Further experiences with the personal response system in statistics teaching

by

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Abstract
This article sets out a preliminary balance of the pros and cons following three full years of experience of using a wireless multiple-choice system in a service course of statistics teaching. As pointed out by several commentators, the system can easily be applied to statistics as well as any other subject, and the multi-choice system does not restrict the types of questions that can be asked. The output files from the personal response system have been used for some preliminary post-processing of the students’ answers. This provides some idea of how the correct and incorrect answers are distributed over the class. Student feedback on the use of the system is almost exclusively positive. In the opinion of the present author, the only negative aspect of the system, is the set-up and break-up time as well as the amount of time it takes to record an answer from the full class. If these time-constraints can be overcome, then the aim is to expand the use of the personal response system to all of the lectures here in Glasgow.

1. Introduction
Over the course of the last five years the Personal Response System (PRS) has received steady attention and the number of publications on the use of the system seems to suggest that there is something exciting going on in the classroom ([1,2]). The PRS is a simple technology to give students the option of anonymous intervention during a lecture. The low threshold to implementing the system, nothing more than a collection of remote controls connected to a computer, means that participation is high and unthreatening. It has been successfully used in philosophy teaching [3], computing science lectures [4], psychology [5], economics [6] and statistics [7]. There is no reason why it should not work for any other subject.

From 1947 until 2000 a group of academics in Holland and Belgium used a one-button, wired rather than wireless, system to gauge students’ understanding of the lecture. Similar systems were introduced in the United States in the 1960s. The main aim of such systems was feedback to the lecturer, rather than an active learning tool, as the PRS aims to be. Professor Jim Boyle (Mechanical Engineering, Strathclyde University), as one of the first in the UK, has been using the PRS since 1998, after experimenting with another handset system (Classtalk) and non-technological alternatives before then. A good academic website about all aspects of the PRS and similar systems is provided by Steve Draper (at http://www.psy.gla.ac.uk/~steve/ilig/). A detailed description of the current PRS and some of its implementations in statistics can be found in a previous article by the present author [7].
2. The PRS system in practice

2.1 Some recent history of using the PRS in statistics teaching

Service teaching is an integral part of the teaching by many statistics departments. The statistics department of the University of Glasgow provides statistics instruction for students in the life sciences, chemistry, nursing and others. The largest of these service courses is the one taught to 200-270 undergraduate psychology students. Throughout one academic year the students receive four hours per week of statistics instruction together with a weekly two-hour computer practical, in which the lecture material is put in a practical context. The computer practicals serve to bridge a gap between the theoretical lectures and the ultimate use students make of statistics within their psychology studies. Techniques discussed in the course are wide-ranging and include, among others, sampling, design of experiments, one-sample and two-sample inference, ANOVA, simple and multiple regression, repeated measure analysis, categorical data analysis and multivariate analysis. A team of four staff members from the statistics department in the University of Glasgow teaches the course.

Whereas the students appreciate the problem-solving approach to statistics, it is felt that some appreciation for the central theoretical concepts of the course is important as well. For example, although it is important to know that the null hypothesis can be rejected if the p-value is small - a form of performative knowledge, - it is important to know that the p-value does not stand for, for example, the probability that the null-hypothesis is true. The peculiar nature of Statistics and human understanding of concepts of uncertainty require some careful focus on theoretical interpretations. For this reason, in addition to the lectures and the computer laboratories, a one-hour mass tutorial is held every two weeks.

Whereas the course, both in terms of formal lectures and computer practicals, has been a sustained success over almost ten years by all available standards - such as student evaluations at the end of the course as well as the perceived impact of the course after several years by these same students - the tutorial system has had a difficult and unimpressive record. After a few weeks into the year, attendance rates would go down to a mere 10-15% and during the tutorials students seemed too shy to ask questions or respond to questions that lecturers posed them. Clearly the class size was a problem. There were no resources for additional small tutorial groups, it was decided three years ago to introduce the PRS system. Immediately attendance rates to the tutorial went up as reported in [7] and have stayed up.

2.2 The current situation

Most of the experience with the handset system has been within a mass tutorial setting, which takes place approximately once every eight lectures. Rather than integrating the handset system in a lecture setting, it has been the preference to concentrate the use of the handsets in a formative assessment session at the end of every two-weekly lecture cycle. This was more out of necessity, rather than choice for several reasons. Although the handset receivers have been installed permanently within the lecture room, the system requires an operator of the computer system as well as the distribution and collection of the handsets to all the students in the class, which, certainly in the beginning of the year when most of the 250+ students actually show up, is a problem.

