

# Training Young Statisticians for the Development of Statistics in Africa

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## **Abstract**

*National development is inextricably linked to statistical development, although few African governments realize this reality. Statistics and statisticians play a major role in the development of all countries and in the advancement of science. While technical statistical knowledge is a prerequisite for all statisticians, effective management skills are also needed by those entering the private sector and government. However, the challenge is that current training programs in Africa require a major overhaul for statisticians to acquire these competencies and skills. In this paper, we propose a new approach to training future statisticians for the development of statistics in Africa. We offer suggestions on how to structure statistics training programs in Africa – mostly at the university level (pre-employment) and at the workplace (on-the-job training or learning). We advocate for the creation of SPAPGA (Statistics Partnership among Academia, Private Sector and Government in Africa) to advance collaboration between the private sector, government, and academia to improve statistical training and capacity building in Africa. We also call for extensive curriculum reform to include mentoring and internships as part of the regular training of young statisticians.*

**Key words:** Internship, Co-op program, Mentorship, Mentoring, Statistics training, SPAPGA

## **Résumé**

*Le développement national est inextricablement lié au développement statistique, bien que peu de gouvernements africains soient conscients de cette réalité. La statistique et les statisticiens jouent un rôle prépondérant dans le développement de tous les pays et dans le progrès scientifique. Si la connaissance des techniques statistiques est nécessaire pour tous les statisticiens, des qualifications en*

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*matière de gestion efficace s'imposent également à ceux d'entre eux qui entrent tant dans le secteur privé que dans l'administration publique. Cependant, le défi persiste que les programmes de formation des statisticiens africains en cours nécessitent une révision profonde pour que ceux-ci acquièrent ces compétences et qualifications. Dans cet article, nous proposons une nouvelle approche pour la formation des futurs statisticiens, en vue du développement de la statistique en Afrique. Nous faisons des suggestions quant à la manière de concevoir les programmes de formation statistiques en Afrique - qui concernent pour la plupart les statisticiens en formation dans les universités (pré-emploi) mais aussi les professionnels du monde du travail (formation continue). Nous préconisons la création du SPAPGA (Partenariat statistique entre le milieu universitaire, le secteur privé et le secteur public) en vue d'améliorer la collaboration entre le secteur privé, les structures gouvernementales et le milieu universitaire afin de rehausser le niveau de la formation statistique et ainsi développer les capacités statistiques en Afrique. Nous proposons également la réforme profonde des programmes d'études afin d'inclure la pratique du parrainage et des stages dans le cursus régulier de formation des jeunes statisticiens.*

**Mots clés :** Stages de formation, programmes coopératifs, parrainage, formation statistique, SPAPGA

## 1. INTRODUCTION

What are the skills and competencies needed by statisticians to advance the development agenda in Africa? This is a question that many authors have attempted to address (Ching'anda 1998; Tulya-Muhika 1990; Woodward 1995). One thing that is clearly needed is rigorous training of statisticians at all levels of the education system: primary, secondary, high school and university. It is often said that "the more prosperous a country is, the better are its statistics" (Rao 1989). National development is inextricably linked to statistical development, although few African governments realize this fact. Statistics and statisticians play a major role in the development of all countries and in the advancement of science. Statistics is a field that cuts across disciplines because it is the means by which data are collected, analyzed, and interpreted to inform policymaking decisions at all levels of government.

Several authors have provided ideas on how to train statisticians for different roles: for working in general industry (Boardman et al. 1980; Hoerl 1993; Kettenring 1995; Marquardt 1979; Porter 1993), government (Bishop 1964; Moore 1991; Moses 1982; Ross 1995), pharmaceutical

firms (Chuang-Stein 1996; DeMets et al. 1994; Hammond 1980; Liss 2003; Newell 1984; Senn 2000), and academia (Bickel 1995; Bailar 1994). Overall, there is some consensus about what the basic skills should be (Bryce 2001; Federer 1978; Hogg 1991; Iman 1995; Kanji et al. 1981; Ritter et al. 2001; Tobi et al. 2001; Watts 1970). The goal is to make statisticians more proficient in applying statistical techniques, but also to be good communicators of statistical information.

