Scan & Learn: Exploring Application of Dynamic Quick Response Codes in Digital Classrooms

C. H. Lai, S. A. Chen, F. S. Hsiao, S. Chen

Abstract—**This study sought for new applications of quick response (QR) codes to improve digital instruction. Dynamic, rather than static, QR codes were applied. Four teachers and four classes of 5th and 6th grade pupils participated in the pilot study, which lasted for four weeks, to understand the effectiveness and the problem of using dynamic QR codes in real instruction. The preliminary results revealed that applications of dynamic QR codes saved much instruction time and make instruction smoother. Solutions to the problems were provided.**

Index Terms—**Dynamic quick response code, Digital instruction, Elementary school**

I. INTRODUCTION

One-to-one digital classrooms [1], where every group or student operates a computer equipped with wireless to conduct learning tasks, have received much attention from researchers and have shown positive learning effects [2-4]. In those class, students have various personal computing devices to conduct learning, such as tablet PC [5, 6], Personal Digital Assistant (PDA) [7, 8], and mobile phone [9, 10]. Nevertheless, teachers teaching in digital classrooms often encounter problems. First, for young children and students whose native language is not English or whose computer competency is low, a certain amount of time is needed to key in correct websites. When multiple uses of the Internet or information searching are involved, the accumulated time for keying in could occupy a substantial portion of a class period. Second, when students exhibit large differences in operating computers, many of them waste time waiting for others to keep up with the teaching steps. Furthermore, the students who cannot keep up are likely to get lost. Finally, teachers lose eye contact with students who are continuously operating their devices. As a result, they have

difficulties mastering students' concentration and learning progress. This could possibly foster student behaviors irrelevant to the instruction.

In this study, dynamic quick response (QR) code is proposed to overcome the above problems. QR code, composed of black and white blocks of different sizes in a square (Fig. 1), is a rapid encoding and decoding method. With a scanning device and the decoding software, retrieval of information could be accelerated. As QR code presents the capabilities of rapid response and reading with fault tolerance, its application in education is promising. It has been used with mobile phones or Tablet PCs to learn biology [11] and chemistry [12], to access supplementary materials [13], and to evaluate students' collaborative learning with procedural scaffolding [14], among others. Moreover, Walsh [15] integrated GPS, QR code, and RFID to create a customized learning environment in a university library. Typically, the applications are static, i.e. connecting to teaching contents on prescribed websites. However, static QR code cannot give feedback on students' responses or be adjusted to meet the immediate teaching needs arising in a class. On the other hand, dynamic QR code, which is generated prior to or in real time during instruction, may eliminate the abovementioned problems. Consequently, this study proposes a teaching model for using dynamic QR codes in digital classrooms. A pilot study was conducted to understand the effectiveness of dynamic QR codes in real instruction.

Fig. 1. Example of QR code

II. DIGITAL CLASSROOMS WITH DYNAMIC QR CODE

A. Classroom setting

Our digital classroom is equipped with access points, 30 students' Tablet PCs with cameras, a charger cart for power supply, a teacher's computer, a projector, and a teaching system

C. H. Lai is an assistant professor in the Department of Computer Science and Information Engineering at National Dong Hwa University, Taiwan. R.O.C. (corresponding author to provide phone: 886-3-8634057; e-mail: laich@mail.ndhu.edu.tw).

S. A. Chen is a teacher and a Director of General Affairs at Taipei Municipal Nan-Hu Elementary School, Taiwan. R.O.C. (e-mail: shyian@nhps.tp.edu.tw).

F. S. Hsiao is the Principal of Taipei Municipal Nan-Hu Elementary School, Taiwan. R.O.C. (e-mail: health99@nhps.tp.edu.tw).

S. Chen is a professor in the Graduate Institute of Digital Learning and Education at National Taiwan University of Science and Technology, Taiwan. R.O.C. (e-mail: sufchen@mail.ntust.edu.tw).

