Audience response systems in practice: Improving Hong Kong students' understanding of decision support systems

David A. Banks
School of Computer and Information Science
University of South Australia

Ann Monday
School of Management
University of South Australia

There will almost always be a number of students who are reluctant to actively contribute in face-to-face learning situations because they are shy or are culturally concerned about potential loss of face. Audience Response Systems (ARS) are part of a technology that, principally through its feature of anonymity, offers the opportunity for all students to safely contribute in face-to-face learning situations via individual keypads. Greater feedback from a group of learners poses benefits for both learner and teacher. For the teacher it can help identify areas where student understanding may be weak or incorrect and thus allow appropriate feedback to be applied. For the learner it allows them to see how fellow students are coping and to gauge their own relative performance. This paper reports on the use of an ARS with a group of students in Hong Kong studying a second year undergraduate decision support course. The ARS was used to provide process support for a revision session that explored decision support systems (DSS) and decision making and also to gather some details about the students as a population of learners.

Keywords: electronic meeting systems (EMS), audience response systems (ARS), decision support systems (DSS), Hong Kong, culture, teaching and learning strategies

Introduction

This paper explores the use of an Audience Response System (ARS) with a group of students in Hong Kong studying a second year, second semester undergraduate decision support course. The ARS was used to provide process support for a revision session that explored decision support systems and decision making and also to gather some details about the students as a population of learners. Not all the questions posed during the session or data collected are reported here. The first part of this paper provides a brief background to ARS, the student cohort and the rationale for using an ARS in this session. The second part of the paper outlines the use of the ARS in practice. The paper concludes with a discussion of relevant issues and reports the student reaction to the session.

Audience response systems

An audience response system is a collection of hardware and software that enables members of an audience to provide responses to situations that are generated by a facilitator. Data is presented to the audience via a public screen and members of the audience express individual responses through a numeric keypad, the collected data being aggregated by the software and fed back to the public screen as part of a learning cycle. Roschelle, Abrahamson and Penuel (2004) suggest that the use of these systems impacts positively upon the classroom environment in such a way as to make learning processes more student-centered, knowledge-centered, assessment-centered and community-centered. In situations where a group of participants may suffer from anxiety in engagement with open dialogue these systems provide an opportunity for interactivity but within an environment of reduced threat to each participant. (Groves, Gear, Jones, Connolly and Read, 2006)

In practical terms these systems typically make use of PowerPoint as the 'container' and questions can be quickly assembled using a variety of slide templates from an extra toolbar in PowerPoint. Standard, non-ARS, slides can also be interlaced to provide an overall session comprising a mixture of standard

presentational slides and interactive slides. Interactive slides can be kept open by the facilitator, allowing students to enter and change data at any time until it is declared that final inputs are required, or various countdown timers can be displayed to limit the time available for responses.

Course details

In this course (subject) students explore the relationship between different types of problems and decisions, the characteristics of different types of decisions makers, individual and group decision making, different approaches to decision-making and two decision support systems (DSS) that support different types of problems and decisions, different types of decision maker and different approaches to decision-making.

The first decision support system the students explore is the spreadsheet DSS. They analyse a complex problem, analyse the decision makers described in a case and develop a small DSS using Microsoft Excel. They are required to scope the problem and plan and manage the project as part of a group. They are also required to learn the software, and ultimately choose the appropriate features that allow them to build a user-friendly application (Banks and Monday 2002, Monday 2001, 2002). The second DSS they explore are two types of Electronic Meeting Systems (EMS), namely keyboard-based EMS and keypad-based EMS. Keypad-based EMS are also known as Audience Response Systems (ARS). In this instance students are introduced to the theory and practice of EMS but until this specific session they have not experienced the hardware and software in a practical situation.

The course has a value of 4.5 units and is one of 24 x 4.5 unit courses undertaken by students to complete the degree program. It has been running annually since 1999 and has been managed, reviewed and revised by the second author throughout this period (Monday 2001, 2002; Monday & Banks, 2004). It is taken by both onshore students (internal and external study modes) and offshore students in Hong Kong (HK). This paper explores the use of an ARS with offshore students who study in their own country. Semesters are 14 weeks long, with 13 weeks of tuition followed by a one-week self-study period before examinations commence. Lecturers visit HK for one week at the beginning of the semester and one at the end to deliver mass lectures of 20 hours in total (4 evenings x 2.5 hour lectures each visit). Between these visits students attend 4 x fortnightly workshops with local tutors who support the software development only. All students can access lecturers via email, telephone and a web-based learning management system throughout the course. The course is scheduled in year 2, semester 2 of the degree program and has pre-requisites of a first year IT course and a second year first semester course in end-user development of databases.

