

# TEACHING INNOVATION USING A COMPUTERISED AUDIENCE RESPONSE SYSTEM

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**Abstract** During the last decade, Internet and web-based teaching has been widely used in education. However, in university teaching-learning activities, the face-to-face communication in lectures and tutorials are still the most important means of knowledge flow. Without improvement of these teaching and learning practices, any teaching method using advanced internet techniques would not make significant difference in educational standard. In this paper, the application of a computerised audience response system in lectures and tutorials is presented. It has been proved that this innovative method can make classroom teaching more effective and enjoyable for both the teacher and students.

## 1. INTRODUCTION

It has been found by more and more teachers and students that the conventional lecture approach in classroom is of limited effectiveness in both teaching and learning. In such a lecture, students assume a purely passive role and their concentration falls off after 20-30 minutes. The following situation might apply in general to some universities:

### Teaching:

- Teaching in classroom is a “one-way flow”. Lecturers often continuously talk for an hour without knowing students’ response and feedback.
- The material presented is only based on lecture notes and/or textbooks. No new materials such as CD ROM, videotapes and physical models are used.
- Teaching and learning are concentrated on the “plug-and-play” equation approach, rather than emphasis on concepts.
- There is insufficient interaction with students in the classroom. The lecturer does not raise questions and students are reluctant to ask or respond to questions.
- Assessment is onerous, especially for large classes (200-300 students), and consequently not performed often enough. Therefore, the lecturer is often not aware of the depth to which their students grasp their subjects.

### Learning:

- In large classes, the knowledge level of students can be very different. Those who have poor background knowledge could not do conceptual thinking and grasp basic concepts.
- Learning from memorization, but not understanding.
- Marks rather than results orientated study.

- Does not participate proactively and think actively during lectures/tutorials.
- Cannot comprehend adequately to follow lectures and therefore don’t bother to attend lectures. Some students come to the lectures and sleep or try to follow but get frustrated.
- Some students have adequate reading comprehension and manage to follow textbooks – a certain level of self-learning skill. They simply do not attend the lectures at all.

The situation could be exacerbated by the continuous increase of large size classes – an unhappy situation that may become worse in the future. Therefore, without the additional efforts from all academics and the university management, it would be difficult to improve teaching and learning. Teaching/learning innovations could be one of the solutions to alleviate this problem.

In 2001, a new teaching method was investigated at Monash University. The overall aims of this project are:

- a) Develop an innovative approach for the teaching of two engineering subjects using a Computerised Audience Response System (CARS).
- b) Develop a method to encourage conceptual thinking and to establish an interactive teaching/learning environment in classroom.
- c) Accumulate experience and evaluate the results of the CARS, with a view to implementing this teaching technique generally within Engineering Faculty.

## 2. THE PROJECT

The development of Internet technology during the last decade has made many new applications in web-based and internet-supported teaching/learning. However, at the moment, over 90% of university

teaching and learning activities are still based on conventional face-to-face knowledge acquisitions. In my opinion, the conventional teaching approach, which has been used for several centuries, can never be completely replaced by internet-based teaching methods. It is therefore important to turn back our main efforts to investigate and improve conventional teaching. Obviously, there are many problems with the conventional classroom teaching, in which the student only plays a passive role. The effectiveness and efficiency of classroom teaching are therefore very limited. Since the lecture is the main teaching activity, it is important to make it a more active experience for the audience, promoting the efficient acquisition and retention of knowledge through active learning.

The proposed method requires an instantaneous student feedback system, which was purchased from a firm in Hong Kong marketing a "Personal Response System" (PRS), a type of computerised audience response system (CARS). The PRS comprises a one-way wireless communication network. Each student is given a pocket-size transmitter which works on an infra-red signal. With these transmitters, students can respond to multi-choice questionnaires. The test time is pre-set to 2-5 minutes with a 30 seconds warning beep prior the end of test period. A student may have 2-5 chances to change his/her answer. All responses are collected by a simple receiver and relayed to a computer. The results are then displayed on the screen and are open to discussion between the lecturer and students. The transmitters are individually coded, so the performance of each student can be tracked and stored in a database.

### 3. PRINCIPLES OF THE CARS

The basis of the CARS interactive teaching and learning method is to a large extent a form of problem based learning. It can be used for many different purposes:

- Promote students to pre-read lecture materials

Students are given reading assignments such as a section of lecture-notes or textbook to be completed before each lecture. The material assigned could be some basic mathematical theories and relevant concepts to be used in the lecture. It could also be a difficult part for students to think and raise questions to the lecturer in the classroom. At the beginning of the lecture, some multiple-choice questions are given using the CARS. This can evaluate the degree to which the students read the material and marks may count towards their final grades.

- Short tests to find students' understanding of a particular section

During the lecture, an extra motivation can be provided by submitting the students to several short (2-5 minute) tests. Using the CARS, the multiple-choice questions can be designed to examine the conceptual understanding of the contents. These conceptual quizzes can encourage students to learn by concentrating on basic concepts rather than on memorization. It may also be used to introduce a new concept.

