BUILDING CAPABILITY IN STATISTICS MAJORS: DRAWING STRENGTH FROM A DIVERSE REGION

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Although structures, systems, problems and outlooks may differ between, and even within, countries, there are common challenges and opportunities which are benefitted by discussion of similarities and contrasts between countries. A unique opportunity was presented in November 2013 when academics from Vietnam, Australia, and USA came together with Vietnamese employers and other international statistics trainers from France, Philippines, Korea and Japan. Sponsored by the UN Population Fund, the group shared experiences and developed a way forward for statistics training in Vietnamese universities. Motivated by this conference, this paper uses reference to three diverse systems, namely Australia, Vietnam and the United States, to identify issues, directions and structural constraints. Possibilities are explored for using both policy and structure to build capacity in statistics majors, in terms of both quantity and quality. Commonalities in lessons learnt and ongoing challenges can inform capacity building in statistics majors worldwide.

INTRODUCTION

The much-quoted prediction of Hal Varian, chief economist at Google - "I keep saying the sexy job in the next ten years will be statisticians" - was made in January, 2009. While the quotation may be at the point of over-use (Davidian 2013), I will note that the decade is now five years old and there is not much time left to produce the capable statisticians required for this decade of activity!

A key source of statisticians is of course from the statistics majors offered at universities worldwide. A unique opportunity was presented in November 2013 when academics from Vietnam, Australia, and USA came together with Vietnamese employers and other international statistics trainers from France, Philippines, Korea and Japan. Sponsored by the UN Population Fund, the group shared experiences and developed a way forward for statistics training in Vietnamese universities.

In this paper, I will concentrate on the perspectives of the first three countries given, namely Vietnam, Australia and USA. Issues, directions and structural constraints raised by the delegates from those three countries will be described. A high degree of commonality exists despite the apparent differences in geography, history and politics of those nations. This means that the way forward for Vietnam that was developed at the conference last year has relevance nationally, regionally and internationally.

ISSUES, DIRECTIONS AND STRUCTURAL CONSTRAINTS: AUSTRALIA

The Australian university system is small and consistent in one sense, with 37 out of 38 universities funded by the Federal Government. Yet on the other hand the Australian system is very diverse. Most of the 38 universities would offer a statistics major, with every university structuring it in a slightly different way. Basically over the last 150 years universities have settled on structures that work for them, and however different they are, they are mostly successful. There is no one set department in which all the statisticians at any Australian university are located. Most are in departments with mathematics; some are in departments with information technology or computer science; and some in departments with econometrics. Some statisticians are even in science departments and some more in psychology departments. The structure and content of statistics majors often depends on the type of department the teachers are in, or indeed the type of teachers they are. The flexible requirements for accreditation set by the Statistical Society reflect the diversity of the Australian system.

So in one sense the Australian system could not be less constrained for statistics majors. And yet there are constraints. These include:

- *Increasing access to university on the one hand, and shrinking departments on the other.* More students are being admitted to Australian universities, and more students are coming with a lower level of preparedness than before, including mathematical and scientific preparedness. Despite this increase in numbers, most statistics departments are either staying the same size or getting smaller, so that there are fewer academics available to cope with large classes and the diverse needs of the students in them.

- *Structures which encourage silos.* There is a tendency for faculties to want to hang on to students in their degrees and offer all the courses needed for a degree, even when a similar course may be offered elsewhere in the university and taught by a more qualified and enthusiastic teacher. This is a huge long-standing challenge which seems to be such an obvious one to overcome, but it has not happened yet in many universities despite many decades of trying, with even outstanding success stories often unable to be perpetuated.

- *Managing public attention.* Mathematics and statistics particularly find themselves in the spotlight following the publication of Office of the Chief Scientist (2011). While most of the recommendations in this report are to do with school teachers, these recommendations will impact upon statistics majors because funding has been made available to train teachers and statisticians should have a much greater hand in training maths teachers. The Statistical Society also imposes standard on statistics majors through its degree accreditation scheme.