Problems encountered

Limited understanding of the use of EMS and ARS

One area of weakness that still caused concern was in the students' understanding of the use of EMS and ARS. They were unable to understand how an EMS or ARS would work in practice to support decision making. They were also unable to appreciate that a DSS is a support tool under the control of the decision makers rather than an attempt to provide a software solution to the problem (Keen and Scott Morton, 1978). Thus they saw the tool as a decision-making system rather than as a 'information system whose primary purpose is to provide knowledge workers with information on which to base informed decisions' (Mallach 1994). Young (1989) regards these systems as '[I]ntended to interact with and enhance the special mental capabilities of the user, thereby facilitating learning, creativity …' Although the students had always had access to one of the common business software applications (Excel) explored in the course and had demonstrated a reasonable and often good understanding of this software, it had never been possible to provide them with access to any form of commercial EMS or ARS.

Language

Students also, in the past, showed problems with the English language requirements of the program. At an informal meeting with a number of students who had recently completed the degree program the students explained that when they started the degree program they estimated they understood 30 per cent of the

required English. By the time they had finished the degree they estimated they understood 70 per cent of the required English. For this course they particularly commented on their difficulty with the language used in the set text originally used, but not the lectures. In order to help students to understand the topics more fully the lecturers have since written a textbook (Monday and Banks, 2004) to accommodate the needs of these students. It must be emphasised that the students are still required to explore the same concepts to the same depth of understanding. The major difference is in the length and complexity of the sentence structures. The response to the new textbook, now in its 3rd edition and updated in response to student feedback, has been very positive and students started to demonstrate a much clearer understanding of the course content.

Group size and interaction

The smallest group size in Hong Kong has been 84 students (the cohort discussed in this paper). Previous group sizes have been at least 120 students and quite often as large as 320 students. All classes are held in large lecture theatres. This large group size has not encouraged students to speak up in class when questions have been posed to them. However, on occasion, when large numbers of students had dispersed at the end of a session, leaving just ten to 20 students who remained to ask questions of the lecturer, the level of willingness to ask questions and engage in dialogue was considerably higher. The approach previously adopted in the lecture theatre had been for students to be given a question which they could answer either individually or in small groups. The lecturer circulated amongst the students checking the answers prepared by the students, providing further direction as necessary until the students had demonstrated a good understanding. Affirmation of their correct answer had then encouraged students to verbalise their answer in the large group. However, given the numbers and the time available it was not possible to work with all students individually or in their small groups.

The ARS in practice – findings and discussion

To explore the problems detailed above the first author, who has considerable experience in using ARS in a variety of educational and commercial settings for over thirteen years, mainly with small groups (Banks, 2001, 2003, 2006), offered to run an ARS session in HK. The system used to support this session was a 40-keypad infra-red system provided by KEEpad and used TurningPoint software.

Ideally we would also want to provide students access to a text entry EMS as well as the numeric ARS but there are practical problems that prevent this. For example, EMS are complex. Set-up time at a temporary location can be considerable and typically they are restricted to a small number of users (i.e. 16) in practice. We are considering the production of a scenario-based video to overcome these problems.

Limited understanding of the use of EMS and ARS

The system was used on the second evening of the second visit. The theory of EMS and ARS had been introduced to the students on the first evening of this visit. The main purpose of the session was to provide students with practical exposure to a technology they have little previous experience of and have difficulty picturing and understanding. In phase 1 of the session the ARS was used to capture some data that would help us to better appreciate this specific student population. In phase 2 the ARS was used to support their revision.

Phase 1: Exploring the student population

Eighty-four students were enrolled on this course and of these 68 attended the ARS-based session. During the session the ARS was used to ask a range of questions but only a limited number of responses are presented in this paper. Students were firstly put into pairs and each pair was issued with a keypad. The first member of each pair was asked eleven general questions. The keypads were then handed over to the second member of the pair and the same questions were asked again. This approach was adopted simply because we had access to only 40 keypads at that time so it was not possible to provide one keypad for each of the students who attended the session. Once the data was collected from each student the two sets of data were aggregated. The ARS allows the export of all collected data into a standard Excel

spreadsheet for this purpose. This initial data-capture process helped to familiarise the students with the technology and to provide some demographic data.

