

Mathematics Education in Rwanda: Investigating the Teaching and

Learning Challenges

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Abstract: In this paper, I will describe my 6-month tenure as a Fulbright Scholar in Rwanda teaching and learning at some of the country's leading universities. My Fulbright project focused on the needs of two particular universities: the Kigali Institute of Education (KIE) and the Kigali Institute of Science and Technology (KIST). At KIE, I was to help Rwanda reform their mathematics curriculum to make it more student-centered. At KIST, I was Director of E-Learning and was tasked with the development of their distance education program. I will explain the goals that I was able to accomplish and what challenges I encountered along the way. I will also share with you ideas and strategies that helped me adapt to challenges in the classroom (and that I think you can use as well). Finally, you will hear about the challenges and successes that this country is experiencing in terms of distance education.

Key words: mathematics education; Rwanda; challenges

1. Overview

In this paper, I will describe my projects in particular and the Fulbright Program in general, discuss educational reform in Rwanda, especially in terms of teaching methodology and incorporating technology, describe teacher preparation in Rwanda, especially focusing on the effect of language, and discuss my international educational experience including the comparisons of the US and Rwandan educational systems and my experiences with Rwandan students.

2. Fulbright Program-General Information

What is the Fulbright Scholar program? "The traditional Fulbright Scholar Program sends 800 U.S. faculty and professionals abroad each year. Grantees lecture and conduct research in a wide variety of academic and professional fields. The Fulbright Program is sponsored by the United States Department of State, Bureau of Educational and Cultural Affairs. Under a cooperative agreement with the Bureau, the Council for International Exchange of Scholars (CIES) assists in the administration of the Fulbright Scholar Program for faculty and professionals." (Quoted from http://www.cies.org/us_scholars/us_awards/).

3. Fulbright Projects-General Description

I was chosen as one of four 2009-2010 Fulbright Scholars to Rwanda, a small, landlocked country located in the southern half of the continent of Africa known as the sub-Saharan region. I was one of approximately 150 other Fulbright Scholars selected to serve various countries in sub-Saharan Africa. I lived and worked in Kigali

(the capital city of Rwanda) for six months (January through June). I worked at two universities: the Kigali Institute of Education (KIE), which is the premier university for teacher training country-wide, and the Kigali Institute of Science and Technology (KIST), "the first public technological institute of higher learning in Rwanda" (quoted from http://www.kist.ac.rw/about/about.html). My project was to assist KIE in achieving three goals: design an appropriate mathematics curriculum for pre-service teachers, create student-centered methodology in teaching mathematics, and enhance teacher training using effective pedagogy. I taught courses that conveyed mathematics content while illustrating inquiry-based, hands-on learning using appropriate manipulatives and technology. In addition, I assisted in curriculum development, materials selection, and staff development necessary to achieve long-term success. In my project at KIST, I served as their Director of E-Learning, conducted hands-on workshops, and helped the faculty develop their course material for online-delivery.

4. Educational Reform & Teacher Preparation in Rwanda

In order for the reader to understand some of the educational challenges that I faced, it would be prudent for me to give a little background information about the educational system in Rwanda and describe some of the recent changes and reform efforts that are ongoing. First, the system consists of primary and lower and upper secondary schools. Until recently, mandatory education stopped at grade 6 (primary); it now continues until grade 9 (lower secondary). The secondary teachers, like my students from KIE, are also the 'teacher trainers' and the ones responsible for training the primary teachers in their school systems. Also, just this year the primary and secondary schools made the switch from education being conducted in French (as it has been since colonization) to English. The previous year, the University system made the language switch (and I can tell you that, even now, when you walk by a classroom at a university, you will hear French, English, and Kinyarwanda being spoken, often all in the same sentence). It was so abrupt and so challenging that school, which normally starts in January, had to be delayed until February to allow the teachers to be somewhat ready for it. Large numbers of Peace Corps volunteers arrived en masse to the country to assist in this huge undertaking. Now, a Rwandan child begins his/her education in primary school and, until grade 4, is taught exclusively in Kinyarwanda. Then, in 4th grade, they begin learning exclusively in English and that continues throughout their educational experience. Keep in mind that most of these students come from homes where either Kinyarwanda or French is the primary language spoken (and is the primary language of their parents).

