

## REFLECTIONS ON USING TECHNOLOGY TO TEACH STATISTICS IN KENYA

David Stern

African Institute of Mathematical Science - Next Einstein Initiative

Maseno University, Kenya

[dstern@nexteinstein.org](mailto:dstern@nexteinstein.org)

*Over the last ten years or more there have been numerous successful integrations of technology in statistics teaching in Kenya. Between them they show overwhelming evidence that technology can significantly improve student learning, but none have really impacted the “status quo”. This paper examines some past initiatives to identify commonalities that have contributed to their successes while also investigating why they have not been widely adopted. Many of the challenges will sound familiar to educators all over the world, for example the lack of academic recognition for good teaching, heavy workloads and institutional resistance to change. Questions are posed relating to how resources, support structures, and incentives or reward schemes might create an educational environment within which good initiatives can “go viral”.*

### INTRODUCTION

In 2002, three ICOTS ago, Odhiambo, a leading figure in Kenyan Statistics presented a paper on the state of statistics teaching in Kenya emphasizing the need to include technology and practical skills in statistics teaching across all academic levels (Odhiambo, 2002). Six years later he followed up with a white paper (Odhiambo & Onyango, 2008). Their conclusions included the uptake of technology being slow, there being a lack of statistical educational resources and a need for research into statistics education. Twelve years have now passed, the need is still here and many of the same challenges remain, but there has been some progress and there is hope for a breakthrough.

This paper starts by providing a candid evaluation of a number of initiatives in most of which the author has been involved, to reflect on what went well and what went wrong. A conclusion is that while there is an opportunity to have a positive impact, the big challenge is to create something sustainable and scalable. It is proposed that current advances in technology may be creating an environment conducive to change, which in turn opens up the possibility of small initiatives having a large impact by “going viral”. This is discussed in the last section, which poses questions to stimulate discussion about possible enabling factors.

### ILLUSTRATIVE EXAMPLES ACROSS ACADEMIC LEVELS AND DISCIPLINES

The examples in this section illustrate how technology has been used in Kenya to improve motivation and results in statistics. There may be advantages to cutting across academic levels (Stern, 2013) so examples include initiatives in schools, diploma programs, undergraduate and postgraduate degrees. All cases demonstrate both the potential impact of technology on statistics education in Kenya and the difficulties of scaling or even sustaining these initiatives. The sequence of influence from one project to the next illustrates the progress that has been made.

#### *Agriculture Undergraduates at University of Nairobi*

Just over ten years ago the Biometry unit at the University of Nairobi started its integration of computers into the statistics education of its agriculture students. Through lots of hard work, a computer lab of refurbished machines, negotiations with statistical software providers, integration of real problems into the curriculum and work on customising an electronic statistics text book, CAST (Stirling, 2005), it was able to get truly remarkable results. Agriculture students were citing statistics as their favorite subject!

Given the success of this initiative, those who developed it felt that it was important to spread the methods to other Kenyan universities. In ICOTS 8 they presented their work, concluding that it was now possible for a determined Kenyan lecturer to bring technology into their teaching (Kurji, McDermott, Stern, & Stern, 2010). Unfortunately the levels of determination needed to maintain the gains proved too much. The group was unable to expand and computers were difficult to keep running over long periods of time. It proved near impossible to replace either computers or

staff, so gradually the enthusiasm waned, though not before the baton was passed to Maseno University in Western Kenya.

#### *Postgraduate Statistics Students at Maseno University*

From around 2008 there were a number of initiatives to include technology in the applied statistics MSc program, building on the resources the University of Nairobi group had worked so hard for. They also introduced eLearning to the university through a collaboration with the University of Reading in the UK (Dale, Clark, Stern, Leidi, & Stern, 2010). Although the numbers on the MSc course were small, these initiatives were used to train junior lecturers (Musyoka, Otieno, & Stern, 2010), which was intended to feedback incrementally into the university structures (Stern, Ongati, Agure, & Oganje, 2010). While the training of junior lecturers proved successful, the more senior members of the department were not interested in changing their approach, leading to a gradual return to a more traditional teaching style.

#### *Undergraduate Statistics Students at Maseno University*

The junior lecturers trained above then started a number of initiatives in their own undergraduate teaching. One of the most exciting instances involved introducing an optional eLearning component to a course for applied statistics undergraduates at Maseno (Musyoka, Stern, & Otieno, 2012) without providing internet access through the university. There were roughly 100 students on the course and almost all managed to complete the eLearning component, using phones, local cybercafés, whatever they could lay their hands on to get access. Even more exciting was that they all asked for more eLearning and by the end of the second semester 70 had a laptop! The average at the university at that time was about 5% of the student body owning a laptop.

