OVERVIEW OF ONLINE TEACHING AND INTERNET RESOURCES FOR STATISTICS EDUCATION

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Abstract

Over the past few years there has been a big increase in the use of the Internet as a resource for helping teach most subjects, including statistics, especially at the post secondary level. This varies from the fairly simple use of the Web as a place to store and disseminate information and provide efficient means of communication, to complete web based courses on statistics. This paper will look at some of the issues in online learning, and particularly at a range of websites that utilise the different aspects of the Internet for the improvement of the teaching of statistics. These include National Statistical Agencies, statistics courses, statistics calculators, probability, history, assessment, datasets useful in the teaching and research in statistics, interactive applets which aim to help students with the development of statistical concepts and explanatory descriptions of statistics techniques. These developments mainly occur in the teaching of introductory statistics, a subject taken by many students at the post secondary level.

Keywords: Online education, teaching statistics, Internet statistics resources

1. Introduction: The emergence of web based learning

"*At 4am, in the small South Australian town of Burra, Craig Wissell is at his computer, studying online for a master of agribusiness. While most of the town's 900 residents sleep, he is communing with classmates from countries as diverse as Samoa, Zimbabwe, Mozambique, East Timor and Argentina.*" Gooch (2001).

This is an example of how delivery methods in many areas of education have changed dramatically in recent years, in particular with the move towards use of the Internet. These methods have a number of names including Online education, Internet learning, Web based learning, E-learning, Virtual education, Flexible learning and more traditionally, Distance education. These innovations have been most prevalent in developed countries but now less developed countries are also increasingly making use of the Internet to try to help solve some of their education problems. These include countries like China and India which have massive problems in reaching their huge and widespread audiences and are getting involved with online learning.

Numerous reports point to such developments indicating plans for extensive use of the new technologies. Matsuura (2001) wrote "*The expansion of distance learning has had a huge impact on access to higher education. In India, more than 1 million people study in the network of national and state open universities. In the rest of the world, ten open universities enrol 2 million students*." Parkins (2001) discusses how China is trying to solve the massive problems of reaching an extensive audience. He reported "*China's ministry of*

education has taken more tentative steps into the online learning environment, allowing 25 universities to carry out Internet trials. The ministry views the net as a potential way to extend higher education provision to previously disenfranchised people, particularly those in outlying regions, at a fraction of the cost."

Education has become much more of a business commodity and has to play its role in a very competitive market place. Richard Katz (2001) vice-president of Educause, a consortium of more than 1,600 universities worldwide warns that Universities must act quickly to grasp the opportunities IT offers for education or risk losing market share to non-traditional providers. However, the early commercial expectations of some online educators were tempered by the start of the 2000's. This was seen in comments such as "*Canadian universities have also realised that e-learning is not about a fast buck and a camera in the classroom. Lowered profit expectations and a call for more instructional design have brought a certain sobriety to the learning technologies and distance-education scene in Canadian universities.*" Fine (2001).

Sir John Daniel who was vice-chancellor of the Open University in the 1990's and now the assistant director-general for education at UNESCO, said "*The likelihood of a lucrative market developing in web-based courseware has now been reduced greatly by the Massachusetts Institute of Technology's recent announcement that it will make all its electronic course material available for free.*" Daniel (2001). Terry Anderson, Canada's first federal research chair in distance education at Athabasca University, commented that the decision to give away such things as lecture notes and classroom videos brought home the idea that content on its own was never the whole story. He said: "*MIT clearly thinks that education is not just dissemination of content. It's the involvement of teachers and students.*" Anderson (2001).

Other commentators discuss the effectiveness of the new approaches. For example Rob Copeland, a research officer with the UK Association of University Teachers, reports how "*plans for a UK e-University (e-U) continue to gather pace, with £62 million of government funding allocated over the next three years."* Copeland (2001). But he points out the need for serious discussion of the effectiveness of distance learning and adds "*Research also shows that information and communications technology cannot simply replace the human element in higher education.*"

Online courses offered by consortiums of universities are attracting much interest in Asia and Europe. For example, Cervini (2003) reported that enrolments at the $95 million online university Universitas 21 Global, a partnership between 16 universities worldwide and US-based publisher, had commenced.

