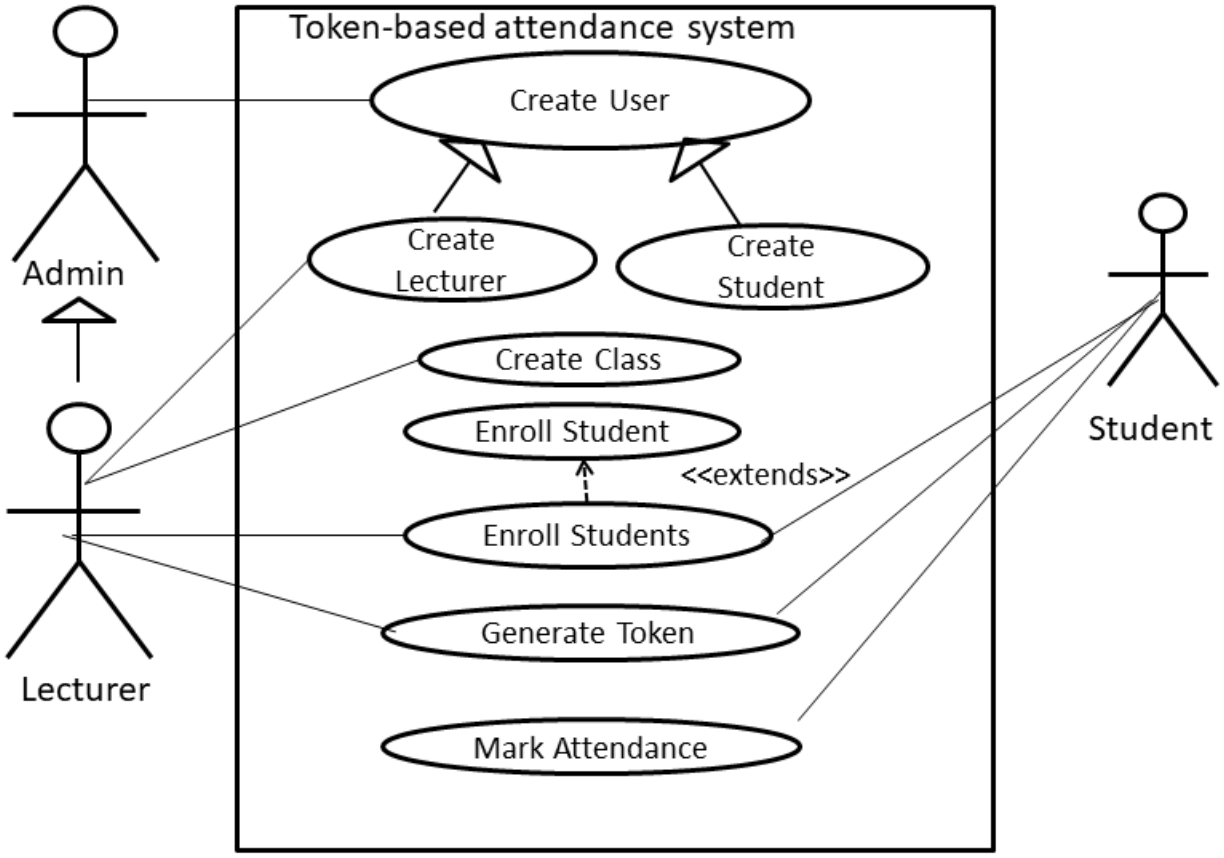


Figure 1: Use case model of the proposed token-based attendance management system

In Figure 1, the topmost use case, *Create User*, is an abstract use case of which *Create Lecturer* and *Create Student*, for the creation of lecturers and students as users of the system respectively, are its concrete realization. *Create Class* is a use case whose main actor is *Lecturer*. It is for the creation of the class of which students would be enrolled. Thus, the *Enroll Student* is for enrolling an individual student to the class while *Enroll Students* is enrolling many students, in batch, to the already created class. The use case *Generate Token* is for the *Lecturer* to generate tokens for the students present in the class. The token is randomly generated alpha-numeric characters. The last use case, *Mark Attendance* is for the students to mark their presence in a particular lecture session. The next section elaborates on the dynamic workflow of the system.

System Workflow

The workflow of the system from the perspective of a lecturer is shown in Figure 2 while the workflow of the system from the perspective of a student is shown in Figure 3.

The top box illustrates the three menus with which a lecturer interacts with the system. These menus are: i). *Class Page*, ii). *Attendance Page*, and iii). *Student Page*. The *Auth* in the Figure represents the required authentication before a lecturer is allowed to access the pages. The *Sign out* represents the logging off from the system. The workings of each of those three pages are elaborated in the bottom box as explained in the next paragraph.

In the *Class Page,* a lecturer can create a class and generates code for the created class. The generated code may be sent to students to join the class on their own. Other things a lecturer can do as indicated in the *Class Page* box include viewing a class, updating a class, and retiring a class. The *Attendance Page* is where a lecturer generates token, print token/reprint tokens. A lecturer can also generate attendance reports. A lecturer can equally check on who used a particular token (in case of dispute). The *Student Page* is where a lecturer can either add an individual student or upload a list of students to be enrolled in the class.

