

DEVELOPMENT OF THE ONLINE STUDENT ATTENDANCE MONITORING SYSTEM (SAMSTM) BASED ON QR-CODES AND MOBILE DEVICES

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Abstract

This paper thus outlines the development of an online student attendance monitoring system (named SAMSTM) based on QR codes and mobile devices. This design was chosen due to its simplicity and cost-effectiveness. The only equipment required by the user (lecturers and students) is a mobile internet device such as a tablet computer or a smartphone. This is deemed reasonable due to the wide availability and high ownership of such devices today. The system is currently in an early prototyping phase to show a working proof of its concept. This paper describes the overall architecture as well as the flow of its implementation in the class room. The method of surveying the effectiveness and user feedback of the system is also discussed. The main advantage of the system is a more accurate and quicker method of recording and monitoring student attendance. With this system, it will be quantitatively easier to discern the students based on their diligence in attending classes, and thus also predict their performance due to the correlation between attendance and academic performance. We found positive feedback for the system in the design phase with some parties interested in commercialization. This encouragement motivates the deployment of the system in a number of trials which will be useful for further development and wider application.

Keywords: Attendance, Monitoring, Online, QR code, Mobile devices, App.

1. Introduction

It has been established in many research studies that student attendance during lectures [1-6] and other learning activities such as labs [7], seminars [8] and workshops [9] correlate positively to the student's performance during their undergraduate studies. Some studies have even found additional compounding factors, such as that the negative effect of absenteeism affect lower-performing students [1] more as well as gender [10]. Thus it is of utmost importance that the student attendance is monitored and efforts are made to improve them.

Students, being the relatively younger generation, are more likely to be familiar and early adopters of new technology. However, technology is only a tool and can thus be a double-edged sword. The use of technology, while making learning more interactive and thus more attractive to younger generations has also the potential to deter them to be physically present for learning activities [11]. The role of virtual or online learning, even with web-based lectures should only be as an enhancement and not a substitute to face-to-face interaction with the educator, and this has been found to be a view of the students themselves [12].

With the benefits of student attendance established and noting the change of the educational landscape in today's world, technology might as well be capitalised upon to manage the attendance of the students in learning activities [11]. This is compounded by the fact that the monitoring student attendance, which is in most cases performed manually, is a tedious and repetitive additional task for the educators, especially with large classes. There have thus been efforts to facilitate the process using technology, such as a software-based system for student management [13, 14] as well as hardware-based solutions such as using RFID based technology [15], biometrics [16-18], or a combination of the two [19, 20]. They have been found to ease the management of students for the educator and thus increase student attendance, which further improves their performance. However, in the first case of a purely software-based solution, while less tedious still requires the educator to manually monitor student attendance before it is entered into the software. In the latter cases on the other hand, i.e. with a hardware-based solution, either with RFIDs or biometric, presents a rather substantial additional cost to the institution, especially with the infrastructures needed to track the RFIDs. In the case of biometric, in addition to the extra hardware needed there is a question of reliability of the system.

Hence in this work, we propose a QR-code based system, in combination with mobile devices to display and scan the QR-codes. This thus removes the need for any additional hardware, noting that in Malaysia there is high ownership of mobile internet-capable devices, especially in the form of smart-phones [21] as well as high mobile internet usage [22], with an increasing aerial coverage and penetration over time. The system is described in more detail in Section 2. In Section 3, we describe the trial deployment of the system over the current academic year in a few selected courses as well as the method of surveying its impact. We also discuss the early anecdotal and response to this plan as well as initial performance tests and comparison with other systems. Finally, we conclude in Section 4 with some notes on the future outlook.

2. Design of the online Student Attendance Monitoring System (SAMSTM)

As introduced in Section 1, the Student Attendance Monitoring System (SAMSTM) utilizes two technologies widely used at present, namely the Internet-enabled mobile devices and QR codes. Student interaction with the system is through a unique QR code that is reserved for each student. A QR code (quick response code) is basically a two dimensional bar code¹ and an example of a QR code that will be used is as shown in Fig. 1.



Fig. 1. An example of a QR code to be used.

The QR codes that are generated for each student can be displayed using a smartphone or printed if the student does not have a smart phone. When students attend classes, the code will be scanned by lecturers using mobile devices such as smartphones and tablets. The scanned QR codes will directly interact with the web-based SAMSTM system and record the student attendance. The overall flow chart of the system from QR code generation and its use for recording student attendance is shown in Fig. 2.