In Africa, the Central Statistics Office (CSO), or Bureau of Statistics (BOS) as they are referred to in other countries, is charged with collecting, analyzing, and disseminating national statistics to help governments to create national development programs. This is a mandate that the CSOs have adopted since the early 1940s (Tulya-Muhika 1990). The success of the CSOs is dependent on successful training programs that address the needs of African countries. In 1978, the Statistical Training Program for Africa (STPA) was created to increase the supply of statisticians in Africa by 1990 (Ching'anda 1998). While this effort has managed to increase the numbers somewhat, achievement of the intended goals is still far off (Tulya-Muhika 1990). In addition, some African countries have been ravaged by war, famine, and the spread of the HIV-AIDS pandemic. The latter has created a new challenge for Sub-Saharan countries and threatens their future development. Statisticians are among the key players in the efforts to fight the epidemic. We have reached a critical time when “statisticians [should] work alongside policy-makers in decision-making if the country is to get full benefits of the available statistical knowledge and skills” (Rao 1989). This view is echoed by Tulya-Muhika (1990), who writes that:

“the statistician of the future will have to be a multi-faceted, knowledgeable, public relations officer. He (or she) will need the capacity to do statistical work; be knowledgeable in data processing and conversant with development issues; be able to work with policy-makers, data processors, and other groups... form an effective bridge-head between statistical information and users of statistics, including the general public.”

Annex 1 provides a comparative summary of the required skills for statisticians working in industry, academia, and government. While technical statistical knowledge is needed by all, effective management skills are also needed by those going into industry and government. However, the problem is that current training programs for African statisticians would need a major overhaul for them to acquire these competencies and skills.

## **2. CHALLENGES, OBJECTIVES, AND METHODS**

### **2.1 Challenges for statisticians**

Statisticians, and particularly young statisticians working in Africa, face a multitude of challenges at different levels, including:

- Limited opportunities for career development. In most Africa countries, statistics is perceived to be driven and required by governments, akin to a by-product;
- Lack of appreciation of the power of information by governments, leading to poor funding, incentives and motivation arrangements for statisticians;
- Professional “pressure” – the field is not lucrative enough compared to other professions;
- Lack of learning materials based on the specific African experience and practices;
- Adaptation of foreign practices to local conditions, leading to poorly sustained capacity;
- Lack of adequate in-service training programs;
- Poorly informed society – inadequate statistical literacy;
- Poor ICT policy (education, curriculum, etc.);
- Lack of a professional ethics code;
- Lack of regulatory bodies on statistical practices (i.e. a code of conduct);
- Poor on-the-job training, including the lack of mentorship programs; and
- Poor administrative structures (administrative boundaries, mobile population, fluid economies, governance, etc.).

Statistical development in the African context requires that we address these challenges at all levels if statisticians are to meet the needs of their individual countries.

### **2.2 Objectives of the paper**

The objectives of this paper are: (i) to briefly review the current approaches for training statisticians in Africa; and (ii) to propose a new approach. Our suggestions cover the training of statisticians mostly at the university level (pre-employment) and at the workplace (on-the-job training or learning).

## 2.3 Methods

We used the Internet as the primary source of information and reviewed statistics programs in African institutions of higher learning in order to answer the following key questions:

- How many universities are there in Africa?
- How many are on the web?
- Of those on the web, how many have statistics programs?
- Of those on the web and with stats programs, how many have co-op or internship programs?

We discuss ways in which academia, industry, and governments can work together to enhance statistical training in Africa.

## 3. RESULTS

### 3.1 Results of the review

There are 53 countries in Africa, including the islands of Madagascar, Comoros, Seychelles, Cape Verde, and São Tomé and Príncipe. Of these, our Internet search found 50 countries with a total of 826 universities or post-secondary institutions. There are 249 universities with a web address, of which 97 have a statistics or related program (see Annex 2). Of the 97 universities with a web address, we found four universities in four separate countries with co-op or internship statistics programs:

1. University of Nairobi – School of Mathematics (Kenya)
2. University of Ilorin – Department of Statistics (Nigeria)
3. University of KwaZulu-Natal – Faculty of Science and Agriculture (Republic of South Africa)
4. University of Zimbabwe – Department of Statistics (Zimbabwe).

Annex 3 provides the relevant statistics programs for the four universities along with the web addresses. Based on these results, there is sufficient evidence to suggest that the prevalence of statistics co-op or internship programs in African universities is very low. This provides, in part, the basis of the proposal that we make below regarding the training of statisticians in Africa.

### 3.2 Suggestions on the training of statisticians

In this section we present suggestions on how to address the training of statisticians at the pre-employment stage, i.e. at the university or college training.

#### *Initiating a dialogue on how to design optimal curricula*

In his call for curricula reform for the training of statisticians in Africa, Tulya-Muhika (1990) recommended that

“curricula reform should move towards introduction of some additional teaching in (a) data processing; (b) development studies; (c) economics; (d) politics; (e) sociology; and (f) industrial and other scientific applications, all in the African context, for all would be professional statisticians in Africa.”