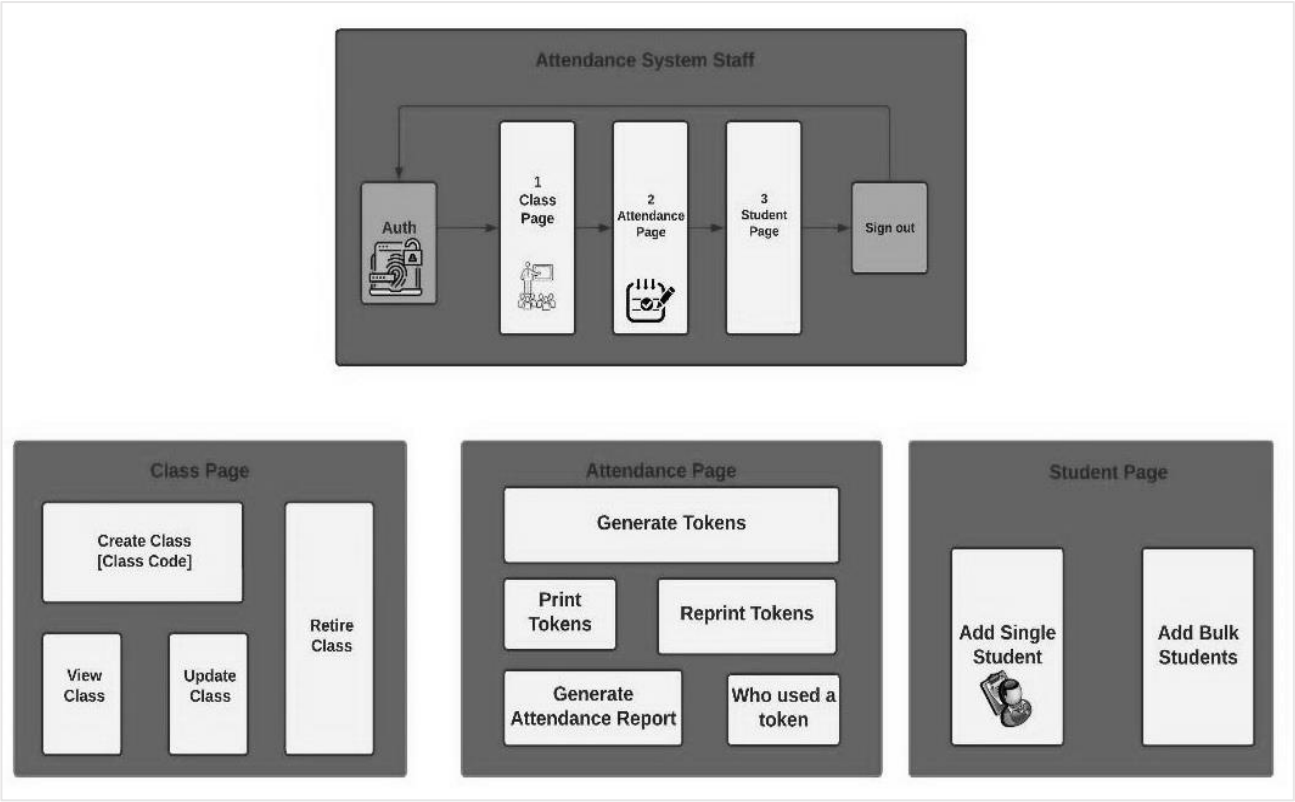


Figure 2: Workflow of the token-based attendance management system from the perspective of a lecturer

How would the students interact with the system is depicted in Figure 3. In the Figure, there are three (3) menus with which a student interacts with the system. These are: i). *Join a Class,* ii). *Mark Attendance,* and iii). *View Attendance.* In addition, as depicted with *auth* menu in Figure 3, a student has to be authorized to use the system.

Upon authorization, a student can join a class if the lecturer of the course has provided the code for the class. If, however, the lecturer enrolled the student, whether as an individual or in a batch, the student can proceed to mark his attendance if present at a particular lecture session and was given a token. A student can also view a history of his/her attendance records in a particular class. Similarly, a student signs out from the system when not in use (see *Sign Out* menu in Figure 3).

