

MEDICAL STUDENTS' PERCEPTION ON THE USE OF QR CODE VERSUS TRADITIONAL PEN-AND-PAPER AS AN ATTENDANCE RECORD TOOL IN MEDICAL SCHOOL

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Background: Student attendance at teaching-learning sessions is traditionally registered using pen-and-paper. This method has many weaknesses: lost, hard to verify, attendance-by-proxy, late submission. The Quick-Response Code is a two-dimensional barcode that can be read with a QR reader on a smartphone that captures and instantly transmits information to a cloud storage. We describe the use of a QRC method to register medical students' attendance and assessed their perception of this method compared to PAP.

Method: The attendance of 112 medical students in all teaching and learning sessions in internal medicine posting was registered either with QRC or PAP. A static QR code was generated using open source software online and linked to Google Document for storage of data registered. At the end of the posting, the students' perception was assessed using a 4-point Likert scale satisfaction survey.

Results: 83 students participated in the survey (74% response rate). 100% owned a smart device and 91.6% had data connectivity. Compared to PAP, the QRC method was perceived to be more convenient, more accurate, more secure and more environment-friendly and preferred (all $p < 0.05$). The QRC method was not significantly faster than the PAP ($p = 0.361$).

Conclusion: The QRC method was the preferred attendance record tool compared to the traditional PAP method. Its adoption in the closed and secure environment of a medical campus and hospital is feasible and should be explored.

Keywords: QR code, attendance record tool, medical school

Introduction

For optimal training of medical students, their physical attendance at all teaching activities is often required. Physical attendance allows face-to-face interactions between the lecturer and students, between fellow students and between students and patients in the wards or clinics. These interactions allow the students to gain wide clinical exposures that will help enhance their competencies as practicing doctors when they graduate.

At the International Medical University (IMU), the attendance of medical students at teaching sessions, be it at the campus or the hospital is registered using pen-and-paper (PAP). Typically, the group leader is responsible to obtain the signatures of all his groupmates at all teaching sessions in a week, either during or at the end of the session. The signatures are registered on an attendance sheet which must be verified by the lecturer or doctor assigned to the teaching session. At the end of each week, the completed attendance sheet is submitted for manual entry on a desktop computer into an attendance repository. This method has several disadvantages:

1. The group leader occasionally forgets to bring the attendance sheet to class, or neglects to obtain all signatures, or forgets to get the lecturer to verify the attendance, or forgets to submit the completed attendance sheet.
2. The group members sometimes forget to sign their attendance.
3. Attendance by proxy can occur when students sign for their peers who are absent.
4. The attendance sheet may be misplaced or lost.
5. The manual transfer of data from the attendance sheet onto the computer for record keeping is subject to human error.
6. Depending on the class size, the attendance-taking process can be time consuming.

These disadvantages may result in inaccurate documentation of students' attendance that may negatively impact the final tally of their attendance. At the IMU, a minimum of 75% attendance per semester in all teaching activities is required as one of the eligibility criteria to appear for examinations. An ideal attendance record tool should be convenient to use, accurate, fast, secure, has minimal impact on the environment, and not easily subjected to the practice of proxy attendance.

The Quick-Response Code (QRC) is a type of two-dimensional barcode that can be read with a scanning device to reveal information stored within the code. It can be used to code characters, images, music, web-links, emails or act as a conduit to transmit data to a designated landing site. The use of QRC is increasing popular with the explosion of mobile devices. QRC codes can be easily generated using many paid or free online sites.

QRC can be divided into static or dynamic codes. In static QRC, the actual landing site is placed directly into the code and cannot be modified. Hence, a new code needs to be generated whenever the information contained within the QRC is changed. A dynamic QRC, on the other hand, allows the embedded landing site to be changed without the need for new codes to be generated.¹ Masalha *et al* described a QRC-based system designed to capture student attendance, generate QR codes for instructors, and run identity and location checks. Attendance was registered via a QR code that was displayed during or at the beginning of a lecture for students to scan with their smart devices.² Deugo described an inexpensive QR code-based system to capture students' attendance in a large classroom setting. The cost of development and maintenance was kept low through the use of open source software.³

We describe an exploratory pilot study utilizing QRC generated with open source software to capture medical students' attendance in teaching sessions in one semester of internal medicine posting and assessed the students' perception of the QRC method compared to traditional PAP method of attendance taking.