- Use CARS for the assessment in tutorial and middle-semester tests

The assessment of large size of classes is always time-consuming. A lecturer has to spend days to mark 200-300 assignments each time which is obviously a big working load. Using the CARS, the test results are collected and analysed by a computer program and can be obtained almost instantaneously. The final exam may also include conceptual questions, which can be done using the CARS, in addition to conventional problem solving types.

- Multi-choice questions prepared by students themselves

Following two hours of interactive teaching, a one-hour tutorial is conducted where students can deal with problem assignments – conventional as well as conceptual. Students are divided into several groups and each group is asked to prepare a multi-choice question according to the material learnt. This question can then be used to test other groups in the tutorial, which help to make the tutorial a very active and effective learning process.

### 4. APPLICATION IN LECTURES

I have used the CARS in my second year subject ECE2002 Electrical Engineering. The class has around 90 students in total. The receivers, software and connection cables were installed in the Theatre. At the beginning of the semester, each student received a transmitter with the code recorded. Students were explained the usage of the CARS and the purpose of this project. With a good understanding about the advantages of the CARS, students have shown continuous interest in participating this project.

In order to successfully apply the CARS in lectures, I spent many hours investigating teaching materials, designing conceptual quiz questions and re-organising lectures. The quiz questions were then used in the lectures. The CARS cannot be used excessively otherwise students will be bored and will lost interest. In each lecture, 2-3 quiz questions were

used, most being conceptual questions. The normal procedure was:

- a) Explain the basic concepts of a chapter and analyse the internal links in the contents.
- b) With examples, further discuss the conditions and applications of the basic theory.
- c) Use a quiz question to check students' understanding. The quiz questions were designed in this way that each incorrect answer was associated with a typical misunderstanding of the specific concept.
- d) From the quiz results, the students can be quickly and accurately assessed. The number of students who selected the wrong answers is very important for the subsequent explanation and organisation of teaching materials. The question was then explained in detail and the mistakes were analysed.
- e) Further quiz questions were given and, following the same procedure, the material was further explained according to students' feedbacks.
- f) Home work and reading assignment were given for students to prepare for attending the next lecture.

In week 8, a test was conducted with 10 quiz questions using the CARS. The test results were received straight away from the program, which provided some important assessment results for the adjustment of the teaching materials and pace. Finally, students' response to the CARS was collected and teaching experience using this system summarised. The CARS used in the classroom is shown in Figs 1-3.

## 5. PROMISES OF THE CARS

The proposed method has been proved to have the following potential benefits:

- a) Students' full attention is assured during the lecture. Using the CARS, they participate more proactively and absorb more than they do with conventional lectures.
- b) Students gain better understanding of basic concepts, in addition to strategic problem solving.
- c) More students learn to use analytical rather than mathematical thinking skills.
- d) A good way to learn is to teach. Students are encouraged to learn through designing their own multi-choice questions, which is the basis of Peer Instruction.
- e) The virtually instantaneous feedback can be gained, which helps the lecturer to know the degree to which students really comprehend the subject. Appropriate adjustments can then be made to the course and presentation.
- f) Multimedia can be used to animate the multi-choice questions and their answers, which

makes the lecture an enjoyable experience for both lecturer and student.

## 6. STUDENT RESPONSE TO THE CARS

At the end of the course, a survey was conducted in the class. Most students gave positive response to the questionnaires. The main responses from students are:

- I am interested in participating the Quiz question sessions
- It helps to check my understanding and get the problems clarified quickly
- I have gained better understanding on the concepts since this system was used
- It keeps me awake in the class

The final examination results clearly show that:

- a) Most of the students who failed in this subject did not regularly attend the lectures or missed many of them.
- b) Students' understanding improves dramatically through the semester. This is not only reflected in the trend of quiz test results of individual students, but also in the final examination results.

It has therefore proved that the CARS is a very useful tool for those academics who really want to improve their teaching and are willing to make a little more effort to make an interactive classroom environment. It is required that the questions are designed to focus on a single concept with adequate multiple-choice answers, not solvable by simply fitting data into equations. They should also be unambiguously worded and neither too easy nor too difficult.

## 7. COSTS OF THE CARS

The new teaching method involves equipping one lecture theatre with two receivers and supplying each student with a transmitter. A PC would be required to work with the CARS. The approximate costs of the system are:

100 - PRS transmitters	HK\$21,000
2 - receivers	HK\$1,290
Software and delivery	HK\$1,000
Total	HK\$23,290
<b>Total in AU\$ (at rate 4.1)</b>	<b>\$5,680</b>

Once students have their transmitters, it will not be expensive to expand the method to the teaching of other courses.

## 8. CONCLUSIONS

From my 25 years teaching experience, I feel strongly that some major problems should be solved in conventional teaching and the following issues need urgent attention:

- How to establish an interactive teaching environment in classrooms?
- How to quickly assess students without significantly increasing the teaching load?
- How to promote active participation in the classroom?
- How to encourage conceptual teaching and learning?
- How to change students' attitude from mark-driven to career-driven?

