

Using QR-Codes for Attendance Tracking

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Abstract – *Students experiencing difficulty with their studies don't often identify themselves as students in need of support. The Science Student Success Centre at Carleton University actively seeks out these science students to give them the help they require. One indicator of need is a student's grades. Another indicator is attendance in class. In this paper, we describe how we used QR-Codes to help track class attendance. While our existing online card swiping attendance tracking system was suitable for small class sizes, using QR-Codes for attendance tracking proved to be suitable for larger classes.*

Keywords: Attendance, Tracking, Android, QR-Codes

1 Introduction

In [1, 2], we described the initial view of our attendance tracking system and piloted its usage in classes to examine its performance and usability. Our motivation for building the system came from The Science Student Success Centre (SSSC) at Carleton University. The SSSC collaborates with other on-campus departments to offer workshops, events, and activities that help to develop a student's academic and professional skills. The SSSC also takes an active role in helping science students struggling in their first-year computer science, math, and science courses with the mission as follows:

- Increase the engagement and retention of students in the Faculty of Science
- Foster the growth and achievements of high performing students
- Identify and support students who may be experiencing difficulty with their studies
- Inform students of professional and academic development opportunities
- Aid in the recruitment of outstanding students to the Faculty of Science

One of the questions for the SSSC was how to determine students in need of its services. One indicator it used was to look at first term, mid-term marks in late October. We also believe that looking at students' attendance records for the same period provides another key indicator of students in need. The SSSC already contacts students with marks less than 60% and asks them to come in and visit with the SSSC team to talk about issues they are facing with their courses and suggest possible techniques and actions they can

take to overcome the issues. We also felt that looking for students with less than 60% attendance records was another group we should meet with individually and that there would likely be a crossover between low grades and low attendance students.

Taking attendance using paper and pen was one approach we could have used, but we knew it was slow and prone to errors. In addition, the paper method required a data entry phase in order to generate reports, which also suffered from similar problems. Therefore, using pen and paper was ruled out from the beginning. We found in [1, 2] that we could use our student card-based system for tracking attendance in classes containing less than 50 students. What we needed was to expand that capacity.

1.1 Goals

Reiterating our goals and objectives from [1]. Our main goal was to provide a fast and efficient attendance tracking system. In addition, the system must work in any and all classrooms at Carleton University, including its electronic classrooms – those with computers and projectors – and those classrooms containing no computers. A further goal was to provide a system that requires minimum hardware, and can be maintained at minimum cost. Our new goal is to break the maximum 50 student class size.

1.2 Objectives

To meet the goals, we had the following objectives:

- Use easily found, inexpensive hardware for the system.
- Make use of mobile devices to help with the attendance tracking process but not require the use of student owned mobile devices
- Use open source software to minimize development and maintenance costs
- Installation should be fast and simple
- Attendance reports should provide end users with the greatest flexibility for manipulating the collected attendance data
- Support both Mac and PC platforms, and Android and iOS mobile devices

1.3 Outline

In section 2, we further describe literature on existing QR-Code based attendance tracking systems. Section 3 describes our system and how it used QR-Codes in the classes to take attendance. Section 4 describes our timing results. Section 5 provides our conclusion and reviews our system's feature set.

2 Background

Several different systems [3, 9] are now using QR Codes as the primary method to track attendance. As [3] mentions, the primary benefit is that:

“you can track attendance with no extra expensive bar code readers or similar hardware, using just your smartphone, tablet or PC with webcam”

Many other systems [3] rely only on smartphones, tablets or PCs running custom applications to manage the entire attendance tracking process, which is often similar in process to the following:

- One creates a user id in order to login to a system manager.
- One creates a class/event to track.
- The system generates a unique URL that one can publish.
- Attendees click the URL and register for one's class or events by entering their name and other data you specify
- Attendees print their QR codes and take them to one's event.
- Attendees scan their QR code at one's event and the system marks them as attended.
- One tracks attendance statistics of one's event by login in to the system.

Pricing models vary, but [3] propose the following:

“Pay only for what you use! Buy checkin credits in chunks of 100, 300, 500 or 1000. One credit cost is \$0.1 USD. Pay only when your user/student scans the card.”