The first set of questions asked students for their age group, gender, what is most important in their life, difficulties they encounter when studying this degree program, the largest grouping in which they feel comfortable making verbal contributions in class, and whether they tend to leave assignment work until the last minute. The aggregated responses for the basic demographic questions are shown in Table 1.

Table 1: Student demographic profile

Indicator	Count	%
Age profile of students		
Under 21	6	9
21–25	14	21
31–35	17	26
36–40	7	11
40+	0	0
Gender		
Male	5	7
Female	63	93
Most important in my life		
Family	53	78
Work	7	10
Sport/leisure	7	10
Education	1	2
Total	**68**	**100**

This confirmed that age and gender profiles, as detailed in Table 1, are typical for the students on this program since its conception. Students from this program had been asked only once before to rank, using pen and paper, what was most important in their life. The results of this earlier cohort mirrored the results shown here for this cohort.

We were interested in gaining some understanding of the difficulties facing the students studying on this degree program. On the evening prior to this ARS session, students were asked to write down what they considered to be their single greatest difficulty in studying this degree program. Fifty-three students submitted an answer and the list generated by the students is shown in column one of Table 2. These were then collected, collated and entered into the ARS ready for the ARS session the following day. The data had to be split into two lists because the infra-red keypads being used provided only 10 choices. In some circumstances the need to split a list can be problematic (Banks and Bateman 2004) and in this instance it has to be recognised that the drawing of the boundary by the authors may have distorted the students' final choice. Many other wireless-based ARS do provide multiple digit entry. The first list represented issues we considered to be more general to their life style whilst the second list was more study focused. The results from the subsequent ARS responses are also shown in Table 2 below. Although the paper-based list presented the two most popular reasons as difficulty in balancing study, work, home and leisure (19 students) and insufficient time to study (13 students) the electronic session indicated a different pattern.

Table 2: Difficulties encountered in studying degree program

	ARS Responses	
My single greatest difficulty in studying this degree program is:	**Count**	**%**
Difficulty in balancing study, work, home and leisure	17	30
Stress to pass course/exam	16	29
The cost of the course	6	11
Insufficient time to study	6	11
Not enough time to gather and analyse data and information for assignments	4	7
Achieving a good or HD assignment	3	5
Difficulty identifying efficient way to study	3	5
Maintaining good group relationships	1	2
English language and communication skills	0	0
Total	**56**	**100**
Another difficulty in studying this degree program is:		
Limited time to understand the subject	26	44
Assignment scheduling causes problems	17	29
Too many assignments	6	10
Not enough lectures and tutorials	5	8.5
Not enough feedback in assignments	5	8.5
Total	**59**	**100**

Language

Of particular interest was that the students did not consider English Language and communication skills to be problematic. This proved to be contrary to informal evidence as mentioned earlier and in part may be accounted for because the authors had introduced a textbook written specifically for this group of students. Although the list of issues had been created by the students on the first evening, in the electronic poll conducted the following evening it did not rank as important. It may be that this was perceived to be less of a problem relative to the other problems they faced and had not occurred to them on the previous evening. It may have been that the students who raised this issue on the first evening were not present on the second evening. Given that anonymity had been guaranteed to encourage participation only speculation is possible. The highest rated item - difficulty in balancing study, work, home and leisure – was reflected in another question that asked students to indicate their agreement with the statement 'I leave my assignment work until the last minute'. Sixty eight per cent confirmed that they do leave their assignment work until the last minute. This comment may be explained by the priorities that students allocate to the various activities in their life (see Table 1).

Group size and interaction

The results from this poll, as shown in Figure 1, supported our observations concerning the group size and interaction difficulties identified earlier. This clearly demonstrates that students are uncomfortable making verbal contributions in large groups. Groves et al (2006) suggest that in an open forum self preservation may take precedence over the task at hand if a participant fears that they may be undermined as an individual. It will be seen later that the students' responses to the anonymity afforded by the ARS were very positive.

