

A Phone-Based Question Management System to Facilitate Questioning and Comprehension Monitoring

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Abstract: Research showed that only very small proportion of questions in class was posed by students. Students tended to ignore the questions encountered in class. They were unlikely to actively tackle their confusion or questions. Therefore, the goal of this study is to develop a mobile phone based questioning management system. By integrating mobile phones, course materials with online discussion forum, the system can assist students to ask, trace, monitor and solve comprehension questions encountered in class or after class. From functional perspective, in class or after class when studying, students can: (a) capture contents of paper slides or online courseware, assemble the contents with questions as a whole, and post the assembled questions on a discussion forum via mobile phones; (b) monitor and track the status of post questions via mobile phones as well as organize their personal notes based on the questions during the processes. From the result of formative evaluation for the question management system, students thought the mark mechanism helped questioner enhance the clarity of the questions and thought the progress icons helped them monitor question resolving state and comprehension regarding instructional materials.

Keywords: Comprehension monitoring, questions management system, mobile learning

Introduction

Effective learners are sensitive to their knowledge deficits. They adopt self-regulatory strategies to improve their knowledge deficits [8]. Research also showed that effective learners can monitor and correct their failures in comprehension [16]. Students inevitably will confront with difficulties regarding course contents or teaching materials. In many cognitive models, questions and confusion are the foundation of the text understanding and social behavior [9], as well as the basis of problem solving [10]. However, according to research, a very small proportion of questions were asked by the students in the classroom settings [8]. Students seldom ask questions or take meaningful strategies during or after the classes. Many factors and costs affect a student's motivation to ask [13], which Graesser [8] pointed out that physical and social factors affect the way in which students deals with their confusion. Physical factors include the gap between the questioner and the answerer. Social factors include the colleague's negative feelings towards the questioner. Only when students break the social and physical barriers, the students will have the motivation to ask questions and try to solve the questions.

Many studies has been attempted to enhance student's quality of questions and the motivation to ask questions through computer supported systems. Among these systems, a discussion forum is the most common and popular components [11]. Some Web-based or

mobile discussion forum systems provided students with a place to review and express their confusion regarding instructional materials [e.g., 12, 14]. Student discussed together on a forum and resolved their questions collaboratively. However, the design goal of these Web- or phone-based forums seems mainly for discussion but not for the support of question solving. Mechanisms that help learners monitor and evaluate the status of questions were not explicitly supported. Several studies also employed mobile devices to facilitate information organization [e.g., 6], collaboration [e.g., 17], or communication with messages [e.g., 5]. However, few of these tools emphasized the integration of mobile devices with paper-based materials and supported the process of question resolving.

Q&A (Question and Answering) system [e.g., 1] provides a place for students to find answers based on questions. Some of the systems are featured in learning communities and others provide FAQ lists. These systems provide well-designed knowledge structures to help learners find out the answers of questions. These structures also require learners to have certain skills or background knowledge so that they can find target answers effectively. On the other hand, class communication tools [e.g., 3] provides an interactive channel between teachers and students in class. These tools assist teachers to instantly assess students' learning status and adjust the teaching strategies accordingly. However, this kind of tools generally requires dedicated equipments or settings.

Although resolving question has become a major role in student knowledge acquisition process, most computer supported systems seldom emphasize the process of the questioning resolving. Practical classroom environment seldom guarantee personal computers for every students. This will leads to a problematic situation that student's confusion and context of their questions are difficult to be captured. With advance of mobile and computer technologies, mobile phones become popular and create possibilities of ubiquitous learning. Due to the requirements of questioning in classroom environments, the goal of this study is to develop a mobile phone based questioning management system. By integrating mobile phones, course paper-based materials with online course-based discussion forum, the system can assist students to ask, trace, monitor and solve comprehension questions encountered in class or after class. From functional perspective, in class or after class when studying, students can: (a) capture contents of paper slides or online courseware, assemble the contents with questions as a whole, and post the assembled questions on a discussion forum via mobile phones; (b) monitor and track the status of post questions via mobile phones as well as organize their personal notes based on the questions during the processes.