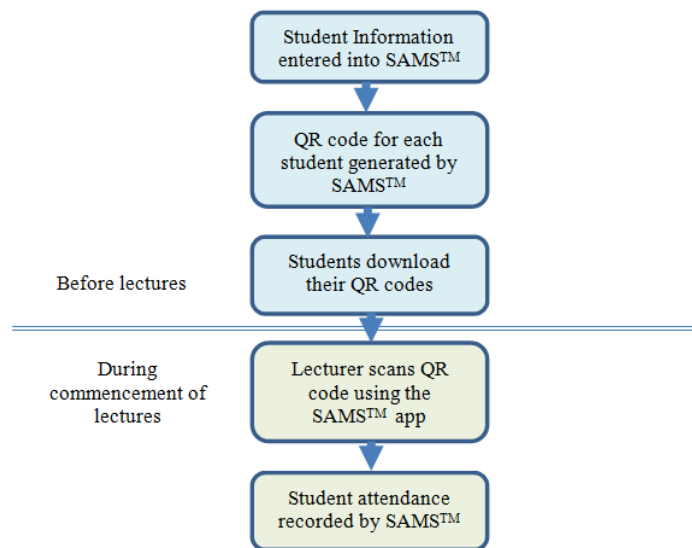


Fig. 2. Flowchart of the SAMSTM system.

¹<http://www.qrcode.com>

The Student Attendance Monitoring System (SAMS™) itself consists of two main components the SAMS™ server and the SAMS™ app. The two main components are detailed below in subsections 2.1 and 2.2 respectively.

2.1. The SAMS™ Server

The system itself is available online and designed for access via mobile devices. An example of the main page displayed on a smartphone is shown in Fig. 3. The entire display when the system is accessed through a computer (or device that has a larger screen such as a tablet) is also shown in Fig. 4.

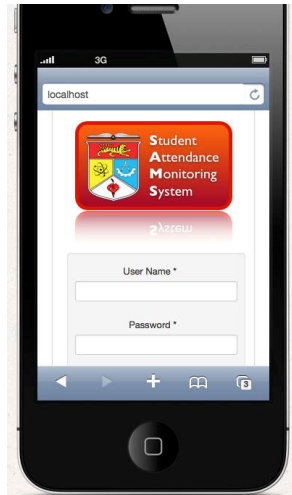


Fig. 3. The main page as displayed on smartphone.

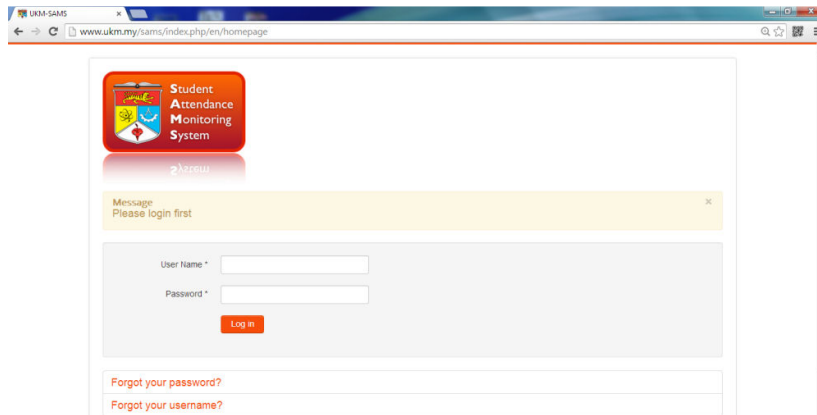


Fig. 4. The main page as displayed on a larger screen.

As can be seen in Figs. 3-4, access to the system is via a user name and corresponding password. This is for security and also enables access for different categories of users to the online system, for example a lecturer or system administrator. The main page also offers a hint if a user forgets the user name or password. When the user logs into the system, its display is as shown in Fig. 5.