The question to address here is whether in principle it would be useful to integrate the handset system in a lecture setting. There are several advantages of doing so. Integration of lectures
and handset assessment would give immediate feedback not only to the student, but also to the lecturer. The lecturer can address in the next or even in the very same lecture apparent difficulties experienced by the students. It can give large lecture courses the feel of interactiveness, which may well increase the sense of ownership of the class among students and stimulate their attendance and involvement.

A disadvantage of integrating the PRS in a lecture setting is the technical difficulty of collecting the answers quickly and, therefore, the resulting disruption to the pace of the lecture. In order to ask a single question, elicit the answers and discuss the results in a moderately size class, it takes at least five minutes. This could be a useful way to build a moment of rest halfway in a 50-minute lecture, given that, as widely reported, students’ attention spans typically do not exceed 20-30 minutes.

However, in the personal experience of the present author when experimenting with the PRS in a lecture, it seemed detrimental to the quality of the lecture to ask more than one or two strategic questions. The main practical problem of using the PRS in lectures is that, currently, it requires to hand out a handset to each student at the beginning of the lecture and collect it at the end, which for one or two questions is not very efficient. Accordingly, the most effective use of the handset system in its current configuration is within a large tutorial setting, which punctuates the lecture series at regular intervals.

Nevertheless, as the lack of interaction in large lectures settings is typically perceived rather negatively (evidenced by student questionnaires, about which more below), a further evaluation of the system in lectures as pointed out in references [1,6] might be considered in the future. Handsets are perhaps not an efficient vehicle of delivering a lot of information, large lectures without much interaction suffer from a strong negative perception which might have the very same effect · if not worse. A very simple way in which the PRS may be effective in lectures is by using it to measure understanding: in each lecture segment, consisting of some didactic unit, the students can press a button whenever they get lost. When the number of responses, which are shown on the screen in real time, exceeds a certain threshold (e.g. 20% of all those present), the lecturer can go back and redo that particular part of the lecture. It is planned to experiment with this system in the coming academic year.

The handset system by its very nature can only ask multiple-choice questions. As discussed before [7], this does not necessarily have to be a limitation to the type of questions that can be asked. Multiple-choice questions can be framed in such a way as to ask about simple facts, about application of knowledge or understanding and even about interpretation issues. Depending on the aim of the tutorial and the aim of the subject, a particular type of multiple-choice question might be better suited than another. However, irrespective of subject or aim, the sheer time it takes for asking, processing and discussing a single PRS question means that the questions need to be framed carefully by dealing only with important issues. It is particularly useful to put questions about persistent misunderstandings in a PRS tutorial. By failing such questions students will be confronted with their misconceptions and are, thereby, hopefully motivated to correct them.

Merely using a handset tutorial to discuss a large number and range of questions, including less important details, is particularly inappropriate. A face-to-face tutorial, or even a handout, would address such questions better. In the experience of the present author it is impossible to ask more than 7-9 questions during a single hour. This includes repeats of questions that were
particularly badly answered. In those cases it is worthwhile to present the class with additional explanation on the general topic of the question and let the students vote again.

3. Student opinion on PRS

One component of the impact of the personal response system relies on measuring the opinion of those that have been subjected to it. It is clear that the PRS has a high novelty value, particularly because this statistics course was the only place where these students encountered it. As a variation of the Hawthorne effect, novelty, good or bad, typically sparks some positive effect for some time. In order to account for this a sample of 21 students were asked their opinion of only the final semester, after a full year experience with the handset system in the statistics tutorials. To avoid an unrepresentative sample, students present at an obligatory attendance session of the course unrelated to the use of the PRS were selected (nevertheless, despite best efforts, there was a 20% absence ratio, who were unlikely to be missing at random).

![Attendance of PRS sessions](image1)

<table>
<thead>
<tr>
<th>Attendance of PRS sessions</th>
<th>mean 51%</th>
<th>SE 7%</th>
<th>-</th>
<th>-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Influence PRS on attendance</td>
<td>more likely 52%</td>
<td>no effect 48%</td>
<td>less likely 0%</td>
<td>-</td>
</tr>
<tr>
<td>Overall opinion PRS</td>
<td>very helpful 5%</td>
<td>helpful 75%</td>
<td>not helpful 10%</td>
<td>no opinion 10%</td>
</tr>
<tr>
<td>Benefits outweigh disadvantages</td>
<td>yes 67%</td>
<td>neutral 33%</td>
<td>no 0%</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 1 - Opinion of 21 mostly second year psychology students on the use and benefits of the PRS system during the second semester of a statistics service course

As Table 1 suggests the PRS seems in general to be appreciated. In particular, the PRS seemed to stimulate attendance for about half of the participants. Attendance to handset sessions was good (50%), particularly in comparison with the general attendance for the lectures (10-40% in the second term). Four out of five students found the PRS helpful or very helpful and none of the students thought that the disadvantages of using the PRS outweigh the benefits.