To address his/her usage in the previous paragraph, I would like to mention that education for girls rarely continues past the mandatory limit. This seems to be due to a variety of factors; however, chief among them is, I believe, is that the girls/women do everything in the country. They are responsible for the plowing, planting, harvesting, cooking, cleaning, water-gathering (a full-time job all by itself), and in general "taking care of" the rest of the household. Also, girls have traditionally been viewed as "less than" boys. This is particularly fascinating from a gender and women's issues viewpoint when you realize that Rwanda has the highest percentage of women in government (Parliament) than any other country (over 50%). Contrast this with any other group and the numbers differ greatly. In my class of 16 at KIE, for example, there were three women. In the meeting regarding the Rwanda Open Learning project (which I will describe in greater detail later in this paper), there were 5 women (including myself and another American) in the group of 33 in attendance. However, the emphasis on girls' education is an important part of President Kagame's plan for the country so these numbers are better

than they were and expected to continue to improve.

Additionally, the entire country has been very enthusiastic about transitioning from traditional lecture to a more student-centered methodology. Though Rwandans want this change and welcome it, they really have no resources, examples, or training on how to make it a reality. When one considers the existing physical and material challenges in the schools, the task of this transition seems almost overwhelming. As my KIE students are constantly asking me, "How do you teach when you have nothing?" ("Nothing", by the way, can include no chalkboards, books, paper, chairs, desks, a building, electricity, chalk, computers, internet, water, etc.) At the University level I saw that no one (not even faculty) had books. Couple that with the fact that I couldn't even get two copies of a handout made nor could I expect to make it through an entire class period with fully functional electricity, I realized that it would be even more challenging to institute the required changes throughout the rest of the nation.

The statistics regarding level of education here in Rwanda are disturbing yet fascinating. The country has a population of about 10 million people (of which close to 1 million live in Kigali) and the number of students that finish secondary school is around 30,000. The total number of students that are enrolled in all tertiary institutions is about 40,000. That works out to 0.004 of the population or less than one-half of one percent. This tremendous need to provide education to their people is one of the main reasons that Rwanda is so interested in distance education—it is the most viable solution to their problem. Lack of education is not the only problem, of course. Life expectancy is in the mid-forties (for both men and women), the GDP per capita is less than \$250, and the unemployment rate is about 33% in the city, higher in the country.

The incredible shortage of books or other written material was amazing to me as a woman who, at any given time, is reading 3-7 books. On the other hand, when one realizes that a written language was not even introduced to Rwanda until the late 19th century, it sort of makes sense. There is a wonderful oral tradition and the country is filled with fabulous storytellers; however, there is not a culture of reading. There are no libraries and there is a complete lack of awareness of how a book can be appealing in its ability to take you away. Given all that, I suppose it's not shocking that when I met my KIE class on the first day and gave them each their very own copy of an NCTM (National Council of Teachers of Mathematics) educational journal they looked at me with adoration and gratefulness. Like the issues with gender equality, though, this one is also being addressed and showing improvement. For example, despite the country's late start with a written language, the literacy rate in Rwanda is about 70% nationwide (higher for men than for women) and there are many projects that focus on reading, literature, and other written forms of communication.

The appropriate use of technology in teaching is a major focus of the National Council of Teachers of Mathematics (NCTM) (Masalski & Elliot, 2005; NCTM, 2000). In our country, the technology used in our classrooms takes three primary forms: web-based platforms and LMS (Learning Management Systems) like Blackboard and My Math Lab, graphing calculators (in the case of my classes at home, the TI83+, TI73, or NSpire), and computer software like Microsoft Excel and Minitab. In Rwanda, however, those types of technology are generally not available, and, when they are, unable to be used effectively due to the limitations presented by unreliable electricity and slow (or non-existent) Internet access. Instead, the technology in Rwanda that is established, reliable, and used in everyday life consists of mobile phones and radio. Interestingly, although the cell phone and the radio are integral parts of a Rwandan's life, they have not really been put to educational use. Instead, the efforts (all coming from outside sources and other countries like the US and UK) focus on trying to

establish web-based footholds for the country to begin using. In the next few paragraphs, I will describe three particular efforts that I was involved with as Director of E-Learning at KIST.

I was invited to a meeting with Dr. Stephen Swithenby from the Open University in the UK and, because of that initial contact, became involved in the nationwide "Rwanda Open Learning" (ROL) project being developed to utilize distance education as a means by which to increase those percentages that I mentioned earlier. One major goal of the ROL project is to "double engagement in higher education (i.e., to 6%) in the next 8 years". Stephen and his colleague, Jerry, were invited by the government of Rwanda to analyze the current status of E-Learning in the country and present a proposal for how to move forward from here in order to achieve the nation's very ambitious educational goals. I was asked to join them in this endeavor and assisted in creating the one-page executive summary and description of the task force that was presented to the Ministry of Education. The Ministry accepted this proposal and the project is in the initial stages (creation of the task force, etc.) at the time of this writing.