- *Making the voice of the profession heard.* The Statistical Society of Australia, would be the best placed organisation to emphasise the importance of statistics to informed decision-making, but its voice is not often as loud as other professional societies such as the Australian Medical Association.

ISSUES, DIRECTIONS AND STRUCTURAL CONSTRAINTS: VIETNAM

Four universities out of fifty in Vietnam offer statistics majors: the National Economics University, the University of Economics in Ho Chi Minh City, the University of Economics in Da Nang, and the University of Economics in Hue. This makes for a much more concentrated system of majors than Australia.

The courses, set by the Ministry of Education and Training , contain only about 45% mathematics and statistics study, compared to up to 70% in Australia and USA. Because of the more concentrated locations of statistics courses, course objectives can be more prescriptive than, for example, the accreditation requirements of the Statistical Society of Australia. For example, the course objectives of the Bachelor of Economic Statistics at the National Economics University are to produce graduates with:

- good qualities of politics and morality, good health, high responsibility for society;
- a basic knowledge of economy and society, management and business administration;
- in-depth knowledge of statistics and data analysis; and
- capacity of thinking independently and of self-obtaining knowledge due to job requirements.

Professional skills to be obtained include the ability to design research, plan survey options, collect and analyse data; along with more specific skills such as to set and analyze national accounts; to mine data to serve the managing and planning of socio-economic policies and the carrying out of management functions at different levels. Previously, statistics departments of different universities used the textbooks of the Faculty of Statistics, National Economics University. More recently, they have been compiling their own textbooks whose content is similar to that of the Faculty of Statistics, NEU, except for the case of the University of Economics in Ho Chi Minh City, whose textbook is somewhat more integrated to international level.

Vietnamese statistics majors are employed in a wide variety of jobs in every sector of the Vietnamese economy; this is a very similar situation to Australia. As in Australia, the Vietnamese university system also experiences constraints including:

- a curriculum and pedagogy in need of modernization and which does not fully integrate internationally, thus it cannot create statistics majors with skills matching the actual skill demand of the labour market.

- admission to statistics majors does not come from the market's demand and there is a lack of encouragement to learners.
- a number of lecturers do not have in-depth and extensive theoretical knowledge as well as practical experience.
- lack of coordination between teaching and practice at statistics offices and businesses.
- statistics is considered as one of the top ten well-paid jobs in the world, whilst one of the "modest"-paid jobs in Vietnam.
- considering scientific evidence from data analysis in decision making is not built in as a habit in the society, especially in the governmental system.

ISSUES, DIRECTIONS AND STRUCTURAL CONSTRAINTS: USA

The United States system is very different to the Australian system but they are probably more closely aligned to each other than to the Vietnamese system, with several broad structures containing statistics majors. These broad structures will now be delineated. The US college system is a major difference because almost every community college offers a general statistics course. Articulation into universities is diverse, as are US universities themselves.

Firstly, statistics majors taught by statistics departments .These typically involve about 30 percent lower division math courses (calculus, linear algebra and differential equations) with the remaining 70 percent upper division courses (divided between core courses, statistics electives, and applied courses in an area which uses statistics, such as economics or demography).

Secondly, statistics taught within mathematical sciences departments. Statistics becomes slightly harder to find at such institutions, with phrases such as "mathematics with an emphasis on statistics" being used to identify statistics degrees in place of "statistics" alone. Up to 70 percent of the degree can consist of mathematics, with the remaining 30 percent consisting of statistics courses at advanced level.

Thirdly, statistics taught by other academic departments (such as economics, psychology, and so on). Academics from other departments often query why this situation arises, and the answers are as varied as the locations where statistics is taught. Often it happens because teaching of statistics by a mathematics department is felt to be too theoretical; sometimes it is because departments feel that statistics should be taught with applications in their discipline (for example nursing). Student experience in these majors can be very good, but it can also be limited. This is because the experience of the academics teaching statistics has often not kept pace with either statistical methodology or pedagogy. Students end up learning the same statistics that their teachers did, and they are taught the same way their teachers were taught. This can mean methods and pedagogy are up to two decades old, a situation that would not be tolerated if the host discipline of nursing, psychology or business were taught this way.