Other ambitious online projects, often of a cooperative nature, have been instigated in many countries including:

- Italy, which involves a consortium of more than 20 Italian universities, Bompard (2001).
- Scotland where three universities have joined together to set up the Scottish Centre for Research into On-Line Learning (Scrolla), Wojtas (2001).
- South Africa is applying distance learning to help entice adults back into the system in the post-apartheid era, MacGregor (2001).

- USA where The Open University and Carnegie Mellon University will be funded for e-learning through a collaboration between corporations interested in e-learning, academic researchers and the US Defense Department, Anonymous (2001).

This is a brief background of the growing worldwide use of the Internet in education. I will now look at specific aspects of teaching using the Internet and in particular look at some resources which are available to assist with the teaching of statistics.

2. Distance learning

Learning by distance has been available for over 100 years but has increased greatly with the advent of specially designed distance courses such as Open Universities and more recently with the Internet. Many standard on campus university courses are now also available over the Internet making access to higher education much more widely available than before. The Pacific Western University website Introduction to Distance Learning http://www.open-universities.com/us/dl/que_es.htm gives a definition of distance education: "*as a system of education where students and teachers are separate by time and distance, aimed principally at experienced people with a desire to investigate who don't require permanent contact with professors or classmates. ... Technology has mobilized the way we communicate, revolutionized our style of work and also our manner of study. ... there is no longer any excuse for those who live far from big cities or those who cannot coordinate their schedule with the program of a traditional university*."

Open Universities are now in many countries around the world including UK, Germany, Australia, Finland, Canada, Greece, Netherlands, Hong Kong, Spain, Bangladesh, India (at least 10), Thailand and the USA. Links to a number of Open University sites are found at sites such as http://www.dlcoursefinder.com/US/ass-aus.htm, http://www.braintrack.com/ and http://www.academicinfo.net/eddistorg.html. Statistics lecturers can use appropriate sites to get ideas for their own courses. For example in the UK Open University, we see four statistics courses Quantitative Methods in Business, Statistics in Society, Analysing Data, Applications of Probability, Linear Statistical Modelling, which provide alternate ideas on what can be offered. We see in the summary for Statistics in Society: http://statistics.open.ac.uk/teach/teach.html. "*What is statistics and what can it do? This course uses statistical techniques to investigate everyday situations and will give you an understanding of statistical ideas. Taking the question 'Are we getting better off?' we develop techniques of exploratory data analysis.*"

As there is increasing demand to include some statistics training for most students at post secondary level, I am sure we can learn from such ideas to help us develop our own courses and work towards improving the general statistics literacy of our students. In addition, there are many sites which enable us to get ideas for teaching more advanced topics. An effort is being made to improve the links to interesting sites on the IASE Statistics resources site which provide many ideas for the teaching both of basic and more advanced statistics concepts, see http://www.swin.edu.au/maths/iase/resources.html.

Features available on the Internet to teach any topic include providing a place to store and disseminate information, enable efficient means of communication as well as the

facility to deliver complete courses. Also available are other Internet resources for statistics educators including the availability of many datasets, interactive applets to help students understand statistical concepts and explanatory descriptions of statistics techniques.

3. The online classroom

Some classroom experiences

At ICOTS 6 Patsy Clarke listed many features of her online classroom which takes in many of the desired features of online teaching, Clarke (2002). These include a classroom homepage, link to an online survey, classroom discussion forum, email for submissions, one-to-one contact and one-to-group contact; class chat for student use and group work; participant list with photographs; readings and links to online resources, a glossary and a link to a dictionary; a growing FAQ section and web cam images of the course facilitator. She saw that many challenges are associated with this form of teaching. These include student motivation, learning activities and assessment tasks. Her method involved an ongoing daily learning journal, submitting a structured online introduction and personal metaphor of learning, completing a web-based survey, doing online readings, using links and examples. Also students attend a 2-day face-to-face practical training course, submit a short written paper based on the readings and resources and carry out several online projects involving data preparation, analysis and discussion forum. Clarke saw the methods employed in her course helped with "*The reduction in 'quantophobia'*," as well as bringing about *"reduced feelings of possible isolation in online learning*".

Copeland-Smith, (2002) also in an ICOTS6 paper, saw the mentor, a past student of the course, as by far the most valuable support mechanism. This also has an advantage to the mentor as a source of income as well as gaining a deeper understanding by providing online help. On the negative side she saw the type of learner that you have to be to study online was not emphasised enough during the course. Who best learns using online experiences is an issue that needs to be considered, but will not be dealt with here.