I hosted a meeting with the members of the KIST ICT Strategy Group (of which I was chosen as Vice-Chair) and we had a good discussion about what has been done on campus regarding E-Learning and what remained to be accomplished to start seeing results. They already had a head start in this effort: a group from Tulane University (which has a campus in Rwanda as well) came and did a few weeks' training on using Moodle and various Web 2.0 tools for delivery of online educational materials. There is a core group of interested and dedicated faculty who had begun putting their syllabi online for student access. The short-term goal is for each department to have their course syllabi available for online access by the end of the year.

I gave a Public Seminar in the boardroom ("penthouse" floor of KIST 3, the math building) on the topic of LMS (Learning Management Systems) and E-Learning. It was well attended (over 75 people including faculty, administration, and students) and everyone participated and asked very thoughtful questions. During the seminar, I showed a few of my BB (Blackboard) courses that I taught last semester at my home university and discussed how "blended" or "hybrid" classes (those that meet both F2F–"face to face"–and have online components) work and how I balanced the blend. At KIST, they will likely use Moodle as their LMS rather than BB since they have already received training on that platform, plus it is open source and has roughly the same capabilities as BB.

To close this discussion on E-Learning and technology in education, I will share two of my personal stories and try to paint a picture of some of the challenges that I saw and experienced.

As I mentioned before, several of the faculty at KIST had completed training on distance education, specifically on using Moodle, and the campus had a Moodle site set up. However, there are two major problems that had not been adequately addressed and are the primary reason why, when I asked the six HODs (Head of Department) present at my meeting how many of them had faculty who at least had their course syllabi available online, their response was one out of the six. Those two problems are bandwidth/speed/reliability of the Internet connection on campus and access to the computer labs (both by faculty and by students). The "ethernet connection" on campus is basically like what I have at home (high speed DSL) except that the one line is shared between everyone on campus–imagine your home line being shared among 1600 people. As a result, when I did speedtest.com the results said, "Ouch, are you on dialup or something? You're connection at the US Embassy in Rwanda was going to take 3 hours to download from my office at KIST. The multiple computer labs are only open and staffed when a class is being held in them. Otherwise they are closed and locked. In other words, if a student

or faculty member wants to use a computer/have Internet access, they cannot because the labs aren't open.

When I went to the boardroom (at 1 pm) to get ready for my public seminar (at 3 pm), I especially wanted to set up the projector with my laptop (since I have a Mac, I anticipated some additional problems) and to test the Internet connection to make sure I could login to BB and access my course materials. Of course, things did not go smoothly. First, there are lots of windows and that day the torrential downpours continued throughout the morning so, by the time I walked into the room in early afternoon, there was about 3 inches of standing water on the floor the cleaning staff was busily trying to mop up. Ignoring the pool, I hooked up the projector to my MacBook Pro only to discover that the projector did not recognize any signal coming from the computer. Then, I plugged in the Ethernet cable and saw that, unlike every other time with my Mac, it did not automatically connect to the Internet and kept telling me a cable was unplugged. In the beginning I tried getting the people (department head, technician, lab manager, etc.) to help me. In the end (when they'd all left, ostensibly to find help/get other equipment), I fixed it all myself (thank goodness for previous experience as a tech!). What was funny, though, was when my department head introduced me, he included my amazing abilities with technology (as demonstrated by the fact that I got it all to work in time for my seminar).

5. Conclusion

In conclusion, I would like to share some of my personal stories, especially from the classroom as illustration of both what I gained and what I learned. What follows are a few such examples from my experiences teaching students at KIE.

I had been assisting Faustin, a Physics educator, with developing their Mathematics Education program, conducting seminars with his class of 250 students on "micro-lessons" (writing and teaching mini lessons), and teaching my own wonderful group of 16 senior-level "teacher trainers" various mathematics and mathematics education topics (including history of mathematics, problem solving, technology, lesson planning, assessment, and number theory). It has been fantastic! The campus, like the city (and, perhaps, the country) in general, has a crazy mix of modern and broken. For example, the huge room where Faustin's class meets has a collection of desks, some of which are broken, and a pitiful excuse of a chalkboard (where it's not even real slate but some type of adhesive material that's all warped from humidity) but it is equipped with a "sound system" and microphone for lecturing.

I was able to do lessons for the entirety of one week with my class using my laptop and their projector, but the week before I had to end class early because the electricity went out (my classes are in the evenings) and the generator (though it exists) is not hooked up to my building (because it's too new).

