

THE USE OF COMPUTER-BASED TESTS TO CONSOLIDATE STATISTICAL CONCEPTS IN KENYA

David Stern¹, Doug Stirling², Ian Dale³ and Roger Stern³

¹Department of Mathematics and Statistics, University of Maseno, Kenya

²Institute of Fundamental Sciences, Massey University, New Zealand

³Statistical Services Centre, University of Reading, United Kingdom

volloholic@hotmail.com

A customised African release of CAST (Computer Assisted Statistics Textbooks) has provided much-needed access to a series of modern statistics textbooks for many students in Africa. The recent addition of a collection of interactive CAST exercises has proved valuable in strengthening the learning of statistical concepts by students. A new CAST testing system has been developed to present the exercises as formal test questions. Students can practice beforehand with similar randomised exercises and can get immediate feedback as soon as the test is finished. This paper describes a pilot study in Kenya to evaluate the added benefit of using the CAST tests and is its first evaluation. Use of these tests is linked to an on-line course called "Statistics Made Simple". The effectiveness of the tests is discussed.

INTRODUCTION

CAST (Computer Assisted Statistics Textbooks) is a series of electronic textbooks (e-books) designed to be read on-line, rather than being printed. E-books can use dynamic and interactive graphics that are more effective for learning than their static counterparts in paper textbooks, and most CAST pages include an animation, simulation or other sort of dynamic display to help explain key concepts. These interactive components in CAST make it a form of active learning that helps to keep the readers' interest and hence improve their learning experience. This is in contrast to the passive experience of reading a paper textbook.

The first version was released in 2000 and the books have been expanded and improved with the regular release of new editions since then. The books are data focused, and include many data sets. Various customised e-books have been prepared since 2003, some for specific groups of users in Africa. The customised book designed as a partner to an e-learning course developed by the University of Reading called "Statistics Made Simple" is described in this paper.

CAST runs within a web browser and may be used over the web by users with fast internet. It may also be downloaded, or installed from a CD/DVD to run locally without need for an internet connection. It can be used without charge under a "Creative Commons Licence" that allows users to freely download, copy and use CAST, provided it is fully attributed to the author (Doug Stirling, Massey University, New Zealand).

Recently CAST has developed from being a series of textbooks into a more general set of resources. These include exercises, described below, and now a module for testing students. The main aim of this paper is to give a first view of the CAST testing system, along with a description of a pilot study which determines the feasibility of using such a system in a Kenyan university.

THE CAST RESOURCES

Figure 1 lists the nine chapters in the customized book for the e-learning course Statistics Made Simple on the left. Each chapter is divided into sections, and each section has pages, just as in an ordinary book. Figure 1 shows the book open at page 5.3.1. Chapters and sections can be selected from the list on the left and the large arrows at the top right move forward and back one page. A red arrow also appears at the top right of this page; clicking it shows a pull-down menu that switches to alternative versions of the page with data from different application areas.

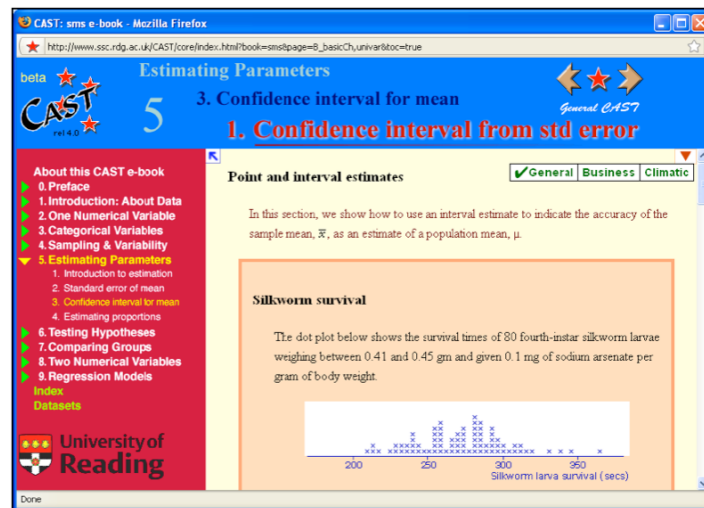


Figure 1. A typical page from a CAST book

Exercises are a particularly effective form of active learning since they make students think and recall information and are therefore more intense than many other ways of studying. Many statistics textbooks therefore include a series of exercises at the end of each section or chapter. They often give solutions, but these may be as little as a statement, or number, signifying the correct answer and there is rarely much feedback to help the student who does not know the approach to use, or who gets the wrong answer. Computer-based exercises have much more potential to enhance the learning experience.