1. Stages for questioning management

When students confront with difficulties and attempt to solve them, search for answers, self-regulation and decision making are involved. To ask a question, Graesser [8] suggested three components of question asking: anomaly detection, question articulation, and social editing. In this paper, we based on Graesser's model and extend it with self-regulatory components for question asking and management. As shown in Figure 1, regarding a question, suggested stages are confusion discovery, question formulation, question announcement, response evaluation, and Q&A organization. For the confusion discovery stage, according to Piaget's cognitive-developmental theory, the mismatch between external information and a learner's internal knowledge structures causes cognitive disequilibrium [15]. This mismatch initiated by new information generates confusion. This stage corresponds to anomaly detection component of Graesser's questioning model.

If the confusion discovered cannot be transformed into a form of questions, it will be difficult to assess and manage. Therefore, question formulation not only encourages students to retrieve their prior knowledge but also enables devices for students to evaluate or construct knowledge base on the questions. This stage corresponds to question articulation

component of Graesser's model and requires support to help students formulate questions with clarity. For the question announcement stage, students uncover their questions to a learning community. According to Vygotsky's zone of proximal development, student's cognitive development requires help from more capable peers or teachers [15]. The display of questions may enhance the interaction, discussion, or collaboration among classmates or teachers. This stage corresponds to social editing component of Graesser's, which suggests that a questioner evaluates the benefit and cost of questioning in order to decide whether to raise questions for help in the public. This stage requires the support to lower the cost and increase the benefit of questioning.

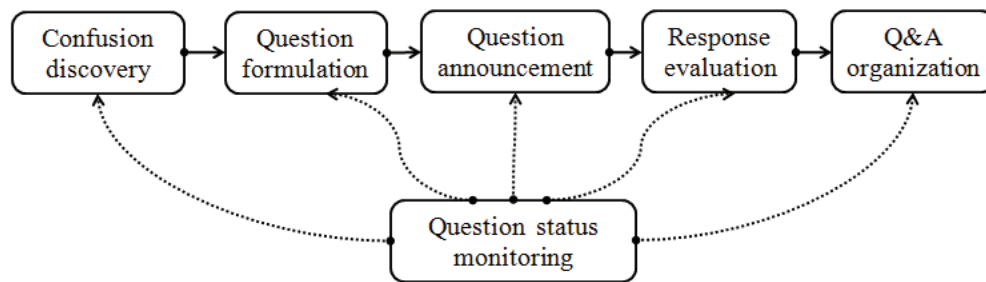


Figure 1. Process of question monitoring

Feedback for questions from peers and teachers is crucial for questioners to evaluate whether they have resolved the questions. During the evaluation, the questioners themselves have to critically assess the contribution of replies, which benefits the construction of knowledge [2]. The response evaluation stage also requires questioners synthesize from difference sources and filter out irrelevant information. Finally, the Q&A organization stage provides students with support that enables connections between questions and corresponding answers. Based on the results of question evaluation stage, students draw conclusions from relevant feedback. Research found that making notes and summary help students establish their own knowledge architecture [4], and create effective knowledge structures. The proposed questioning stages make question-resolving explicit and systematic. Students can follow the suggested steps and expect the arriving tasks for the planning and management of their learning resources. As showed in Figure 1, five-stage question resolving framework is used to develop the phone-based question management system.

2. System design

Figure 2 shows the system architecture of the question management system. The system incorporates mobile phones, paper-based slides, and online discussion forum to facilitate students to trace, monitor and to solve their comprehension questions. The paper-based slides are embedded with unique barcodes so that students can use a camera-based phone to scan the codes and formulate their questions regarding specific confusing areas of slides. The questions together with confuse-marked slides can be post on an online discussion forum. Trough discussion by other students, feedback and answers are gathered and stored in a learning portfolio database. Students can monitor the current status and know the latest feedback and questions updates. Students can evaluate the feedback of questions which are most relevant and mark the feedback as useful messages. Finally, students organize questions and answers for future reference.