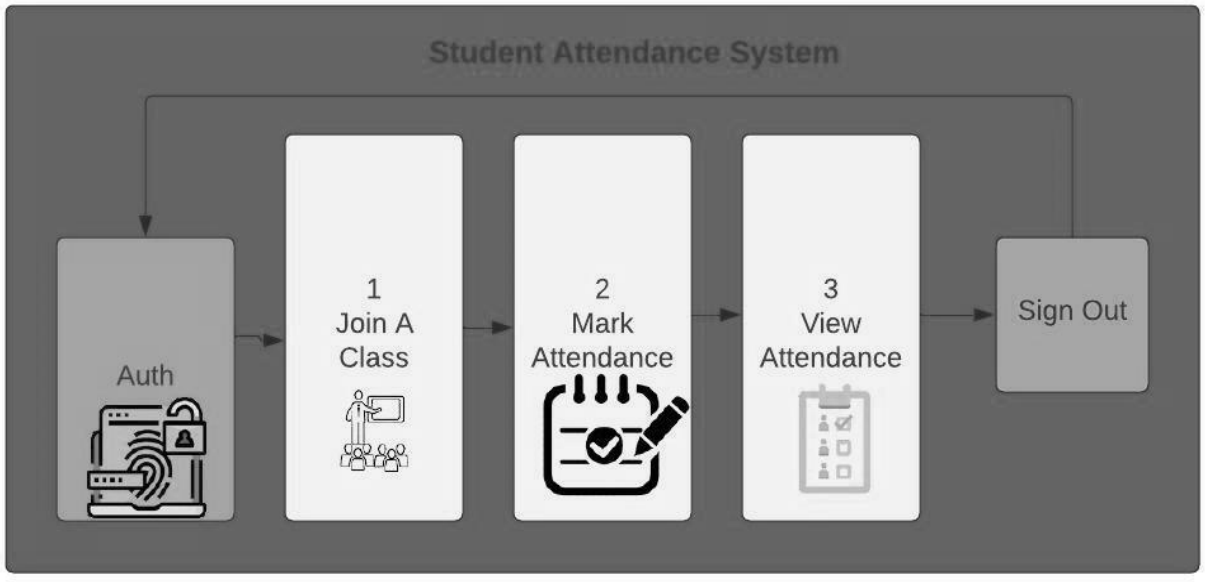


Figure 3: Workflow of the token-based attendance management system from the perspective of a lecturer

Database Schema

Figure 4 depicts the database schema of the proposed system. The *lecturer* table stores information about lecturers such as staff id, names, email address, employment status (status), and so on. The *course* table stores information about the course such as course code, course title, and credit units (credit hours). The *student* table stores information about students such as student id, name, email address, and so on.

A *class* table store information about a specific course to be taught by a specific lecturer at a specific academic session and semester. Consequently, there are one-to-many relationships from the *course* and *lecturer* tables to the *class* table. The *student_enrolled_class* table stores information about the students' enrollment in the class created by the lecturer. Thus, there are also one-to-many relationships from the *class* and the *student* tables to the *student_enrolled_class* table.

The *token* table stores the generated tokens, each token is associated with a specific *class*. There is one-to-many relationship from the *class* table to the *token* table. When the token is generated and when to expire, and whether or not the token has been used is equally stored in the *token* table. The *attendance* table stores information about the marked attendances such as the id of the token used, the id of the class in which the student is present, the student id, and the date for the attendance. Since a token can only be used once, there is one-to-one relationship from the *token* table to the *attendance* table. However, there is one-to-many relationship from the *student_enrolled_class* table to the *attendance* table.

