THE GROWING ROLE OF COMPUTERS FOR TEACHING STATISTICS IN KENYA.

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Until recently, the teaching of statistics in East Africa has been a traditional chalk-and-talk affair. In the last few years computers have become more widely accessible. At the same time many statistical resources of the highest quality are freely available for Africa, including Computer-Assisted Statistics Textbooks (CAST), an electronic textbook, GenStat Discovery Edition, (a statistics package), and training resources such as the Southern African Development Community (SADC) Training Pack DVD prepared by Statistics Services Centre (SSC) , Reading University. This means that change is not only possible but is within reach of lecturers all over Africa. Experiences at two Kenyan universities are described. Initiatives for undergraduates and postgraduates in both service teaching and specialist teaching of statistics are discussed

INTRODUCTION
      The availability of computing as part of both postgraduate and undergraduate training in statistics in Africa is relatively recent. Previous limitations were the lack of both computers and of computing skills by staff as well as students. The arrival of cheap computers, freely available software, mobile phones and ease of use of the Internet has transformed communication and has created an environment ready for change.
      Computers have transformed the subject of statistics as a whole. The world over, people have recognised the importance of updating their teaching methods due to the changing needs of the students. Some of the ideas that we are implementing today date back to the 1970's when computers for students were first arriving on the scene, e.g. Mead and Stern (1973). Now computers are standard tools in teaching applied statistics degree and service courses. Our aims in modernising statistics teaching are not new, but are in line with the aims in other universities. For example the guidelines for assessment and instruction in statistics education (G.A.I.S.E.) (Franklin and Garfield, 2006) at the post-secondary level, which were developed with support from the American Statistical Association, encourage active learning and stress the use of technology and real data to foster better understanding of statistical concepts and development of statistical thinking. Use of assessments to improve and assess student learning are also emphasised as important components of this approach.
      Moving directly from a purely theoretical, factual, teaching of statistics to one that incorporates these ideas may seem a daunting task. However there is sometimes an advantage to coming late on the scene as one can learn from the experiences of others and choose from a wide variety of available resources, each of which provides part of the solution to improving statistics education. Using such resources in combination puts the modernisation of teaching and learning methods within reach of lecturers throughout the world.

THE RESOURCES
      Within Kenyan universities there is still a reluctance to invest continually in software and resources. Investment is patchy and updating licenses can sometimes be a lengthy and costly process. As such we focused on using resources that are freely available to ensure sustainability.

The conceptual resources
      No single resource is enough to transform the statistics teaching, but, once the students have access to computers, we have found the following teaching aids essential:

- *An electronic textbook.* Keeping an up to date library is expensive and students cannot afford to buy textbooks. An electronic textbook is a solution and comes with many fringe benefits that help good teaching.

- *Statistical software.* Computer literacy of staff and students is still problematic so, as well as promoting a variety of packages, we needed a powerful general package that is easy to use and promotes good statistical practices.
- *Realistic data.* By realistic data we mean either real or simulated data that relate to actual scientific problems. This often takes the form of case studies or statistical games.
- *The Internet.* Good internet access is obviously preferable but even poor access provides important opportunities to communicate and make information available.

One other issue is how to distribute resources, particularly when the intranet or internet is not good enough to use a learning management system. We found that CD's or DVD's are cheap enough to be a cost effective option even if students had to pay for a blank one.

Actual resources used
- There is an abundance of alternative resources available to support this list of teaching aids. We chose the following resources and worked with the developers to make them as relevant as possible for the students The Biometry Unit from the University of Nairobi organised funding for CAST for Africa, a set of electronic statistics textbooks, to be adapted to complement the new curriculum, to include local examples, and to be made free for distribution in Africa, (Stirling et al 2009). CAST has recently been developed further to include imaginative exercises (Stern et al 2009b) and tests (Stern et al 2010a).
- In 2003 the Biometry Unit staff and their partners, SSC, Reading and the Research Support Unit, ICRAF, negotiated with VSN, the developers of GenStat, to provide GenStat version 5 free to non-profit making institutions in Africa. This "Discovery Edition" has now been updated to Version 7 and further updates are planned. This adds to a large range of statistical software that is freely available and satisfies all our conditions above. Other software we have used include: R, an excellent open source statistics package; Excel, with the SSC-Stat add-in promoting good statistical practice in Excel; Instat+, a small statistical package from SSC particularly useful for climatic analyses; and Winbugs, a Bayesian statistics package.
- Real life case studies that expose the students to the complexities they were likely to encounter in the field were provided by our partners and a growing network of collaborators in the user community. Case studies and other teaching materials were obtained from resources such as: the SADC Training Programme in Statistics (http://www.reading.ac.uk/SSC/media/sadc-training-pack/index.html; RUFORM Research Methods Resources for Researchers, Lecturers and Students, CD Version November 2007 (much of the same material on http://www.reading.ac.uk/SSC/media/RUFORUM_DVD_2009-Aug/index.html); and the Biometrics and Research Methods Teaching Resource by the International Livestock Research Institute(ILRI) (http://www.reading.ac.uk/SSC/media/ILRI_2006-Nov/default.html). Data from case studies from these resources were supplemented with simulated data generated from statistical games (Stern et al 2009a) and historical climatic data from Kenya and other African countries.

BIOMETRY UNIT, UNIVERSITY OF NAIROBI

Statistics is offered as a compulsory service subject at the College of Agriculture and Veterinary Sciences (CAVS) at both the undergraduate and postgraduate levels and students have always viewed it with trepidation. With large classes and no teaching aids, lecturing by necessity had to be traditional technique based 'chalk and talk' affair. Only well behaved, small artificially contrived datasets which bore no resemblance to what the student was likely to encounter could be used, leaving the learner totally unprepared for the warts and complexities of real data. The students, burdened with packed timetables and few outdated books, had neither the inclination nor resources to put in extra time to internalize a subject which seemed neither important nor relevant.