The benefit of this model is that the attendance data is not stored on the device, but is maintained by a server, allowing for regular backup and maintenance. The disadvantage is that the generate QR Codes are event specific. Therefore, if used in a university setting, students will need to keep and maintain upwards of ten codes a year for all their courses. Another disadvantage to the system proposed by [3] is that it is currently under development and not ready to be used.

One system that is already being used is by [4]. Focused more in the conference and trade-show domain but still available for education requirements, their system creates badges for users that can be scanned using specific equipment located at conference booths or event entrances in order to track attendance or control access. An advantage to this system is that it provides the following capabilities:

“generates real-time views on session attendance and duration, exhibit floor visits, traffic patterns and event activities.”

Another benefit is that their system supports QR Codes, Bar Codes, RFID, and NFC. One disadvantage is that their system maintains the collected data on their servers, which in a university setting, may not be possible due to personal information security concerns, policies and laws.

Rather than using a server approach for storing collected attendance data, systems like [5] keep everything on the device and rely on attendance taking to be done manually. As the attendance taker, it is one's responsibility to define the events and people being tracked. There is support for importing contacts, but it is still one's responsibility to add new attendees. The same goes for backup and restoration of attendance data. One uses the application to manually “tick off” people that attend an event as attendees are not required to maintain any form of QR Code.

In [6] the attendance system uses QR codes, a server and proposes that:

“the instructor to do nothing extra beyond presenting the slides of the course to the students. Hence, students may register their presence at any time they wish during the class, while having in mind that registration times are recorded.”

They believe that the time taken by instructors to take attendance may be viewed as a waste of lecture time. Their system relies on the ability of students to perform that attendance tracking activity on their own device. However, relying on students having their own devices and remembering to use the corresponding application on them can be problematic in certain settings. If attendance tracking is important, we believe there is a strong reliance on the involvement of the instructor. Moreover, in classes using experiential learning [7], where learning is through reflection on doing, the one-on-one interaction between student and instructor during class permits attendance taking to be done at that time, as part of the interaction, rather than before or after class where no real interaction is done.

In [8], QR Codes are used for checking attendance rather than taking attendance. With this approach, instructors track attendance using Excel spreadsheets that are forwarded for processing and entry into a database by an administrator.

Instructors post QR codes on class doors or select points where students can scan them using their phones in order to review their absentee rate. The benefits of the system are that it eliminates the need for a notice board identifying students' absentee rates and helps keep student data private.

Focused in the conference domain, where check-ins and session tracking is important, [9] uses a combination of QR codes that each attendee have, typically on their conference badge, and conference support staff having iOS and Android devices running their custom application to scan and track attendees. Their system provides real time reports and registration details to registered users. The disadvantage of this system is that it focuses in the domain of conferences, where the number of events and attendees is usually small. A mid-size university can have hundreds of classes and over 25000 students to track on a daily bases. The sizes of the education domain make typical costing models around attendees and sessions expensive.

While none of these approaches are adequate for the educational domain, they do suggest several important features:

- Real time reports
- Fast Scanning
- QR Code per attendee
- User rather than attendee device app
- End User id and registration

All of these features are provided in our approach described in the next section

3 Approach

As indicated in [1, 2] in our system users are instructors or people that are taking attendance in classes or at different events. They are provided with a user id, which is their email address, and a unique password. After logging into the system using the Event Tracker website, shown in Figure 1, users can download their attendance real time report for any class or event.

In the previous versions of our system, users attached a USB card reader and swiped student cards in order to track attendance. We also had a mobile app that students could use on their phones, to identify themselves as attending the class or event. In the current version of our system, these capabilities are still supported. However, we have added the ability for students to generated custom QR codes that are scanned by users or instructors using a custom application that runs on a smartphone or tablet. The scanned information is then sent back to the system's server and a person's attendance at a class or event is record. These steps are described in more detail in the following sections.