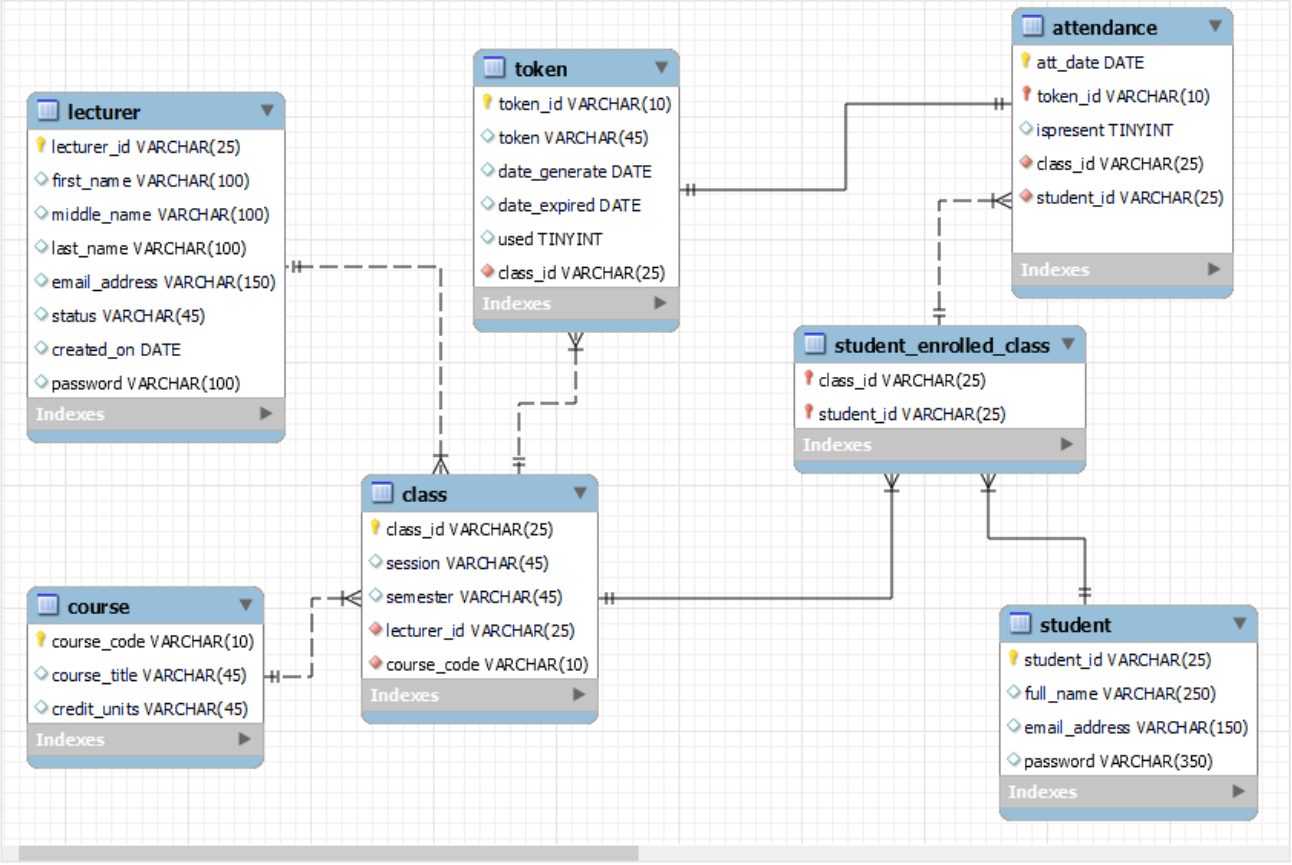


Figure 4: Database schema of the token-based attendance model using MySQL Workbench

Implementation

The front end of the system was implemented using Hypertext Markup Language (HTML), Twitter Bootstrap, and JavaScript. The application logic was implemented using Hypertext Preprocessor (PHP). The database was implemented in MySQL. There are separate sections for the lecturers and the students as indicated in Figure 5.

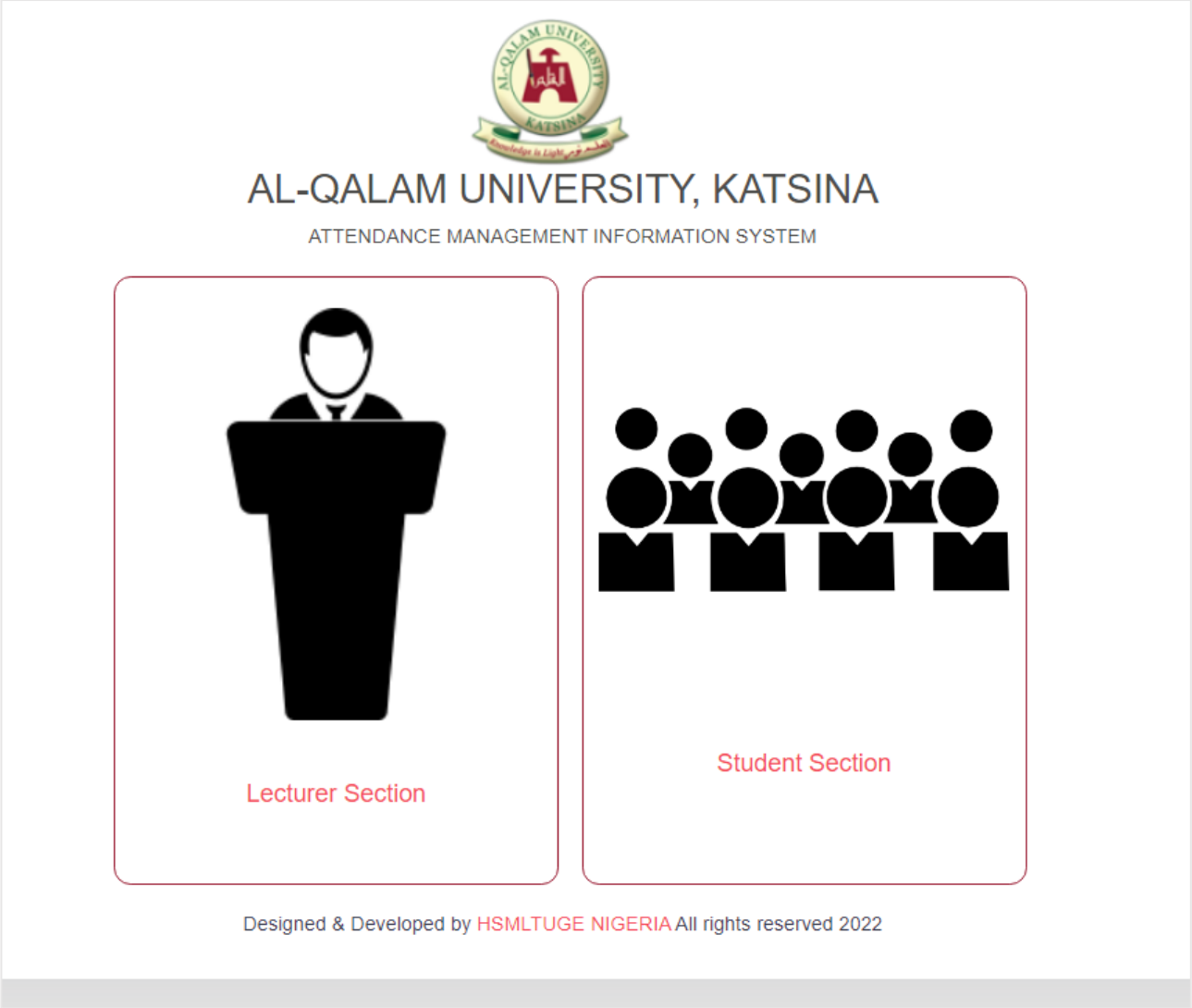


Figure 5: **Landing page depicting lecturers and student's section**

As depicted in Figure 6, the lecturer can create, edit, and retire a class. The class has a class code that is given to the students to join that class. Only students that join a class can use attendance tokens generated for that class.