Sporadic efforts were made to improve the statistics training, but these were mostly at postgraduate level where a few computers were available; and it was not until 2001 when discussions with postgraduate students identified the problem at the foundation level, that significant changes were initiated at the undergraduate level.

Changes at the undergraduate level

The proposed changes included a restructuring of the statistics courses; offering a descriptive course in the second year and inference in the third year followed by a course on practical aspects of scientific investigation in the final year culminating in a final year project. This was accompanied by a change from a technique based approach to a data based problem solving, approach. Fortunately for the success of this initiative, a number of other favourable factors were falling into place:

- Computer Aid, a UK- based charity organization, was offering second hand computers at very reasonable rates to organizations in developing countries and UK Met Office, which was sponsoring a Statistics Course for Meteorological officers in Africa in which the Biometry Unit was involved, offered to buy fifty second hand computers to help establish an undergraduate computer laboratory at CAVS.
- The College administration agreed to provide space to house the computers and infrastructure and technical support to maintain the lab.
- At the same time the resources mentioned above were becoming available.

With hardware, reputable user-friendly statistical software and an exciting interactive text book, the scene was set to make a positive impact on our students.

Contact time could now be used to explain, demonstrate and work interactively with students. With easier access to computers, it is possible to post the materials and replace transcription with attention during lectures and, encourage students to go back to the materials in their own time. One noticeable improvement is the increase in collaborative learning–looking across at a neighbour's screen does not seem as underhand as looking over somebody's shoulder to see what has been written! Classes are livelier and there is more discussion between students and with faculty.

A series of simple guides was prepared to support the teaching and give suggestions on how different resources can be used in teaching. For example, one of the resources used are the Statistical Games, a series of computer games which simulate data for practical scenarios; "Learning Statistics–the fun way" (http://www.ssc.rdg.ac.uk/software/games/stat_games.html) gives suggestions on how to use these Statistical Games for teaching when computer facilities are available. It also describes how to make handmade versions, in the event that computers are not available. The article "Teaching Statistics using Climatic Data" (http://www.ssc.rdg.ac.uk/bucs/Manna%20from%20Heaven.pdf) shows how to use climatic data in teaching. Guides for using climatic data are also available for Instat and Genstat.

Changes at the postgraduate level

While postgraduate students have had some access to computers at CAVS since the late1980's, the use of the teaching resources and easy to use, freely available software has improved our postgraduate training greatly.

The CD copy of the RUFORM Research Methods Resources used by postgraduate students becomes their electronic library for the course and weekly readings are assigned. Students are encouraged to see that their access to information and ideas is not limited to the resources of the University of Nairobi. In addition the research methods course makes frequent use of the case studies available on the Biometrics and Research Methods Training resource CD. Students are able to put the data sets into a research context before reproducing the analysis, in whole or in part, using GenStat.

It is necessary at CAVS to use freely available statistical software for postgraduate teaching and research. The open source software package, R, was experimented with briefly but the command driven language made it difficult for students to concentrate on syntax and statistical concepts at the same time. Both Instat and GenStat have dialogue boxes with drop down menus that allow the students to focus on the information needed for a procedure without having to memorize commands. Although we are open to students bringing and using other software we find GenStat well suited to most of our research needs.

MASENO UNIVERSITY DEPARTMENT OF MATHEMATICS AND APPLIED STATISTICS

Over the last couple of years there have been similar changes at the Maseno University, in Western Kenya. As with the Biometry Unit in the University of Nairobi, the changes have started at the postgraduate level but for statistics students. Part of the reason for starting with postgraduates was because the changes are easier to implement than with the large undergraduate classes, and partly to train lecturers who will then change the undergraduate teaching. Plans for 2010 include extending the style of teaching to the statistics undergraduates, as described in (Stern et al., 2010b).

Maseno has made the most of the resources the Biometry Unit has worked so hard for, and continued to collaborate with the developers to improve them even further. CAST and its exercises have been used extensively and the testing system was first trialled on Maseno MSc students (Stern et al., 2010a). Some of the Maseno students and staff have also taken some facilitated e-learning courses offered by the SSC, (Dale et al., 2010). This was partly to learn the course content but mainly to learn about the new teaching methods and evaluate the local need. The aim is to develop a collaborative relationship whereby Maseno is involved in giving local support to the e-learning course so that a blended approach can be offered to other organisations in Kenya.

One aspect where Maseno differed from the biometry unit was in the use of statistical software. GenStat was still the main package but working with statistics students it was deemed important that they become familiar with a range of software, partly for their courses, and also so they develop the skills of being able to use new (statistical) software as the need arises. Hence they also made use of R and Winbugs.

For the service teaching Maseno has started by training the lecturers. The aim is to get them involved and updated, before changing the teaching of their students.

CONCLUSION

Throughout the world applied statistical teaching has been in a transformation from the didactic theory lecture towards the principles outlined by the G.A.I.S.E. guidelines. This transformation is especially challenging in the resource limited universities of the developing world. The advent of access to computers and the Internet (albeit limited), freely available software and an abundance of teaching materials has made it possible for lectures at Nairobi and Maseno Universities to move toward active, concept centred, learning using real data in real contexts.

We do not wish to overestimate our progress or underestimate the challenges but are convinced that change is now within reach of determined lecturers wherever they may be.

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