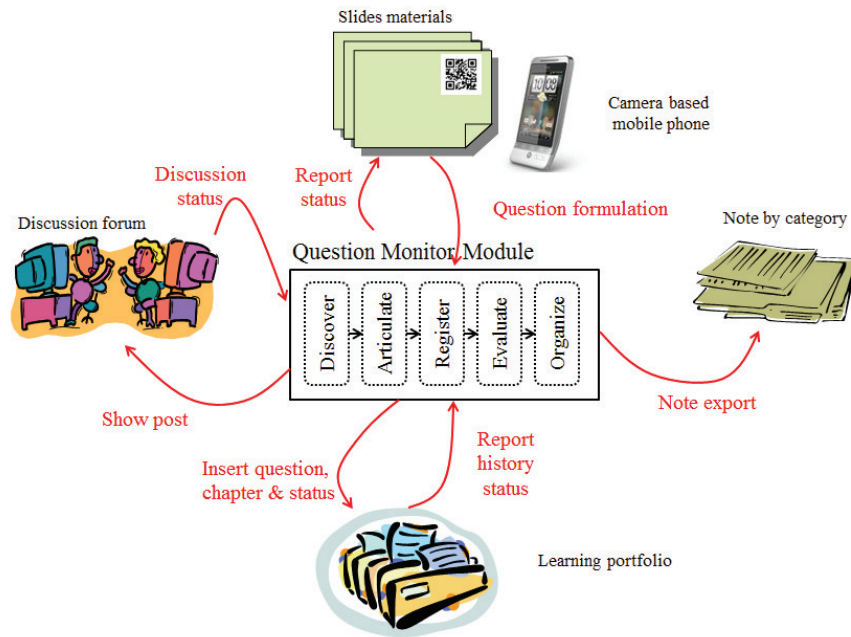


Figure 2. System architecture

2.1 Support for question asking

On a tradition discussion forum, a questioner often has to describe the question clearly. But most of the person who asked is only a beginner and the knowledge is limited. Some student thinks that asking directly with a book is much faster and easier because they can point out the question and describe using symbol and draft. We take this scenario into a classroom, we need to ensure that when students face difficulties they can capture the difficulties immediately and transform them into questions which can be discuss with others. For this point some students may only need examples to understand or they totally don't understand with the content of lecture slides. As shown in Figure 3(a), a lecture slide evenly divided into 9 regions, each region is selectable by touching the regions. The marked regions are highlighted with green color. Students can mark the areas where the students feel confused. They can either find related question on this slides or create a new question based on the marked areas.

With these marks students can intuitively know where they are confused and it is helpful for other students who would like to answer the questions. When the student click the "Ask a question" button, another form for question formulation appears (Figure 3b). A question bank is prepared for students to choose suitable questions. This saves time for students as mobile phones may slow down text input process. After choose the most suitable question the student can add-on additional description for questions at the box provided. At the left side of the screen the marked slide is shown for reference. The students have the choice to keep the question to their self or post out to public area for discussion. After posting questions, students can see their questions are shown on a discussion forum from a question register list (Figure 3c). The system automatically sets the title as a combination of question description, the details of the questioner and the marked slides. Students can freely switch the display of questions between traced and non-traced questions.

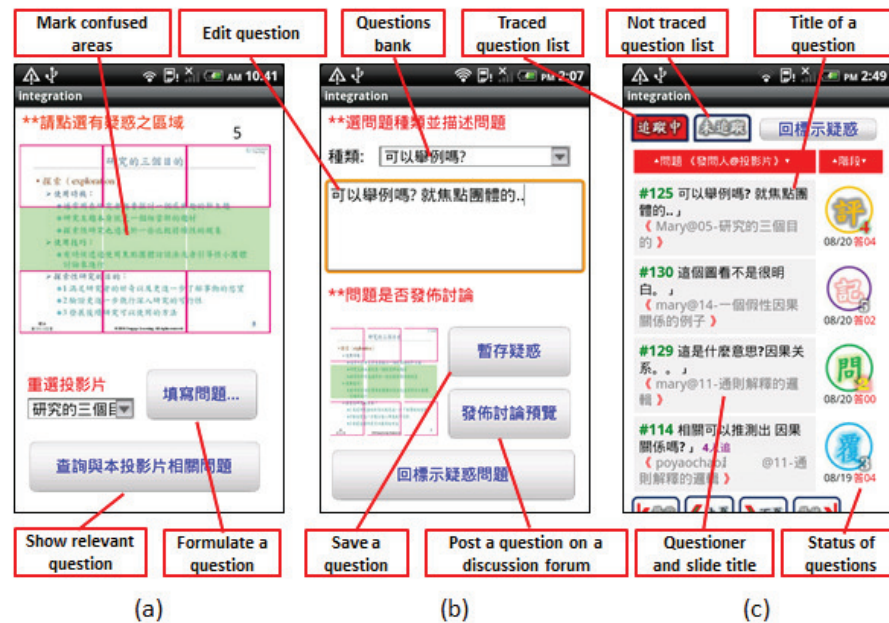


Figure 3. (a) Mark confused areas of a slide; (b) formulate questions based on marked regions; and (c) a list of questions with status icons

