UNDERGRADUATE STATISTICS CURRICULUM FOR THE WORKPLACE: A CASE STUDY OF PUBLIC UNIVERSITIES IN UGANDA

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ABSTRACT

This study explored the statistics curriculum for undergraduate programme in public Universities in Uganda. Two public Universities were purposively selected for the investigation. A survey was conducted following both qualitative and quantitative paradigms. Interviews and documentary analysis were conducted. And six administrators and 60 graduates were interviewed. The data were analysed using constant comparative analysis to categorise the type of information that arose from interviews and documents. The institutions taught different statistics content to their undergraduates. Some statistics techniques used by graduates in the workplace were not taught while others were taught but not applied in the workplace. The content taught is not perfectly aligned to the needs of the workplace. The implication of the study is the need to align statistics content for the workplace and to prepare graduates appropriately for employment. Graduates need techniques that are tailed to either industry or to schools. Educational implications are discussed.

1. INTRODUCTION

Any standard curriculum addresses *what* is taught (content), *how* it is taught (methods), *when* it is taught (level and time), *who* is taught (clientele) and *how* assessment is conducted (making judgement). Effective practices for teaching undergraduate statistics at University and the content of such programmes remain a basis of extensive debate among educators. Generic skills are increasingly valuable to University graduates in flexible careers and in the requirements of the workplace. The new economy will involve new paradigms in how we educate, train, and develop the workforce (Hartanto, 1993). Meanwhile, business strategies will become more dependent on the quality and versatility of the human resources. Consequently, what is taught in a subject should extend beyond mere knowledge to its applicability any time and moment it is required. For example, Mason and Spence (1999) have argued that "the central problem of education is that *knowing-about* does not in itself guarantee *knowing-to"* (p. 135). *Knowing-about* a subject involves '*knowing-that'* which is familiarity with factual knowledge; '*knowing-how'* is acquaintance with techniques and skills; and '*knowing-why'* is fluency with a story to structure actions from which to reconstruct actions, while *knowing-to* requires familiarity with active knowledge that is available at the moment it is needed. Students of statistics should not only know-about statistics but more importantly they should know-to apply statistics.

One of the biggest challenges for statistics instruction in higher education is the number of graduates who demonstrate inappropriate skills to the subject and its applications in the workplace. With the advance in technology the demands are ever changing and so are the skills needed for the workplace. Simultaneously, modern technology has, and is shifting how we live, work, and learn. According to Harraway and Barker (2005, p. 44) "an ability to manage data and use statistics software is also crucial in the workplace." Meanwhile, influential business and industry clients are arguing that education must transform to teach new kinds of mathematical and statistical skills and problem solving ability that will be essential for the employee of the future (Putnam, Lampert, & Peterson, 1990). However, there are types of questions that remain unanswered in higher education that include: What types of statistical reasoning do students need later in their working lives as employees? What then should students learn in statistics education for the workplace? Students are often contented with manipulating symbols and doing routine problems without ever reading and acquiring a deep and personal understanding of the statistical concepts and techniques with their applications. Ironically, students tend to value only what is assessed (Garfield, 1995) and ignore what

they would probably need later in the workplace. Employers are interested to see that the graduates they employ possess attitudes, knowledge and skills that are appropriate to the world of work.

Several surveys and studies have been conducted to investigate the statistics in undergraduate courses in various countries like Britain and Ireland (Smeeton, 2002), in New Zealand (Harraway & Sharples, 2001). Similarly, statistics has been explored in the workplace (Cobb, 1992; Harraway & Barker, 2005; Holmes, 1998; Mortlock, Spencer, & Mengersen, 2003). Meanwhile Holmes' (1998) searched the internet and found little literature that associated statistics teaching with the future needs of employment but he identified the attitudes of graduates in the workforce to the content of statistics courses which they studied at University to be related. Other studies have explored the statistics and opinions of graduates in the workplace (Bregar, Ograjensen, & Kveder, 2002; Mortlock, Spencer & Mengersen, 2003), together with graduates' attitudes to the content of the statistics courses offered at University (Holmes, 1998). In addition, Utts (2003) has argued that since the introduction of statistics in University curriculum in the USA much has changed in terms of "the audience, the tools available to students, and the world around us" (p. 74), together with the content and applications, but the teaching has been static not reflecting these changes to reveal what an educated citizen needs in order to interpret statistical information. Several scholars have addressed efforts to improve and make University programmes more relevant to students at their workplaces such as teaching statistics for future government services in Africa (Turya-Muhika, 1990), a shift in emphasis of the University programmes in Australia (Martin, 1990) and engaging students in consultancy apprenticeship (Schuenemeyer, 1990).

