Audience response systems (ARS) comprise hardware and software that is used in conjunction with face-to-face educational processes to support, deepen, and enhance learning by promoting greater interaction between all those engaged in a learning activity. The price of the systems has fallen dramatically over the past 10 years, and they offer a low-cost investment that has the potential to significantly improve face-to-face teaching and learning. They can be used with small or large groups, and can easily be set up for a single one-off session, or established as permanent installations.

The overt aspects of interaction are achieved by means of a feedback loop in which a question is asked, or an issue is raised (Figure 1). The question is typically displayed via PowerPoint slides. Each participant indicates their response from a set of options provided on the slide by using a personal data entry device to transmit one or more digits to a receiver attached to a computer. The input device may be a simple numeric keypad, sometimes referred to as a “clicker” or “zapper,” or a full-text entry device such as a laptop computer, personal digital assistant (PDA), or mobile phone. The ARS software on the computer then processes the acquired data and displays the resulting transformed data on a public screen via a data projector. It is possible, and in many cases desirable, to insert a nontechnology-supported discussion activity between the raising of a question and the entry of responses.

The process can be used to encourage responses from all participants, and these responses can be anonymous. For students who are shy or from some cultures where “loss of face” is a significant issue, the anonymity afforded by an ARS can provide an opportunity for them to participate without fear of ridicule, should they volunteer an incorrect response. Students are also provided with the opportunity to see how other members of the group view the issue, and are thus able to gauge their own level of understanding relative to the whole group. In some cases there may be a single “right” answer, and this allows summative assessment to take place, if required. In many other cases there will be no single “right” answer, and in this situation, the collected data can be used as a trigger for discussion, that is, for a formative development process.
Although it can be argued that the word “audience” may not be the best word that could be used to describe these systems in the context of education, it has been used in the title of this book for the pragmatic reason that this will obtain the greatest number of “hits” when an internet search is carried out by readers wishing to find more information. Five years ago, the systems would typically have been found under the headings of group decision support systems (GDSS) or group process support systems (GPSS), and these still provide rich and significant areas of literature to support the application of these systems. The nomenclature used to describe these systems is still evolving, and they can be found variously described as classroom response systems, electronic voting systems, or simply by their product name.

The word “audience,” coupled with the use of this technology in such popular game shows as “Who Wants to be a Millionaire,” can suggest a relatively passive, or at best, intermittently-involved group of participants, but the key aim of the technology in educational settings is to turn potential passivity into dynamic interaction. The techn-
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technology itself cannot achieve this, of course. Only when such technology is carefully
embedded within designed human processes can significant gains be made in the overall process. This suggests that the users of the technology need to have a clear idea of why they are using the technology, and how it can be used effectively within broader educational structures and processes. The technology, in itself, does not offer some wonderful new “magic bullet” that will offer learning gains simply by its adoption. It can certainly provide novelty and fun for all participants, but must be used within the context of the teaching and learning process for its full promise to be achieved.

In the context of education, the “systems” aspect of the phrase should be taken, as for all information systems, as meaning that the technology is simply part of an overall learning system that has as its actors the academic and support staff, and the learners, and is situated within an educational environment. The instant feedback provided by the technology allows the learning facilitator to identify problem areas, and immediately revisit areas where there is evidence of lack of understanding. Prior knowledge can be explored when a course first starts, so that the risk of boring students who may already have a grasp of the basic subject material can be avoided. The feedback can also allow adjustment of pacing as easily. In cases where the feedback indicates that some ideas are quickly assimilated, the pacing of the course can be adjusted so that more time can be spent on more problematic areas.