The key point here is contextual training of African statisticians. This requires closer collaboration between employers (government and industry) and educators at all levels of statistical training to ensure that the curricula address the evolving needs of African countries. We recommend developing a strategic partnership similar to the Statistics Partnership among Academe, Industry and Government (SPAIG), created in 1994 to foster collaboration between the parties (see SPAIG website). SPAIG has been described as a win-win partnership, providing opportunities to all parties (Peck et al. 1998). Chief among its achievements are:

- Enhancing the practical use of statistics;
- Increasing the utility or value of statistics to society;
- Improving the educational experience for students;
- Enhancing student career decisionmaking processes and outcomes;
- Improving communications among statisticians;
- Fostering greater awareness of partners' needs, issues and concerns;
- Boosting the self-image of statisticians;
- Making statistics a more rewarding profession; and
- Ensuring that statistics continues to grow as a field.

The role of the proposed SPAPGA (Statistics Partnership among Academe, Private Sector and Government in Africa) is to foster collaboration among the parties, and to facilitate discussions through annual trilateral meetings and regular seminars. These would include discussions about curricula development that would meet the ever-changing needs of African countries.

It is important to note that most African countries are non-industrialized, but have a private sector that includes industry.

We already have some good examples where governments and training centers have come together to enhance training practices for young statisticians. These include the Institute of Statistics and Applied Economics (ISAE) – Makerere University in Uganda and The Eastern Africa Statistical Training Centre (EASTC) in Dar es Salaam, Tanzania. In both cases, not only are the Boards of these Centers staffed by policymakers in government, but also with heads of National Statistics Offices who actually make recommendations on curriculum development. In addition, the staff of the training centers participate in statistical activities in government. Also some staff of NSOs teach practically oriented courses at these centers.

### ***Incorporating experiential learning in the curriculum***

Internship and co-op academic programs (which we define later) have been widely used in different disciplines, including medicine (Baker 1999), sociology (Danzger 1988; Dodson 1951; Kelly 1986; Neapolitan 1992; Satariano 1979), law (Stone 1999), engineering (Hilburn 1997), nursing (Owens et al. 2001), education (Corcoran 1988), business (Johnston et al. 1986), and statistics (Darch 1995). Again, the success of such programs depends in part on the cooperation between academic programs and governments and industry. There is sufficient evidence in the literature to indicate that internship programs enhance students' learning and careers (Brooks et al. 1995; Gault et al. 2000; Inzelt 2004; Thompson 1950). One of the roles for SPAPGA would be to facilitate co-op or internship programs.

Internship and co-op training provide several benefits to students, universities, and employers (see Annex 4). Overall, these provide an excellent, valuable pre-employment experience for students, enhance communication skills with non-statisticians (statistics users), and improve practical problem-solving skills and computer literacy (practical statistical software training for data management and processing; working with large databases). As the old Chinese proverb says, "Tell me, I'll forget. Show me, I'll remember. Involve me, I'll understand." In essence, this emphasizes the importance of practically experiencing the learning as a way to enhance awareness, understanding and application of concepts.

### ***Introduction of a mentoring component in statistics training***

Professional statisticians often work in multidisciplinary teams. Effective statistical collaboration in a multidisciplinary environment requires skills

not covered in the usual statistics courses. Graduates often learn such skills through trial-and-error. Scientists have long advocated the use of mentoring as a way to facilitate the acquisition of important career skills (Alberts 1999; Garfield 1992; Hoover 2005; Thabane et al. 2006). Mentoring, from the Greek word “*mentur*”, which means enduring (Consumer Guide 1993), is defined as a sustained relationship between a youth and an adult. Thabane et al. (2006) further define mentoring as “a relationship between a mentee (usually a young person) and a mentor (usually a caring and more experienced adult) whose primary purpose is to help the mentee to define individual career and life goals and find ways to achieve them.”

We recommend designing training programs that include formal mentorship of students beyond the usual supervision of students, which aim at helping students attain the academic goals of thesis write-ups. Thabane et al. (2008) used this principle to develop a course on biostatistical collaboration in health research, which aims to close the gap between classroom instruction on biostatistical techniques and the application of the techniques in real-life collaborations. The course combines classroom discussions, mentoring and internship to advance both the technical and non-technical statistical skills necessary for biostatisticians to be effective in health research collaborations. We recommend extending this model to training statisticians for all applications of statistics, including government and private sector or industry. Students receive valuable pre-employment guidance on how to plan their career from the mentor.

### ***Training on important survival skills***

Introduction of training programs that provide opportunities to enhance other non-statistical skills is equally important. Examples include offering workshops or courses on stress management, time management, team work/dynamics, conflict resolution, financial management, and leadership skills. Many of these skills have been identified as essential for practicing statisticians (Bryce 2001; Federer 1978; Hogg 1991; Iman 1995; Kanji et al. 1981; Ritter et al. 2001; Tobi et al. 2001; Watts 1970), yet they are not part of most regular training programs. These often prove to be the most useful skills for students joining the workforce, and for subsequent career development (see Annex 1).

