PERSONAL RESPONSE SYSTEMS FOR TEACHING POSTGRADUATE STATISTICS TO SMALL GROUPS

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Technology is increasingly used to aid the teaching of statistics. Personal Response Systems (PRS) involve equipping students with a handset allowing them to send responses to questions put to them by a lecturer. PRS allows lectures to be more interactive and can help reinforce material. It can also allow the lecturer to monitor students' understanding of course content. PRS is most commonly used in large lectures where interaction from the students is particularly difficult. However, we consider its use in a small group (around 15 students) of MSc in Statistics students. Recommendations based on this experience are discussed, in particular the importance of good question design. We consider possible diagnostics for the appropriateness of questions based on response data.

INTRODUCTION

Technology is increasingly used in the teaching of statistics. Personal Response Systems (PRS) or Electronic voting involve equipping students with a handset allowing them to anonymously send responses to questions put to them by a lecturer. PRS has been used in the teaching of statistics (Draper & Brown, 2004). Retkute (2009) provides a recent review of the use of PRS in mathematics and statistics teaching. PRS has been most commonly used in the teaching of large groups of students. One of the main proposed uses of PRS is to facilitate interaction between the lecturer and students, which is particularly difficult for large groups (Lass, Morzuch & Rogers, 2007). Service course teaching of statistics to students of non-mathematical backgrounds is also common (Wit, 2003). Such courses often involve students lacking in motivation and an argument for the use of PRS is to provide some novelty interest.

In our study, PRS was used in the Principles of Epidemiology module of the MSc in Statistics at Lancaster University. The course consisted of 5 lectures, each of two hours duration, plus additional tutorials and workshops. PRS was used in the course in both 2008 and 2009. The class sizes for each cohort were around 12-15 students. With such a small class size it could be argued that conventional (verbal) interaction between student and lecturer is possible without the aid of technology. However, in our experience, many students in mathematics and statistics are reluctant to admit to not understanding a particular part of a lecture. Moreover, this reluctance often extends to not admitting when they do understand.

IMPLEMENTATION

Handsets were given out and collected in at the start and end of each lecture. This was unproblematic because of the small class size. The students were each given a unique ID number, whilst retaining an element of anonymity, so that the patterns of response for individual students could be tracked. A total of 22 questions were set for the course, each lecture having between 3 and 5 questions. All the questions in the course took on a multiple choice format. Despite this the questions were quite diverse in nature. Some questions were simply testing understanding of the definition of a particular concept. In other questions students were required to apply a method to example data and then choose the correct numerical (or algebraic) answer.

PRS allows the lecturer to assign a time limit for a particular question. However, particularly for computational questions, it is difficult to know *a priori* what a sensible amount of time is. As a result, an ad hoc approach was used where an initial guideline time was used, but extended if necessary so that the vast majority of students had a chance to respond.

In most cases the same questions were used in both years. Two computational questions from 2008 proved problematic in taking the students a long time and yielding a low success rate. One of these questions was deleted entirely, while the other was split into two questions.

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ANALYSIS AND RESULTS

Question Results

The average time taken for all responses to be collected was 3m 18s in 2008 and 2m 52s in 2009, meaning in both years over an hour of the total 10 hours of lecture time was spent waiting for responses. The time for half the students to respond was 1m 17s and 1m 09s in 2008 and 2009 respectively. Across all questions the time ranged from 45 seconds up to 8 minutes. The percentage of responses that gave the correct answer was 65% and 78% in 2008 and 2009 respectively, and by question this ranged from 33% to 100%. Individually, students ranged from 46% of correct answers to 95%.

Questionnaire Results

Both cohorts of students were given an online questionnaire to complete to evaluate their PRS experience. The response rates were about 70%. Students' attitudes to PRS were predominately positive, with 81% rating their overall impression as positive compared to 9% with a negative impression. Similarly 80% said they enjoyed using PRS in the lectures. Most felt it was useful for assessing their own understanding, but were less convinced it was useful for introducing new topics. The responses to the multiple choice questions are summarised in tables 1 and 2. Students were also asked to give the main advantages and disadvantages of PRS. The advantages listed mostly mirrored the aims of PRS, e.g. to provide a way to break up lectures, to consolidate their understanding of the course and to ensure they understood the course content. Some also felt that the questions provided motivation to try to pay attention during lectures.

Table 1. Results of Yes/No questions in questionnaire

Question	Yes	No
Have you ever used PRS before?	2	16
Was it useful to see other people's answers?	14	4
Did you enjoy using PRS?	13	4

Table 2. Levels of agreements with statements in the questionnaire

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
PRS was useful for assessing my own personal understanding and strengths and weaknesses	3	12	1	1	0
PRS is useful for introducing new topics	5	5	4	2	2
The use of PRS in lectures was an unnecessary distraction from learning the material	2	0	4	10	2
Being able to answer questions anonymously using PRS was important to me	4	11	2	0	1

When asked about the disadvantages of PRS, despite students understanding that the results of PRS would not count towards their module mark and that their responses would be anonymous, several students said they felt pressurised by the PRS questions. Two students felt that PRS was a waste of lecture time, particularly the time spent waiting for other students to respond, and that the time could be better spent giving additional examples. There was also a belief among some students that PRS was not a fair assessment of their understanding because they had not had enough time to reflect on the material, e.g., that the questions were introduced to soon. One student also felt that PRS was not being used effectively, e.g., when the class performed badly there was not enough further explanation of why they had got it wrong.

