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A PROMOTION SYSTEM FOR CLASSROOM INTERACTIONS

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Abstract. *For a long time, the teaching and learning performance is a critical issue in education. Time required by manual activities occupies non-ignorable time length of classroom interactions. This article presents a technology that enabled promotion system for classroom interactions to greatly reduce the time required for the interactions and thus to practically improve the performance of teaching and learning. The system is analyzed, designed, implemented, and verified as expectation. The result shows that the performance is obviously enhanced by applying the system for a class.*
Keywords: Technology, Promotion system, Teaching and learning, Performance

1. **Introduction.** Teaching and learning performance is a critical requirement of education in school. There are many factors affecting the performance of teaching and learning [1-3]. Questioning to check for understanding and to facilitate student learning [1], integrating technology to support collaboration among students [2], and formative assessments to provide feedback to teachers and students [3] indicate that the performance could be enhanced via periodic questioning and assessments by the help of new technologies. However, a hand-raising style is the traditional way of opinion expression in classroom interactions and the results are usually counted by a teacher himself. With this manner, some students are often shy to explicitly express their thought. Intuitively, the results of the survey are biased. In addition, the counting for the results is time consuming and prone to be incorrect. Moreover, if the questioning in hardcopy is applied as the quiz of the class, the results shall be manually scored and recorded by the teacher, too. All the above mentioned factors obviously decrease the available time of a teacher for a class. Accordingly, the teaching and learning performance is encumbered by the factors.

The goal of this research is to invent and implement a system to assist teachers to improve the performance of the teaching and learning in classrooms. On one hand, the system shall reduce the time of manually counting and recording for the interactive questioning or formal assessment. On the other hand, the students do not worry again about showing their thought during public interactions in a classroom. Finally, the scoring routine, learning evaluation, and further analysis are possible to be automatically accomplished by the new technology.

The structure of this paper is organized as follows. Section 1 introduces the motivation and solving consideration of the promotion system for classroom interactions. The system analysis and design together with related technologies are described in Section 2. Section 3 explains the details of the system implementation. Finally, the conclusions are given in Section 4.

2. **System Analysis and Design.** Before the research, the time required by a teacher to conduct the classroom interactions during teaching and learning had been classified and

Table 1. Time required for classroom interactions

Activities[a]	Measured Time Length[b]	
	Single Q&A (Hand-Raising)	Quiz with 10 Questions (Hardcopy)
Dispatch Question	20s	30s
Collect Answers	60s	30s
Scoring Answers	NA	15s × 40
Recording Answers	NA	5s × 40
Instant Feedback	Yes	No

a. The activities exclude the reasoning time by students.

b. There are 40 students in four rows.

measured, and is listed in Table 1. The column 1 in Table 1 shows the classified activities during the classroom interaction for questioning and replying. The activity of dispatch question means that the question of a single Q&A shall be explained to all students at the beginning. The collect answers means the time required for all students to respond their answers for each selection to the teacher. Scoring and recording is the required time for the teacher to score and record the results of all students. The feedback of the Q&A is ideally known in a short time. However, it is impossible to have the feedback instantly in hardcopy examination. Regarding column 2 in Table 1, the time required to dispatch question and collect answers in hand-raising way is non-trivial for single Q&A. With the help of technology, these 2 activities are possibly reduced in a fraction of original time length only.

The consideration of the promotion system for classroom interactions (PSCI) is composed of 3 aspects, e.g., for students, for a teacher, and with the information and communication technologies (ICT). On the aspect of students, the system shall furnish a device to each student for the opinions or answers expression. On the aspect of a teacher, the system shall provide a device with convenient Q&A management functions. The last aspect is to connect these devices into one interactive group via new ICT technologies.

Lots of technologies and combinations [4-7] could be applied to the design of the PSCI system. For instance, the device for students may choose APP running at a smart pad or a smart phone. This is one of the quickest and most flexible approaches to conform the functional requirement. However, the percentage of owning a smart phone is difficult to reach 100%, especially in certain developing or undeveloped countries. Except that all students have smart devices, this approach would not be feasible. Thus, there is a need to design a low cost device for each student to express their opinions. After elaborate analysis, a keypad (KP) is designed for this requirement. The KP is allocated to each student upon the beginning of the class for the opinions expression. The KP has a display unit to show the content of a question, and at least 2 status LED to indicate the state of the KP is in waiting question state (keyboard is disabled) or pressing answer state (keyboard is enabled).

Next, a smart phone or smart pad pre-installed with the Q&A management software (chairing APP) is designed and is handled by a teacher to issue a question and to collect the responded opinions from all students. Since there is only one teacher for a class, there is almost no difficulty to apply the chairing APP approach. The display of the APP shall provide the teacher to download all questions from database to the APP, to dispatch questions in batch mode or per each question mode, to collect and to check the answers from all students, and to record the results back to database for further evaluation and analysis.