### ***Internship and co-op statistics programs***

Consideration should be paid to introduce internship and co-op statistics programs that provide students with the opportunity to gain some work experience prior to finishing their study. These will equip them with the technical and non-technical skills they will require when they take up full-



time jobs. The term “co-op” and “internship” may be defined differently in various programs, but in general:

- *Co-op* usually refers to a multi-work term agreement with one employer; traditionally with at least three work terms alternated with school terms, resulting in a 5-year degree program. Co-ops are full-time, paid positions.
- *Internship* usually refers to a one-term work assignment, most often in the summer, but not always. Internships can be full- or part-time, paid or unpaid, depending on the employer and the career field.

(Definitions 2006)

### ***Providing opportunities for students to interact with other students***

We propose the creation of statistics student societies, whose role would be to enhance cross-fertilization of ideas among students and to exchange experiences.

### ***Providing opportunities for students to be involved in publication of their work***

Writing and editorial skills are important learning competencies that every student should possess. Introducing a student-centered Journal of Statistics is one way for students to participate in the peer-review process to advance science. This also provides them with ample opportunity to improve their writing and editorial skills – skills that are often in great demand in the workplace.

### ***Increased funding from governments to enhance statistical training***

Statistical offices in Africa face severe funding problems, and largely depend on the generosity of development partners. Many governments fund only the recurrent budget and only a minimal portion goes to development and capital expenditure. Even what goes to the recurrent budget is too small to provide incentives and motivate statisticians. The budget needs to be increased in line with the development policies that require statistics and information for the implementation of the national development agenda. Recently there have been talks to integrate the statistical development strategies within the development frameworks such as Poverty Reduction Strategies (PRSs) or Medium-Term Expenditure Framework (MTEF) budget process to ensure adequate funding for statistics, and to boost the effectiveness of statistical technical assistance (Kibuka 2007).

### 3.3 Career development initiatives

#### *On-the-job learning*

Wood and McQuarrie (1999) define on-the-job learning (also known as “job-embedded learning”) as “learning by doing, reflecting on the experience, and then generating and sharing new insights and learning with oneself and others”. Those participating, while simultaneously performing their duties, learn by doing, reflecting on specific work experiences to uncover new understanding, and listening to colleagues share best practices. On-the-job learning can be through formal or informal interaction.

On-the-job learning does not require participants to set aside a separate time to learn, as it occurs while they are actively performing their job-related tasks. In this way, time efficiency and cost are maximized, and this also promotes immediate application of what is learned. Examples of on-the-job learning include study groups, reflective logs, action research, peer-coaching and mentoring. This paper will focus on the latter, mentoring. The reason for our choice is that on-the-job mentoring has been widely applied in many areas such as medicine, nursing, and surgery (Thabane et al. 2006).

#### *On-the-job mentoring for young statisticians*

There are two main types of on-the-job mentoring, namely, natural mentoring and planned mentoring. Natural mentoring may occur through an established friendship, collegiality, teaching, coaching, etc., while planned mentoring is through established and structured programs in which mentors and mentees are selected and matched. We advocate for the establishment of structured mentoring programs to help young statisticians joining the workforce to acquire important survival skills. Thabane et al. (2006) suggest ways in which this mentoring relationship can be formulated for the benefit of both mentee and mentor. As part of its role, the proposed SPAPGA can be charged with: (i) providing support to help agencies develop structured internal mentoring programs, and (ii) organizing mentoring workshops to train potential mentors to gain basic mentoring skills, including providing support with continuing education efforts.

#### *Assisting young statisticians on their career path*

There is a general consensus that statistics (and evidenced-based decision-making) is important to the development of a society, and to a nation for that matter. Capacity building, through the development of statistical processes and skills that respond to policy and development questions, are critical now and will become more so in the future. There is a need

to further develop the management of statistical systems, and for serious curriculum reform that includes mentoring elements in statistical training, as noted earlier. The development of statistics largely depends on the type of training and mentoring arrangements in place. Acquisition of management skills can help to direct and supervise an institution, such as a statistical agency, more effectively. Mentoring programs, which go beyond graduate education, have a role to play in the process, including the capacity to identify mentors and mentees.

Other ways to assist young statisticians include: in-service programs, affiliation with statistical societies, and exchange programs, as detailed below.

### ***In-service programs***

These skills-enhancing programs are predominantly implemented while in employment. In-service programs are intended to help employees develop their skills in a specific discipline or occupation. They are mostly conducted during a break in the individual work schedule. Such programs assist young statisticians to improve their performance and keep up to date with technological advances. They boost life chances by improving qualifications, employability, efficiency and productivity – thereby providing a sense of career direction.

### ***Affiliation with statistical societies***

Statistical societies or associations of statisticians in Africa are few in number. Where they do exist, not many statisticians are affiliated. Some of the objectives of a statistical society are to support and foster the ideals of the profession, to provide guidance on practices, and to act as a resource for sharing experiences. The statistical society also acts as a source of mediation among its members, and to protect the reputation of its members, including occasions when a legitimate professional finding comes under attack.