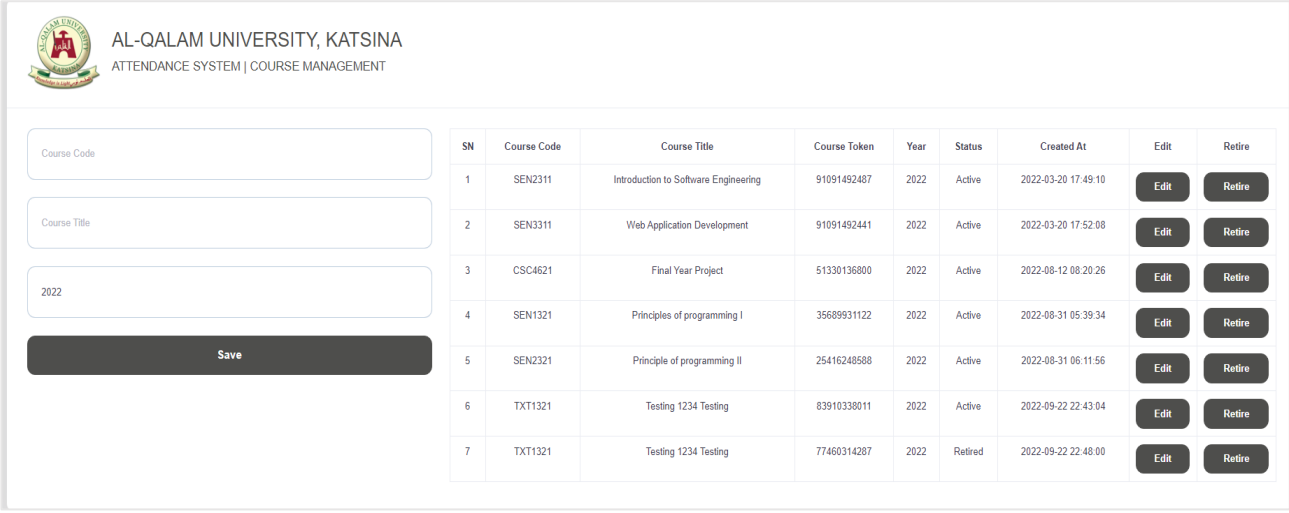


Figure 6: **Implementation of class management**

The lecturer can add students to class by using the individual or bulk upload (see Figure 7).