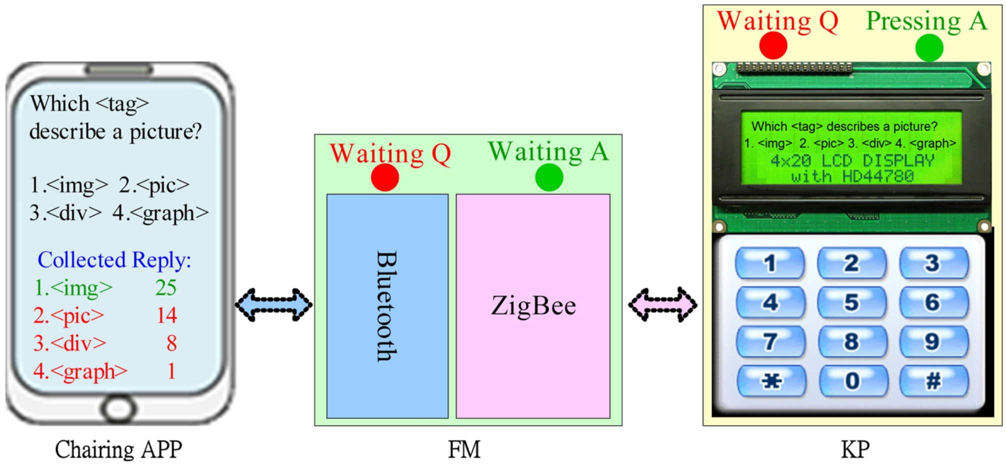

FIGURE 1. System blocks diagram

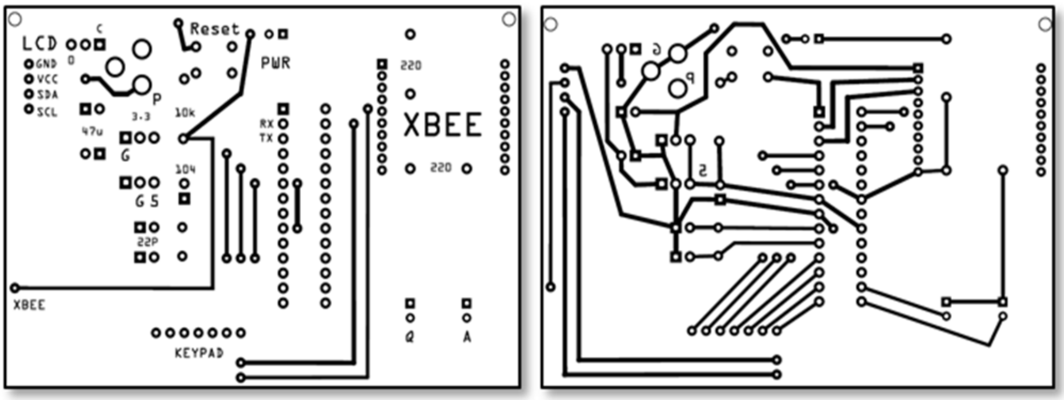

FIGURE 2. KP PCB layout

Then, the teacher's smart phone and all KPs may be connected via several possible wireless communications, i.e., WiFi, Bluetooth, ZigBee, etc. Firstly, ZigBee is almost not supported by all smart phones directly. However, it enables topological flexibility and scalability. Bluetooth is convenient yet only supporting short communication range and enabling less total numbers of clients in a group. WiFi has less restricts compared to the other two technologies. However, the cost of WiFi chips is the highest among them. Therefore, a compromise approach is selected to chain all devices to achieve the low cost requirement. The approach is to design a forwarding module (FM) with two wireless communications, i.e., Bluetooth and ZigBee. The FM is utilized as the gateway to build a virtual channel between the smart pad of running the chairing APP for the teacher and the KPs for the students. The structure of the system composed of 3 portions is shown in Figure 1.

3. **System Prototype Development and Implementation.** In principle, the system prototype is developed and implemented by several open-source tools. The PCB layout is drawn by Fritzing [8], the control firmware of the microcontroller is written by Arduino C compiler [9], and the APP is developed by MIT APP Inventor 2 (MIT AI-2) [10,11].

3.1. **KP implementation.** The KP of the prototype consists majorly of a microcontroller for controlling, an LCD module for displaying, a keypad for opinion expressing, and a ZigBee chip for communicating with the FM. The power supply circuit and status LED are also added on the KP to form a complete opinion expressing device. The PCB layouts drawn and generated by Fritzing are shown in Figure 2.