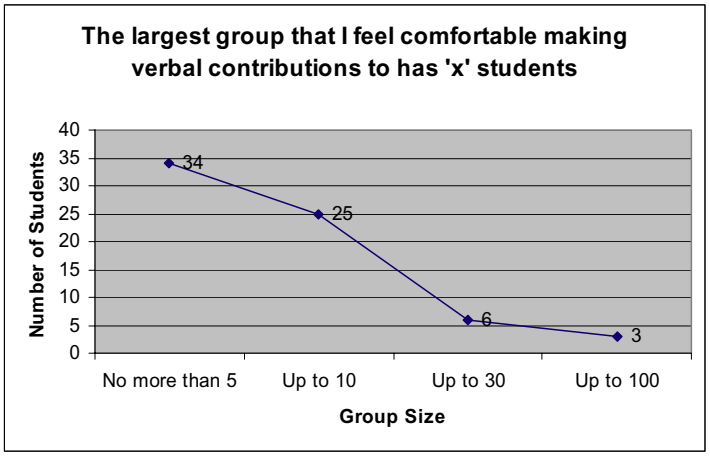

Figure 1: Group size and interaction

Phase 2: Supporting the students' revision

For the remainder of the session the students worked in pairs with one keypad shared by two students who discussed each question between them before indicating their response with the keypad. This approach is identified by Mazur (1997) as Peer Discussion and encourages students to discuss their answers before offering a response.

The first question asked the students to indicate what type of system we were using to support the session, the possible responses being GDSS, ARS or EMS. The responses are shown below in Table 3, with ARS being the correct response in this context, although GDSS as a generic label would also be a reasonable response.

Table 3: Type of system in use – first and second poll

	First poll		Second poll	
The type of system we are using now is an:	**Count**	**%**	**Count**	**%**
GDSS	0	0	0	0
ARS	***31***	***91***	***33***	***97***
EMS	3	9	1	3

Note. In this and subsequent tables in the paper showing the student responses we have italicised the 'correct' answer.

As can be seen, three pairs of students (9%) provided an incorrect answer to this question. We were interested to explore the findings of d'Inverno, Davis and White (2003) who reported that typically around 40% of their students failed to identify the correct answer to simple questions. Interestingly they found that if the same question is asked again around 20% still provide the wrong answer. (They do, however, suggest that there may be some deliberate entry of incorrect answers as not all students feel that the technology offers them benefit.) To explore this finding we discussed the differences between the various systems and then asked the question again. Examination of the keypad response data (Table 3, second poll) indicated that one pair of students who answered 'EMS' the first time the question was answered still believed the answer to be 'EMS' even after some class discussion. It is possible, using this system, to correlate the answers from a particular keypad. Had we had more time in the session it would have been useful to explore the reasons that this pair had for steadfastly maintaining their view. This effect requires further research and supports the belief that an ARS can provide some interesting insights into what is happening in the class.

Another question was asked twice and the results are documented in Table 4. The question asked which box in the diagram related to laissez-faire management. This showed a greater variation in responses.

After some discussion about the various management styles in the context of the diagram the results indicate a greater consensus.

Table 4: Management style – first and second poll

	First poll		Second poll	
Which box represents laissez-faire?	**Count**	**%**	**Count**	**%**
A	3	9	0	0
B	2	6	0	0
C	7	21	3	9
D	***22***	***65***	***30***	***91***

Some questions posed no difficulties at all for the students, as can be seen in the responses presented in Table 5:

Table 5: Time and place dimensions

ARS technology normally supports meetings that are:	**Count**	**%**
Same time, same place	***34***	***100***
Same time, different places	0	0
Different time, same place	0	0
Different time, different place	0	0

Other questions produced broad spreads in responses as indicated in Table 6:

Table 6: Number of participants

What is the maximum number of participants that an ARS can support in a single meeting?	**Count**	**%**
Sixteen	3	9
Fifty	9	26
Several hundred	11	32
Several thousand	***11***	***32***

The spread of responses suggests that this may have been a useful question to discuss and then re-poll to determine what students were thinking when they were answering the question. Limited time did not allow for this but it has made us consider why this question produced such a broad spread. It is quite possible that the issue here is more to do with the question itself rather than with student understanding, though the question does not appear to be difficult. It could be that we had only just introduced the topic and they had not had time to assimilate the information.

