
Do Mathematics Interactive Classrooms Help Academics Engage Learners (MICHAEL)?

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In recent editions of this newsletter, Ray Inverno (2003) and Ernst Wit (2003) have described the benefits of using the PRS Personal Response System or “zappers” in mathematics teaching. PRS has been well used at Portsmouth for over 5 years (McCabe, Heal and White, 2001) in several subject areas, including mathematics, and prior to that a more expensive system called Teamworker (Irving, 2000) was used. In fact, the PRS system is just one of several “group response systems”, which are themselves a subset of the more powerful “classroom communications systems”. Michael McCabe has been exploring the use of these interactive classrooms in his National Teaching Fellowship project LOLA (Live and On-Line Assessment). The following light-hearted (and partly true!) conversation attempts to explain how this work has evolved:

“Oh, so you use those zipper things in your teaching! Isn’t it like asking the audience in that dreadful millionaire game show ?”, commented a grade 5 applied maths research-focused lecturer from the Institute of Cosmology and Gravitation.

“Well, yes. Sort of”, I responded, “I prefer to call them handsets for group response systems. They allow students to input answers to questions during classes by pressing a button on a small, handheld device and enable me to display the results instantly. You can think of it as a one-way classroom communication system (CCS).”

“A classroom communication system, indeed! I thought that was called a lecturer”, he joked.

“That’s true, but lecturers can’t communicate personally with large numbers of students in a classroom. There just isn’t enough time to help every student individually. Classroom communication systems extend a group response system by enabling two-way communication between a lecturer and students. I’ve even started using a portable CCS, my Mobile Interactive Classroom Kit.”

“So, you’re taking the MICK when you teach!”

“I guess so. If we’re in humorous acronym mode, how about Mathematics Interactive Classrooms Help Academics Engage Learners? MICHAEL, that’s my name! Look, let me explain from the beginning.

Once upon a time I worked in an electricity industry research division. For 10 years I did nothing but research, except for some part-time teaching for the Open University. In the OU students have completed computer marked assignments for decades. They shade boxes on an answer sheet, submit it by post and get sent their results a few days or even weeks later.”

“What’s this got to do with zappers?”

“Handsets enable answers to be submitted and results presented immediately in front of a live class. But let me continue my story. Eventually I returned to higher education as a lecturer here at the University of Portsmouth. Before long, I found myself with 22 hours of teaching contact a week and large classes. My idea of a lecture was to generate a large number of transparencies and talk my way through them. This seemed easier than writing on a board, but it was the mounds of repetitive assessment to mark, which came as serious

shock. In 1991 I discovered that a computer could mark questions and was delighted to see scores for hundreds of students generated automatically. Of course, my initial motivation was selfish, but I quickly learned to emphasise the benefits for students: immediacy of results, question feedback, objective marking, test availability and so on. Nowadays, issues such as test security, reliability, question design and suitability for higher level learning are important considerations too. CAA is still a growth industry, especially now that it can be delivered on-line and used within VLE/MLEs."

"But what about zappers ... er ... handsets?"

"Handsets are a form of CAA, live assessment if you like. The next stage for me was in developing Computer Based Learning CBL software. If computers could assess, then they could teach as well. Large sums of money were invested. I, and many others, spent years developing mathematical software, which was going to be so exciting and straightforward to use that students would simply click their mouse and understanding would prevail. Initially the premise was that interactive multimedia would free up vast amounts of teaching time and save money. Later the argument was that the software would enrich courses, make "teaching" available at any time and allow for diversity of learning styles. Yet even with the advent of on-line learning the computer is limited in what it can deliver on its own. There are even some who would prefer to see these weapons of mass (math) instruction eliminated altogether!"

"How do you see on-line learning then?"

"It's great if there is no alternative. Furthermore on-line learning does not eliminate the human element altogether. E-moderators can help students with their e-tivities and facilitate e-learning. On-line learning can also be used to support more traditional teaching methods. The lecturer becomes the guide on the side rather than the sage on the stage."

"OK, but what about conventional face-to-face lectures?"