A new e-book of exercises (Stirling, 2008, 2010) was recently added to CAST. It attempts to maximise the benefit to students of using an interactive resource to learn statistical concepts, as demanded by McKenzie (2007). Each exercise is a Java applet, like the other dynamic diagrams in CAST, and the use of this powerful programming environment allows great flexibility in the format of questions and the potential for constructive feedback. Examples are in Figure 2.

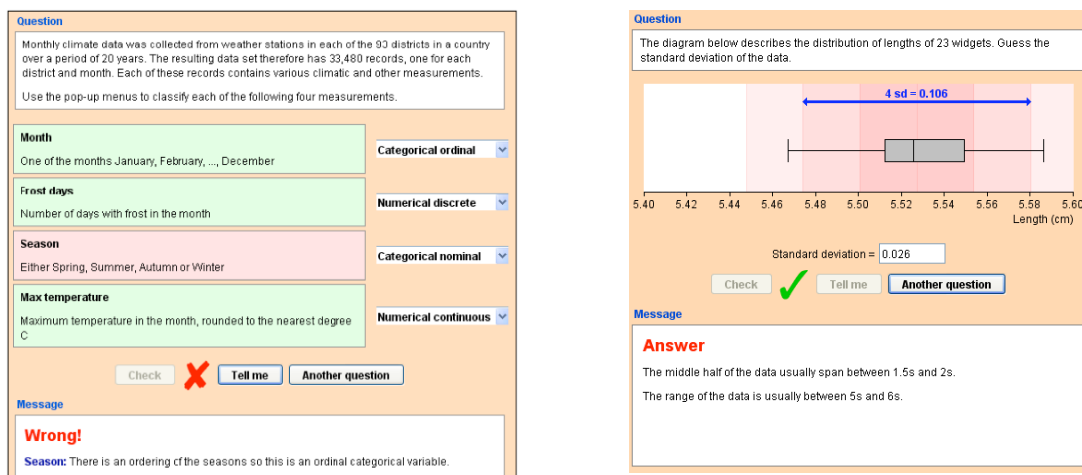


Figure 2. Examples of CAST exercises

In the first example in Figure 2, three of the four answers were correct when the button Check was clicked, but the fourth was not. CAST has shaded the wrong answer to indicate where the error occurred and has added the solution, with an explanation.

Two key features of all exercises and shown in Figure 2, are as follows:

- *Tell me* button. If a student does not know how to do a task, the computer provides the correct response,

- *Another question* button. This randomises as many aspects of the question as possible, including the context and data sets. This allows the student to repeat an exercise until they have really understood the concepts.

A second CAST exercise is shown on the right of Figure 2, with the feedback from the correct answer, after the “Tell-me” button has been pressed; the pink bands are not displayed initially. Figure 3 shows the sort of feedback from incorrect answers.



Figure 3. Feedback from incorrect answers

The CAST tests are the latest addition to the set of resources. Unlike the usual CAST e-books and exercises that can be installed on any web-server or local hard disk, the tests use an SQL database and PHP scripts so installation and administration is more complex.

There are two parts to the testing system. The teacher uses a web-based administration module to set up the test and provide information about the students. Students then use a different web-based interface to log in to the server, specify the test they will take and then answer the questions. The test questions are identical to the exercises, shown above, except there is no button for “Tell me” or for “Another Question”.

As soon as the test is finished, the student may request a review. This gives the mark for each question and also the same feedback as is provided for the corresponding exercises. Because of the extensive random elements associated with each question, the teacher can allow tests to be taken more than once, if that is deemed to be educationally desirable. Hence the system of testing can be used either for summative assessment, or as formative assessment to support students in mastering the material.

MASENO UNIVERSITY: A CASE STUDY USING THE TESTS

CAST with exercises was used for two successive groups of MSc statistics students at Maseno University, Kenya. Some of the students had very little computing skills and their previous training in statistics was theoretical. With the emphasis on concepts, the students found they had a lot to learn, even though the level of the material is relatively elementary. The exercises added a dimension to the book as described in Stern et al. (2009).