Method

Student population

Our study was conducted at the clinical campus of the IMU in the city of Seremban, State of Negeri Sembilan, Malaysia. The student population was 112 medical students in their first year of clinical training. These students were divided into three groups and each group was posted to the internal medicine posting for 7 weeks on a rotational basis in a semester. Apart from clinical sessions such as ward work, clinics, and bedside teachings, their posting also included lectures; task based learning sessions and medical seminars.

Register of attendance using QRC

Eight internal medicine lecturers were chosen to participate in the study. Four of them were assigned to register the students' attendance in all their teaching sessions using the traditional pen-and-paper method while the other four were assigned to register students' attendance using a static QRC generated from an open source software online (Figure 1).⁴ At the beginning of each internal medicine posting rotation, the students were briefed regarding the objectives of the study and how their attendance would be registered during their posting. At the end of each teaching sessions of the posting, medical students were asked to scan the QRC provided by their lecturers using a QR scanning app on their smart devices. Students were allowed to scan the QRC once and enter their details once. Those who failed to log in were considered absent. In small group teaching sessions, the lecturers were instructed to carry the QRC with them, either as a small print out or downloaded onto their smart phones. The students are instructed to register their attendance in the presence of the lecturer. In sessions involving large number of students, the QRC was projected onto a screen on the wall for a limited time and the students were asked to log in their attendance by scanning with their smart devices from a distance.

The embedded information within the QRC would link the students to an interface created using Google Form (Figure 1) where they were required to enter their names, student registration numbers and the teaching sessions that they had attended. These

information were automatically uploaded on to an online Google Doc database. Once a week the consolidated database of registered attendance was downloaded from Google Doc directly into the campus' attendance repository. The remaining four lecturers were instructed to capture the students' attendance in the usual way using pen and paper. To minimize the risk of students clandestinely obtaining a copy of the QRC and using it to log in their attendance remotely or sending it to their friends for them to log in their attendance while being absent, the QRCs are periodically changed without the knowledge of the students.

Assessment of medical students' perception on attendance record methods

At the end of each internal medicine posting, the medical students were asked to respond to a self-administered online questionnaire created using an open source software.⁵ They were asked to rate their experience of having their attendance registered using QRC compared to PAP. Seven criteria was used for comparison purpose (Table 1). A 4-point Likert scale was used for rating purpose where '1' represented 'strongly disagree' and '4' represented 'strongly agree'. Each student was allowed to participate in the survey once. Participation was voluntary and they were allowed to complete the survey at leisure without interruptions.

Statistical analyses

To determine statistical significance, comparison of mean using the one sample student-t test was