Packages used to deliver online courses

The development of packages used to deliver online courses has been a big growth industry over the past few years. A quick Web search revealed over 40 packages which have been commercially developed for delivering course materials on the Web, and there are many more home grown packages. A number of sites offer assistance to educators when making decisions about the choice of an online course management system. These include the Ocotillo Online Learning Group site, http://www.mcli.dist.maricopa.edu/ocotillo/courseware/compare.html, the Texas State Library site for Distance Learning, http://www.tsl.state.tx.us/ld/pubs/dl/resourcesw.html, the Comparative Features Analysis of Leading Course Management Software site, http://www.futureu.com/cmscomp/cms_comp.html, and the Edu Tools online site, http://www.edutools.info/course/index.jsp.

Like any software package, there is no "best" package, just many which do a similar job, hence what is used often comes down to personal choice, availability and cost. The packages which appeared frequently in my quick search were WebCT, the most mentioned, with other popular courseware software appearing to be Web Course in a Box (WCB),

TopClass, Learning Space, FirstClass, and Blackboard. No doubt market forces will determine which survive.

The detail relating to online classrooms per se will be taken up by other speakers at this meeting. I will focus more on some of the resources available for statistics educators, whether they are using online or more traditional classroom teaching.

4. The Web as a place to store and disseminate information

The Web is widely used to store and disseminate information. Playing an important role in this are agencies such as the National Statistical Agencies, the International Data Base the United Nations Statistical Databases, Data Archives and Statistics Societies.

National Statistical Agencies

The introduction of Web sites by national statistical agencies in the past 10 years has provided a great source of information and data in many countries. Initially the agency Web sites contained primarily what had been decided by the producers and not the users of the data, Bäcklund (2001). But things are changing. The fact that statistics are now being regarded as a public good is partly an outcome of the change in dissemination of statistics.

For example the Australian Bureau of Statistics, ABS, provides a significant amount of data from their site http://www.abs.gov.au/, some to everyone, others to any participating Australian university. In particular AusStats is a Web based information service providing the ABS's full standard product range on-line. It includes: all ABS publications from 1998 onwards, over 2,000 spreadsheets containing economic and social time series data, and data cubes in the form of multidimensional datasets in SuperTABLE format and Excel spreadsheets; for 1996 and 2001 Census Data.

Similar resources are available in many other countries. Statistics Canada's Learning site http://www.statcan.ca/english/edu/index.htm provides resources for school age students, teachers and postsecondary level while the Data Liberation Initiative (DLI) provides affordable access to Statistics Canada data files and databases for teaching and research. A simple example for school level statistics is the most popular sports site http://www.statcan.ca/english/Pgdb/arts16.htm.

Web-servers for the Statistical Agencies for many countries can be found at the ISI Directory of Official Statistical Agencies & Societies http://www.cbs.nl/isi/directory.htm. These are most valuable sources of demographic information and data for students of many statistics topics. At times the raw data or tables you wish to use may not be provided as separate data files, rather they may appear on a html page. In such cases an intermediate step may need to be used such as saving the Web page as a html file then opening in Excel, cleaning it up and transferring it to your preferred statistical package.

International Data Base and United Nations Statistical Databases

A most informative website for demographic data which is provided free is the International Data Base (IDB) found in the US Census Web site at www.census.gov/ipc/www/idbnew.html. The IDB is a computerized data bank containing statistical tables of demographic, and socio-economic data for 227 countries and areas of the world. It includes: summary demographic data for selected countries, data for selected

tables, countries, and years, aggregated demographic data for selected regions and/or countries, population pyramids and world population information.

The United Nations Statistical Databases http://unstats.un.org/unsd/databases.htm provides much data with unrestricted Internet access including: Millennium Indicators Database, Social Indicators, Population of capital cities and cities of 100,000 and more inhabitants, Good practices database, InfoNation which provides learning project for middle and secondary students with statistical information on countries.

Both these sites are very useful for making international comparisons on a whole range of demographic information and are a great source of information for student projects and research.