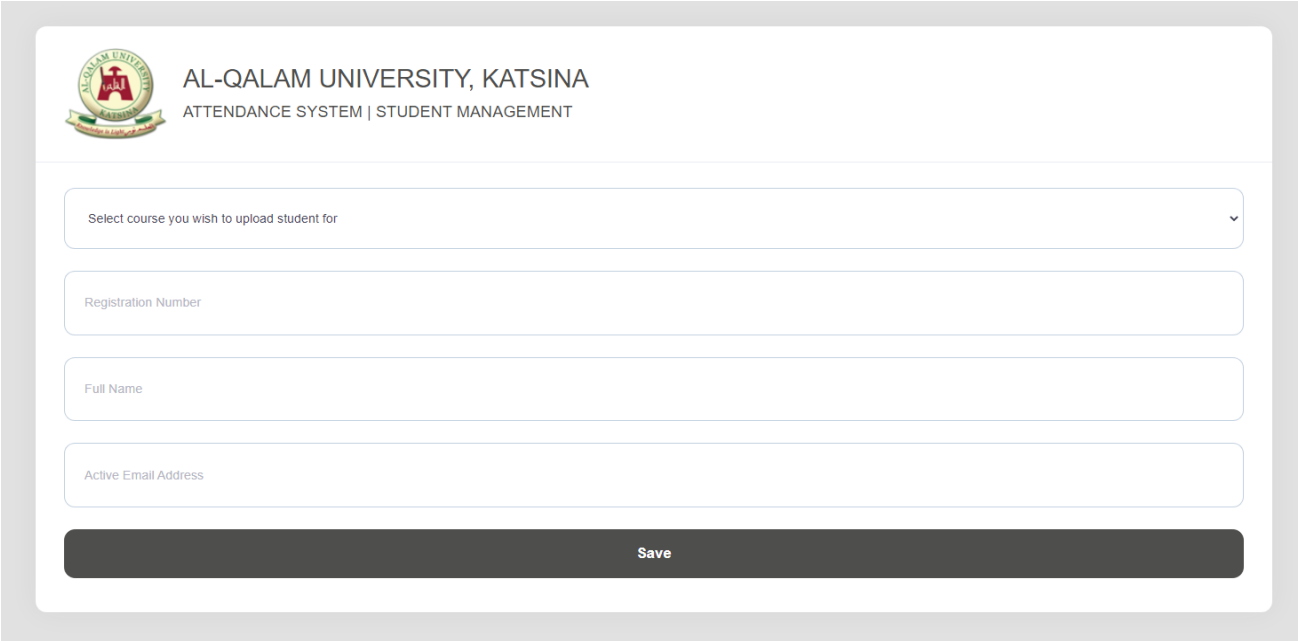


Figure 7: implementation of enrolment of students to class

As depicted in Figure 8, a lecturer can generate tokens for a lecture session. A token can only be used once by a student.

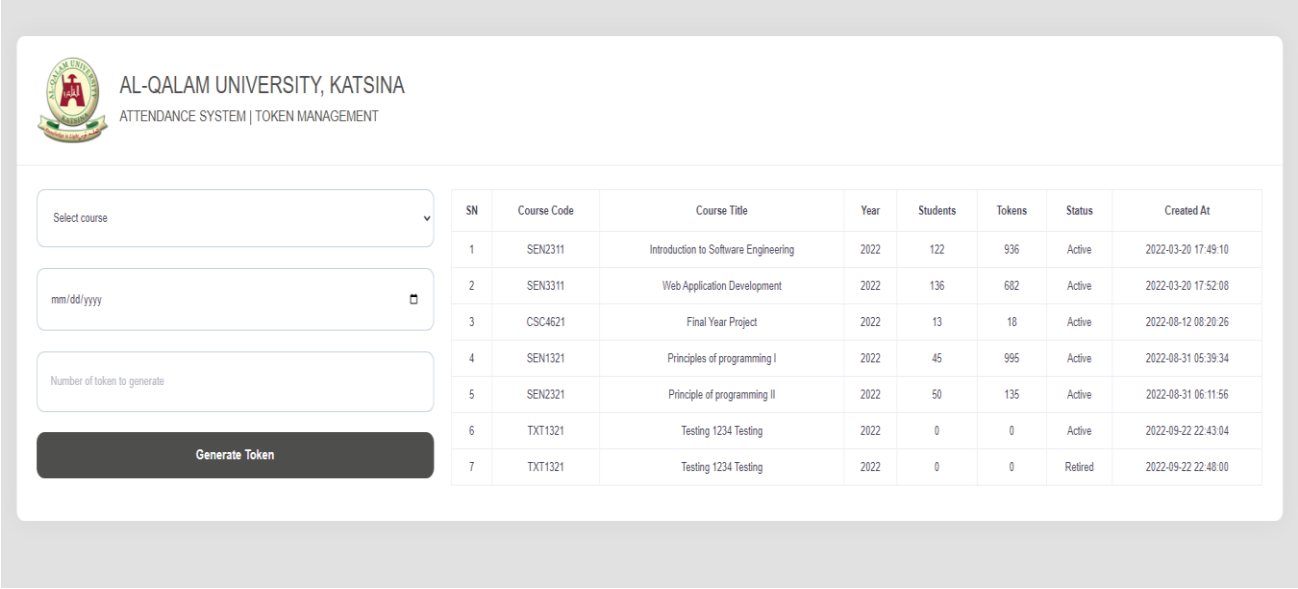
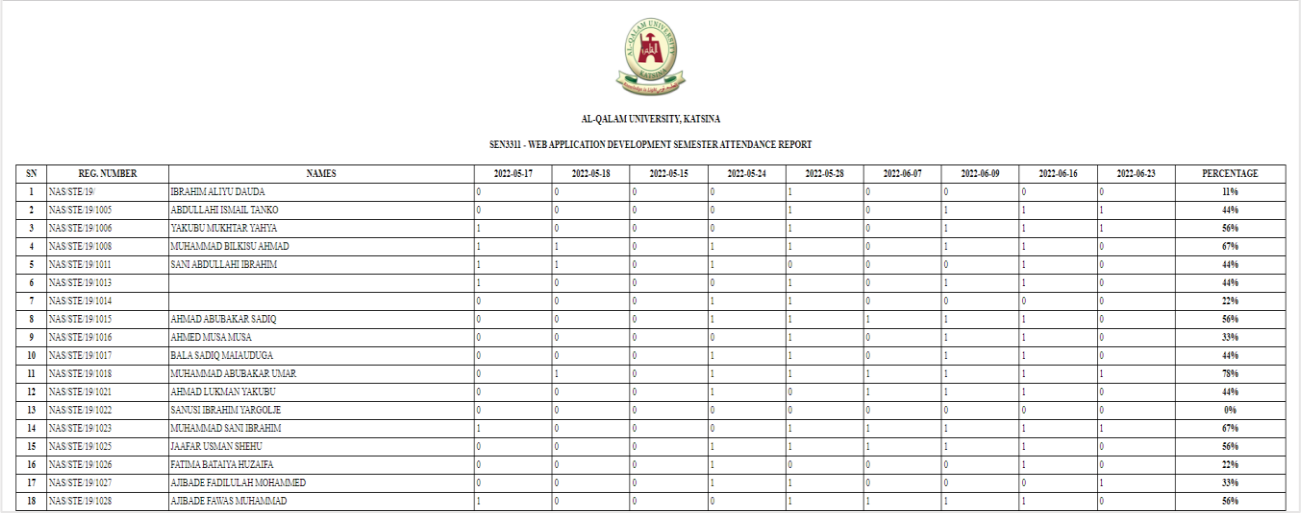


