

# Distance learning and the empowerment of students: applied statistical analysis for students of the Built Environment

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## Background and Rationale

Built Environment students (including construction management, quantity surveying and so forth) generally exhibit limited understanding of mathematics and statistics, both from a theoretical and practical perspective (cf. Johnson, 1998; Llewellyn, 1999; Mtenga and Spainhour, 2000). This statement is supported by the fact that over half of the first year students (2001/2 intake) who completed an Individual Learner Profile (ILP) admitted to exhibiting poor mathematical skill. In addition, fewer than one in forty students have gained a mathematical qualification higher than a GCSE. Hence, undergraduate students are faced with a huge task when initially conceptualising the analytical component of a dissertation. Consequently, students elect to avoid robust and rigorous analysis in preference for elementary and somewhat naïve statistical methods to interpret any gathered data. This problem is further exacerbated by the reference to many 'introductory' statistical texts that are written for persons who have an 'above average' mathematical knowledge. Due to their background, Built Environment students struggle in transferring their data into a format that can be analysed and interpreted by statistical software. To do so requires time and commitment of staff combined with student initiative and drive. The problem here is that over 50% of students in the School of Engineering and the Built Environment (SEBE) attend University on a part time basis. Hence, physical restrictions limit these students' ability to access the library and search for an appropriate textbook. Therefore, an easily accessible (internet) reference tool would provide an ideal opportunity with which to overcome this potential stumbling block.

Statistical analysis is not a prerequisite taught undergraduate subject in any course offered by the Built Environment division at undergraduate level. Yet statistics forms an integral and quintessential role in decision-making and forecasting situations (Chatfield, 1998). Specifically, with reference to construction professionals 'average' working day, it has been determined that a decision has to be made every three seconds, and every ten seconds the decision is directly influenced by a numerical computation (Edwards et al., 2002).

Inherently, construction projects require a considerable amount of applied 'computational' mathematical and statistical knowledge to plan and control. It is therefore vital that students acquire such skills, since these transferable skills are synonymous with a successful career within industry. Therefore, providing students with pragmatic 'construction biased' worked examples and additional supplementary methods such as conversion of qualitative into quantitative data, students will learn: fundamental software applications; how to interpret data generated thereafter; and more importantly, how such relates to industry. The proposed 'internet based' tool (which is freely accessible to students) will not only improve the teaching and learning process but will also act as an advertising tool to both employers and potential future students. For new universities like Wolverhampton, this all-important 'added value' service may mean the difference between high and low recruitment figures,

year-on-year! More importantly from the students' perspective, having invested two years of full-time study or four years of part-time study on a degree course, being referred in the dissertation means the individual is:

- a. restricted from entering the job market and capitalising on their qualification; and
- b. forced to commit themselves to a further year's study to placate the minimum D5 requirement.

## Aims and objectives of project

The aim of the proposed project was to develop an internet-based tool to assist undergraduate students learn 'applied' statistical analysis of data (relevant to typical construction problems) not just statistics per se. Such a tool would facilitate students, who actively seek to enhance their general mathematical and statistical knowledge as well as gain an insight into using commercially available statistical software simulation packages. The fundamental 'anticipated' outcomes of the project are to provide a:

- a. demonstrably improved quality of service to dissertation students; leading to similar improvement in dissertation content;
- b. student reference tool for data mining and subsequent qualitative and quantitative analyses; and possibly
- c. benchmark standard against which to 'measure' student grades; this will be used to monitor student performance and thereafter provide 'auditable' information that will feed into quality control loops (and further refinement, where needed, to the internet tool).

However, other incidental outcomes are also retrievable. Since statistical knowledge is a precursor for higher degrees (MPhil's and PhD's), undergraduate students who demonstrate an aptitude for exploiting data could be identified as potential higher degree candidates. In turn, supervisors of higher degree students could use the benchmark standard developed to assess potential candidates' academic performance.

## Methodology

As teaching and communicating the essentials of statistics is not new, it follows that reviewing best practice in such would provide a solid grounding upon which to build the learning tool. The methodology for determining the content of the tool therefore embraced two facets: a. a comprehensive literature review of statistical texts; and b. informal discussions with lecturers at 'redbrick' universities regarding their approach to teaching the subject.

A comprehensive review of relevant statistical texts and techniques was undertaken. It was determined that there are a plethora of statistical techniques available, ranging from complex multivariate to simple bivariate analysis. However, underpinning the majority of such techniques are fundamentally ten broad skills that require comprehension if any detailed understanding of statistics is to be gained. These techniques being:

1. descriptive statistical measures (e.g. mean, median and mode);
2. standard deviation;
3. coefficient of variation;
4. standardisation of data;
5. correlation analysis;
6. chi-squared test;
7. student's t-tests;
8. moving averages;
9. linear regression; and
10. time series forecasting

It was therefore considered that these aforementioned procedures should be considered in the tool.

In certain redbrick universities, statistics are taught as a core subject to all construction students and the assessment regime for these statistics modules demand that students remember mathematical formulae for exams i.e. no formula sheet is provided. Due to the aforementioned general poor mathematical ability of built environment students at Wolverhampton University, this strategy was considered inappropriate. To overcome this learning obstacle, the decision was made to focus onto Data Analysis using Microsoft Excel. The reason for selecting this software (as the basis for conducting analysis) is that students tend to have a general understanding of Excel and its constituent working principles. Hence, by embracing this widely available software, which the majority of students have access to either at their work and / or home, students failing to use appropriate statistical procedures can therefore use minimal excuses. After all, it has to be remembered that learning statistics is presently defined as being encompassed in the dissertation element of a student's learning. Unnecessary obstacles (i.e. learning a new software package) should therefore be removed.