Statistical societies in Africa are vulnerable – they have no power or local professional support systems, especially when their practices are subject to political interference. In such a situation, statisticians have little or no recourse to seek professional redress, thereby rendering the UN Fundamental Principles of Official Statistics redundant. There is therefore a pressing need for statisticians and indeed statistical agencies to consider setting up statistical associations in African countries. Statisticians and other related professions such as economists should be encouraged to take up membership. The country associations must be affiliated with a regional body and subsequently with an international body.

Statisticians must also have access to the International Statistical Institute (ISI) Ethics Professional Declaration (ISI 1985), not only to provide support, but also to understand and appreciate the ethics and conduct of statistical practices.

Affiliation with a statistical society encourages the sharing of knowledge and keeping abreast of new developments and techniques.

### ***Exchange programs***

*Within a country:* Introducing inter-agency or inter-departmental seminars, including working in different divisions of a statistical agency, can provide opportunities for cross-fertilization of ideas and models between divisions, agencies, and departments. This allows participants to learn about the types of issues or problems that they may be presented with. It also provides opportunities to network and obtain a mentor, depending on the career goals.

*Across borders:* South-south cooperation through study visits or an exchange of staff for an agreed period of time not only improves the skills of statisticians, but allows for the sharing of common best practices among agencies. This helps to broaden both the scope and the knowledge of young statisticians.

## **4. THE WAY FORWARD**

Overall, our review shows that almost all African countries have at least one university. However, not all of them have statistics programs, let alone a web linkage. Of those with a web linkage, four have statistics programs with co-op or internship as an integral element of the training. This situation is not unique to African universities or statistics programs in general. However, we propose the creation of a model for training statisticians which embraces integration of in-class instruction with experiential learning through internships or co-op placements either in industry or government. This will require all parties – government, industry, and academia – to work closely together to design appropriate curricula.

Following the lead of SPAIG (Peck et al. 1998; SPAIG website), we advocate for the creation of SPAPGA, a consortium between universities, the private sectors and governments in Africa, whose role would be to oversee and enhance collaboration between the parties. The goal is to enhance the quality and quantity of statistical training in Africa. It is crucial for

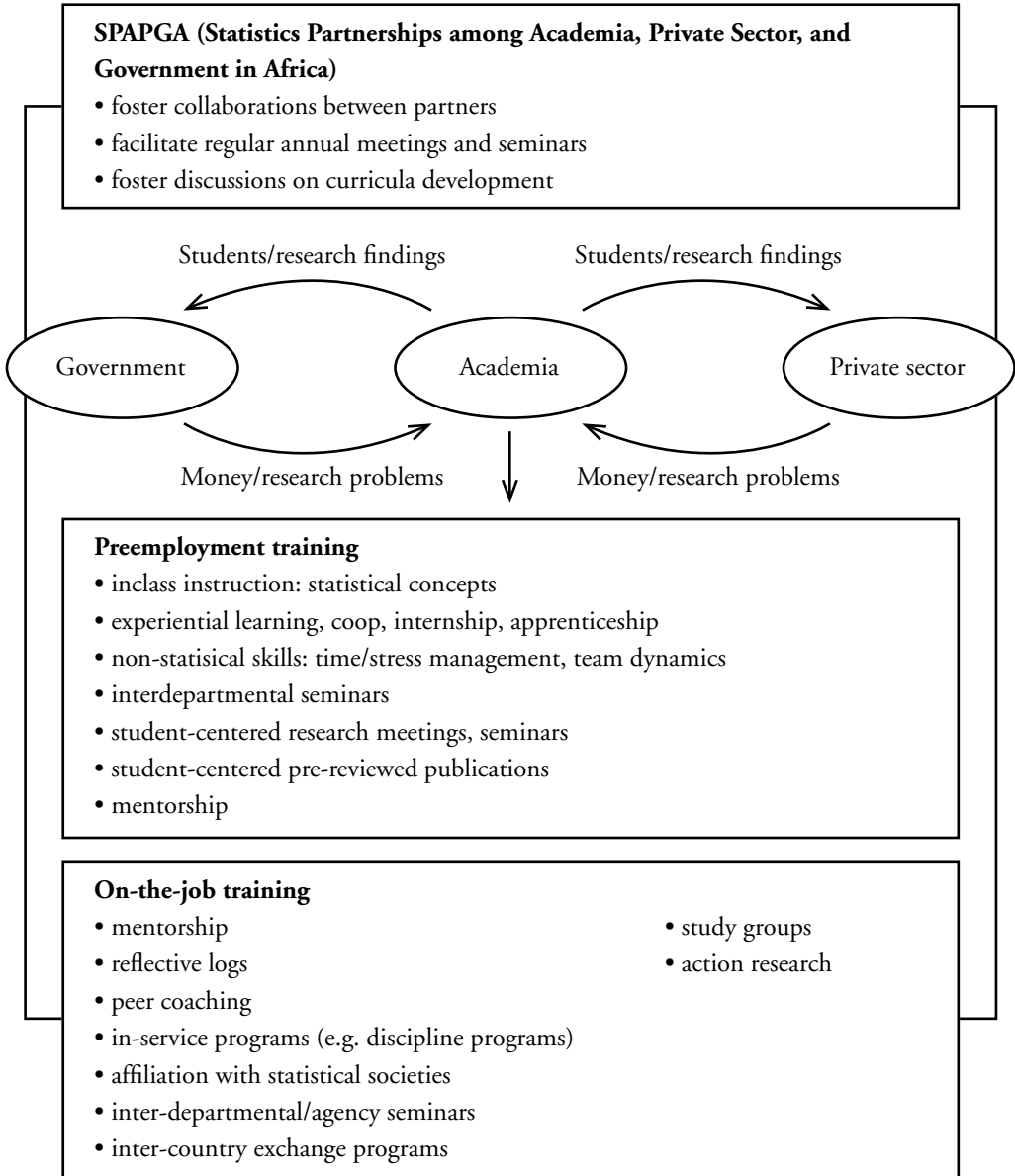
SPAPGA to formulate a clear process to facilitate this goal, including the creation of indicators of success to monitor progress.