These systems have been, and still are, used in business, as well as at all levels of training and education. The words “higher education” appear in the title of the book to manage the scope of the publication. This does not mean that the approaches detailed by the authors of the chapters cannot be applied in other settings, and some authors have extended the boundary of “higher education” into K-12, and into conference and consultancy areas. Even though the cost of these systems has been constantly dropping in the past 5 years, there will still be a need to justify the purchase in an educational environment where competition for scarce resources is increasingly problematic. The possibility for extended use of these systems to support public relations’ exercises, links to K-12 for recruitment support, and for consultancy opportunities with the business world may help build a stronger case for procurement.

From my own perspective, I found it frustrating that although there was a considerable body of literature relating to these systems, it was scattered throughout a wide range of journals, books, and collections of conference papers. My aim in editing this book was to bring together, into a single collection, the work of a number of authors who have been involved with the development of these systems, are currently using the systems, or who are extending the underlying theory or technology. Chapters range across articulation of the history and development of these systems, discussion of educational theories that appear to be appropriate for their use, and cases illustrating current examples of their use in practice. The subject areas illustrated in this book include law, engineering, computing, medicine, physics, mathematics, and psychology. There is no reason to prevent the systems from being used to support art, history, or philosophy, or any other subject area. This is an exciting area to work in, and there are important lessons to be learned by looking at the work of those people who have been involved in the development and application of these systems. Some of the authors in this book have a long history of involvement with these systems, while others are only just starting the journey. All adopters of these systems seem to go through a similar development process, and this means that considerable “reinvention of the wheel” has taken
place. It is hoped that this book will not only prompt more educators to explore these systems, but also help reduce the need for reinvention and allow ideas to be shared so that both teaching and further research can be encouraged in this field.

The book is organized into three main parts, or themes, although there is some overlap between them. The first part (Chapters I to IV) provides some historical context from the perspective of individuals who have been involved with Audience Response Systems for a considerable period of time. The midsection of the book (Chapters V to XX) provides practical cases in a variety of subjects, interleaved with discussions of aspects of pedagogy associated with the application of these systems in educational settings. The final part of the book (Chapters XXI to XXIV) outlines some of the directions that the technological components of these systems may take in the future.

I have used the final chapter to outline some of my own work, to draw together the key themes in the book, and to suggest possible directions for the future. A brief description of each chapter follows.

Section I

Chapter I: A Brief History of Networked Classrooms: Effects, Cases, Pedagogy, and Implications, by Louis Abrahamson of The Better Education Foundation. This chapter poses the question “for an idea apparently more than forty years old, why did it take this long to happen?” It provides a brief history of early response systems, and draws upon the author’s experience to outline hardware development, and some of the pedagogic challenges and successes. It concludes with a positive and enthusiastic view of the future of these types of educational support systems.

Chapter II: Audience Response Systems: Insipid Contrivances or Inspiring Tools? by Eugene Judson of Arizona State University and Daiyo Sawada of the University of Alberta. This chapter also provides some historical material, and then goes on to take a critical view of the value of these systems in terms of their impact on student achievement, the overall benefits that may be obtained, and the impact on pedagogy for ARS to be used effectively. They suggest that one powerful way forward is to consider the deliberate formation of learning communities.

Chapter III: The Use and Evolution of an Audience Response System, by Ray A. Burnstein and Leon M. Lederman of Illinois Institute of Technology (IIS), Chicago, reports on 10 years of development of wireless ARS at IIS from the spring semester in 1994 with an elementary physics class. Approaches to developing ARS questions built on Bloom’s Taxonomy are presented, and they explore a multiple-choice category identified as “partially-correct multiple choice” that supports the higher levels of the Taxonomy. Several limitations to the use of ARS are presented and some thought offered on ways that academics can be helped in their adoption of these systems.