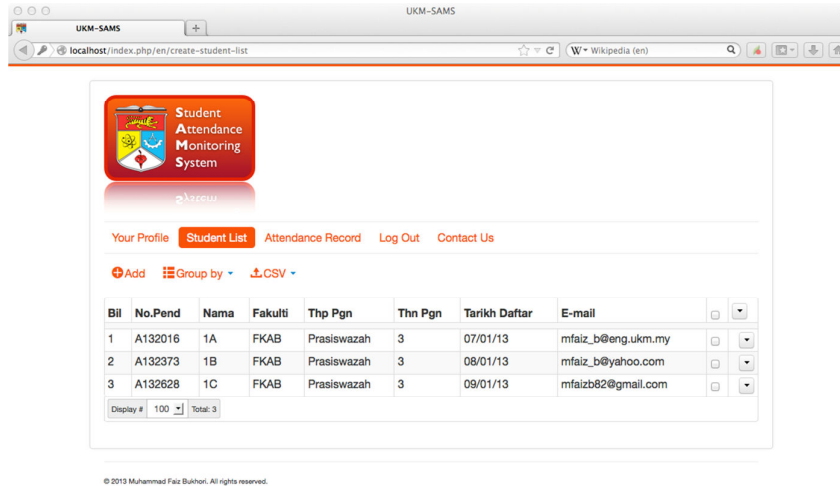


Fig. 5. The interface after logging in to the system.

In this display, the tabs at the top (under the SAMSTM logo) show the available choices. Users can check own profiles, see the list of students, attendance records, log out, or contact the system administrator. In the student list view, the information is listed according the university's student information system. The information listed is student number, name, faculty, degree and year of study, date and the e-mail address. The student list may be modified, displayed according to certain groups and downloaded in comma separated value (CSV) form. A new row can be added (+) or existing lines can be modified via a pull down menu accessed via the down arrow mark on the right (▼).

After the student information has been updated, a unique QR code can be generated for each student. The QR code is sent via email. An example of this email is shown in Fig. 6.

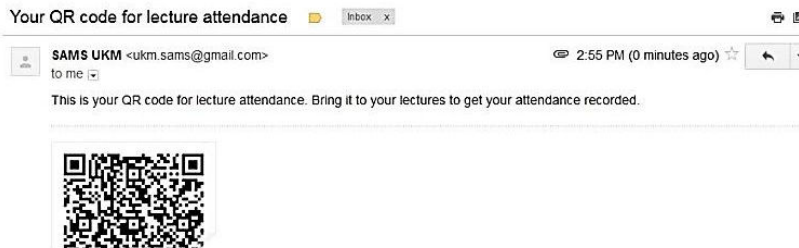


Fig. 6. An example of the email assigning a QR code to a student.

Once all students have received their QR codes, it can thus be used to record their attendance. As mentioned above, the student can present their code to their lecturer either using their smart phone or with a print out. The QR code can then be scanned by the lecturer using the SAMS™ app which is described in subsection 2.2.

2.2. The SAMS™ App

The SAMS™ app is a dedicated software application intended for better integration of QR code scanning with the SAMS™ systems as a whole. Its flow chart of operation for scanning QR codes can be represented by Fig. 7 below.

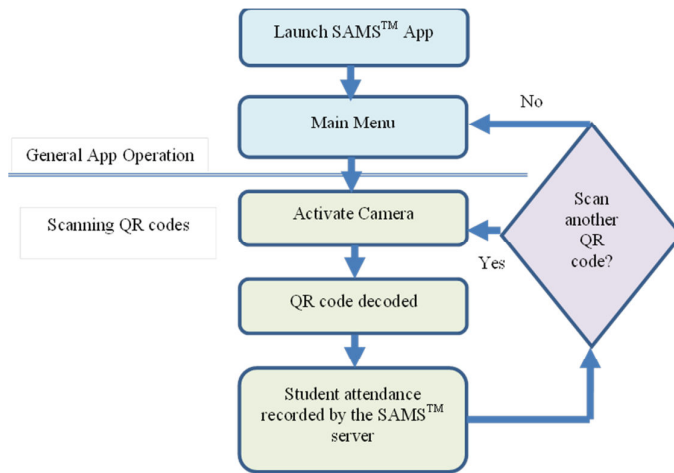
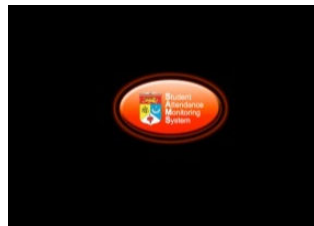


Fig. 7. Flowchart of operation of the SAMS™ app for scanning QR codes.

When launching the SAMS™ app, a splash screen will first appear with a start-up audio theme. Figure 8 shows the splash screen depending on the orientation of the display of the mobile device used.



(a) Vertical orientation.



(b) Horizontal orientation.

Fig. 8. The splash screen in (a) vertical and (b) horizontal orientation.