At Makerere University, the Institute of Statistics and Applied Economics (ISAE) founded in 1969 has three departments (Statistical Methods, Planning and Applied Economics, Population Studies), and is mandated to "provide facilities for the high level professional training of personnel in statistics and applied Economics to meet the needs of Uganda as well as those of other English speaking countries in the context of, the formulation and implementation of national plans for economic and social development" (ISAE Prospectus, 2007). The ISAE offers both undergraduate and postgraduate programmes. The undergraduate programmes last three years and are delivered through lectures, seminars, practical work and field research. These programmes target those students who will have obtained two principal passes including Mathematics at the Uganda Advanced Certificate of Education (UACE) Examinations or their equivalent.

At Kyambogo University, the Faculty of Science (FoS) has the Department of Mathematics where statistics courses are taught. The department of Mathematics also teaches courses in mathematics to the Faculty of Education. The undergraduate programmes for education last two years. The courses are delivered through lectures, practical work, projects and school practice for future teachers. These programmes target those students who will have obtained two principal passes including Mathematics at UACE Examinations or their equivalent or Teacher educators with Diplomas in Education and a three year teaching experience. In both institutions the academic year is two semester of 17 weeks (15 weeks of teaching and two weeks of examination).

Holmes (1998) has suggested further research is needed to judge the effectiveness of service teaching in statistics and ensuing equivalence with employment. A knowledge gap therefore exists as little research has been conducted to understand differences between the real workplace environments for the various specialities that are taught in higher education. The real workplace environment differs for different programmes that are taught in Universities, but these have not been extensively studied. This study aims at contributing to bridging this knowledge gap. Based on this review of literature I posit that statistics graduates from public Universities need adequate preparation for the tasks of the workplace. But, because of the limited number of studies on the boarder-crossing between higher education and meagre knowledge of the tasks of the workplace, and the key activities in each domain I preferred to propose the following research questions:

1. What is the statistics curriculum offered to undergraduate students in public Universities?
2. What are the statistical techniques used in the workplace?
3. What elements in the current statistics programme prepare graduates for the workplace?

2. METHODOLOGY

The study used interpretive research methodology (Erickson, 1986) in which the data were primarily qualitative from interview transcripts, which were obtained from examining curriculum documents, prospectus, interviews with administrators (N=6), graduates. Detailed information about statistics teaching at Makerere and Kyambogo Universities were collected. All contacts were made by physical visits and face-to-face interviews with the participants. At Makerere University the programmes from the ISAE and at Kyambogo University, the statistics programmes in the Mathematics Department of the Faculty of Science were mined. The sample included faculty administrators, lecturers and graduates. Sixty graduates were drawn from engineering companies (N=8), Banks (N=10), Data consultancies (N=6), Clearing, Forwarding and Freight Companies (N=6), Distrcit local governments (N=6), Uganda Bureau of Statistics (N=4) and schools (20) were used for the study.

The interview guide for data collection was adapted techniques of the statistical use in the workplace identified by Harraway and Barker (2005) and modified to include 19 techniques. The interviewees were asked what statistical techniques they engaged in at the workplace and which techniques they had been taught. The frequencies of various techniques named were recorded.

The qualitative data were analysed using constant comparative analysis (Merriam, 1998) to categorise the type of information that arose from questionnaires, interviews and documents. The statistics for the workplace was compared to the content of the statistics programs taught.

3. RESULTS

1. *Statistics curriculum offered to undergraduate students in public Universities*

The first question was ‘what is the statistics curriculum offered to undergraduate students in public Universities?’ The answer to this question was derived from documentary analysis of the course outlines, prospectus and interviews with the stakeholders. The findings reveal that the programmes offered in the ISAE at Makerere University include: (a) Bachelors of Statistics, Bachelor of Science in Population Studies, Bachelor of Science in Actuarial Science, Bachelor of Science in Quantitative Economics, and Bachelor of Science in Business Statistics (ISAE Prospectus, 2007). Meanwhile, Bachelor of Science with Education, Bachelor of Education for Tutors and Bachelor of Education for school teachers are offered at Kyambogo University.

Table1 shows that the statistics topics that are indicated in the two institutions for their undergraduate programmes are similar but there is more content coverage at ISAE. The table also shows the year and the semester when each topic is taught. Courses at ISAE are between two and five credit units but at FoS the courses are either two or three credit units. The Universities cover the similar curriculum as a course of study designed to fill the needs of the student structured at different times of the academic year by year and semester. The findings of the study reveal that both Universities use traditional methods of course delivery such as lectures and tutorials. However, at ISAE it was reported that some of the teaching is conducted through seminars, which were not reported at FoS. The clientele of the programmes are usually advanced level school leavers. The students register for the various courses at the beginning of each year and semester based on the student registration requests, lecturers’ availability and administrative input. The assessment of the statistics programmes follows the traditional timed-written papers.