3.2. FM implementation. With a slight difference, the FM of the prototype comprises a microcontroller for controlling, a ZigBee chip for communicating with the KP, and a Bluetooth chip for communicating with the chairing APP at a smart handheld device. The power supply circuit and status LED are also added on the FM to form a complete forwarding gateway device. The PCB layouts drawn and generated by Fritzing are shown in Figure 3.

3.3. Q&A chairing APP implementation. There are several APP development paradigms, i.e., Java by Eclipse, Web by HTML5 [12], MIT AI-2, etc. To decrease the cost of the APP development, the MAI-2 was chosen as the IDE of this research. The MIT AI2 is a cloud-based IDE and includes two tools as shown in Figure 4. One is the GUI designer and the other one is the block editor in which a programmer would construct visual blocks instead of literal programming statements. In this way, a developer may focus on the programming logic rather than the syntax of the statements. The IDE develops an APP project via a web-browser. All the GUI display, the program blocks, and project related files are accessed over the cloud. The installable package, for either Android or iOS, could be finally downloaded to a smart device by scanning the generated QR code of the APP. A part of the GUI display and the blocks are shown at the left and the right in Figure 4, respectively. Some Chinese characters occurring on the left of

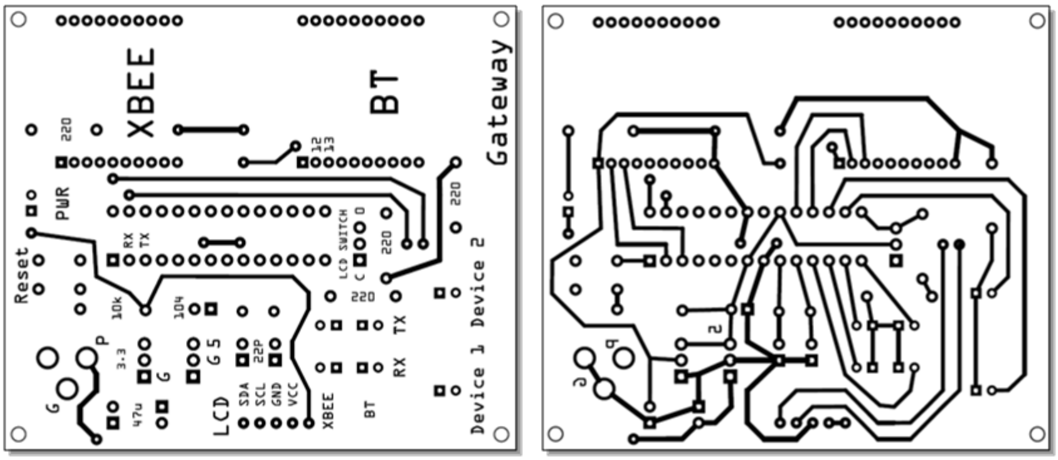

FIGURE 3. FM PCB layout

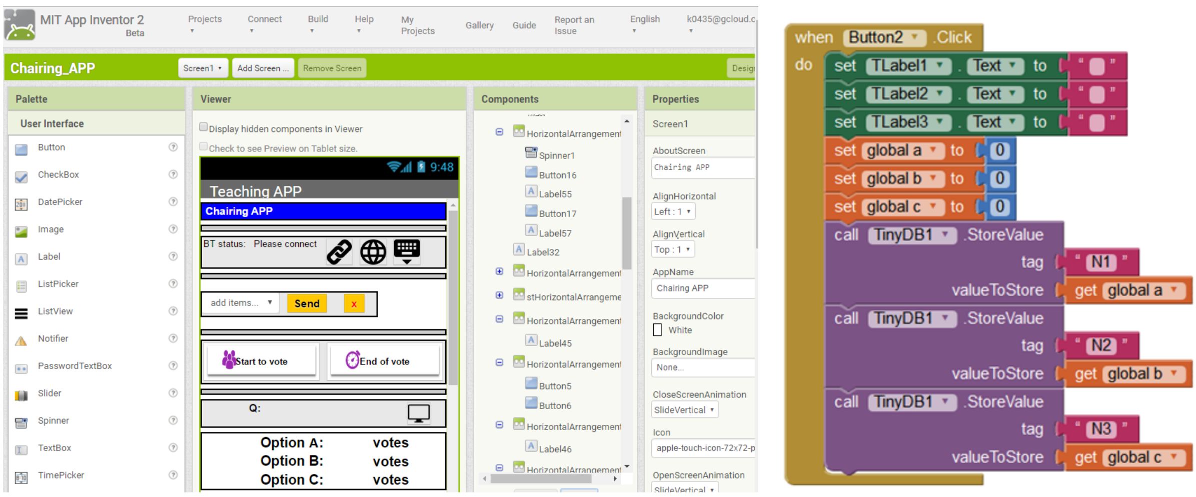

FIGURE 4. Screen of designer and blocks of editor

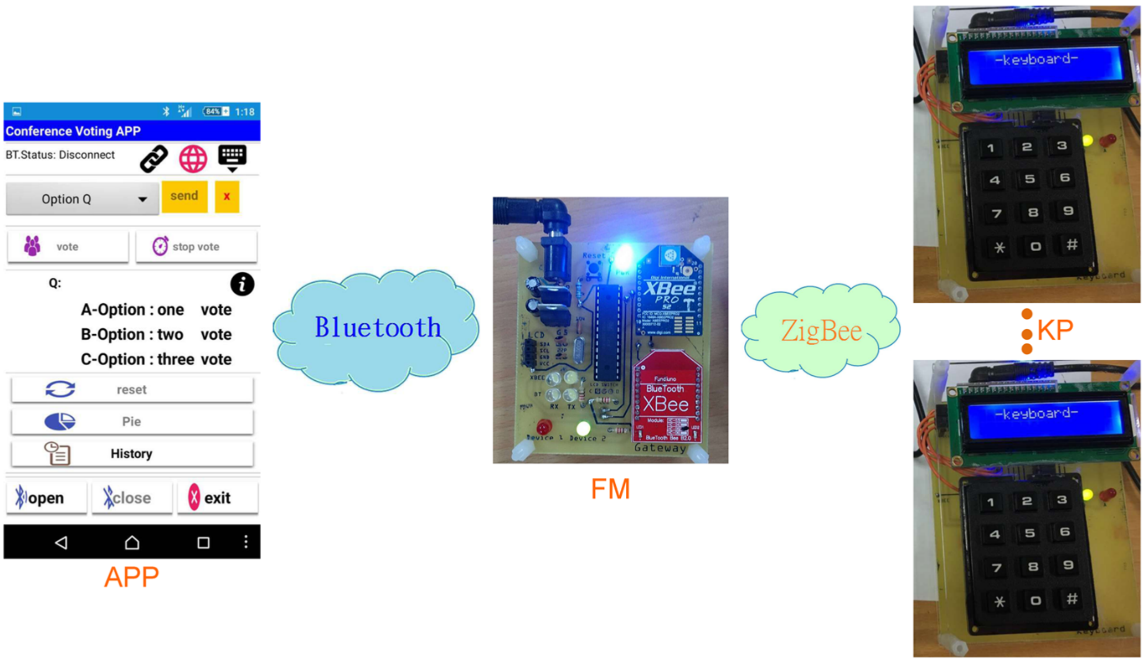

Figure 5. System prototype

Table 2. Time required for classroom interactions by comparing the PSCI

Activities	Measured Time Length		
	Single Q&A (Hand-Raising)	**Single Q&A (Using PSCI)**	Quiz with 10 Questions (Hardcopy)
Dispatch Question	20s	**3s**	30s
Collect Answers	60s	**3s**	30s
Scoring Answers	NA	**Yes**	15s $\times$ 40
Recording Answers	NA	**Yes**	5s $\times$ 40
Instant Feedback	Yes	**Yes**	No

Figure 4 can be switched to English by touching the language button on the APP screen during execution.