"For some the sheaf of OHP transparencies has been replaced by e-lectures with slick Powerpoint presentations, even featuring animations and other multimedia. Students passively watch the show and walk happily out with their neatly printed notes. Some call this "Death by Powerpoint". Coupled with computer based tests or "Inquisition by Question Mark" teaching and assessment can become as appetising as pre-processed ready meals!"

"So, what's the answer?"

"Live teaching can be made more engaging and interactive in many ways, which don't involve learning technology. Much has been written about simple techniques to improve lectures, but there is a common difficulty. If you ask a question, either a precise objective question or a more open-ended, subjective question, how do you collect the answers, analyse them and then provide feedback? Worse still, a problem may involve several stages. If a worksheet is handed out to a class, it becomes nigh impossible to monitor what every student is doing simultaneously. Furthermore, how do you encourage all students to ask questions, especially the apparently stupid questions, without fear of embarrassment?"

Learning technology is often viewed as sidelining human communication, but we rarely think that way about mobile phones and cars. It's really about whether you focus on the I or the C of ICT, Information and Communication Technology. Let me put it another way!

Whether you, as a cosmologist, look up into the stars of the night sky or out into the faces of students in a classroom, the problem is similar. What is going on out there? Cosmic distances can be less of a barrier than the space between lecturer and student heads. Technology helps reveal the mysteries of the Universe, but it can also help in exposing the thinking within student minds. An astronomer observes electromagnetic radiation and develops theories about the Universe; a lecturer observes responses to questions or solutions to problems and interprets them. The lecturer may then try to provide suitable feedback and adapt subsequent teaching."

"Right. So handsets solve the communication problem?"

"Not exactly, but they can help. Basic use might involve students inputting answers to multiple-choice questions and their confidence levels during a revision class or a quiz at the beginning or end of a class. Results can be viewed by lecturer and students together and then discussed further. The anonymity of individual answers encourages all students to participate. More advanced use integrates teaching and questioning more closely. For example, peer instruction is a technique in which students are encouraged to discuss and maybe modify their answers to conceptual questions in groups. Individual student scores and feedback in computer-assisted assessment are replaced by group score distributions and confidence levels. The lecturer rather than the computer generally provides the feedback and the group response system becomes a tool helping a

lecturer to communicate with students better.”

“So what are the limitations of group response systems using handsets?”

“Firstly the computer communication is one-way. A good way of illustrating this is to recognise that students cannot ask questions via a handset. They can only answer them. Anonymity is as valuable in asking questions as in answering them. Two-way computer communication opens up a greater range of computer and human interactions. Secondly, most handsets are quite limited in the varieties of question types, which they support. Typically only multiple choice and simple numeric questions are all that is possible. Lastly, the transporting and setting up of a group response system can be a hassle if it is not installed in a classroom already.”

“Ah, you said you used a classroom communication system.”

“Yes. First of all we set up a special interactive teaching lab (Fig 1). The lecturer faces the students and controls the delivery of information or questions to the student computers. There could, for example, be a Web page on the right of the screen and an objective question to answer on the left, based on study of the Web page.”

“What do you mean by an objective question?”

“An answer which is right or wrong. Although there may be many correct answers and a single question may

have several component parts.

Student responses are submitted, analysed and fed back to the lecturer, who then decides what happens next. The results can then be used privately or publicly. In the latter case they would typically be sent to the student screen as a bar chart or pie diagram for further discussion. The computer is not a substitute for conventional teaching and verbal communication, but rather it extends the lecturer’s ability to communicate.”

“What about questions without a correct answer?”

“Open-ended or subjective questions are an interesting option. For example, students can be asked to write brief notes, including mathematical expressions. The lecturer can see what every student in the classroom is doing instantly, while they are doing it. Answers can be reviewed by the lecturer and some or all of them presented back to the student screens for further discussion.

Another interesting example is the skeleton worksheet. Conventionally a lecturer gives out printed notes with blank spaces for the student to complete in class. The lecturer walks around, looking over shoulders, and tries to help students individually. Instead a lecturer can view the progress of each student simultaneously and adapt teaching accordingly, with computer feedback of answers, verbal comments and so on. You could say that “face-to-back teaching” can revert to “face-to-face teaching” again. Graphical questions with hotspots are yet another possibility.