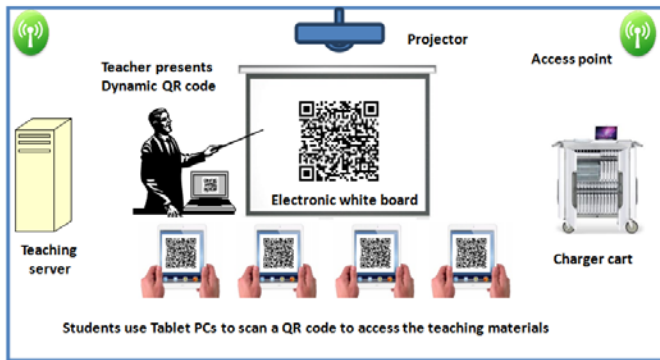stored in the teaching server to support the digital teaching (Fig. 2).

Fig.2. Digital classroom setting with dynamic QR code

B. Applications of dynamic QR codes in instruction in digital classrooms

The applications of dynamic QR codes in the instruction (Fig. 3) cover the log-in function at the beginning of class, main teaching activities, and evaluation after the instruction:

1) Log-in function: The teacher projects the QR code corresponding to the log-in website on the whiteboard (Fig. 4). After scanning and decoding, students connect to the name list page. Then, each student clicks on her/his name and presses "OK" to complete the log-in procedure. It could solve the problems of students memorizing and keying in long websites and passwords, which they often forget or type incorrectly. The teacher's computer immediately displays the log-in conditions of students.

2) Teaching activities: Dynamic QR codes are created for a wide variety of teaching activities. For example, a code may guide students to carry out experiments in a simulation system followed by another code linking to an online discussion board. Or students may scan a code to access extensive reading articles, Wikipedia, or a video on YouTube. During Internet searching, if a student finds information that is meaningful to the whole class, the teacher can instantly generate a code to share it.

Dynamic QR codes grant teachers great flexibility to adjust teaching activities and deliver extra materials in real time.

3) Evaluation: Dynamic QR code allows the teacher to transmit a quiz or test to the students and carry out remedial teaching according to the evaluation and analyses to achieve individualized instruction.

Fig. 3. Students scan the Dynamic QR code via tablet PC

III. METHOD

Four classes taught by four different teachers in one elementary school were recruited for the pilot study in order to understand the function of dynamic QR codes in digital classrooms. The teachers are two males and two females. The school located on the outskirts of Taipei city with the normally distributed students in every class. The participated students' distribution was shown in Table 1. Mandarin and Social Studies were respectively taught to 30 and 29 5th grade pupils (aged 11), while Mathematics and Social Studies were taught to 29 and 27 6th grade pupils (aged 12). The teachers conducted instructions in the abovementioned digital classrooms and teaching systems lasted for four weeks. There were 4, 3 and 6 different class periods of 40 minutes a week in classes of Mathematics, Social Studies, and Mandarin respectively.
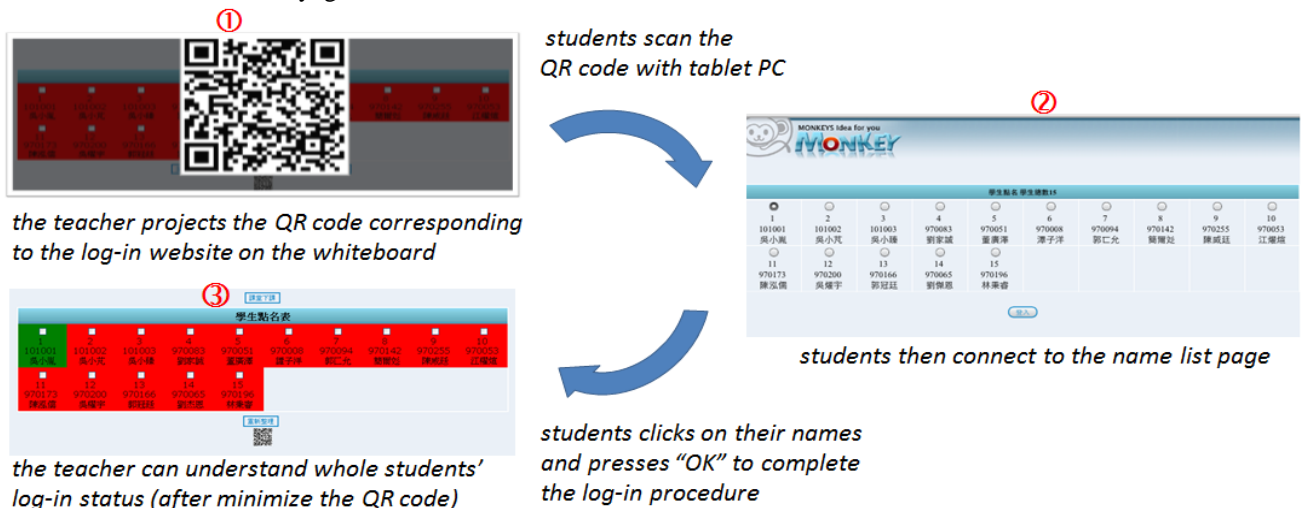