The CARS is proved to be a very promising teaching tool to address the above issues. In summary, the application of the CARS in teaching has the following advantages:

- a) Attracts much attention from students
- b) Improves student participation in question-and-answer sessions
- c) Instant feedback on students' responses, including test and quiz results
- d) Automatic attendance check
- e) Automatic recording of student answers
- f) Enables shy and other disadvantaged students to be proactive
- g) Encourages students' preparation before attending classes
- h) Helps to establish an active learning environment in the classroom

There are many other applications such as the assessment in class and peer instruction in tutorials.

Students' responses to this system have been very good. With appropriate preparation, a lecturer can gain many benefits of this powerful teaching tool, which can turn large group teaching sessions into a truly interactive and fun experience for both the lecturer and the audience.

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Fig. 1 Students answer multi-choice questions with the individually coded transmitters

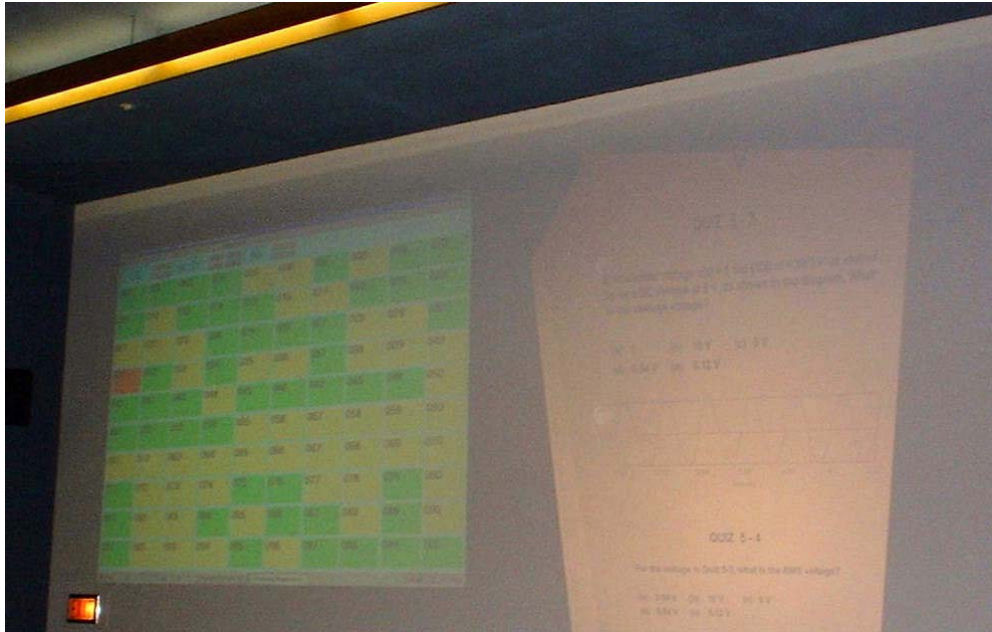


Fig. 2 The multi-choice question is shown on the right hand side and students' answers are received by the receiver and relayed to a computer to display on the screen (left). Each student has a number. The number turns red when the student's response is received. It then turns to green colour after two seconds.

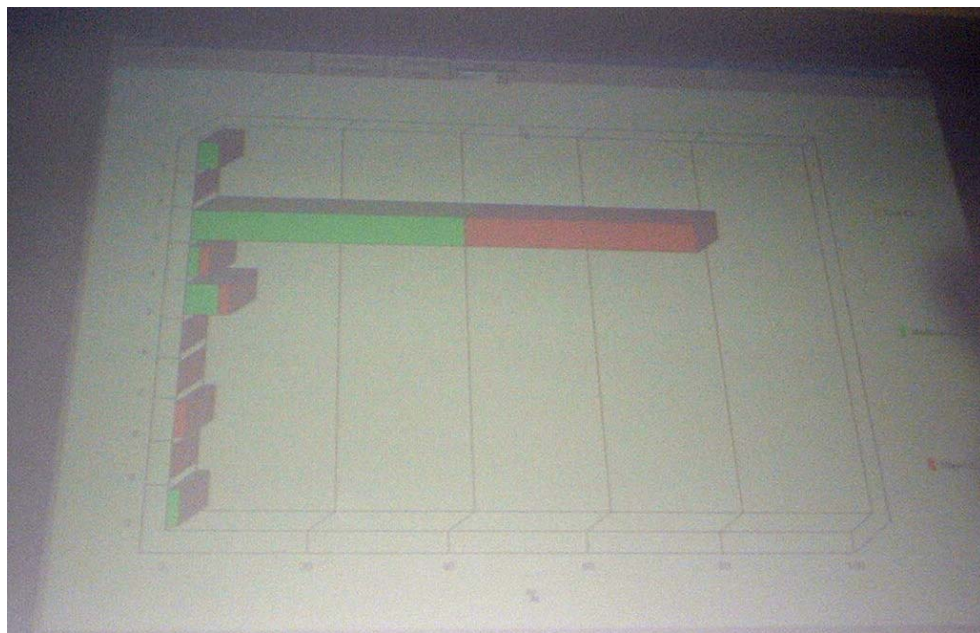


Fig. 3 At the end of the preset test time (2-5 minutes), the students' answers are summarised and displayed on the screen in statistical form. The results are then open for discussions between the lecturer and students.