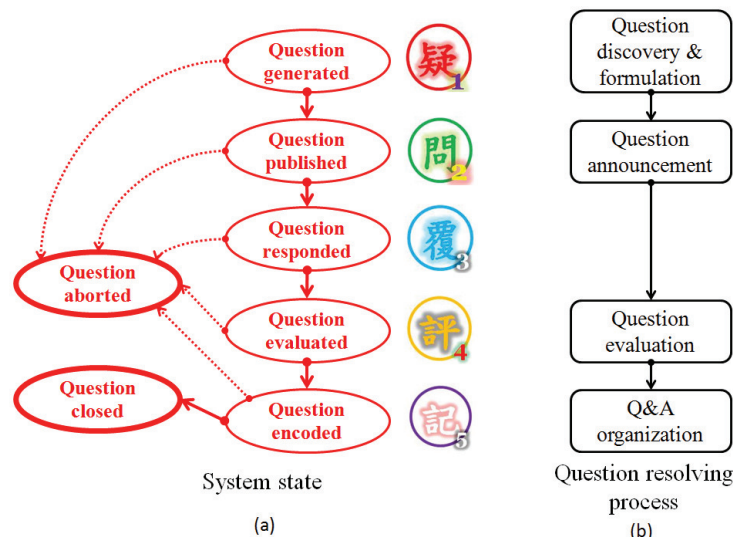


Figure 4. System state and question resolving process

2.2 Support for question resolving and monitoring

Students can monitor the progress of their question as shown in Figure 3(c). Question status represented in the system are categorized into 5 states (Figure 4a). Except the question responded state, each stage in question resolving process is initiated by questioners and corresponds to one state represented in the system. For example, the question generated state stands for the time when students mark down where they are confused and formulate corresponding questions. Therefore, from student's discovery of confusion to organization of Q&A notes, the system has corresponding state in every stage (Figure 4b).

Figure 5(a) shows a student respond to a question. Students name and time of responses will be recorded when a student makes a post. Students can choose to reply the post or evaluate the post when enough post is available. Student who asked the question can delete the question if he/she found out that the questions is not suitable. Students who trace a question can stop tracing the question if no longer of interested. Figure 5(b) shows a post being

selected as useful. When the questioner decides to evaluate the answer, he/she will choose appropriate answers from different students and mark it as useful. These answers then will be transfer to Figure 5(c) which shows the editing of the selected post and being transformed to a note.

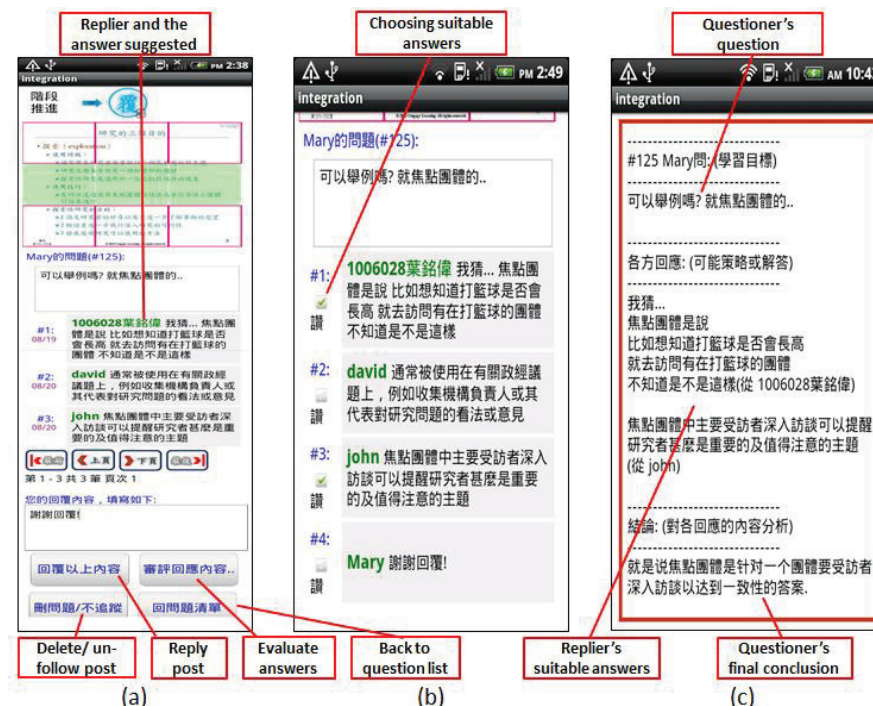


Figure 5. (a) Respond to questions; (b) evaluate replies from different sources; and (c) organize questions and useful replies

3. Evaluation

A formative evaluation was conducted to examine the system's usability and its implication on question resolving. Flagg [7] stated that formative evaluation is one of the most critical steps in the development of learning materials. The goal of the formative evaluation is to help system designers during its early development stages improve system's quality.