One result from the feedback questionnaire was the overwhelming preference for student-owned laptops with university wireless internet over computer labs. However the following year the university bought and installed 40 computers in the maths lab, due in part to the department's success at integrating technology. Ironically it has now been much harder to regain the same levels of engagement and involvement from subsequent groups of students. There were also administrative complications that led to disengagement with the courses by both students and staff.

#### *Business Diploma Students at Kenya Institute of Management (KIM)*

One of the Maseno MSc students was teaching at KIM and integrated CAST into his teaching with convincing results. Over a period of time with different classes and teachers, students who were taught with CAST had on average 10% higher grades on a centralised exam. (Manyalla, Mbasu, Stern, & Stern, 2014). Despite the conclusiveness of this evidence, the program was discontinued simply because the two teachers both moved to new jobs.

#### *School Teachers and Children in Western Kenya*

A second Maseno MSc student adapted the KIM experiences for secondary school teachers to use in the classroom (Mbasu, Stern, & Ogwel, 2012). Although difficult to measure the impact on results, surveys indicate that the motivational effect is substantial and that students and teachers would like equivalent educational materials for the whole of the mathematical curriculum and not just statistics. Although where it is taken up, the effect is positive, the uptake rate is still low partially because teachers do not want to increase their workload. Some teachers cite the fact that the whole curriculum is not covered as a major reason they do not use the materials. School administrators have gone further to say they are not interested because they want solutions for all their teachers and subjects, not just for one subject.

#### *Research Methods eLearning Masters Students at Maseno University*

In 2011 Maseno launched full eLearning degrees on the back of the previous success with short courses (Dale, Clark, Stern, Leidi, & Stern, 2010). Among the new degrees was an MSc program in Research Methods. The structure of the program was built from the full time MSc in Research Methods offered by JKUAT (Jomo Kenyatta University of Agriculture and Technology), funded by RUFORUM (Regional Universities Forum, whose funding in turn came from the EU and the Gates foundation). The initial year of the program at Maseno was very successful, with

good self-financing enrolment from a wide range of disciplines, high student satisfaction rates and, most importantly for a professional degree, the content was seen as immediately valuable. In an evaluation, thirty seven out of the thirty eight students responding agreed with the statement that they would find the module content useful even if it did not count toward a degree (Stern, Coe, Stern, & McDermott, 2013).

The success of the first year of the program demonstrated the possibility of having sustainable scalable postgraduate training to reach professionals in many fields who are hungry to learn and also willing to pay for the statistical skills if they are related to their research needs. However it also happened concurrently with a change of political power within the University, who took advice from a statistics professor from University of Nairobi and realigned the course with more traditional statistical content that other lecturers were happy to prepare and teach. The MSc has now been renamed and enrolment figures have plummeted.

## THE CHALLENGE AND THE OPPORTUNITY

Throughout the previous section, the examples from Kenya have shown where technology has been used successfully to change attitudes and performance in statistics. But none of the initiatives have proved to be stable or scalable. The problems each initiative has encountered include many which will be familiar to colleagues all over the world. There is a lack of institutional recognition for teaching success, opposition from traditional senior colleagues, difficulties with administration, over reliance on particular individuals, worries over increased workload and of course institutional politics. Two issues that are rarer in more developed countries are the difficulties of maintenance and the stated desire for an all-encompassing solution.

Illustrating the problems is an important part of this paper, but most of the initiatives are attempting to cope with the problems and one could argue that growth is simply a slow process. The student behind KIM using CAST has now returned and is taking up where he left off, the schools ideas are being taken up by the Ministry of Education, the Maseno undergraduate initiatives are still alive with considerable student input and another Kenyan University is very keen on reviving the postgraduate research methods course, learning from the Maseno experience.

There is an alternative to accepting that growth is simply a slow process. Many economic indicators are pointing to an African boom over the next decade (Robertson, 2012) and many experts are pointing to technology as an enabler permitting Africa to leapfrog straight to the cutting edge. The way mobile banking has taken off in Kenya illustrates how a technological innovation can originate in Africa (Kabukuru, 2010; Dean, 2012). Technology provides an equivalent opportunity for education and it is possible that Africa could leapfrog here too. Groups like Digital Data Divide are showing how data management and statistics are becoming tools for economic development, showing directly how improvements in statistics education could have a social impact.