3.4. **System integration and verification.** Figure 5 shows the system prototype after the implementation and integration. During the verification, a teacher is able to utilize the chairing APP to pick a question from a list, and to issue the question to all students via the relay forwarding of the FM. The question is normally received and displayed on the LCD module of separate KP of each student. At the moment, the green LED on KP turns on to indicate that the student may now press the keyboard to express the answer. After the press, the red LED is on. Then the KP disables itself and waits for the next question. Meanwhile, all responses are transferred back to the APP via the FM. Then, all answers are collected, scored, and recorded by the APP.

The data in column 3 of Table 2 show the time required by the PSCI is only a few tenths of that of the hand-raising way. However, the batch Q&A function is not completed yet, e.g., the improvement to the column 4 of Table 2 will be proven in future. Since the microcontroller processing time difference between 1 and 10 Q&A is trivial compared to the manual time as the figures in the column 4 of Table 2, the enhancement would be worthwhile expecting.

4. **Conclusions.** This article presents the analysis, design and implementation of a promotion system for classroom interactions. The system is an integration of microcontroller-based devices and a smart APP. The performance validation of the system shows that the teaching and learning interactions could be supported by the system, e.g., the questions could be successfully dispatched to every individual student KP, the answers of all students could be correctly responded back to the teacher APP via pressing the keyboard on the student KP, the virtual channel built by the forwarding gateway could properly chain the both sides into a group, and the result could be exactly calculated and shown by the APP. In future, the batch dispatching mode will be extended to support all types of examinations. Moreover, the connection between the chairing APP and the student evaluation database will be developed to automate the student evaluating and scoring routines for a teacher in the whole semester. In this way, the teaching and learning performance would be further enhanced.

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