Chapter IV: ARS Evolution: Reflections and Recommendations, by Harold M. Horowitz of Socratec, Inc. This chapter documents the more technical aspects of the development of ARS from work carried out by the author at the IBM Management Development Center in the mid-1980s through to several recent commercial systems. He notes that an infrared transmitter today costs less than 10% of a similar device a decade earlier. He finally offers 10 pragmatic tips, based on his many years of experience with these systems, for the effective use of these systems.
Section II

Chapter V: Practical Lessons from Four Years of Using an ARS in Every Lecture of a Large Class, by Quintin I. Cutts of the University of Glasgow in the UK, reports on the introduction and extensive use of an ARS in an introductory computing class. He stresses the need for, and great value of, the sharing of logistical and pedagogical ideas among the staff at his university. Unlike many adopters who introduce the use of an ARS in a rather piecemeal way, he outlines a much more sweeping introduction. The chapter shares many practical insights involved in the complex process of adapting existing courses for use with an ARS.

Chapter VI: Using an Audience Response System to Enhance Student Engagement in Large Group Orientation: A Law Faculty Case Study, by Sally Kift of the Faculty of Law at Queensland University of Technology, explores the application of an ARS to help a large and diverse cohort of students who are faced with transition between disciplines, or at their first entry point to the university. This is a stressful time for students and traditional orientation processes, and Kift puts forward a persuasive case that suggests that an ARS can offer significant benefits at this critical transition point.

Chapter VII: Question Driven Instruction: Teaching Science (Well) with an Audience Response System, by Ian D. Beatty, William J. Leonard, William J. Gerace, and Robert J. Dufresne of the Physics Education Research Group at the University of Massachusetts, explores Question Driven Instruction, a pedagogic approach that focuses specifically upon teaching that is supported by an ARS. The chapter is a blend of theory and practice, and illustrates how an ARS can be used to encourage and support deep learning. They advocate ARS-mediated activity as a primary course design goal, rather than an approach that uses an ARS as an occasional adjunct to traditional practice. They acknowledge that using new teaching techniques can be difficult or threatening, and offer their experiences in approaches to support new adopters.

Chapter VIII: Anonymous Polling in an Engineering Tutorial Environment: A Case Study, by Steven M. Durbin and Kristi A. Durbin of the University of Canterbury in New Zealand, provides a case study examining the introduction of an ARS to a second-year introductory-level engineering tutorial. The ARS was introduced in response to problems created by poor attendance at tutorials due to changes in the profile of the student population. It was felt that increasing student participation, and adopting both visual and verbal approaches, would help to alleviate this problem. The new approach was well received, and several other departments are exploring the technology.

Chapter IX: Using Audience Response Systems to Develop Critical Thinking Skills, by Robert Webking of the Department of Political Science at the University of Texas and Felix Valenzuela of the Yale Law School, discusses the introduction of an ARS to political science classes at the University of Texas at El Paso. The chapter explores a number of issues related to active participation, and the place of anonymity in the process. They strongly feel that the introduction of an ARS has improved the level and quality of student engagement in a variety of class sizes, and has contributed positively to the development or enhancement of critical analysis skills.

Chapter X: Using the Personal Response System to Enhance Student Learning: Some Evidence from Teaching Economics, by Kevin Hinde and Andrew Hunt of the University of Durham, examines the extensive use of an ARS with introductory economics students to support the building of classroom communities, to promote deeper ques-
tioning, and as a feedback mechanism to inform the teaching process. The system was introduced partly in response to the need to improve face-to-face learning in the light of both increasing class sizes and shifts in the expectations of recent student cohorts. They provide discussion of data from a questionnaire administered to 219 students who had used the ARS.

Chapter XI: Evaluating Electronic Voting Systems in Lectures: Two Innovative Methods, by Gregor E. Kennedy of the Biomedical Multimedia Unit at the University of Melbourne, and Quintin I. Cutts and Stephen W. Draper of the University of Glasgow, departments of Computing Science and Psychology respectively, focuses upon observation and audit trails as tools for evaluating students’ and teachers’ perceptions of Electronic Voting Systems. They have developed an observational coding schema, and present the results of their observational work. Their second approach examines ways of dealing with the wealth of rather messy data that is generated during the use of these electronic systems, so that it can be used to support auditing to provide insights to the process under consideration.