Figure 8: Implementation of token generation

As depicted in Figure 9 a lecturer can generate attendance reports for a course



AL-QALAM UNIVERSITY, KATSINA

SEN3311 - WEB APPLICATION DEVELOPMENT SEMESTER ATTENDANCE REPORT

SN	REG. NUMBER	NAMES	2022-05-17	2022-05-18	2022-05-15	2022-05-24	2022-05-28	2022-06-07	2022-06-09	2022-06-16	2022-06-23	PERCENTAGE
1	NAS/STE/19/	IBRAHIM ALIYU DAUDA	0	0	0	0	1	0	0	0	0	11%
2	NAS/STE/19/1005	ABDULLAHI ISMAIL TANKO	0	0	0	0	1	0	1	1	1	44%
3	NAS/STE/19/1006	YAKUBU MUKHTAR YAHYA	1	0	0	0	1	0	1	1	1	56%
4	NAS/STE/19/1008	MUHAMMAD BILKISU AHMAD	1	1	0	1	1	0	1	1	0	67%
5	NAS/STE/19/1011	SANI ABDULLAHI IBRAHIM	1	1	0	1	0	0	0	1	0	44%
6	NAS/STE/19/1013		1	0	0	0	1	0	1	1	0	44%
7	NAS/STE/19/1014		0	0	0	1	1	0	0	0	0	22%
8	NAS/STE/19/1015	AHMAD ABUBAKAR SADIQ	0	0	0	1	1	1	1	1	0	56%
9	NAS/STE/19/1016	AHMED MUSA MUSA	0	0	0	0	1	0	1	1	0	33%
10	NAS/STE/19/1017	BALA SADIQ MAIAUDUGA	0	0	0	1	1	0	1	1	0	44%
11	NAS/STE/19/1018	MUHAMMAD ABUBAKAR UMAR	0	1	0	1	1	1	1	1	1	78%
12	NAS/STE/19/1021	AHMAD LUKMAN YAKUBU	0	0	0	1	0	1	1	1	0	44%
13	NAS/STE/19/1022	SANUSI IBRAHIM YARGOLJE	0	0	0	0	0	0	0	0	0	0%
14	NAS/STE/19/1023	MUHAMMAD SANI IBRAHIM	1	0	0	0	1	1	1	1	1	67%
15	NAS/STE/19/1025	JAAFAR USMAN SHEHU	0	0	0	1	1	1	1	1	0	56%
16	NAS/STE/19/1026	FATIMA BATAIYA HUZAIFA	0	0	0	1	0	0	0	1	0	22%
17	NAS/STE/19/1027	AJIBADE FADILULAH MOHAMMED	0	0	0	1	1	0	0	0	1	33%
18	NAS/STE/19/1028	AJIBADE FAWAS MUHAMMAD	1	0	0	0	1	1	1	1	0	56%