After showing the splash screen for 6 seconds (optional and can be skipped), the main menu itself will appear. This is shown in Fig. 9. The 7 options on the main menu are “Login”, “Your Profile”, “Scan QR”, “Attendance List”, “Attendance Record”, “Contact Us” and “Log Out”. Lecturers can access the SAMS™ server with the “Login” option. The main page as shown in Figs. 3 and 4 are displayed as in Fig. 10 when accessed through the SAMS™ app.

To scan QR codes, lecturers use the “Scan QR” option. The display when the camera is activated to scan a QR code is as shown in Fig. 11(a). When the QR code has been decoded, the display is as shown in Fig. 11(b). After the QR code has been decoded as in Fig. 11(b), the lecturer can select “Add to attendance” to complete the recording of the student’s attendance. Once this has been performed, a message “Done” will appear as shown in Fig. 11(c). The steps shown in Figs. 11(a)-(c) are repeated to record the attendance of each student. The three figures correspond to the three steps of scanning QR codes in Fig. 7. The other options available from the main menu, namely “Your Profile”, “Student List”, “Attendance Record”, “Contact Us” and “Log Out”, are shown in Figs. 12(a)-(e).

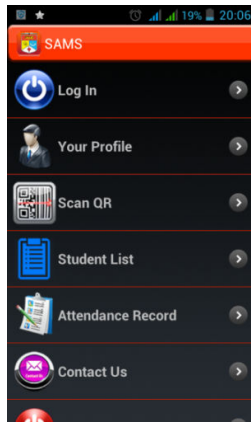


Fig. 9. The main menu of the SAMS™ app.

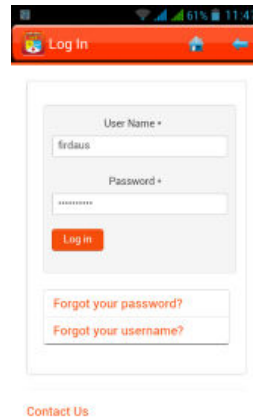
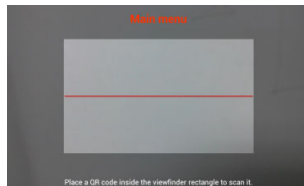
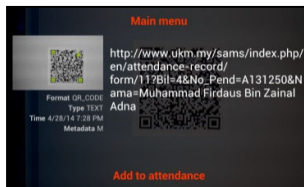


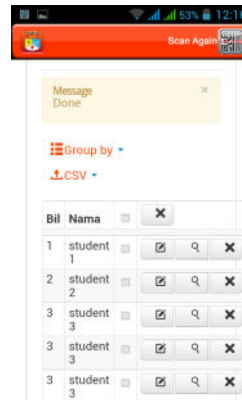
Fig. 10. The login page as displayed via the SAMS™ app.



(a) Display when the camera is activated.

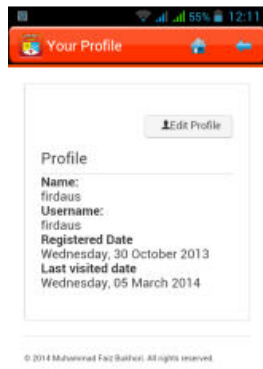


(b) Display when a QR code has been decoded.

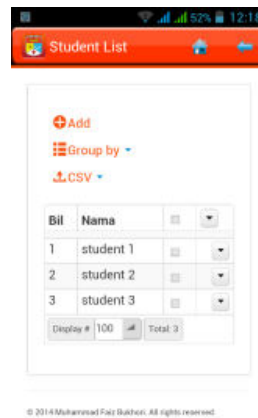


(c) Display when a student’s attendance has been recorded.

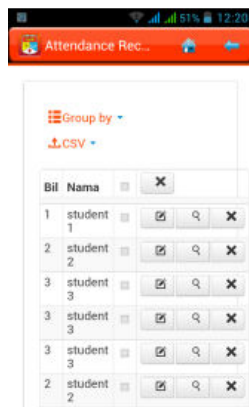
Fig. 11. The three steps of scanning a QR code using the SAMS™ app.



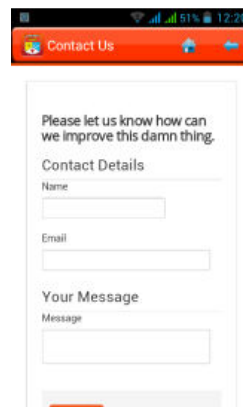
(a) "Your Profile"



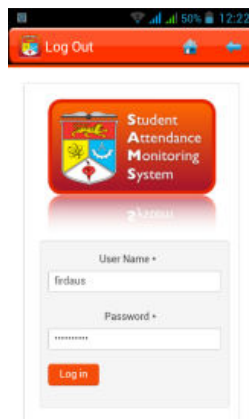
(b) "Student List"



(c) "Contact Us"



(d) "Log Out"



(e) "Log Out"

Fig. 12. The other options available from the main menu of the SAMS™ app.