Data Archives

Many countries now provide wonderful sources of data for research in their data archives. These house data provided by many research and government organizations which can be obtained by researchers and for educational purposes at reasonable cost. For example in the USA the Inter-university Consortium for Political and Social Research, ICPSR, http://www.icpsr.umich.edu/, maintains and provides access to a vast archive of social science data for research and instruction, and offers training in quantitative methods to facilitate effective data use Similarly in the UK, the Data Archive, UKDA, http://www.data-archive.ac.uk/ is a resource centre that acquires, disseminates, preserves, and promotes the largest collection of digital data in the social sciences and humanities in the United Kingdom. Its primary aim is to support secondary use of quantitative and qualitative data for research and learning.

Statistics Societies

Most statistics societies have a Web presence, many of these sites can be found from http://www.swin.edu.au/maths/iase/societies.html. These sites generally give useful information, both local and international, for statistical educators in that country. Of particular relevance to statistics educators are the Statistics Education sites found at the RSS site http://science.ntu.ac.uk/rsscse/ and the American Statistical Association, ASA site found at http://www.stat.ncsu.edu/stated/homepage.html

5. Sites especially designed by and for statistics educators

Most University statistics courses these days have their own web sites. These may contain simply places to store lecture notes, Powerpoint presentations, and data sets, exercises etc. Such sites are increasingly used to disseminate information and provide efficient means of communication and in some cases provide complete web based courses on statistics along with assessment tools.

Data especially selected for teaching statistics

There are many websites which contain data which has been especially designed or selected as useful in teaching certain statistics topics. Among a long list include:

- *StatLib Datasets Archive* http://lib.stat.cmu.edu/. An original source for archived data.
- JSE Data Archive http://www.amstat.org/publications/jse/archive.htm. Datasets contributed by teachers.

- *The Data and Story Library* http://lib.stat.cmu.edu/DASL/. A collection of datasets and related stories which may be searched by data subjects or by statistical techniques.
- *OZ Data and Story Librar*y http://www.statsci.org/data/. Similar to DASL for Australasia
- University of Massachusetts - Amherst http://www.math.umass.edu/~scc/statdata. A collection of links to datasets organized by statistical topic.

These are just a few of the sites listed on the IASE statistics resources site where data is freely available for teachers and students to help show the application of statistics with real world data.

Datasets for some Statistics texts

Many statistics texts now have a website associated with them. These often contain datasets for exercises in the text which can be downloaded. Sometimes the files are provided in a variety of formats, but whatever format is used, the data can generally be transferred to the desired one. Some examples of sites with datasets from texts are found in the IASE resources site. There are many other similar examples which provide excellent datasets and other resources not only for those using that text, but also for adaptation by teachers in their own lectures, normally with the permission of the author or publisher.

History of Statistics

Several sites provide a rich source of historical data about the development of statistics and famous statisticians. In particular these include University of St Andrews, http://www-groups.dcs.st-andrews.ac.uk/~history/index.htm and UCLA History of Statistics page http://www.stat.ucla.edu/history/. Information from these sites can be used to add interest to classes and provide information for student assignments.

Applets Simulations/Demonstrations

Many students gain a better understanding when visual images are used to explain statistical concepts. With this in mind many demonstrations, simulations and dynamic applets have been produced and are available freely on the web. These are programs written in the JavaTM programming language that can be included in an HTML page, much in the same way as an image is included. These have been especially popular for explaining ideas in correlation and simple linear regression, but are being extended to many other concepts such as statistical power.

The many sites with useful statistical applets include Rice Virtual Lab in Statistics: http://www.ruf.rice.edu/~lane/rvls.html, Duke University Institute of Statistics and Decision Sciences, http://www.stat.duke.edu/sites/java.html, Hossein Arsham's Univ. Baltimore site http://www.mirror.ac.uk/sites/ubmail.ubalt.edu/~harsham/Business-stat/, Robin Lock's site http://it.stlawu.edu/~rlock/maa99/, and Susan Holmes, Stanford site http://www-stat.stanford.edu/~susan/surprise/index.html

The Census at School project

This project, which arose from the RSS Statistics Education Program, provides a rich source of statistical experience especially for secondary students and now operates in several countries, including UK, South Africa, Australia, New Zealand, see http://www.censusatschool.ntu.ac.uk/. Experiences with this project are described for the

UK by Connor, D. (2002) and for Italy by Conti C. (2002). Involvement in these or similar projects are highly recommended.