A takeaway message from the examples is as follows: *There are known ways of using technology to have a positive impact on statistics education in Kenya across disciplines and academic level but it is not known how to make the implementation easy and compatible enough to become stable and scalable within Kenyan institutions.*

The evidence points towards there being a real opportunity for large scale impact on society through improved statistics education using technology if scalability can be achieved. So the big challenge facing statistics educators is to identify and resolve constraints to scaling up. There are many possible approaches to scaling up and technology is particularly influential in enabling innovations to “go viral”.

## QUESTIONS ON HOW TO “GO VIRAL”

Identifying and resolving the constraints to scaling up touches on topics that are largely absent in African statistics education research. This section does not aim to provide answers; rather it poses questions which may stimulate areas of investigation and research. The focus is on scaling up through initiatives “going viral”, which is interpreted as being a bottom up, voluntary approach to adoption.

### *Questions about Resources*

When thinking about which resources to use in Kenya, there are serious considerations associated with scaling up, related to ease of use, cost and access. Given educators workloads and the administrative difficulties with payments, there are two “golden rules” which resources must satisfy to have the potential to “go viral” in Kenya: Using the resource must be able to save educators time! The resource must be free to distribute!

Exercise and testing systems giving student feedback have been the most successful initiatives trialled. Once set up and working they satisfied the two golden rules, but the setup process is time consuming and technically difficult. There have also been problems maintaining the systems, which is in line with difficulties maintaining the technology in working order. In universities, students often partially navigate these difficulties using alternative solutions including their phones, netbooks, laptops and cyber cafes, but internet access and speed remains one of their biggest barriers to rich resources.

The following questions are posed as guidelines for educational interventions:

- Can technology reach students so that educators can simply assume access?
- Do our educational resources satisfy the golden rules, for both deployment and use, while also impacting on student learning?

These questions are surprisingly difficult when applied to an educational study. None of the studies described in the previous section could answer yes to both, though some come close. A conjecture is that answering yes to these two questions is a prerequisite to an educational initiative “going viral” in Kenya.

### *Questions about Support Structures*

People are at the heart of any initiative and there are already people innovating on the ground, with recognition of what needs to be done and ideas of how to achieve it. It is important to support their successes so their innovations have a chance of “going viral” and creating impact. There is not a shortage of people wanting to innovate but they are often younger staff who therefore often lack mentorship and do not have the influence to implement their ideas. Collaborators and international institutions can play an important role as support structure for potential innovators.

One difficulty which is often faced by international experts looking to help is the conflict between a specialist and a generalist. International experts naturally tend to be specialists in their area of expertise, but on the ground in Kenya there is often a need for general solutions, as with the school administrators wanting a single solution for all subjects. This is one reason commercial groups often step in and offer comprehensive solutions. Unfortunately not only are these solutions expensive but they often do not have strong educational value and once initiated can be very hard to displace. For statistics education this is a particularly pertinent problem as statistics touches on many subjects in schools but, as there are no specialists statistics teachers, it is seen as having low importance. It may be possible to turn this problem around by statistics educators being the instigators of interdisciplinary efforts towards more comprehensive solutions.

International support has an important role to play in enabling innovations to “go viral”, but there are questions, namely:

- How can international support structures provide mentorship to improve quality?
- How can international support structures enable good innovations to be recognized and supported by institutions?
- How can specialist structures collaborate to provide comprehensive support across disciplines?

### *Question about Incentives or Reward Schemes*

Any system has its own internal incentives and reward schemes and within the system they are determined by measures of success. In environments with limited resources and opportunities, these measures often take on an importance they do not warrant. For students this tends to be exam results and for staff this tends to be promotion. There is also the financial issue. In Kenya the word

“motivation” is often used to refer to financial incentives that are expected to go along with an intervention, but research into incentives shows how questionable the effects of financial incentives can be (Camerer & Hogarth, 1999). For tasks requiring original thinking, there are classic results suggesting they can have a negative effect (Glucksburg, 1962). As such, the existing incentives and reward schemes can often stifle rather than promote innovation.

The bottom up, voluntary approach associated with “going viral” makes incentives and reward schemes central to success. It is sometimes possible to fit in with existing structures, for example facilitating university lecturers to publish, but there are also alternative forms of rewards. Examples of alternative incentives include interaction with experts and mentorship. Technology also provides more social avenues for recognition such as followers of a blog or hits on YouTube. In Kenya there is a value to having a combination of conventional and alternative incentives, partly because of the difficult balance between personal advancement and personal development. An example of this is where good people are so in demand that they get promoted too quickly and it limits their own personal development.

A phenomenon may or may not “go viral” based on its environment. This leads to the obvious question:

- What combination of incentives and reward schemes can create an environment in which innovations in statistics education can “go viral”?