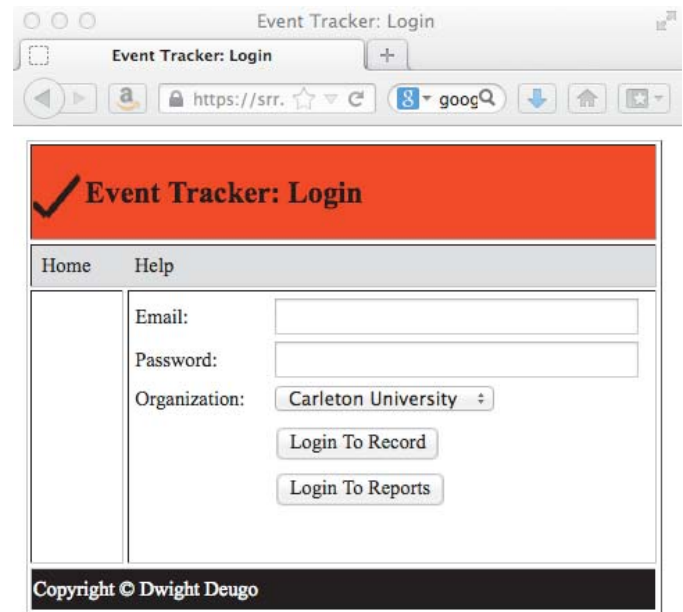


Figure 1: Login Screen

3.1 QR Code Generation

Students generate their QR Codes by going to our QR Code Generation website, as shown in Figure 2. At the site their first step is to enter their relevant information: first name, last name, student id, and email address. For general events, there is also a comment field included to collect other relevant data. The second step is for students to click the Generate Your QR Code button. This will generate a QR code on the web page as well as display the information in the QR Code. Using any scanner app, such as the Android QR Barcode Scanner app, one can immediately scan the generated QR Code. Figure 3 is the result of scanning the code in Figure 2 by the QR Barcode Scanner app on an Android device.

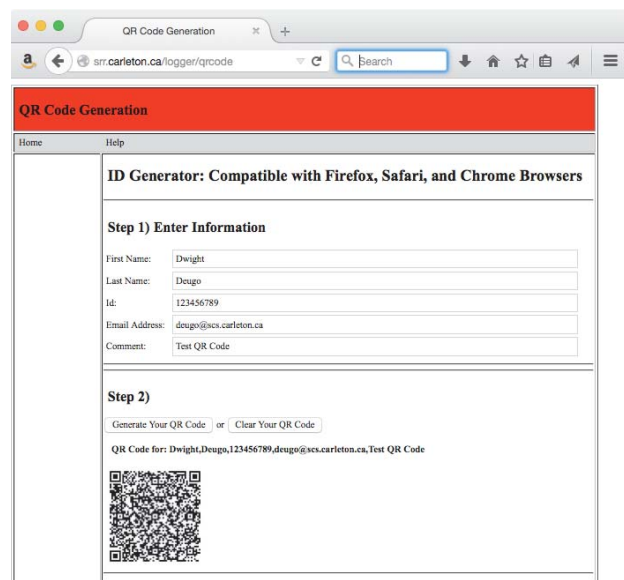


Figure 2: QR Code Generator



Figure 3: Standard Barcode Scanner Result

Step 3 in the process at the website, shown in Figure 4, is for a student to save their QR Code. A student has three options. The first, step 3.1, is to hit the Print Your QR Code button that will display the QR code on its own web page and initiate the corresponding browser's printing functionality. One can print the QR Code on a printer or print it as a PDF file that can be saved to hard disk. By using step 3.2, a new web page is created containing the QR Code, as shown in Figure 5. Using the browser's File->Save Page As... menu option the QR code can be saved as a GIF file with a given name. Using this option the QR Code can also then be printed, emailed, or moved onto a student's mobile device.

Provided a student enters the correct Recaptcha text, hitting the Email Your QR Code To Above Email Address, step 3.3, will do as the name suggests.

The QR Code Generation and its three steps provide a quick and easy approach for student to generated their individualized QR Codes and be able to save them to disk or print them out. The next part of our approach is for students to bring their QR Code to class in order for their attendance to be tracked.

3.2 Taking Attendance

Taking attendance using the QR codes is done through a mobile app running on an Android device. The single view app, shown in Figure 6, named EScanner, permits users to login, scan and upload their collected attendance tracking data.