Fourthly, it is worth noting that statistics in health sciences, such as biostatistics, is very often taught in schools of public health by biostatisticians. Departments of biostatistics are often separate from statistics departments, and tend to be close to teaching hospitals, for example, Harvard School of Public Health.

Constraints facing USA statistics majors include:

- *accreditation*. Both the Statistical Society of Australia and the American Statistical Association accredit individuals, but this accreditation has not yet met with the public acceptance of, for example, accountancy certification. Other certifications such as Certified Analytics Professional have even lower profiles.
- *providers outside universities*. Corporations such as SAS offer e-learning, as do smaller businesses such as statistics.com. Massive Open Online Courses (MOOCs) have also burst onto the scene as a possible replacement for courses offered in traditional university settings at both introductory and advanced level.
- *universities' slow reaction to fast-moving issues outside the university sector*. Social media has sped up our awareness of what's "hot" to learn about e.g. big data. However universities can be incredibly slow to respond with whatever is required, be that new courses or new modes of teaching.

REGIONAL RECOMMENDATIONS FOR BUILDING CAPACITY IN STATISTICS MAJORS

A forward-looking decision of the UN Population Fund brought together academics from Vietnam, Australia, and USA together with Vietnamese employers and other international statistics trainers from France, Philippines, Korea and Japan. In November 2013 the group shared experiences and developed a way forward for statistics training in Vietnamese universities. The recommendations from that conference are valid worldwide despite varying location and socio-economic environment. Three key issues that impact upon building capacity in statistics majors were identified, along with recommendations for tackling the issues.

Key Issue 1: Confirmation of the Importance of Statistics and Need for Stronger Advocacy on the Importance of Statistical Work in Society

The role of statistics is very wide; it provides scientific evidence for decision making at the national and sub-national level; it is linked with all types of activities in society including government, business and industry; and "Big data" discussions are very prominent and are fueled in part by social media.

Key recommendations 1:

- strengthen advocacy for politicians, policy makers, educational leaders, and society in general on the important role of statistics for development, monitoring and evaluation policies, strategies, programs and plans at different levels. Government agencies such as national Statistics Offices could take a leading role in this advocacy.
- promote a correct understanding of statistics and statistics work via social media, marketing campaigns, and other social activities such as competitions.
- make profiles of successful statistical careers very public so that they can be used for advocacy.
- strengthen the integration of statistics at different levels for schools to raise awareness of statistics. Curriculum is set in one part of legislation and official statistics in another (at least in Australia); this makes the integration of statistics training in schools and universities, and the strengthening of statistics training at all levels just a little harder.

Key Issue 2: Ensuring Best Statistical Academic Practice

A number of problems are faced by many countries such as: average mathematics levels at secondary school vary from country to country; a differing proportion of the course requirements for a statistics major is reserved for mathematics; and the focus on data analysis within statistics majors varies.

Key recommendations 2:

- keep in mind that the global situation regarding the position of statistics and data analysis is complicated.
- Encourage global collaboration, between private and public employers, universities and training structures, facilitated by the information and communication technology.

Key Issue 3: Ensuring Quality Statistics Training Programs, Given Existing Institutional Constraints

Key issue 3 encompasses four directions (curriculum, faculty, students and structural constraints).

Curriculum. Curriculum issues span the whole life cycle of a course, from its content to the method of teaching to the connections between it and the workplace.

Key recommendations 3A:

- update curricula and achieve a proper balance between theory and applied statistics. Reduce the number of courses with overlapping, unnecessary and incomplete content.
- reduce class time devoted to theory, give more guidance for self-study, increase the amount of practice and internship at statistics offices and enterprises. The value of the "soft" skills obtained by these practices has been emphasized many times; see for example Bryce (2005).
- increase the proportion of statistics knowledge in the statistics major to at least 60% and allocate more time to compulsory basic statistics courses.