Chapter XII: Selected and Constructed Response Systems in Mathematics Classrooms, by Leslee Francis Pelton and Timothy W. Pelton of the University of Victoria, Canada, discusses their use of audience response technologies to support the teaching of mathematics. They differentiate between the typical keypad systems that allow participants to choose from a menu of predetermined options (selected response) and systems which allow participants to construct their own responses, which are entered onto a handheld computer (constructed response). They provide details of their use of both types of systems in practical classroom settings.

Chapter XIII: Theorizing the Transformed Classroom: Sociocultural Interpretation of the Effects of Audience Response Systems in Higher Education, by William R. Penuel (SRI International, USA), Louis Abrahamson (Better Education Foundation, USA), and Jeremy Roschelle (SRI International, USA), develops a theoretical framework to support exploration of the use of ARS in classroom settings. They note the importance of helping students to identify misconceptions as a vital step in development of deeper learning. Such approaches can be challenging for staff and students alike, and the chapter considers how the idea of classroom communities based on mutual trust may help in providing an appropriate basis for improved ARS-mediated learning environments.

Chapter XIV: Wireless Interactive Teaching by Using Keypad-Based ARS, by Jiankun Hu, Peter Bertok, Margaret Hamilton, Graeme White, and Anita Duff of RMIT University in Melbourne and Quintin Cutts of the University of Glasgow, brings in their experiences in the use of ARS, particularly with students from a variety of cultural backgrounds. They present two cases, the first being a fairly concrete programming-oriented course with a rich mix of cultures; the second case being a broadcast network engineering course with more abstract concepts, again with a high percentage of students with a non-English speaking background. The chapter also considers practical implementation issues, and closes with some future plans.

Chapter XV: The Audience Response System: A New Resource in Medical Education, by Vivienne O’Connor, Michele Groves and Sandy Minck of the University of Queensland, shows how ARS have been adopted as part of the response to increases in various demands in medical education, as the educational mode shifts from a tradi-
tional teacher-centric model towards a learner-centred interactive model. Building from a problem-based learning model, they explain how an ARS can be used in conjunction with large-group clinical symposia to explore such issues as misinformation, clinical reasoning, and medical errors. The chapter presents data from a year-end survey, along with comments from students.

Chapter XVI: Learning and Anxiety: Exploring Individual Judgement Processes in a Learning Environment with a Group Support System, by Sam Groves, Tony Gear, Cath Jones, and Michael Connolly of the University of Glamorgan, and Martin Read of the University of Portsmouth, shows how an understanding of group support processes can coupled with appropriate use of an ARS to reduce the social influences that may inhibit a group from arriving at desired outcomes. They argue that the use of an ARS can help to provide a safe environment within which effective communication and shared meaning can be achieved. They provide a brief educational case, and then identify a range of other activities that an ARS can support.

Chapter XVII: The Trial of an Audience Response System to Facilitate Problem-Based Learning in Legal Education, by Kelley Burton of the School of Law at Queensland University of Technology in Brisbane, provides a case-based perspective on the trial of an ARS to support a core second-year undergraduate law subject. The trial involved 140 full-time and 40 part-time students, and was based around a case study involving a specific legal issue. A problem-based learning approach is used, and the task is of a formative nature. A survey of the students was undertaken using the ARS and the feedback was strongly positive, but the author acknowledges that this may be due to the novelty of the approach, and further studies are needed.

Chapter XVIII: Live Assessment by Questioning in an Interactive Classroom, by Michael McCabe of the Department of Mathematics at the University of Portsmouth, UK. This chapter builds on the analogy of popular TV quiz shows, and provides a wide range of interesting and practical ideas for the use of ARS in the classroom. He notes the problem of the unpredictability of students’ responses, and stresses the need for a lecturer to develop the skill to utilise the technology effectively, and to be able to respond in flexible and “unscripted” ways to the flow of the process. He also stresses the importance of pedagogy driving the development of the technology rather than the other way round.