Fig. 4. Procedure of Log-in function

After the experiment, the four teachers and students took questionnaire and were interviewed respectively. The questionnaires are four-point Likert scales. They asked both the teachers and students about the attitude toward the digital learning system with dynamic QR codes (eg., the learning system with QR codes are helpful for the instruction / learning; the learning system with QR codes motivate students / me to learn).

Table 1. Demographic statistics of the sample

Sample	Girls		Boys		Total
	N	Percentage	N	percentage	
5th grade class 1	15	50%	15	50%	30
5th grade class 2	13	44.8%	16	55.2%	29
6th grade class 1	17	58.6%	12	41.4%	29
6th grade class 2	14	51.9%	13	48.1%	27

IV. PRELIMINARY RESULTS

From the preliminary experiments, the following findings are concluded:

1) Dynamic QR codes significantly reduced the operation time. To enter a website address as simple as http://www.google.com.tw., it took the 5th grade classes three minutes and the 6th grade classes two minutes and twenty seconds on average. In contrast, each instruction transmitted through a dynamic QR code took on average one minute for the four classes to complete the decoding and start the learning activity. A considerable amount of time was saved when students needed to input websites several times during a lesson. As much as a quarter of a class period could be saved if five keying events were replaced by QR codes.

2) No child left behind. Even the students who were originally diagnosed as having learning difficulties or who presented low computer competency could operate the dynamic QR codes to access the learning activities.

3) Both teachers and students considered the instruction procedure as smoother and tighter with the use of dynamic QR codes.

4) The action of scanning with dynamic QR codes was easily observed by the teachers, and the teaching system allowed rapid feedback. Thus, students' attention in digital learning was better monitored.

5) A technical problem was found during the study. The students seated in different locations in the classroom might have difficulty taking photos of the QR codes from the same whiteboard. The teaching system was therefore improved: (1) Two sizes of QR code were displayed at the same time (Fig. 5), so students in different positions could choose an appropriate size for scanning; (2) The teacher could enlarge or reduce QR code sizes according to the actual size of the classroom; (3) As students sitting at certain angles could not scan, a relay mode was provided by the system (Fig. 6) whereby the QR code could be enlarged on the tablets of students who had successfully decoded the code. They could then share the codes with those who encountered problems.

Fig. 5. Two sizes of QR code on the electronic whiteboard

Fig. 6. Students can scan other students' QR code

V. DISCUSSIONS & CONCLUSIONS

This study aimed at applying dynamic QR codes into digital classrooms to improve instruction in digital classroom and to make it smoother. Key-in for some young pupils are big problems, especially on mobile devices without physical keyboards. QR codes, which can efficiently save key-in time, have been gradually applied in outdoor mobile leaning (eg., [16]). With the characteristic of their real-time responses, QR-code tags which are glued on the learning objects can also achieve context-aware or location-aware learning [15].

However, most research focused on static QR code (eg., [14-16]) and applied them in mobile learning. That is, few dynamic QR codes were applied in classes. The static QR codes cannot be easily and quickly adjusted following a real-time changed instructive environment. Therefore, this study put on dynamic QR codes with great convenience and flexibility into digital learning. According to the pilot study on four classes, dynamic QR codes were applied to save instruction time. Students can easily as well as quickly scan the QR code to link the learning material instead of wasting time on typing the URL. The results are similar to Huang, Wu and Chen 's study [14] which used static QR codes with smart phone. The teacher-student interaction in the digital classrooms was enhanced. Moreover, the instruction was smoother, tighter, and easier to prepare. A relay mode accompanying the dynamic QR

code is also recommended. However, the more actual effects require further study and complete experimental design and analysis.

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