The way that questions were posed indicated some interesting responses that require further investigation. For example the range of responses to a Likert-based question is shown in Table 7;

Table 7: Decision styles –first poll

Someone who uses large amounts of information and alternatives and copes well with ambiguity is classed as being 'Directive'	**Count**	**%**
Strongly Agree	1	4
Agree	9	33
Disagree	***8***	***30***
Strongly Disagree	***9***	***33***

The situation here is that 63% disagree or strongly disagree with the proposition. Both of these answers are appropriate. This data was discussed with the students and then they were given a short time to

discuss the question and the data in their pairs. The same basic question was then posed using a different response frame and these results are documented in Table 8:

Table 8: Decision styles – a different response frame

Someone who uses large amounts of information and alternatives and copes well with ambiguity is classed as:	**Count**	**%**
Directive	0	0
Analytical	***23***	***88***
Conceptual	3	12
Behavioural	0	0

The results in Table 8 show that the majority of students who previously felt that the answer was 'Directive' changed their position following discussion and a rewording of the question. This time 88% of the total student population offered the correct response 'Analytical'. Again, with more time these issues could have been explored with the ARS providing feedback to the students about their changing views. This illustrates the need for careful wording of questions both when the ARS session is developed and during its use.

Use of a generic slide

The previous slides outlined here were all produced to support specific issues but it is possible to use a generic slide around which any issue can be discussed. By repeatedly using the generic slide it was possible to put forward a number of scenarios and ask the students to classify them. The same slide can be re-used as many times as required and then the session moved on to a new scenario once the students demonstrate an understanding of the current scenario. In this case the generic slide was titled 'what kind of problem is this for the case organisation?' and a range of scenarios could be verbalised around this generic slide.

This slide was used to obtain feedback from the students about their perception of a number of problems that related to the case study. A specific issue facing the case organisation was first outlined and then the students asked to decide if the problems would be best classified as Structured, Semi-structured, Unstructured or Wicked. For one case example that was outlined, the student responses, shown in Table 9, were:

Table 9: Problem classification – first and second poll

	First poll		**Second poll**	
What kind of problem is this for the case organisation?	**Count**	**%**	**Count**	**%**
Structured	0	0	0	0
Semi structured	***6***	***67***	***9***	***100***
Unstructured	2	22	0	0
Wicked	1	11	0	0

After some discussion of the distinguishing features of the problem the question was posed again (Table 9, second poll) and the feedback indicated that there was a change in student position.

Conclusion

Observation of this course over a period of time suggested a number of issues of significance. Three of these have been explored in this paper - language difficulties faced by students, their dislike of interaction in large groups and their limited understanding of the use of ARS.

Firstly, our concerns about the language issues were not identified as significant by this group of students. The data from the session did not support the feeling that students had language difficulties. However, this may be explained by the use of a textbook written specifically for this student group.

Secondly, this group of students was reluctant to ask or answer questions in a large public forum. On previous deliveries of the course we had observed that the students were reluctant to ask questions in a large group in open forum. We had also observed that at the end of sessions when most students had left, questions were forthcoming from the remaining small group. Our data from the ARS session strongly suggests a relationship between willingness to ask open forum questions and group size. The anonymity provided by an ARS helps to alleviate this problem.

Thirdly, one specific area of the course, namely EMS/ARS, was unfamiliar to them in both concept and practice. This unfamiliarity with some of the course material combined with a reluctance to ask questions in public, contributed to a lack of understanding. We felt that the anonymity afforded by an ARS would allow us to create a learning environment where the majority of the group would be able to contribute to the learning process. We further felt that providing some hands-on experience of this unfamiliar technology would also prove beneficial to them. Their subsequent performance in the exam questions relating to EMS/ARS appeared to be better than for previous cohorts. It has to be acknowledged that we cannot prove that this is a result of the ARS approach we adopted, but we are sufficiently encouraged to seek to repeat the approach in further deliveries.

The data also provided some useful and unexpected insights into the problems facing this particular community of learners. They are clearly juggling a number of complex and inter-related factors in their lives and perceive study as less significant than family and work. The various family and work pressures acting on them combined with their perception of education leads to last minute work on assignments and probably as exam preparation. Given these problems and the somewhat limited amount of face-to-face contact time available with the overseas lecturers, it would appear to be vital that the learning opportunities are maximised in these contact times.