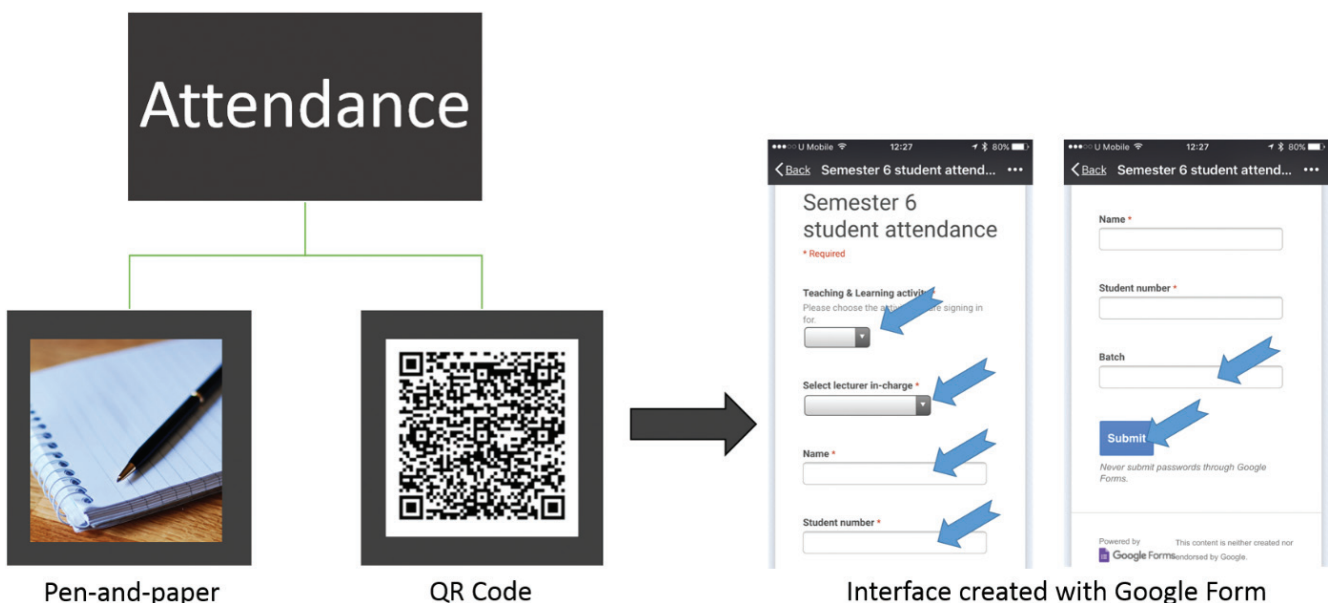


Figure 1: Attendance registration process using either pen-and-paper or QR code

Compared to PAP, the QRC method...	Rating [†]				Mean	SD	P value [*]
	1	2	3	4			
1. Is more convenient to use	8	26	27	24	2.83	0.935	0.002
2. Is more environmental-friendly	1	5	22	55	3.58	0.665	<0.001
3. Is more accurate	3	23	28	29	3.00	0.883	<0.001
4. Is faster	18	21	19	25	2.61	1.135	0.361
5. Is more secure	1	15	34	33	3.19	0.772	<0.001
6. Minimizes attendance-by-proxy	5	9	34	35	3.10	0.862	<0.001
7. Is preferable	7	16	35	25	2.94	0.915	<0.001

[†]Number of respondents under each category of the Likert scale: 1: strongly disagree; 2: disagree; 3: agree; 4: strongly agree. ^{*}P value derived from comparison with a test value of 2.5 with 95% confidence interval. PAP: pen-and-paper; QRC: QR code; SD: Standard Deviation.

Table 1: Students' perception of QRC as an attendance record tool compared to PAP

performed using a test value of 2.5. Mean values above 2.5 were considered as agreeing to the question statement while mean values below 2.5 were considered as disagreeing to the question statement. All p values were 'two tailed' with 95% confidence interval with $p < 0.05$ considered to be statistically significant. All statistical analyses were performed using the IBM SPSS Statistics for Windows, Version 19.0; IBM Corp. Released 2010. Armonk, NY.

Results

Eighty-three students participated in the survey (74% response rate). All of the students possessed at least one smart device and 91.6% (76) had either 3G or 4G connectivity on their smart devices. The responses of these 76 students regarding their perceptions of using QRC as an attendance record tool compared to PAP are tabulated in Table 1.

Discussion

The medical students in our study rated their experience using the QRC method more favorably than the traditional PAP method as an attendance record tool. They felt that the QRC method was more convenient to use, more accurate, more secure, and more environmental-friendly (all p values < 0.05). Ironically, the only item that did not differ significantly between the two methods was 'speed' ($p = 0.361$), considering that the QRC method uses technology and therefore should logically be faster compared to PAP. The discrepancy could be explained by the lack of stable 3G or 4G connectivity in many certain areas and in the IMU campus. Mobile connectivity in the hospital differed greatly depending on the quality of service provided by different telecommunication companies in Malaysia. Although Wi-Fi was freely available in the IMU campus,

connectivity was often dependent on the number of users and bandwidth availability. The slow data connectivity may have caused the students to rate the QRC method less favorably in terms of speed. In addition, in the PAP method, the attendance sheet was often passed around for the students to sign even while the teaching session was in progress thus making their experience of both methods of attendance taking to be similar with regards to speed. Nevertheless, in general the QRC method was preferred over PAP method by the students ($p < 0.001$).