There are so many interesting stories to share but there is a special one that comes to mind. My students had just finished the "Chipton" activity. For those of you who aren't my students, in this activity I explained that, when they entered the classroom, they went through a portal and are now in a different world. In this new place, called "Chipton", they have been brought to interview for a job as an accountant. You see, the Queen of Chipton is making so much money she has to hire new people all the time just to keep up with it all. I asked the students to get into pairs then have one come up and get a bag of "stuff" consisting of white, blue, red, and yellow poker chips and a die. They each have a trading mat where they can put their chips in the appropriate column. I explained that in Chipton the white poker chip is the unit of currency and that the magic number is 3. Whenever you get three of something, you can trade them for one of the next biggest something. In this case, three white

chips can be traded for one red chip; three red chips can be traded for one blue chip; and, finally, three blue chips can be traded for one yellow chip. The activity involves each pair taking turns rolling the die and earning a set number of white chips, which they then put on their recording mat. Whenever they can make a trade, they must because, as I explained it, the Queen hates the sound of chips jangling together and has made a law that, in Chipton, one is not allowed to have more coins than necessary for the value. In other words, if you have four white chips you are 'illegal' because, for that value, you could just have one white and one red chip (less noise). I informed the whole class that they are honorary "coin cops" (as am I) and that, if they catch someone in violation, then they may confiscate that person's money and add it to their own mat. We practice the "official" statement: "I hereby confiscate your coins in the name of the Queen!" (Preferably stated very loudly and formally and with some type of accent.) Anyway, the pairs all compete, trying to be the first to get to a yellow chip (where you "win" the interview and earn the job) and everyone has a blast. Then, the "math" comes in when we discuss trading and connections to numeration systems and, specifically, place value and base. We compare Chipton, a base 3 world, with ours, a base 10 world, and convert numbers from one base to another by answering questions like "how many white chips are in one blue chip?"

Right about here in the lesson my students are just getting the idea that this whole game/activity/thing was all a sneaky way to teach conversion of bases without lecturing and we're recording all of our patterns/connections to exponents/etc. on a table on the board and then, just like that, the power goes out all over campus. Several of us were in mid-sentence and one of my students was in mid-writing (recording our data on the board) when the electricity went off and we were all plunged into total darkness. I finished my sentence and waited a second for the power to return (as the electricity goes off regularly in Kigali) because most public places (schools, hotels, restaurants, etc.) have generators that come on automatically when the power goes off. Then I realized that the building next to ours was illuminated while we all sat in darkness (later I discovered that our building, because it is so new, is not yet connected to the generator). Before I could decide what to do next, almost as one, each of my students got out their cell phone and turned on the flashlight (all cell phones in Rwanda have a flashlight feature) and aimed them at the board so the student could finish recording the data and we could finish our discussion! Isn't that simply amazing! It was such a we-are-the-world moment!

There was not even a suggestion of simply stopping and going home. They are just so eager for knowledge and they will go through extraordinary lengths to achieve it. It's a very pleasant change from some of the attitudes I've seen in students in the US (no offense students in the US, you know I love you guys!)—it's just so obvious that education is valued here in a way we do not at home. For students to even get into KIE they must earn a almost impossibly high score on the country's mandatory examination, then they have the added challenge of trying to finding funds. There are no opportunities like we have in America for things like scholarships, loans, or even part-time work (the unemployment rate in Kigali is about 33%, higher outside of the city). So when a student gets in and has the funds to go to school, you better believe s/he wants to get the most out of it.

My class at KIE was literally a dream class: they are excited, motivated, interested, fun, I mean, you can't ask for more than that! My second story involves another memorable lesson involving a lesson that I call "handshake problem" with this class. It's just a fun way to teach problem solving by having students act out the situation, look for a pattern, and figure out the formula to answer the question "There are 25 people at a party. Everyone shakes hands with everyone else. How many total handshakes happen at the party?" Of course the excitement was palpable when I whipped out my iPod and mini-speaker, turned on my "party" playlist, and had

them get up and "party around the room" shaking hands in groups of 3, 4, 5, etc. people. So, here is the scenario in my class: my students are "partying" around the room, shaking hands, laughing, and recording their data; the iPod is blaring music; and, here's the best part, it attracted a crowd! The windows in my classroom are filled with students watching from the outside–I had 75 people outside watching my lessons every day after the handshake lesson! It was so fun to teach in a place where not only your students are insanely interested but also the rest of students on campus are too!

I hope that hearing and reading about my experience as a Fulbright Scholar will awaken you to the potentials in your own students, motivate you to expand your own horizons, and inspire you to go beyond your initial limitations. I can honestly say that applying to become a Fulbright Scholar was one of the best decisions I've ever made and my experiences in Rwanda changed me and made me a better teacher and a better person.

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