- allow emerging issues such as "big data", and topics such as statistical software, sample design and sampling methods should be considered as additions to the curriculum.
- invite businesses and statistical agencies to talk to students about the actual use of statistics.
- reduce the disconnect between skills required for the job market and university curricula. There is an exaggerated emphasis on theory in many statistics majors. This is in part due to a strong emphasis on theory in the faculty's training. A lack of knowledge about statistical practice by faculty can also be an issue when it comes to building capacity in the major.
- develop a network of universities and employers. Connect universities with employers (private or government including enterprises), and work with them on updating and transforming curricula; especially obtain information on skills that employers need from employees; develop collaboration between universities with statistics programs and employers by organizing regular meetings between the two; encourage statistics faculty to work with employers on subject content, research projects and the like.
- Evolve teaching methods in order to make statistics courses more attractive. More lively teaching, more interactivity and active learning, seeking regular student feedback, and acting on positive recommendations can all assist.

Faculty. Faculty issues also span the life cycle of a university's engagement with faculty, from recruitment to continued development of existing academics. There is a shortage of faculty to teach future statistics professionals; and continuing education for statistics faculty needs to be kept in mind. Extraordinary continuing education work is already being done for instance in Korea, the Philippines and Japan. However, when international "consultants" come and provide training, the model recommended by most presenters, which consists of "training the trainers", is likely to be the most effective. The consultant works with future instructors of the course to prepare materials. Instructors then teach the course in the presence of consultant at least part of the time and with translation if necessary. Language problems are critical in statistics majors (Richardson, Dunn & Hutchins 2013a, b) which are redoubled when translation is involved. Very few individuals can translate even basic statistics effectively and training of linguists in statistics, or sciences more broadly, whilst out of the scope of this paper, would be an interesting topic for further research.

Key recommendations 3B:
- recruit students globally among very large populations and train at the master's and PhD level.
- join forces internationally, supported in part by internet technology.
- make use of retirees from the statistical system, some of whom are very strong and up-to-date in modern statistics. They devoted their career to statistics and are quite possibly willing to devote the rest of their lives to raising future statisticians.
- join forces and help each other internationally; faculty can be invited to attend graduate lectures remotely; the technology exists to do this and is cheap in some cases!
- establish co-supervision of PhD students by both an international and local supervisor
- encourage virtual global academic communities.
- strengthen North-South and South-South cooperation via conferences, training and so on.
- promote continuing education courses in virtual or e-learning format.
- develop training courses for enhancing knowledge and capacity of statistic faculty at universities, for example on new issues in statistics and data analysis, on new statistics pedagogy.

Student recruitment issues. These have to do in part with the image of statistics, and is essentially a marketing problem, related to advocacy.

Key recommendations 3C:
- begin promotion campaigns displaying roles and success of statistics graduates in "cool" jobs with high salaries, whether in business, industry or government.
- remove institutional barriers to the recruitment of statistics students.
- ensure government and universities work together to develop a strategy for recruiting undergraduate students

Structural constraints. One of the key constraints that was noted in Australia and the United States, was the "ownership" of statistics training in universities. However, very strong market forces are in favour of statistics, which helps statisticians to innovate within existing structures even in difficult or hostile environments.

Key recommendations 3D:
- increase the visibility of statistics in the university admission process.
- assign responsibility for statistical training to a particular faculty

CONCLUSION

Many issues and constraints affect the system that produces statistics majors, as the experiences of Australia, Vietnam and the Unites States show. Managing these issues and constraints, while at the same time establishing new directions for statistics pedagogy, place a lot of strain on the small number of busy people expected to implement them. The recommendations above will inevitably lead to more work, but I believe that there are enough energetic individuals in the system to bring them about.

Every statistician-academic can act individually and immediately by starting with these four action points.
- improve advocacy, don't wait for someone else to do it.
- improve recruiting and training of the next generation of statistics professionals
- keep innovating even under structural constraints
- keep individual knowledge up-to-date and at global standards

Individual action can of course be backed up with joint action. Joining forces will lead to success; collaboration is key. Commonalities in lessons learnt and ongoing challenges have been described in this paper, and they will inform capacity building in statistics majors worldwide.

ACKNOWLEDGMENTS

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