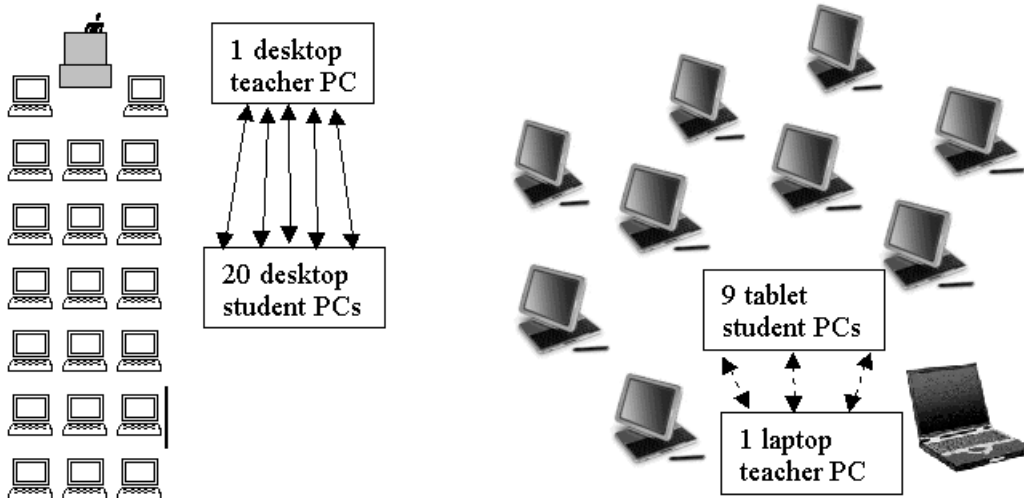


Fig 1 Classroom Communication Systems
Left: Networked Interactive Classroom Kit (NICK)
Right: Mobile Interactive Classroom Kit (MICK)

The ability for a lecturer, and not just a computer, to provide immediate feedback is the real power of a CCS. We've come a long way from CAA, CBL and even on-line learning."

"Have others done this before?"

"They have (Dufresne et al., 1996), but the technology has been rather clunky. It is only in recent years that the hardware and software have become adequate for the task."

"Are there drawbacks in all this?"

"You could say that knowing instantly that your students don't understand is a drawback. You can't just plough on with your Powerpoint presentation or OHPs assuming that students follow what you are saying. An extreme proposal is to provide a light in the corner of the lecturer screen, allowing students to convey their understanding of a lecture continuously. The light changes from green to red as more students express their bewilderment. That's quite different from feedback forms at the end of a course, but students do have other ways of expressing their opinions!

The skill needed to combine conventional teaching with interactive classroom technology is not trivial. There is always the danger that the technology gets in the way and becomes an end in itself. In our teaching lab the computers do that quite literally, because students tend to peer over the top of their screens. The technology can be intrusive."

"What about taking the MICK, your Mobile Interactive Classroom Kit?"

"Yes. That's a recent development. I use a laptop PC, while students use tablet PCs, which are far more discreet. The tablets can even be laid flat on a desk and use a stylus for input. The whole system is wirelessly connected, independent from the university network, and can be transported around in a shopping trolley."

"A shopping trolley?"

"Yes. I have thousands of pounds of equipment, but I push it around in an old trolley purchased for £5 from an Oxfam shop. Normally you only see little old ladies pushing them. One sceptical colleague even asked me which supermarket I used!"

"What do students think of all this?"

"At first they are quite bemused by it all. That is always the risk when you ask students to work in a class on something new! The majority do like the greater class involvement. Furthermore they like having the ability to both answer and ask questions anonymously. I am well aware that I have barely scratched the surface of what is possible, but it is encouraging when students ask why they can't have more classes like this as they leave the room. I am trying to do just that."

"What about staff?"

"I am just beginning to work with colleagues, who can see the opportunities for use of interactive classrooms. I used my MICK at an international conference recently. Some delegates were as bemused as students, but there was recognition of the potential for the technology. Perhaps I should leave the last word to my co-presenter after the session."

"That was great intercourse we had", he suggested.

"I wouldn't go that far. You're taking the MICK!", I replied.

In the next edition of *MSOR Connections*, Michael will explain in more detail how interactive classrooms are being used for the teaching of mathematics.

References

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