3. Initial Performance Test and Discussion

An initial performance test has been performed by measuring the response time of scanning QR codes on commercial mobile devices over various networks. The tests were performed using a Ninetology Black Pearl II smartphone over Wi-Fi and HSDPA as well as using a Samsung Galaxy Note II device over 4G LTE. The response time is measured from when “Scan QR” is clicked (refer to menu in Fig. 9) until the message “Done” appears indicating the attendance has been recorded (refer to Fig. 11(c)). The measurements are repeated three times and are as shown in Fig. 13 with the numeric values in Table 1. The corresponding network speeds during the measurements are as listed in Table 2 for reference.

From Fig. 13, it can be seen that the average response time over Wi-Fi is 11.16 s, over HSDPA is 12.27 s while over 4G LTE the response time is 10.64 for an overall average of 11.36. This is not far above other tested systems such as the biometric system in [16] while not having the disadvantage of added hardware as mentioned in Section 1. Moreover, the response time depends on many factors such as the screen size (larger screens may take longer), mobile device processing speed, network speed, camera speed and user handling. Early results from further development indicate that this response time can be decreased even more.

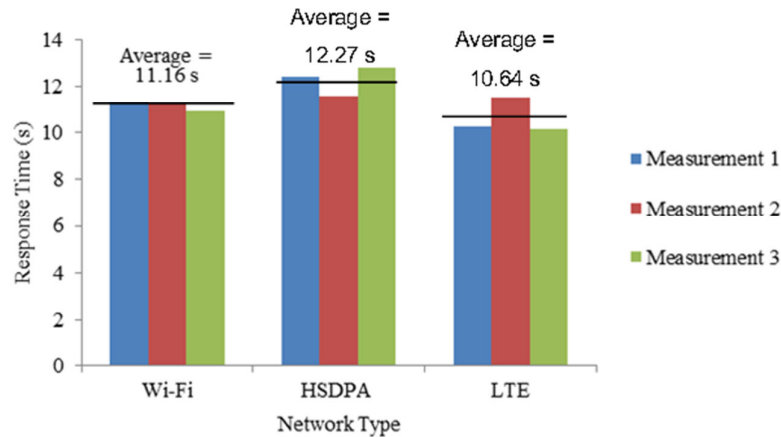


Fig. 13. Graph of the response times.

Table 1. Response time measurement.

Measurement	Response Time (s)			Average
	Wi-Fi	HSDPA	LTE	
1	11.30	12.41	10.24	
2	11.24	11.58	11.55	
3	10.93	12.83	10.14	
Average	11.16	12.27	10.64	11.36

Table 2. Network speed.

Measurement	Speed (Mbps)					
	Wi-Fi		HSDPA		LTE	
	Down-load	Up-load	Down-load	Up-load	Down-load	Up-load
1	2.56	4.13	7.15	1.64	11.51	3.39
2	1.22	3.30	10.17	1.68	11.57	3.00
3	2.37	4.09	8.93	1.79	11.65	3.11
Average	2.05	3.84	8.75	1.70	11.58	3.17

Initial outlook

The authors are positive of the receptiveness of this system based on the encouraging initial feedback when SAMS™ was pitched at a research commercialization workshop as well as at a teaching and learning conference organized by Universiti Kebangsaan Malaysia. Additionally, 15 lecturers and 25 students were surveyed on three aspects of lecture attendance:

- Importance of lecture attendance
- Opinion on current manual attendance recording system
- Tendency to use a physical device and/or app for recording attendance

The feedback for the first two aspects is in the form of a five point Likert scale. For the first aspect the scale is in the order of increasing importance whereas for the second aspect the scale is in the order of increasing dissatisfaction with the current system. Figure 14 shows the average scores given by lecturers and students on these two aspects. The error bars show the standard deviation of the scores.

From Fig. 14, it can be seen that on average both lecturers and students agree on the importance of lecture attendance. On average both also tend to be unsatisfied with the current method of recording attendance, although students have a noticeably higher level of dissatisfaction. However, there is more variability with the satisfaction level of lecturers and hence the difference is deemed insignificant according to a χ^2 goodness of fit test at the 5% significance level [23]. This is also the case with agreement on importance of attendance.