Chapter XIX: Eight Years of Asking Questions, by Jim Boyle of the University of Strathclyde, reflects on the experiences of the Department of Electrical Engineering in their attempts to remedy declining class attendance through the development of an interactive classroom. The technology was only one part of the project, considerable thought being given to the whole learning experience. In addition to the introduction of an ARS, attention has been paid to Peer Instruction, Problem-Based Learning, and Studio Teaching, along with revised curricula. The latter part of the chapter presents the lessons that have been learned from their experiences, and looks forward to future developments.

Chapter XX: Interactive Response Systems in Higher Education, by Mick Wood of the Learning Development Unit at the University of Central Lancashire, provides a view through the eyes of a multimedia development officer. He details the procurement process and some of the technical issues that needed to be addressed to implement the chosen system. The chapter indicates the type of support services that need to be
provided for these systems to be brought into operation and maintained. The chapter provides details of how the system is being used to support e-marketing and physiology modules, and also a conference application.

Section III
Chapter XXI: *CommuniCubes: Intermediate Technology for Interaction with Student Groups*, by Stephen J. Bostock, Julie A. Hulme, and Mark A. Davys of Keele University, provides details of a nonelectronic approach that can be used in both large lecture theatres and small seminar rooms. The chapter makes the point that if the learning design is well thought through, it is possible to make use of quite simple “technology.” This technology has the added benefit that a Braille version could be used with blind students, providing greater opportunities for disadvantaged students. Details of the use of CommuniCubes with 120 first-year psychology students in lecture, s and with smaller groups of law students are presented.

Chapter XXII: *Creating a Constructed Response System to Support Active Learning*, by Tim Pelton and Leslee Francis Pelton of the University of Victoria, Canada, outlines the development of a prototype classroom interaction system that utilises handheld computers that participants use to communicate with a laptop computer managed by the learning facilitator. The handheld computers enable students to produce images that can be shared via the central laptop computer. After a short training time, students became proficient and had a positive response to the system. The prototype is non-commercial, and the authors encourage broader participation in the ongoing development.

Chapter XXIII: *Instructor Mobile Audience Response System*, by Jay Dominick and Anne Bishop of Wake Forest University, USA, describes an ARS in which the instructor has a PocketPC wireless linked to the students, thus allowing freedom to roam and work with small student groups in a lecture theatre. The instructor device can access the lecture theatre computer and remotely manage data that appears on the public screen. The authors present the view that this freedom to roam allows instructors to operate in their natural classroom style without the need to return to a fixed computer. Pilot projects using the system with physics, chemistry, sociology, and mathematics are briefly presented.

Chapter XXIV: *Using Mobile Phones and PDAs in Ad-Hoc Audience Response Systems*, by Matt Jones of the University of Waikato, New Zealand, and Gary Marsden and Dominic Gruijters of the University of Cape Town, South Africa, explains their novel use of mobile phones as ad hoc audience response systems. Unlike many of us who ask for mobile phones to be turned off when we start sessions, these authors request that phones be turned on! The pilot study system is described, and applications to first-year programming and human-computer interaction classes are presented. The latter part of the chapter explores the use of PDAs and advanced mobile phones.

Chapter XXV: *Reflections on the Use of ARS with Small Groups*, by David A. Banks of the University of South Australia, focuses on the use of ARS with groups of between 5 and 50 students to support presentation feedback, peer review, course evaluation processes, as well as some group activities, to support a process-oriented Masters course. Three brands of ARS have been used to support this work, and the use of a larger
electronic meeting system is also outlined to indicate the value of text entry systems: some comparisons being drawn between the various systems.

Endnotes

1  http://www.keepad.com
•  All chapters in this book have been subjected to review by at least two reviewers. The authors were not advised of the names of the reviewers, and the reviewers were not advised of the names of the authors.