Before logging in, a user can configure the server IP address, how scans are recorded (manual or automatic) and can clear out local scans saved for bulk upload by accessing the app's settings, as shown in Figure 8.

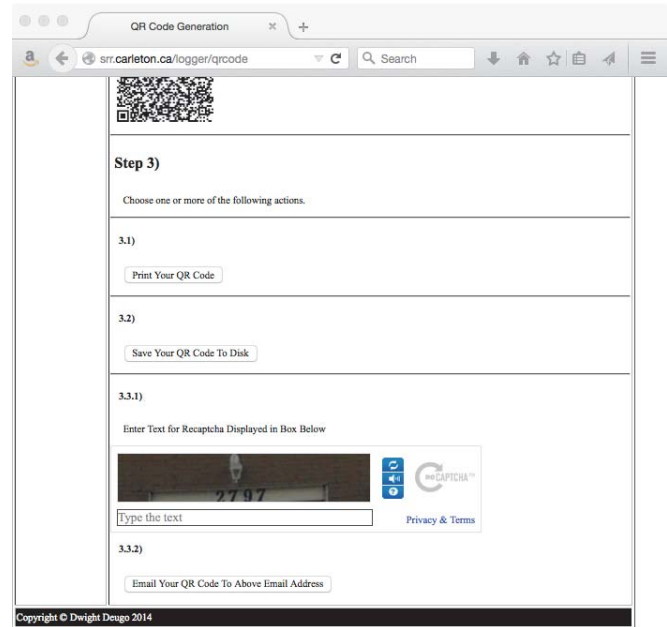


Figure 4: Saving QR Codes



Figure 5: QR Code

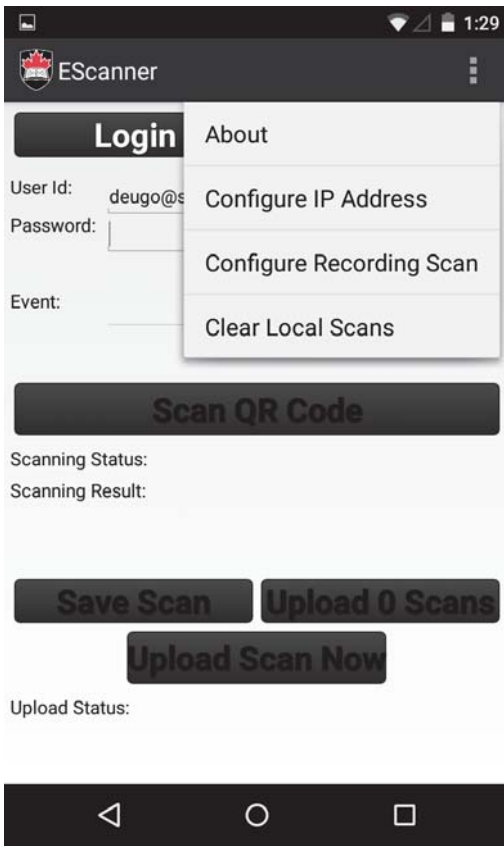


Figure 6: Settings

An instructor who has been given an account id and password simply enters that information and selects the Login User button. If the login is successful, the screen changes to what is shown in Figure 9. Choosing the About options provides the user with a quick look at their existing settings, as shown in Figure 7.



Figure 7: Settings Overview

After a successful login, the user is presented with a list of courses/events they are responsible for. After selecting the correct event, the user is ready to scan an attendee's QR Code. By selecting the Scan QR Code button the user is transferred to their device's camera application where they can simple point it at a students QR code and it will capture the information for the code. Figure 9 shows the results of scanning the QR Code shown in Figure 5. Provided the code is on of our custom codes, the user can immediately upload the scanning data to the server, or save it on the device for uploading later. The delayed upload feature is useful when the device is not connected to the network. The application

can currently store up to 1000 scans for uploading later. Whether the scans are uploaded immediately or saved locally depends on which of the corresponding buttons the users selects after scanning the QR Code. However, in the options menu the user can turn on automatic uploading or automatic saving to speed up the process of scanning QR Codes with out having to select the completion action.