## **The innovation**

### **Learning tool development**

To ensure that the contents of the web page contained sufficient detail for students to understand their content, a random sample of students were asked to comment on the web page. Random in this sense is defined as students from different Built Environment courses and at different stages of progression in such. Student feedback was an important element in the development of the web page. After all, failure to communicate effectively with students would lead to the web page being rejected by those it is intended to help. Initially, a paper survey was given to forty students, however, some reluctance to fill in the questionnaire was experienced; this being based on several grounds. First, students felt that this formal approach could identify an individual's potential mathematical weakness. Second, others could not help due to coursework and exam commitments (which they perceived, quite rightly, as being of the utmost importance). To resolve this problem, face-to-face informal interviews were held with students, each being given strict assurances of confidentiality. Initial comments received from this strategy identified that the 'conceptual' concept of the web page was of interest to students; though it failed to spell out in explicit detail step-by-step instructions regards data manipulation a priori to analysis. As a result of this critical observation, the project programme was adjusted so that greater detail (in the form of prescriptive step-by-step guidance augmented with screen dumps) was included in the web page to ensure that the students' interests were retained. This was a challenging task and subsequently took considerably more time than was allowed for in the initial programme. Reprogramming of the project subsequently made the web page formally accessible after the Easter 2002 break (see <http://www.wlv.ac.uk/sebe/stats>). Whilst this development (and thus delay) was unexpected at the outset of the work, it should be noted that the production of this tool followed a 'robust' iterative process of development and test. Such iterations ensured that the optimum product, within the resource (time and cost) restrictions was delivered to students.

## **The outcomes**

Initial communication with a pilot sample of students identified and reinforced that they (generally) have a poor understanding of mathematics and IT software packages. Subsequently, this fact had a major negative influence on students being able to grasp and utilise even the most basic techniques during dissertation studies; indeed, often only cursory

percentage observations are made. Further, because students perceive statistics as a subject that is complicated and beyond them, they tend to become disheartened when faced with analysing any data collected during their dissertation study. Despite these observations, students were extremely positive regards the proposed statistical web page, not least because statistics would be applied in a contextual 'construction' background vis-à-vis theoretical concept(s) that are often presented in various (so-called introductory) textbooks. Moreover, students are generally resilient and actively seek to learn new techniques, provide such learning is presented in a coherent and industry contextual format. Students could thus envisage the solution, using statistics, to a given construction problem. It is recognised that the web page will not provide the definitive answer to **all** statistical principles; rather, an insight into statistics will enable students to gain invaluable knowledge and experience that will enhance their dissertation marks and prepare them better for industry.

Points of particular interest that were observed when asking students to comment on the web page development were:

- a. students did not want a web page with pop up windows appearing at key stages in any analysis procedure being described. This was an interesting observation because it was initially perceived that students would like a web page that demanded them actively clicking hyperlinks to gain information;
- b. students wanted to be able to print out the web page and follow it step by step when carrying out any analysis work. This meant that, in combination with point 1, the web page had to be simplistic in usage and presentation;
- c. students did not realise how powerful a tool Excel is; the majority perceived it as being a tool for adding and subtracting one column of numbers from another; and
- d. students did not want to know the intricacies of mathematical formulae underpinning statistical procedures, they simply wanted to know how to analyse data and interpret the results.

## Project evaluation

Following the student comments received when asking for their response to the web page, more in-depth work was required to develop the tool than was initially considered necessary. Nevertheless, when students were asked to critically appraise the web pages that have ultimately been developed, they expressed general approval. As some students find following text difficult, the inclusion of sound clips could be added to the web page to allow the information to be transmitted more effectively than textual communication. This observation has been considered as a potentially valuable mechanism by which to make the tool even more user-friendly. However, when developing an audio section for one of the pages, the download time became excessive. As a result, because many students indicated that they would be downloading the page from home (and would be paying for the cost of the connection to the web as they go), it was felt that until necessary advances in server speeds were made, audio clips would negatively distract from the tool being used.

At present, because the web page has only been publicly accessible since Easter 2002 an opportunity for dissertation students to access the tool and use it in the context it was intended has not been possible. Despite this, students who did finish their dissertation this year and were shown the web page did offer positive comments about it, its layout and language used to explain a potentially complex subject.

## Conclusion

It would be foolish to claim that the developed tool is an elixir to the problems and obstacles that final year students encounter when conducting their dissertation. The tool does however offer students a clear insight into what can be achieved with any gathered data; how to manipulate the data and most importantly how to interpret the results gained.

A key observation made was that Wolverhampton University's Built Environment students are not required to study and formal statistical course during their studies. This is different to certain redbrick universities who demand that statistics is studied over at least one semester. Evidently, if Wolverhampton's students' degrees are to be valued on a similar level to that of the redbricks, then this is one possible area that could be considered for embracing.

The developed tool was continually exposed to students to gain their comments and opinions. It was found that students did not want to offer formal negative comment on the web page due to them perceiving this would highlight their ignorance of the subject and / or indicate their general poor mathematical ability. Subsequently, feedback was gained on an informal basis and proved to be an excellent method of gaining the respective audience's opinions. Further, students wanted something that got to the point; allowed them to start analysing data at the earliest possible opportunity; and which did not demand them learning complex mathematical formulae.

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