3.1 Participants and procedure

We adopt user-based evaluation that involves users completing tasks in an appropriate environment. In this study, five graduate students aged around 23 (4 male and 1 female) majoring in information communication in a university participated in the formative evaluation. Each participant was given a camera-enabled mobile phone. These mobile phones can read barcodes and connect with the Internet through wireless networking functions. Paper-based slides included 50 A4 printed pages and each page is embedded with two dimensional barcodes. Participants were asked to study the paper-based slides during one week evaluation. They are also asked to use the question management system for comprehension question resolving.

Participants were asked to write down operational difficulties and opinions in diary. At the end of the evaluation, participants are asked to perform specific tasks and interviewed. Therefore, observation, interview, and computer logs were collected for analysis.

3.2 Question formulation

There are 43 questions posted by participants using the question management system during the evaluation (9 in stage 2, 13 in stage 3, 18 in stage 5, and 2 questions been deleted). Overall there are 70 replies message during the one-week evaluation and a total of 33 notes has been generated (15 duplicated notes which copied by other students).

From question formulation aspect, three out of 5 students used to generate questions without posting it on discussion forum first. They thought that the clarity of the questions was important before announcement of questions. They would make sure that other people could understand what they were asking about. For example, one of the student states “I usually generate a question whenever I think the confusion exist without posting it out first. After finishing the chapter, I will then refine the question...” The register of questions helps them find answers from rest of the chapter and then refine the questions.

We also found that all participants thought the mechanism of marking confused regions would benefit them. The mechanism helps them shorten the questions when asking. Since there is a marked slides aided, the question would be expressed in a more clear and specific way. Moreover, with the help of marked slides, students can better understand other students’ questions and provide feedback. This mechanism is especially beneficial when asking questions regarding figured-based slides.

3.3 Question resolving and monitoring

Representing questioning stages by icons provides students with guidance in question resolving and helps them develop a processing priority. Students finished question resolving stage by stage. These progress icons assisted students to predict incoming stages and the course toward their goals. For example one student said “I would go from post stage to evaluation stage and then create my notes...” The progress icons also helped students develop personal processing priority and adopt different strategies accordingly. For instance, one student said “I would first read questions which have reached the final stage because the questions usually have specific conclusions. Then I will read questions that most students have responded to them...”

Students also used the progress icons to assess the degree of comprehension to the lecture slides. The overall state of the questions may also influence students’ confidence to the mastery of lecture slides. Most students reported that the more questions in organized stages, the more confidence to a test they can have. On the other hand, if most of a student’s questions still stay in question published stage and no followers trace the student’s questions. The student will come to a conclusion that he/she may post questions with low quality or importance.

All participants’ thought the questions organized as notes was beneficial to questioner and the students tracing them. Four out of 5 participants reported that they would copy their notes in the system and annotate the notes on their textbooks or slides. They all confirmed that these notes are useful when preparing for a test.

4. Conclusion

The goal of this study is to develop a mobile phone based questioning management system that assist students to ask, trace, monitor and solve comprehension questions encountered in class or after class. Students use mobile phones to capture contents of paper slides, assemble the contents with questions as a whole, and post the assembled questions on a discussion forum. The system tracks questions stages and provides students with progress icons to help

monitor and trace the status of post questions as well as organize their personal notes based on the questions during the processes.

From the result of formative evaluation, students thought the mark mechanism could help questioner enhance the clarity of the questions. This is especially useful for novice students with limited background knowledge. Students also thought the progress icons could guide them to the final stage of question resolving and help them assess the comprehension regarding instructional materials. Some students provided useful suggestion for the system. First, a summative status report was suggested. Students could know the distribution of question stages and tackle with different strategies accordingly. Second, a function of anonymous reply seemed useful for students to provide advice or feedback. This is especially beneficial for students who would like to contribute their opinions but fear to make mistakes.

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