Some of the additional comments the students made put this in an even starker contrast. A comment, such as “[Handsets] make for good interaction between class + lecturer and also hold my attention better” shows that the handsets somehow bridge the considerable distance between a student and a lecturer in front of a large class. A stronger sentiment, such as reflected in “tutorials are more useful than lectures” and “lectures need more interaction”, suggests that perhaps it might well be useful to include the PRS routinely in the lectures.

4. Post-analysis of PRS data

Although the PRS system is anonymous, most systems do collect and store per student response information. This can be useful to analyse the data after a handset session. Three questions are particularly of interest for the lecturer:

(i) which questions caused the most difficulty;
(ii) are there any clusters of questions that are answered consistently correctly or incorrectly by the students; and,
(iii) are there any subgroups of students that do better or worse than others.

The first question will probably be obvious from the handset session, although it is always good to have a record of this fact. For questions two and three, it can be useful sometimes to visualize the data via simple clustering.

**Fig 1 - Two-way clustering of the answers (correct/incorrect) to 7 questions over 85 students in a statistics PRS tutorial. Roughly four groups of students and three groups of questions are distinguished.**

Fig 1 shows the two-way clustering for a handset tutorial in a Statistics course for psychology students. The tutorial discussed 7 questions (excluding 2 repeats of questions 5 and 6, question cluster 2). The figure suggests that there may be 3 clusters of questions and 4 clusters of students. Question cluster 1 consists of questions 1 through 4, which seems to have been done well by a large fraction of the students, except those in student cluster 1. Questions 5 and 6 in question cluster 2 seem to have been poorly done by most students, whereas cluster 3 or question 7 was done well by most, except, perhaps surprisingly, by those in student cluster 3, who otherwise did very well in this tutorial.

Some of these results could be explained. Questions 1 through 4 (question cluster 1) were relatively straightforward, stressing important points of the course in general. Questions 5 and 6 (question cluster 2) had been discussed in the lectures previously and addressed several common misunderstandings. The final question (question cluster 3) was a bit tricky and it seems that the good students were particularly fooled by it.

As the students in this course do not own their own PRS handset, but have to pick one up every time the PRS is used, it is unfortunately impossible to follow individual students up over time, except within a single session. If each student could be equipped with an individual handset, this would open up not only the possibility of a richer analysis, but also more detailed feedback.
to the students as well as the lecturer. It would be interesting to see, for example, how dropout rates are related to PRS scores and whether these can be used for early intervention.

5. Discussion and Conclusions

Although some studies have suggested that handset systems might improve examination pass rates [8, 9], use of the PRS in the Statistics Department at Glasgow University has not been employed in a controlled fashion in order to suggest any effect of this kind. However, feedback from students suggests that they enjoy using the PRS in large statistics tutorials. Moreover, improved attendance rates suggest that the PRS is helpful in stimulating active learning. Finally, the immediate feedback the PRS provides to the lecturing staff is helpful in adjusting the delivery of the lectures and support to students.

This author strongly recommends using the PRS to anyone. The PRS is being utilised in a service course environment, where a fraction of the students is expected to be unmotivated to the subject. However, evidence has shown that the PRS can be used in any didactic environment. Two warnings from the Glasgow experience are:

(i) Do not underestimate the amount of time it takes to use the PRS; and,
(ii) Prepare carefully the multiple-choice questions in advance in order to avoid strategic voting and to encourage learning of the specific type of knowledge that was intended.

To summarise the conclusions of this article a series of commandments can be stated:

Thou shalt use the personal response system in...

• a large tutorial environment (full hour); and,
• a short interval halfway during a lecture or practical.

Why shalt thou use it?

• For formative (rather than summative) assessment of the students;
• To give students a sense of ownership of the course;
• To increase student involvement;
• To maintain an individual student’s anonymity; and,
• For feedback to the lecturer with regard to student understanding.

How shalt thou use it?

• Using well-designed multiple-choice questions suited for the particular type of knowledge to be tested;
• Focusing on important points of the subject;
• Dealing with persistent misconceptions and mistakes;
• Providing lots of feedback to the answers; and,
• Redoing badly answered questions after having provided feedback.

How shalt thou not use the PRS?

• As a rapid question-answer series;
• Dealing with minor points or unimportant subtleties of the subject; and,
• With insufficient technical support or knowledge of the system.

As with any “rule” in education, breaking a couple of these commandments can actually be quite effective from time to time. Moreover, they do not sum up comprehensively what can be done with the PRS. Having said this, this author does believe that a lot of personal experience, both positive and negative, with the PRS is contained in them.

References