Software and Statistical calculators

Everyone carrying out data analysis now uses some form of statistical package, either a widely used package like Excel or a statistically more powerful one like SPSS Minitab, SAS or Stata. Another very useful learning and statistics package is ActivStats which is a complete statistics course and includes access to Data Desk. However these can be expensive for students to buy, and it may be possible that some of the free software provided on the Web would be sufficient for many basic statistics courses. A very comprehensive site that has links to calculators that perform most of the commonly used statistical calculations has been compiled by John Pezzullo at http://members.aol.com/johnp71/javastat.html. This site has over 600 links including 380 to calculating pages, and is growing. Another example is the Pearson site which has a number of useful calculators, especially for market researchers, such as determining sample sizes, see http://www.pearsonncs.com/research-notes/sample-calc.htm.

Probability

There are a number of sites that are especially helpful to students, teachers, and others for the development of ideas in probability. These include the NCTM: see http://illuminations.nctm.org/index.html This New Vision for School Mathematics site includes useful tools for data analysis and probability for school age children. Also the Probability Web http://www.mathcs.carleton.edu/probweb/probweb.html is a collection of probability resources on the Web.

Assessment

Conducting courses online raises questions with regard to assessment. This is sometimes done in the traditional way for distance courses in which students sit their tests at a co-operating institution, or they have a supervisor who administers the tests. In recent times online testing options have become more available. Clarke (2002) described how student work was assessed using ongoing assessment of attitudes and behaviour in (online and face-to-face) class interaction; submitted paper and contributions to online peer evaluations of papers; contributions to on-line discussions; group project and process; individual data analysis project and submission of a portfolio. Lipson, (2001) described an online testing system which is used as part of the assessment in her introductory statistics course and now used in her Open university course. A number of authors include sample tests and exams on their sites. Thomas et al (2002) are examining ways of testing higher level mathematics and statistics skills on the Internet. Generally assessing statistics online still appears to be in its early stages and there is a need for research and development into this important aspect.

Other sites

At ICOTS6, Neil Binnie gave a demonstration of useful statistics education sites, http://www.aut.ac.nz/depts/stats/index.html. Furthermore, many sites of interest to statistics educators quoted in papers in the ICOTS6 Proceedings can be accessed at

http://www.swin.edu.au/maths/iase/ICOTS6_Links.html. Also many of the statistics software packages include explanations of statistic topics, for example the Statsoft electronic text book, http://www.statsoftinc.com/textbook/stathome.html. Other excellent information on sites useful to statistical educators have been established by individuals who keep their eye on the Web and regularly update their links. I will not list any here, but a number of them appear on the IASE resources site.

Evaluating Web Sites

In Gabriella Belli's paper given at this meeting, Belli (2003), she refers to sites where a user can learn more about evaluating Web sites in general. This is most welcome as a major problem when using material taken from a website is that there are often no checks on the quality of what appears there with regard to correctness, accuracy and being up to date. There does not appear to be specific information about evaluating statistics sites, but the points made about websites in general apply to any site.

6. Concluding comments

The use of the Internet in education is increasing and becoming more refined. Entire courses are now offered online and the resources available are extensive. Some of the earlier expectations of the commercial potential of online courses has not yet materialised. Rather, the generous nature of many agencies and authors has made a large amount of material of use in statistics courses and research readily available to any statistics educator who chooses to use it. This paper gives a sample of the resources that are now available on the Web and which are increasing daily. They are not necessarily the best available, as it would be a huge task to critically evaluate all the resources available. However they do provide wonderful resources for teachers of statistics at all levels to give their students a greater opportunity than ever to learn and understand statistical concepts. These and may more sites can be accessed from http://www.swin.edu.au/maths/iase/resources.html, the IASE resources page.

These Web based resources can be used by any student, not only those studying online. As Parkins (2001) writes "*These changes do not only apply to students who do not attend classes, in increasing situations students enrolled on conventional programmes are also receiving a similar Internet educational input via computers or big screens and electronic keyboards or writing pads.*" The Internet is here to stay and all educators should use it in the best way possible to assist their students learning.

NOTES: All electronic references were tested 1 June, 2003.

Comments in the Introduction were taken from The Times Higher Education Supplement web pages: http://www.thes.co.uk/archive/

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