On the third aspect of the survey, both lecturers and students were asked if they would agree on using a physical device and/or app to record lecture attendance. The percentages that agreed are as shown in Fig. 15.

From Fig. 15, it can be seen again that both lecturers and student agree to use a physical device and/or app to record lecture attendance. A majority of students also agree to use both a physical device and app whereas almost 50% of lecturers also share the same opinion. Only a small percentage (around 25%) of students and lectures do not agree on using either a physical device or app. From Fig. 15, we can also see that there are a slightly higher percentage of students and lecturers that prefer to use an app over physical devices. The survey thus presents a favourable prospect for the SAMS™ system.

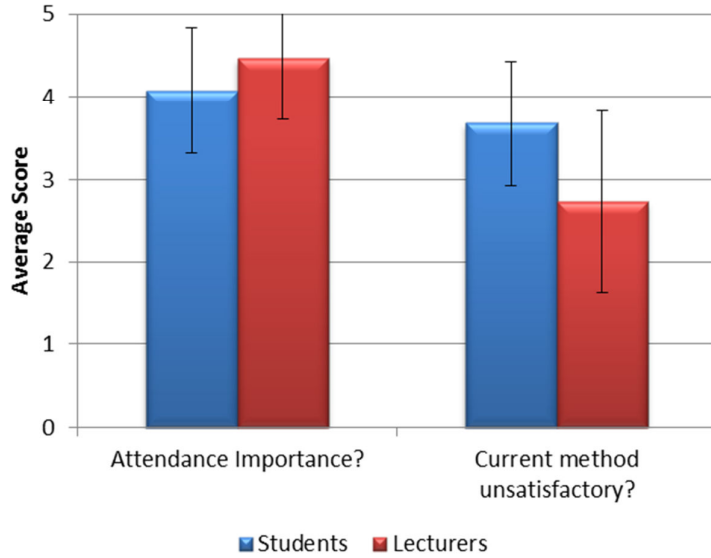


Fig. 14. Average scores of the response of students and lecturers on attendance importance and dissatisfaction with the current attendance recording system.

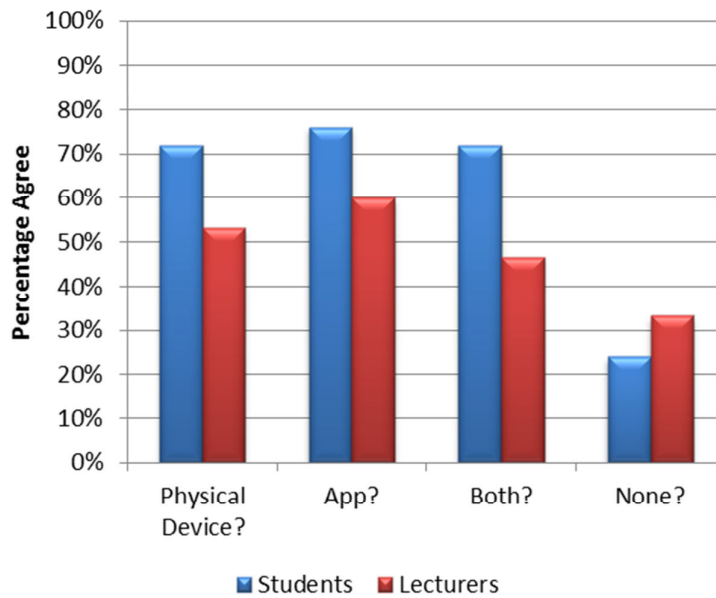


Fig. 15. Percentage of responses in agreement/disagreement of using a physical device and/or app for recording attendance.

4. Conclusion and Future Work

The authors are of the opinion that there is good prospect for the SAMS™ systems based on the early outlook so far as presented in Section 3. The system is ready to be used and preliminary test will be performed in lectures at the Department of Electrical, Electronic and Systems Engineering, Universiti Kebangsaan Malaysia. Any practical issues will be identified during the test and used to improve the system. The SAMS™ app as shown in Section 3 is also only developed for Android devices due to the popularity of this mobile operating system². Hence the app will be ported to other popular mobile operating systems namely iOS and Windows. Additionally, spatial locating can be considered for incorporation into the system as performed by others [19-20], based on the feedback that many do not mind using physical devices (Fig. 15), as long as any potential additional cost is deemed suitable. In conclusion, with this system, the technology that is presently widely used can be utilised so that students can benefit more from lessons by their presence without burdening the instructors.

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