Figure 9: Implementation of report generation

As depicted in Figure 10, a student can mark his/her attendance

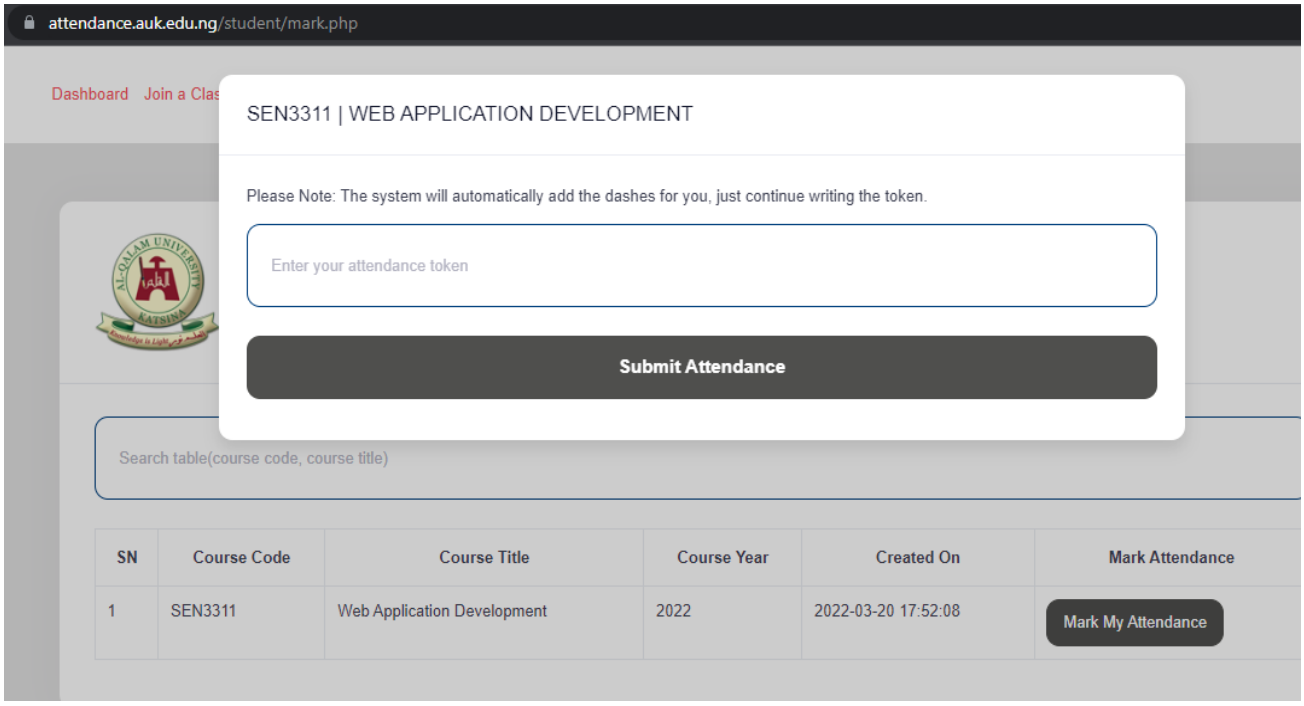


Figure 10: Implementation of marking attendance by students

As depicted in Figure 11, the student/guardian can view the student's attendance for a class the student has joined, the report shows the student the tokens used to mark the attendance and when was the attendance marked.

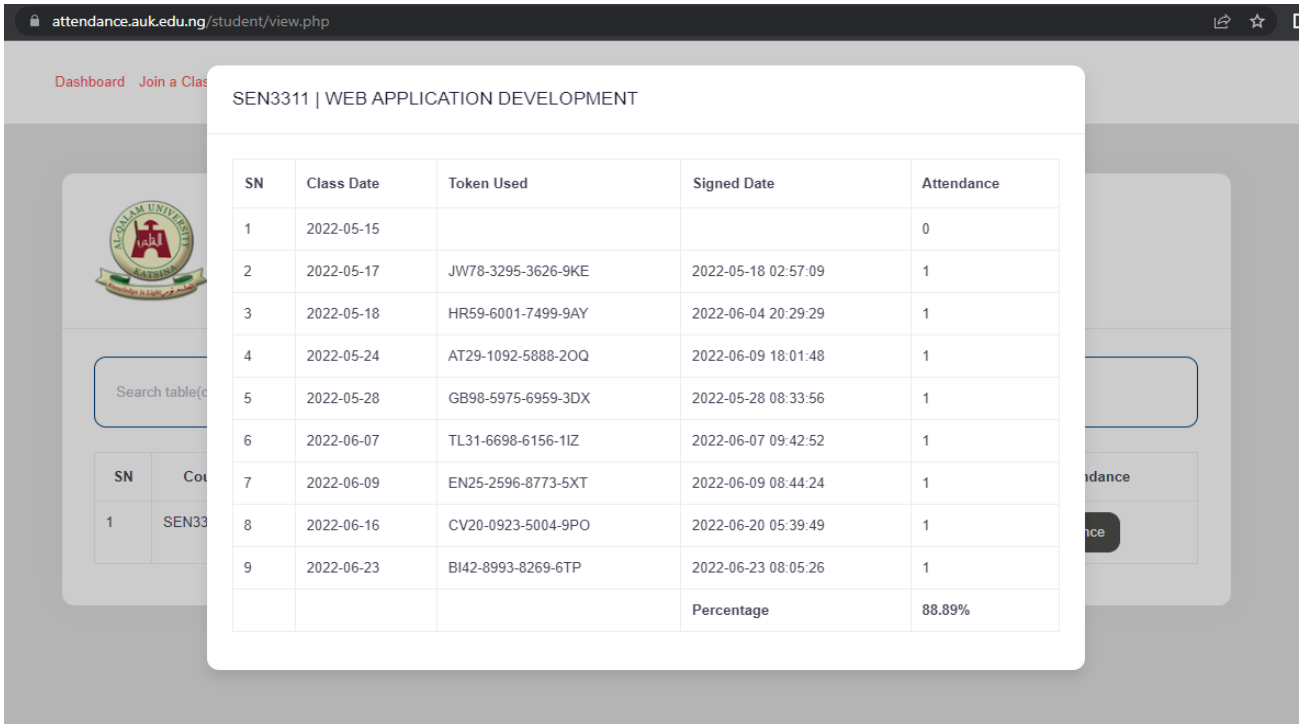


Figure 11: Tracking attendance of an individual student

CONCLUSION

This paper reported the design and implementation of a token-based attendance system as an affordable and an alternative means of managing students' attendance. The system was deployed and put to use at Al-Qalam University Katsina. It would equip the university policymakers and their parents\guardian with rich information to make informed decisions.

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