Our proposal includes the use of mentoring to be incorporated within university and on-the-job training programs. Mentoring can greatly improve the learning process for students and mentees. It is also recognized as an important ingredient for the future of science and human development (Alberts 1999; Garfield 1992; Thabane et al. 2006). Partly motivated by the SPAIG partnering model (SPAIG website), Figure 1 below provides a summary of our vision of the proposed training model for statisticians in Africa.

## 5. SOME CONCLUDING REMARKS

It is generally claimed that “the more prosperous a country is, the better are its statistics” (Rao 1989). We venture to add that “the better the statistics of a country, the more prosperous it becomes”. The future and betterment of statistics in African countries depend on the well-envisioned training of young statisticians. We challenge all stakeholders – educators, governments and private sector partners – to take part in the discussion to improve statistics education programs at all levels, and to endeavor to make the statistics training contextual to address the growing demands of qualified statisticians to lead evidence-based development planning. Experiential learning is the key to successful training for future statistical leadership. An African proverb states “if you want to go fast, go alone; if you want to go far, go together.” We believe that working together, in partnership with all stakeholders, can go far to advance the training of statisticians for the betterment of development in Africa. Enhanced cooperation between academic programs, governments, and private sector can bridge the gap between classroom instruction and the workplace where statistics is applied.

**Figure 1: Proposed Training Model for the Development of Statistics in Africa**



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## ANNEX 1: SKILLS REQUIRED FOR STATISTICIANS WORKING IN DIFFERENT AREAS

Area	Pharmaceutical	Industry	Academia	Government
<b>General skills</b>	1. <i>Social skill</i> : involving all aspects of the working environment (i.e. administration) 2. <i>Interpersonal skill</i> : to listen, communicate, propose, negotiate and persuade 3. <i>Interdisciplinary skill</i> : to learn and understand a variety of disciplines 4. <i>Writing skill</i> : to write reports in a plain language with minimum statistical complication 5. <i>Presentation skill</i> : to summarize data, display graphics, and present results in an effective and clear fashion 6. <i>Statistical methodology</i> : solid statistical thinking and ability to develop new methodology 7. <i>Good mathematical foundation and computational skill</i>			
<b>Non-statistical skills</b>	<ul style="list-style-type: none"> <li>• knowledge of clinical/some medical issues</li> <li>• ability to plan and develop research protocols</li> <li>• understanding of drug regulations</li> <li>• consulting</li> </ul>	<ul style="list-style-type: none"> <li>• knowledge of economic and technical aspects of the companies</li> <li>• understanding of policies</li> <li>• own unique perspective</li> <li>• organizational effectiveness</li> <li>• ability to develop partners and alliances</li> </ul>	<ul style="list-style-type: none"> <li>• teaching skill</li> <li>• faculty/scholar philosophy</li> <li>• ability to develop and define own area of interest</li> <li>• collaboration</li> <li>• ability to maintain a good balance between theory and practice</li> </ul>	<ul style="list-style-type: none"> <li>• knowledge of privacy issues and legal requirements</li> <li>• understanding of policies</li> <li>• greater emphasis on communication</li> <li>• ability to grasp a broader view of statistics</li> <li>• consulting</li> </ul>
<b>Statistical skills</b>	<ul style="list-style-type: none"> <li>• formulation, stability and pre-clinical toxicology testing</li> <li>• bio-equivalence study, post-marketing surveillance</li> <li>• design, safety and efficacy of clinical trials</li> <li>• categorical data analysis, survival analysis</li> <li>• Bayesian statistics</li> <li>• medical/statistical literature research</li> <li>• use of statistical packages</li> </ul>	<ul style="list-style-type: none"> <li>• statistical quality/process control, reliability analysis</li> <li>• experimental design, analysis of data</li> <li>• analysis of variance (ANOVA/MANOVA)</li> <li>• modelling building (stochastic or non-stochastic)</li> <li>• time series, forecasting</li> <li>• multivariate analysis</li> <li>• statistical literature research</li> <li>• SAS programming, use of statistical packages</li> </ul>	<ul style="list-style-type: none"> <li>• strong mathematical statistics</li> <li>• probability theory</li> <li>• regression analysis</li> <li>• design of experiments</li> <li>• nonlinear/non-parametric estimation</li> <li>• contingency tables</li> <li>• numerical analysis</li> <li>• computer intensive methods</li> </ul>	<ul style="list-style-type: none"> <li>• survey sampling</li> <li>• bootstrapping</li> <li>• demographical analysis</li> <li>• multivariate analysis</li> <li>• analysis of historical data, estimate of trends in output</li> <li>• use of statistical packages</li> </ul>