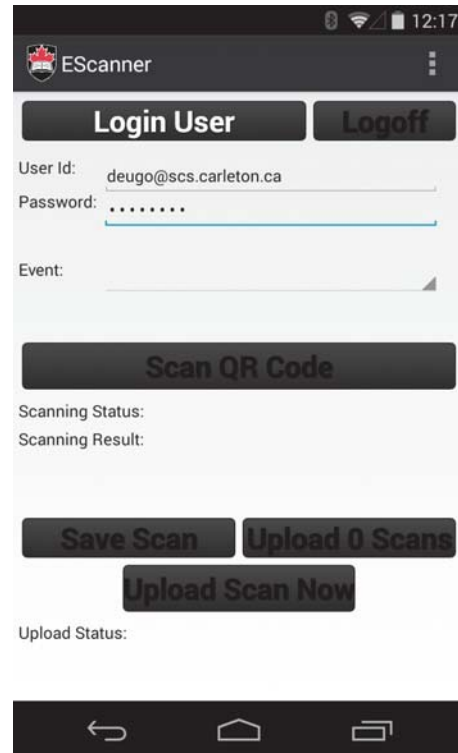


Figure 8: EScanner

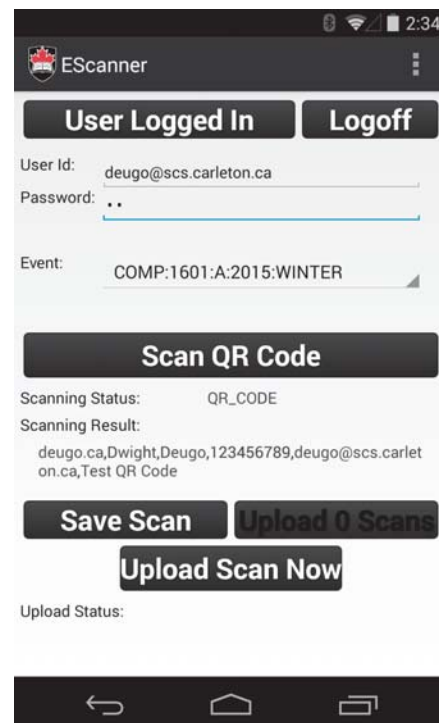


Figure 9: After Scanning

Once a user logs out of the app, saved scanning data remains intact but no uploading of saved data or new scans are possible.

4 Results

Of significance to us is how quickly it takes to perform individual attendance tracking? This question can be broken down into different parts. The first part is how long does it take to scan one person? The second part is how long does it take to send the scanned information to the server. If a user selects automatic upload, how long does the combination of scanning and uploading take? The final question is, if the user simply scans and chooses to do a bulk upload of scans, how long does this action take.

To answer the first question, we used our mobile application to scan the QR Codes of 10 people 10 times and recorded the total time required to perform the scannings. The average and median results for scanning 10 QR Codes are displayed in Table 1. Next we uploaded 10 scan results one by one to the server and computed both the average and median times to send the individual result, shown in Table 1. The third row in Table 1 identifies how long it takes to scan and upload a QR Code. This happens when a user of the mobile application has configured the corresponding combined option. This option results in one less button push for the user to actually upload the scan results. The final row in Table 1 indicates how long it takes to bulk upload 10 scan results. Again the average and median results are presented.

Table 1: Scanning and Uploading Timings

	Average Time (sec)	Median Time (sec)
Scanning of 10 QR Codes	50 or 5 per scan	50 or 5 per scan
Uploading of 1 QR Code Scan Result	2.3	2
Scanning and Uploading of 1 QR Code Scan Result	5.7	6
Bulk Upload of 10 QR Code Scan Results	3 or 0.6 per scan result	3 or 0.6 per scan result

From these results we can compute the following: The time required to take 1 QR Code scan and then upload it is $(5 + 2.3)$ 7.3 seconds on average or $(5 + 2)$ 7 seconds on median. If we chose to do automatic uploading immediately after

scanning, the total times are decreased to 5.7 and 6 seconds respectively. However the fastest results are achieved when we scan many people and then do a bulk upload of those results. Using this option for 10 people, it took $(50 + 3)$ 53 seconds to perform the task or 5.3 seconds per person.