The second group made more use of the exercises, largely because of the new test module. They were introduced to the exercises in an examples class, where they worked in pairs and proceeded to the next exercise once they had three correct answers in a row. Some pairs proceeded faster than others and therefore did more different types of exercises. They were asked to complete the exercises in their own time, which they all did, because of the forthcoming test.

The questions in the test are identical in form to the corresponding exercises, but without the “Tell Me” button, the option to choose another question, or immediate feedback.

This group took a 21 question test on two occasions, and the best mark of the two was taken as part of their “continuous assessment”. On the first occasion they took the test at a time of their choosing, during a 4-day period and the test was configured to provide each attempt with a different random version of each question. The second occasion was about four days later and was taken in a fixed period, with all students being given the same randomisation of each question.

The time allowed—one hour—was more than we felt was needed for the test. This was agreed by about half the students on the first occasion, and by almost all on their second run.

The CAST test system was installed on a local server at the University. This was the first time the system was used, and some problems were uncovered. One occurred when the server was

switched off while the test was being taken. This sort of interruption was anticipated, possibly due to power cuts, but the tests could not be resumed as planned. These issues were rectified before the second round of testing was given.

The students were asked for their views, following the tests. Despite the logistic problems all were enthusiastic about the extra dimension the test added to their learning experience, over and above the use of the books and exercises. All had worked hard in the period between the two occasions, and almost all improved their marks considerably.

The students appreciated that they were part of something new and provided interesting feedback. Some of their suggestions are included in the conclusions to this paper.

E-LEARNING AND CAST TESTS

The CAST books, exercises and tests have also been incorporated into an e-learning course, called "Statistics Made Simple" (Dale et al., 2010). This was originally offered as a three-day intensive course for science PhD students who needed a refresher in basic statistics. The e-learning course was later developed for the same audience. It was also taken by a small group of University of Maseno MSc statistics students in early 2009, and they recommended it be offered for incoming MSc statistics students at the start of their course.

Following this recommendation, the current MSc statistics students from Maseno and a larger group of research methods students Coe et al. (2010) are taking the latest run of the Statistics Made Simple course. This latest run of the course includes a series of short CAST tests, which will be run on line from a Moodle server. Moodle is a popular open-source learning management system. The CAST testing system has been linked to Moodle, so the students list is obtained automatically, and the results from the test are passed back to the Moodle gradebook.

These tests will be taken for the first time in November 2009.

CONCLUSIONS AND FURTHER WORK

This pilot study has confirmed the feasibility and potential of a testing system based on the CAST exercises. A next step is to perform a more objective study of the effectiveness of this CAST testing system on the students' learning. This is currently one of the aims of an M.Sc. project at Maseno university.

Courses in many African Universities, and elsewhere, include a continuously assessed component. Where appropriate, the CAST tests could be part of the continuous assessment. Neither staff nor students felt that it was important to have exactly the same random instance of each question, so the system would work for large classes where groups take the tests at different times.

The students valued the opportunity to take the tests more than once, and requested a timed test mode be included as part of CAST exercises. This would not be connected to a server so it could be distributed easily, and would be purely for the student's benefit.

An alternative way is to use the tests as "mastery" exams, i.e. exams that can be taken multiple times but students can only proceed with the course if they obtain the required grade. It is a hurdle that the students have to jump over to proceed. This uses the CAST testing system primarily as a learning tool. The students appreciated getting their results immediately, being shown what was wrong and being able to see the correct answer. As a "mastery" system this works particularly well since students know what to work on for the next time.

REFERENCES

- Coe, R., Stern, R., & Adipala, E. (2010). Keeping biometry training in-line with needs. To be presented at the *ICOTS8 conference*.
- Dale, I. C. Clark, C., Stern, R. D., Leidi, A. A., & Stern, D. A. (2010). E-learning of statistics in Africa. To be presented at the *ICOTS 8 conference*.
- McKenzie, Jr. J. (2007). Exercises and questions for electronic assessment of statistical concepts. *ISI 56th Session*.
- Stirling, W. D. (2008). CAST exercises, <http://cast.massey.ac.nz?book=exercises>.
- Stirling, W. D. (2010). Random Computer-based exercises teaching for statistical skills and concepts. In P. Bidgood, N. Hunt & F. Jolliffe (Ed.), *Assessment Methods in Statistical Education*, John Wiley, Chichester.
- Stern, D. A., Stirling, W. D., & Stern, R. D. (2009). Improving the learning of statistics with computer-based exercises. Paper presented at the *SUSAN conference, Nukuru, Kenya*.