The ARS may be one tool that can help achieve this goal, by providing anonymity that promotes greater interaction and engagement. As a classroom technology it is easily integrated into the learning environment and was seen by this group of students in a positive light. The majority of the students (90%) felt that this was both a useful and enjoyable experience. Clearly there may well be a novelty factor at work here and this was only a one-off session, but the ARS literature does suggest that positive student response is typically maintained over time. In future sessions we would hope to explore the underlying reasons for these positive responses and particularly to determine if anonymity is indeed a significant benefit for this particular student population. Overall we feel that the session provided benefits for both staff and students and has suggested directions for further work. It is our intention to seek funding for further research is this area.

References

Banks, D.A. (2001). A critical reflection on the value of course evaluation questionnaires: using group support tools to explore student evaluations, *Information Resources Management Association (IRMA) Conference*, Toronto, May

Banks, D.A. (2003). *Using keypad-based group process support systems to facilitate student reflection,* Australian Society for Computers in Learning and Tertiary Education (ascilite) Conference, Adelaide, Dec

Banks, D.A. (2006). Reflections on the Use of ARS with Small Groups, in Banks, D.A.(Ed) *Audience Response Systems in Higher Education: Applications and Cases*, Idea Group Inc., PA

Banks, D.A. & Bateman, S. (2004). *Using an Audience Response System to Support a 'Lost in the Desert' Learning Scenario*, International Conference on Computers in Education (ICCE) Conference, 'Acquiring and Constructing Knowledge Through Human-Computer Interaction: Creating New Visions for the Future of Learning', Melbourne, November

Banks, D.A. & Monday, A. (2002). *Interpretation as a factor in the development of flawed spreadsheets*, European Spreadsheet Risks Interest Group (EuSpRIG) Conference, 'Spreadsheet Roulette: the hidden corporate gamble', Cardiff, UK, July

d'Inverno, R.A., Davis, H.C. & White, S.A., (2003). Student Feedback … A Lesson for the Teacher, *Teaching Mathematics and Its Applications*, 22, 163–169

Groves, S., Gear, T., Jones, C., Connolly, M., and Read, M., (2006). Learning and Anxiety: Exploring Individual Judgement Processes in a Learning Environment with a Group Support System, in Banks,

D.A. (Ed) *Audience Response Systems in Higher Education: Applications and Cases*, Idea Group Inc., PA
Keen, P.G.W. & Scott Morton, M.S. (1978). *Decision Support Systems: An Organizational Perspective,* Addison-Wesley, Reading, Massachusetts
Mallach, E.G. (1994). *Understanding Decision Support Systems and Expert Systems*, Irwin, Sydney, Australia
Mazur, E., (1997). *Peer Instruction: A user's manual,* Prentice Hall, Upper Saddle River, NJ
Monday, A. (2001). *The reality of teaching large groups of local and international business students to develop end-user applications*, Information Resources Management Association (IRMA) Conference, Toronto, May
Monday, A. (2002). *A Strategy for Developing End-User Developers: I thought I hated every minute, but I learnt such a lot*, Informing Science and IT Education (InSITE) Conference, Cork, Ireland
Monday, A. & Banks, D.A. (2004). *"Decisions, Decision Makers and Technology Support",* 3rd edn, Pearson Education, Australia
Roschelle, J., Abrahamson, L. & Penuel, W.R. (2004), *Integrating classroom network technology and learning theory to improve classroom science learning: A literature synthesis*, Paper presented at the Annual Meeting of the American Educational Research Association, San Diego, CA
Young, L.F. (1989). *Decision Support and Idea Processing Systems*, Wm. C. Brown Publishers, Iowa

Acknowledgements

Our thanks go to KEEpad Pty, Australia (Keepad Pty, keepad.com) for the supply of the keypads and TurningPoint software used to support this work.

Author contact details

David A. Banks, School of Computer and Information Science, University of South Australia, 27–29 North Terrace, Adelaide 5000, Australia. Email: David.Banks@unisa.edu.au.
Web: http://www.unisanet.unisa.edu.au/staff/homepage.asp?Name=David.Banks.

Ann Monday, School of Management, University of South Australia, North Terrace, Adelaide 5000, Australia. Email: Ann.Monday@unisa.edu.au.
Web: http://www.unisanet.unisa.edu.au/staff/homepage.asp?Name=Ann.Monday.