Then end result is that performing scans and then doing a bulk upload would let us track, under the best conditions, approximate $(600 / 5.3)$ 113 students in a ten minute period (600 seconds) before the start of a class or event. The best conditions would be were the queue of attendees with QR Codes is large enough where there is always another code ready to be scanned after the previous scan and there are no time delays connecting to the server to perform the bulk upload.

5 Conclusion

We believe our current mobile app and server-based system can be used for tracking attendance in classes of up to 100 people. Moreover, if students attend different events, they do not need register with subsequent events, as the system does not require an attendee to have a different QR Code. Our custom QR Codes contains all of the required attendee information. And, unlike the previous versions of our system, there is no time required to register an attendee with the system before they are tracked.

After working on three different versions of our system, we see the following feature set emerging as the basis for different attendance tracking system:

- Tracking Data Location: The location of event tracking data is usually stored either on the device, on a server, or a combination of the two. In this last case, data is stored locally on a device for later uploading to a server.
- Attendee Identification: attendees of event tracking systems identify themselves with cards, QR Codes, id numbers, or something on a device/card that is unique. In some systems, the id/card/code is verified before attendance is tracked. In other systems this task is not a requirement.
- Tracking devices: tracking devices range from a few devices running a mobile application that is used by one or a few users to track the attendance of a single event to systems where every attendee has a device with a mobile app they used to indicate their attendance at an event.

A final issue, which in itself is a feature, is the technique to ensure that an attendee is actually at an event when being tracked. If every attendee has access to a required mobile application, then the potential is there for them to identify themselves as at an event when they are not actually there. Using the location of the device is one technique one could use to help determine a device's location, but depending one

when the device starts, stops, has Wi-Fi, cellular, or GPS information, the identified location can be inaccurate. With QR Code scanning, students must be at the event or class.

Our working system has the following features. Ultimately, attendance tracking data is stored on our server. We support the creation of a user with corresponding events they wish to track attendance. Users can login to our system with their user id and password in order to retrieve real time Excel reports of who has been tracked at one of their events. We have a web site where those attending events generate a unique, custom QR Code that they bring with them to any class or event. The custom QR Code only works with our system, and can be printed on paper, or stored as an image on a laptop or mobile device. Only a user, not an attendee, has access to the mobile app required to track attendance. This fact ensures that attendees are at actually at the event, as their codes are scanned at the same location. Finally, while attendance tracking data is stored on our server, we support the having a user scan up to 1000 QR Codes and storing them on their device before bulk uploading them. The reason for this feature is two fold: The first is that it increases the speed at which attendees can be scanned and processed at an event. Secondly, if the mobile device is having difficulty connecting to the network, the user can still process attendees and upload the scanning data at a later time.

6 References

- [1] Deugo D. "Attendance Tracking". The 9th International Conference on Frontiers in Education: Computer Science and Computer Engineering (FECS 2013), 79-85. 2013.
- [2] Deugo, D. Tracking Attendance Pilot. The 10th International Conference on Frontiers in Education: Computer Science and Computer Engineering (FECS 2014), 101-107. 2014.
- [3] QR Bubble – attendance tracking. Web 15 May. 2015. <<http://www.qr-attendance.com/>>.
- [4] Attendance Tracking Software. Web 15 May. 2015. <<http://www.alliancetech.com/solutions/attendee-tracking/intelligent-attendance/overview>>.
- [5] Attendance Tracker – Android. Web 15 May. 2015. <<https://play.google.com/store/apps/details?id=peterman.apps.attendance&hl=en>>.
- [6] Masalha, f. and Hirzallah, N. A Students Attendance System Using QR Code. (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 5, No. 3. 2014.
- [7] Corbett, A.C. Experiential Learning Within the Process of Opportunity Identification and Exploitation. Entrepreneurship Theory and Practice, Volume 29, Issue 4, 473-491. July 2005.
- [8] Baban, M.H.M. Attendance Checking System Using Quick Response Code for Students at the University of Sulaimaniyah. Journal of mathematics and computer science, 10 (2014), 189-198. 2014.
- [9] Attendance & Session Tracking. Web 15 May. 2015. <<http://www.eventrebels.com/products/er-mobile-onsite>>.