The results of our study is proof-of-concept that the QRC method is a feasible alternative that can be adapted for use at the IMU as a quick, secure, convenient and accurate alternative tool for attendance record. With this method, the element of human error can be minimized. Less reliance on pen and paper would mean less expenditure in the long run for the university, and a smaller carbon footprint. The QRC method is particularly useful in two medical settings – when the group is too large to rely on PAP method to capture the attendance of all participants in the group accurately, for example, in a medical conference or seminar; and in the hospital wards where students are typically scattered over a large area of the hospital, often on different floors where their attendance becomes hard to monitor. In the latter, the attendance of students can be registered in a reverse manner to that described in our study methodology, whereby instead of the lecturers, each student can be assigned his or her own unique QRC embedded with his or her identifying information such as name and student number. Dedicated QRC scanners may be installed in the hospital wards for the students to log in their attendance simply by scanning their individual QRC.

The QRC method we have described is not infallible. As it is dependent on the internet, any disruptions in the internet would render the system to fail in which case the use of PAP may be necessary as backup. As for the accuracy of information captured using the QRC, it would be logical to assume digitally captured data are more accurate than manually captured data. In our study, we have determined that the information captured using the QRC were accurate although we did not compare this with information captured using the PAP method. The was because using both methods to register attendance in a teaching session would take up too much time causing lessons disruption. It may also induce unintended bias as the students, knowing their attendance would be captured twice via two different methods, may be compelled to be extra careful and vigilant in registering their attendance especially via the PAP method that may affect the comparison of accuracy between the two methods.

The QRC method is not impervious to fraud, particularly in the setting of a large group of users in medical seminars or conferences where it would be near impossible to ensure everyone login only once or to prevent a picture of the QRC being clandestinely circulated for absentees to login remotely. Additional features such as enabling geolocation detection at log in and two-step log in requiring passwords may be considered to minimize the risk of fraud or proxy attendance. Security concerns regarding the use of QRC have been raised from time to time that included the risk of leakage of personal information of users to unauthorized people and the illegal channeling of QRC users to fraudulent and phishing sites.⁶ However, within a closed and secure environment like a medical campus and hospital, and with the use of reliable anti-virus and internet security app, the QRC method can be good and reliable alternative to PAP with little or no security risk.^{2,3}

Conclusion

The QRC method was the preferred attendance record tool compared to the traditional PAP method. It was perceived by medical students to be more convenient, more accurate, more secure and more environmental-friendly compared to PAP. Its adoption in the closed and secure environment of a

medical campus and hospital is feasible and should be explored.

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Ethical approval

Approval for our study was obtained from the IMU's Joint-Committee on Research and Ethics (IMU New Research Project Number: 352/2016).

References

1. Dynamic QR codes. <http://blog.qrstuff.com/2012/08/12/dynamic-qr-codes> (accessed 21 February 2017)
2. Masalha F, Hirzallah N. A students attendance system using QR code. *International Journal of Advanced Computer Science and Applications*. 2014. **5**(3):75–79.
3. Deugo D. Using QR-codes for attendance tracking. *Int'l Conf. Frontiers in Education: Computer Science and Computer Engineering (FECS 2015)*. 2015. 267–273. <http://worldcomp-proceedings.com/proc/p2015/FEC2508.pdf> (accessed 21 February 2017)
4. Kaywa™ QR Code. <http://qrcode.kaywa.com/> (accessed 21 Feb 2017).
5. SurveyMonkey. <https://www.surveymonkey.com/> (accessed 21 Feb 2017).
6. Ahuja S. QR codes and security concerns. *International Journal of Computer Science and Information Technologies*. 2014. **5**(3):3878–3879.