## ANNEX 2: AFRICAN UNIVERSITIES WITH A STATISTICS PROGRAM

Country	No. of Universities*	No. of Universities on Web**	No. of Universities on Web with Statistics (or Relevant) Program
Algeria	62	15	5
Angola	14	2	0
Benin	15	1	1
Botswana	3	3	1
Burkina Faso	5	2	0
Burundi	6	1	0
Chad	10	0	0
Cameroon	18	10	6
Canary Islands	2	2	0
Cape Verde	1	1	0
Central African Republic	2	1	0
Comoros	1	0	0
Congo	1	0	0
Congo (Democratic Republic)	83	6	1
Cote D'Ivoire	8	4	1
Djibouti	1	1	0
Egypt	96	14	4
Eritrea	1	1	1
Ethiopia	9	5	1
Gabon	7	2	0
Gambia	1	1	1
Ghana	12	7	2
Guinea	10	2	0
Kenya	20	15	6
Lesotho	3	2	1
Liberia	12	4	1
Libya	19	2	2
Madagascar	11	6	2
Malawi	9	7	2
Mauritania	3	1	1
Mauritius	4	2	2

*/cont...*

## ANNEX 2: AFRICAN UNIVERSITIES WITH A STATISTICS PROGRAM (Cont.)

Country	No. of Universities*	No. of Universities on Web**	No. of Universities on Web with Statistics (or Relevant) Program
Morocco	119	8	3
Mozambique	6	3	1
Namibia	4	3	1
Niger	6	2	0
Nigeria	59	27	12
Reunion	1	1	1
Rwanda	7	5	2
Senegal	4	3	2
Sierra Leone	3	2	2
Somalia	9	5	0
South Africa	32	26	17
Sudan	34	8	2
Swaziland	1	1	1
Tanzania	15	10	1
Togo	3	2	0
Tunisia	33	7	6
Uganda	29	9	3
Zambia	3	2	1
Zimbabwe	9	5	1
<b>50</b>	<b>826</b>	<b>249</b>	<b>97</b>

\* Sources:

<http://www.unesco.org/iau/onlinedatabases/list.html>

<http://library.stanford.edu/africa/africaneducation/african-universities.html>

<http://www.africaeducation.org/universi.htm>

<http://www.chem.ru.ac.za/afuniv.html>

\*\* Sources:

<http://library.stanford.edu/africa/africaneducation/african-universities.html>

<http://www.africaeducation.org/universi.htm>

<http://www.chem.ru.ac.za/afuniv.html>

<http://www.uneca.org/statistics/Links.htm>

<http://www.informaworld.com/smpp/title-db=all-content=t777285702-tab=summary>

<http://www.stat.ufl.edu/vlib/statistics.html>

### ANNEX 3: UNIVERSITIES WITH A CO-OP OR INTERNSHIP COMPONENT IN THEIR STATISTICS PROGRAMS

Country	University / Faculty	Program Feature	Source
<b>Kenya</b>	University of Nairobi, School of Mathematics  BSc and MSc Statistics MSc Social Statistics	1. Train statisticians for various government departments and other organizations  2. Students spend some time in a semester learning the practice at the organization	<a href="http://www.uonbi.ac.ke/faculties/faculty_page.php?fac_code=147">http://www.uonbi.ac.ke/faculties/faculty_page.php?fac_code=147</a>
<b>Nigeria</b>	University of Ilorin, Department of Statistics  BSc, MSc, PhD Statistics, Postgrad Diploma Statistics	1. Industrial Training Internship	<a href="http://www.unilorin.edu.ng/newsite/academy/deptofstatistic.htm">http://www.unilorin.edu.ng/newsite/academy/deptofstatistic.htm</a>
<b>South Africa</b>	University of KwaZulu-Natal, Faculty of Science and Agriculture  BSc, BSc Hons, MSc Biometry, Statistics and Financial Statistics	1. Internship in Biostatistics with the medical research council and CAPRISA (Aids Research Unit)  2. Government internship at the National Census Office (Statistics South Africa)	<a href="http://www.ukzn.ac.za/prospective/pietermaritzburg.asp">http://www.ukzn.ac.za/prospective/pietermaritzburg.asp</a>
<b>Zimbabwe</b>	University of Zimbabwe, Department of Statistics  Diploma, BSc, BSc Hons, MSc	1. Students have been offered internships in banks, insurance companies, National Statistics Office and research organizations in the country	<a href="http://www.uz.ac.zw/science/statistics/">http://www.uz.ac.zw/science/statistics/</a>

**Cooperative Education:** an academic program that integrates academic studies with career-related work experience and involves an arrangement of periods of study and periods of work experience. Work authorization is granted by the Designated School Official.

**Internship Program:** a period of apprenticeship when students work off-campus, under supervision, in a school, factory, hospital, business, laboratory, or government agency or program. It also allows students to learn practical applications of classroom material.

## ANNEX 4: BENEFITS OF CO-OP AND INTERNSHIP PROGRAMS

Beneficiary	Benefits	Source
<b>Student</b>	<ol style="list-style-type: none"> <li>1. Well-rounded education in both classroom and workforce (hands-on experience)</li> <li>2. Provide flexibility for the course of education</li> <li>3. Enhance understanding of course material</li> <li>4. Have opportunity to develop new skills and expand knowledge</li> <li>5. Improve by feedback from employer</li> <li>6. Be in better position for future competition</li> <li>7. Explore and better understand career options</li> <li>8. Build network with potential employers</li> <li>9. Get financial support</li> </ol>	<p><a href="http://www.science.mcmaster.ca/cooped/about/Benefits.html">http://www.science.mcmaster.ca/cooped/about/Benefits.html</a></p> <p><a href="http://www.sfu.ca/coop/stud_benefits.html">http://www.sfu.ca/coop/stud_benefits.html</a></p> <p><a href="http://coop.sheridaninstitute.ca/stu_benefits.cfm">http://coop.sheridaninstitute.ca/stu_benefits.cfm</a></p> <p><a href="http://www.stvincent.edu/academics3/#TjtaRMCmgqInyJ3E9OEqag">http://www.stvincent.edu/academics3/#TjtaRMCmgqInyJ3E9OEqag</a></p>
<b>Employer</b>	<ol style="list-style-type: none"> <li>1. Bring fresh perspectives and enthusiasm to the workplace</li> <li>2. Learn latest theories and ideas from the academic world</li> <li>3. Meet short-term human resource needs</li> <li>4. Have better assessment of student's performance for long-term recruiting needs</li> <li>5. Reduce manpower and future recruiting costs</li> <li>6. Bridge with academic institution</li> </ol>	<p><a href="http://www.science.mcmaster.ca/cooped/about/Benefits.html">http://www.science.mcmaster.ca/cooped/about/Benefits.html</a></p> <p><a href="http://explore.bradley.edu/scc/index.php?page=employers/internship_coop">http://explore.bradley.edu/scc/index.php?page=employers/internship_coop</a></p> <p><a href="http://www.studica.com/internship/index.cfm?fuseaction=inter.details#benefits">http://www.studica.com/internship/index.cfm?fuseaction=inter.details#benefits</a></p>
<b>Institution</b>	<ol style="list-style-type: none"> <li>1. Get feedback from employers on the program curriculum</li> <li>2. Attract top-quality students</li> <li>3. Enrich the general educational community</li> <li>4. Enhance visibility and reputation</li> <li>5. Get information on current R&amp;D in employer sectors</li> <li>6. Have opportunities for collaborative projects</li> </ol>	<p><a href="http://www.science.mcmaster.ca/cooped/about/Benefits.html">http://www.science.mcmaster.ca/cooped/about/Benefits.html</a></p> <p><a href="http://www.studica.com/internship/index.cfm?fuseaction=inter.details#benefits">http://www.studica.com/internship/index.cfm?fuseaction=inter.details#benefits</a></p> <p><a href="http://www.ilceia.org/benefits.html">http://www.ilceia.org/benefits.html</a></p>
<b>Country</b>	<ol style="list-style-type: none"> <li>1. Improve the job market</li> <li>2. Improve future education</li> <li>3. Enhance human development</li> <li>4. Improve national statistics</li> </ol>	