## CONCLUSION

Reflecting on the varied experiences of integrating technology into statistics education in Kenya, it is the successes that come to mind. The experiences mentioned in the examples section had very little support or planning; they were opportunistic, responsive to observed needs and driven by passion. They cut across academic levels through individuals being infected at one academic level and implementing at another (Stern, 2013). In the right environment this opportunistic approach could create initiatives that “go viral”. This leads to the conclusion that: *Small interventions can lead to a big impact if they “go viral”. To create an enabling environment for innovations to “go viral” it is important to think about the right resources, support structures and incentives.*

A scalable solution for Kenya will almost certainly not work even in a neighbor like Ethiopia because of differences in cultural and social structures, but a viral solution may evolve and adapt. A viral solution created in resource poor environments is likely to be able to adapt and spread to resource rich environments but the opposite is not true. So facilitating initiatives to “go viral” in Africa could be a pathway to global improvement. The continent set to boom over the next ten to twenty years and that inherently brings change. This environment of change across the continent means that Africa is possibly the best place in the world right now to support and encourage innovation with the potential for global impact.

## REFERENCES

- Camerer, C. F., & Hogarth, R. M. (1999). The effects of financial incentives in experiments: A review and capital-labor-production framework. *Journal of risk and uncertainty*, 19(1-3), 7-42.
- Dale, I., Clark, C., Stern, R., Leidi, S., & Stern, D. (2010). *E-learning of statistics in Africa*. Paper presented at the 8<sup>th</sup> International Conference on Teaching Statistics (ICOTS8), Ljubljana, Slovenia.
- Dean, M. (2012). U.S. should follow Kenya's Mobile Lead. *American Banker*, 177(36), 8.
- Glucksburg, S. (1962). The influence of strength and drive on functional fixedness and perceptual recognition. *Journal of Experimental Psychology*, 63, 36-41.
- Kabukuru, W. (2010). Mobile banking: Kenya leading a new revolution. *New African* (494), 76-77.
- Kurji, P., McDermott, B., Stern, D., & Stern, R. (2010). *The growing role on computers for teaching statistics in Kenya*. Paper presented at the 8<sup>th</sup> International Conference on Teaching Statistics (ICOTS8), Ljubljana, Slovenia.

- Manyalla, B., Mbasu, Z., Stern, D., & Stern, R. (2014). *Measuring the effectiveness of computer assisted statistics textbooks in Kenya*. Paper presented at the 9<sup>th</sup> International Conference on Teaching Statistics (ICOTS9), Ljubljana, Slovenia.
- Mbasu, Z., Stern, D., & Ogwel, J. (2012). *Improving the teaching of mathematics in Kenyan schools via in-service training*. Paper presented at the 12<sup>th</sup> International Congress on Mathematical Education (ICME), Seoul, Korea.
- Musyoka, J. K., Stern, D., & Otieno, J. (2012). *Using e-learning to engage Mathematics and Statistics Students in a Kenyan University*. Paper presented at the 12<sup>th</sup> International Congress on Mathematical Education (ICME), Seoul, Korea.
- Musyoka, J., Otieno, J., & Stern, D. (2010). *Training of lecturers at Maseno University, Kenya*. Paper presented at the 8<sup>th</sup> International Conference on Teaching Statistics (ICOTS8), Ljubljana, Slovenia.
- Odhiambo, J. W. (2002). *Teaching of Statistics in Kenya*. Paper presented at the 6<sup>th</sup> International Conference on Teaching Statistics (ICOTS6), Cape Town, South Africa.
- Odhiambo, J., & Onyango, S. (2008). *Statistics education in Kenya: Developments and Challenges*. Retrieved 04 28, 2014, from Strathmore University: <http://www.strathmore.edu/research/images/docs/pubs/statistics-in-education.pdf>
- Robertson, C. (2012). *The fastest billion: The story behind Africa's economic revolution*. Chicago: Renaissance Capital.
- Stern, D. (2013). Developing statistics education in Kenya through technological innovations at all academic levels. *Technology Innovations in Statistics Education*, 7(2).
- Stern, D., Ongati, O., Agure, J., & Ogange, B. (2010). *Incremental modernisation of statistics teaching and curriculum at Maseno University, Kenya*. Paper presented at the 8<sup>th</sup> International Conference on Teaching Statistics (ICOTS8), Ljubljana, Slovenia.
- Stern, R., Coe, R., Stern, D., & McDermott, B. (2013). MSc Training in Research Methods Support. *Technology Innovations in Statistics Education*, 7(2).
- Stirling, D. (2005). *CAST for Africa*. Retrieved February 23, 2014, from CAST: [http://cast.massey.ac.nz/collection\\_african.html](http://cast.massey.ac.nz/collection_african.html)