Question diagnostics

The PRS software reports the time to response for each student. These can be exported to standard statistical software to give Kaplan-Meier estimates of response times. Figure 1 shows the response times for three selected questions in the course. Question A was a simple knowledge based question, where around 40% of students were able to respond quickly. Question B was a short computational question, where some responses were very quick but ranged up 3 minutes. Question C required more extensive computation. Here we see that no responses were received for 3 minutes and the question took over 6 minutes to complete.

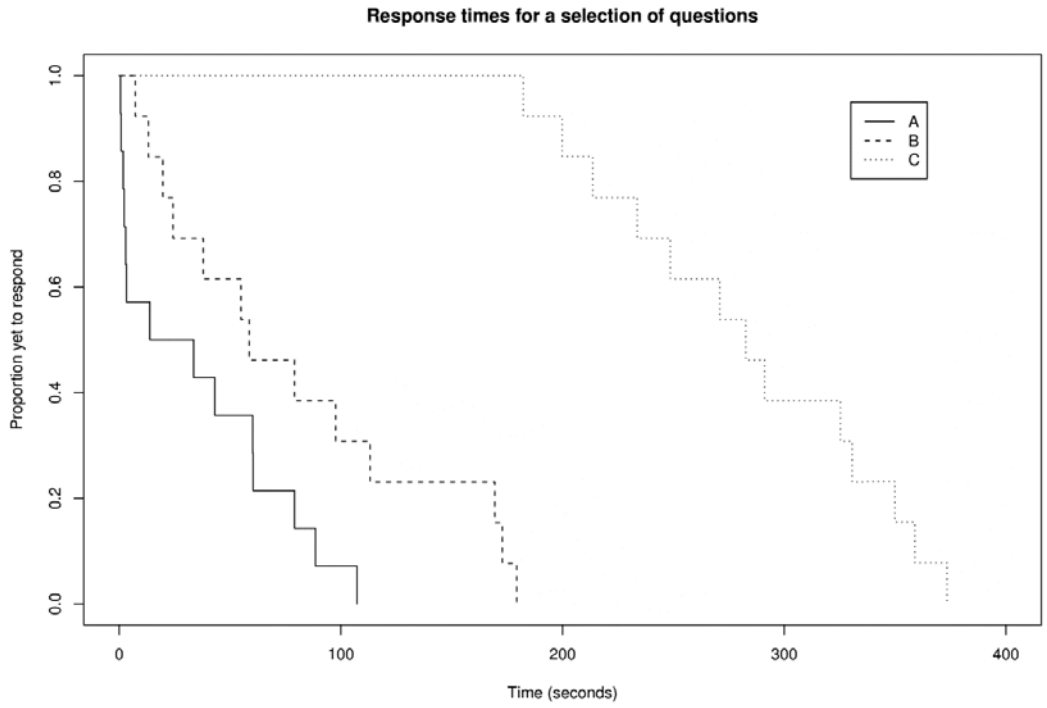

Figure 1. Response times for three selected PRS questions

The response times are able to provide additional information about the difficulty of the question than the proportion of correct answers. This can have some use for assessing the appropriateness of a question for future use. For instance, if the vast majority of students are able to quickly respond correctly to a knowledge-based question, that question may not be necessary. In contrast, if a significant proportion of students require some time to respond, perhaps because they need to refer back to their lecture notes, this would suggest the question was of use in reinforcing a particular concept. The response times can also indicate a suitable time limit to be used in future implementations of the question (e.g. one could take the time for 90% of students to respond). Finally, the response time graphs can identify questions that are inappropriate due to being overly time consuming.

CONCLUSION

PRS can be effective for use in teaching postgraduate statistics to small groups. In our experience, PRS was used with very few technical problems. Moreover, PRS was popular with the majority of students. It was considered less successful for introducing new topics and some students felt there was not enough action taken when students were unsuccessful at answering a question. It may be possible to improve this aspect of PRS by taking a more dynamic approach. For instance, Wit (2003) suggested that ideally one should have a sequence of branching questions, chosen dynamically depending on the responses to previous questions.

In our implementation, students' responses remained anonymous and did not count to the final module mark. In some implementations the results of PRS have counted towards the final mark (Butler & Butler 2006; Lass, Morzuch & Rogers, 2007). Alternatively, some institutions have produced anonymous league tables of students based on their PRS answers, allowing them to know their relative performance compared to their peers. However, such measures don't seem appropriate in the small group setting as it would be difficult to maintain anonymity and would place greater pressure on the students who already feel some pressure by the use of PRS.

It does not seem appropriate to set complicated computational or algebraic questions within a lecture as these cannot be completed in an acceptable time (e.g., 5 minutes). When explaining procedures that involve multiple steps, it may be more appropriate to set a PRS question on one step of the procedure, or a series of questions leading the student through the steps. Alternatively, PRS could be used to obtain answers to complex questions in a tutorial/workshop setting after the students have spent sufficient time on the problem.

Time seems to be the main constraint to including PRS within lectures. Distributing handsets, posing questions, waiting for responses and explaining answers all require time. The course which we used PRS within was fortunate in having a flexible allocation of lecture time in relation to the content to be covered. More often this will not be the case and the inclusion of PRS would have to be at the expense of covering material. The choice and design of questions also becomes more important if lecture time is limited.

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