2. *Statistical techniques used in the workplace*

The second question was ‘what are the statistical techniques used in the workplace?’ Table 2 shows that over 50 per cent of the graduates contacted reported using Descriptive Statistics, Basic Statistical Tests, Survey Design and Report Writing. Meanwhile, over 90 percent of the graduates indicated that they do not apply Multivariate Analysis of Variance, Principal Component Analysis, Logistic Regression, Non-parametric Regression and Discriminant Analysis. The findings indicate that Descriminant Analysis is not taught in any institution. Meanwhile, over 90 percent of the graduates are applying techniques that were taught during the undergraduate programmes that

included Descriptive Statistics and Graphing, Basic Statistical Tests, ANOVA, Survey Design, Multiple Regression and Estimation Theory, while some Mathematical Statistics and Monitoring and Evaluation are also covered.

Table1: Undergraduate Statistics Content Covered at Makerere and Kyambogo Universities by Year and Semester

		UNIVERSITY	
Year	**Semester**	**Makerere (ISAE)**	**Kyambogo (FoS)**
1	I	Descriptive Statistics, Time Series and Index Numbers, Official Statistics, Statistics Practical I	Probability and Statistics, Elements of Statistics and Probability
	II	Statistical Organisation, Probability Theory I, Statistical Inference I, Non-Probability Statistics	Probability and Statistics:
2	I	Statistical Inference II, Sampling Theory, Time Series Analysis, Probability Theory II, Industrial Statistics	Probability Theory
	II	ANOVA and Experimental Design, Energy and environmental Statistics, Regression Analysis, Statistics Practical II	Probability and Statistics: Regression and Correlation, Index numbers, Analysis of Time Series, Probability Theory
3	I	Multivariate Analysis, Monitoring and Evaluation, Industrial Statistical Modelling, Natural Accounting and Income Analysis, Workshop on Socio-Economic Surveys	Inferential Statistics,
	II	Econometric methods, Elements of Development Planning, Research Project, Statistics Practical III	Operations Research

3. What elements in the current statistics programme prepare graduates for the workplace?

Table 2 shows the elements that were named as preparing graduates for the work place that include Descriptive Statistics, Basic Statistics, Survey Design, Report Writing and Monitoring and Evaluation as the techniques derived from those mentioned by over 50 percent of the respondents.

4. DISCUSSION

In general the present analyses suggest that there are differences in the statistics content that is covered by students who follow different programmes and aspire for different career trajectories in the workplace. The findings from this study indicate that there are differences in the statistics content covered in the two institutions. The differences could be attributed to the different careers that graduates in the two institutions envisage to follow. The ISAE produces statisticians for industry who use figures to make informed decisions, whereas the FoS mainly produces teachers of mathematics and statistics for schools. The FOS curriculum focuses on what is contained in the school statistics curriculum. The statistics for the workplace for teachers and other employees involved in other works of life differ. Yet Bregat et al. (2002) emphasise statistics training *at* the workplace rather than the statistics *for* the workplace. This finding reinforces the need for appropriate statistics menu for the appropriate employment needs of the individual. For example, Higgins (1999) has advocated for a specialist major in statistics to meet the requirements of employers.

Table 2: Statistical Use in the Workplace

Statistical Technique	**Percentage Using Technique N = 60**	**Percentage Not Using Technique N = 60**	**Percentage Taught Technique N = 60**	**Percentage Not Taught Technique N = 60**
Descriptive Statistics & Graphing	70	30	100	-
Basic Statistical Tests	55	45	100	-
Simple Linear Regression & Correlation	30	70	80	20
Analysis of Variance (ANOVA)	30	70	100	-
Survey Design	95	5	100	-
Multiple Regression	20	80	100	-
Multivariate Analysis of Variance	-	100	80	20
Principal Components Analysis	-	100	80	20
Non-linear Regression	5	95	65	35
Logistic Regression	-	100	10	90
Mathematical Statistics	20	80	95	5
Non-parametric Regression	-	100	35	65
Operations Research	15	85	75	25
Discriminant Analysis	-	100	-	100
Estimation Theory	30	70	100	-
Report Writing	95	5	80	20
Time series Analysis	20	80	85	15
Industrial Statistical Modelling/Quality Control	5	95	80	20
Monitoring & Evaluation	50	50	90	10

Another finding is that the teaching of statistics at ISAE uses multiple teaching approaches whereas the FoS mainly uses the traditional talk-and-chalk. It is clear that in both institutions there is minimal use of technology for teaching statistics, yet Bregar et al. (2002) claim using Information and Communication Technology (ICT) improves the quality and efficiency of statistics training. These findings indicate that the assessment is focussed on techniques and procedures derived from assignments, textbooks and handouts. There is little or no application of project work and assessment so that students can generate their own data and prepare appropriate reports. This could be because the lecturers seem to assess students in the way they themselves were assessed during their school days. This reinforced the importance that both lecturers and students tend to give assessment scores (Garfield, 1995).

5. IMPLICATIONS FOR TEACHING AND RESEARCH

This study made an important contribution in providing a clearer understanding of the state of statistics teaching in higher education in Uganda. This finding calls for the need for appropriate statistics menu for the appropriate employment needs of the graduates. Higgins (1999) has argued for data specialists majors to meet the demands of employers, whether in industry or in schools.

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