The Millennium Cities Initiative

School-to-School Connectivity Project

Final Report

Elizabeth Kubis • Kumasi, Ghana • 2010-2014

One of the Millennium Development Goals (MDGs) is achievement of universal primary education by 2015. We must ensure that information and communication technologies (ICTs) are used to help unlock the door to education.

~ Kofi Annan (2005)

Former United Nations Secretary General and son of the city Kumasi, Ghana

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PROJECT DESCRIPTION

In January 2010, at the request of government officials from Ghana's second largest city, Kumasi, the Millennium Cities Initiative (MCI), with the assistance of Columbia Teachers College (TC), partnered with the Kumasi Metropolitan Assembly (KMA) and two global communications firms, Ericsson and Zain Communications (Ghana) Limited (Zain Ghana, now Airtel Ghana), to set up a three-year School-to-School Connectivity Partnership pilot project (S2S). [1] The program was designed, in support of an unfunded Government of Ghana mandate, to assist Kumasi teachers in utilizing the Internet as an educational resource, particularly in the teaching of the STEM subjects (science, technology, engineering, math). The program would also connect Kumasi and New York City math and science junior high school teachers, so that they might collaborate in teaching these subject areas and together consider ways of integrating instruction related to the Millennium Development Goals (MDG) into their lessons.

Fifteen schools were chosen by a committee, consisting of KMA and Kumasi Metropolitan Education Directorate (KMED) representatives, as well as Ms. Abenaa Akuamoa-Boateng, the West and Central Africa Regional Coordinator and Kumasi Project Manager for MCI.[2] In order to participate, each school agreed to build its own computer lab: an electrified room with security bars on the windows and doors, air-conditioning and /or fans and tiled floors. Once the labs were built and each school received two Dell 2007 desktop computers from the KMA, a router from Ericsson, and Internet access from Zain (Airtel), MCI began training.[3] It is important to note that 5 of the 15 schools had computer labs before joining the program.

The goal of the project was to assist 30 Math and Science junior high school teachers (one subject teacher from each Kumasi school) to use the Internet as an educational resource to access subject-related content, lesson plans and activities and for these teachers to connect with their counterparts overseas to collaborate and share lessons.[4] However, once the project began,

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[1] See Appendix A for Memorandum of Understanding (MOU).

[2] See Appendix B for Original Project Proposal.

[3] See Appendix C for information on project personnel.

[4] See Appendix D for information on school and teacher demographics.

it was clear that the goals of the project needed to be adjusted to fit the situation on the ground. Before teachers could use the computer and the Internet as educational resources, their school personnel first needed to learn how to maintain the computers. As soon as the computers were set up, problems occurred. Several of the computers were missing cables, all of them needed converters and none of them had anti-virus software. In addition, setting up, connecting and paying for internet was difficult and expensive. Once the computers connected to the internet, the majority of them ended up with viruses.

The project team was able to assist the schools in procuring the missing materials and installing anti-virus software. However, it was clear that the schools needed technical training and consistent support in maintaining their computers. Luckily, the project was able to connect with a local technical college, Wesley College, to provide school personnel with trainings on how to reformat a computer, physically clean a computer internally and externally and to update software.

But this was not enough. Schools still found it difficult to keep their labs up and running, mainly because there were not enough funds to pay one person at each school to maintain the labs. Administrators, teachers and students would use the labs, but there was no one there to make sure that the computers were shut down and to check for viruses. Each school had an ICT teacher, but an ICT teacher is mostly trained in how, theoretically, to teach students Microsoft software. At some schools, the ICT teacher took on this extra responsibility, but this was not always the case.

In response to this issue, a Computer Lab Maintenance Protocol was created by the project, for schools to follow on a weekly and monthly basis. The protocol noted what to do when a computer broke down, how to check Internet credit, steps in organizing the lab, how to keep track of computer usage, how to check for viruses and how to get rid of them, as well as a number of other things. In addition, the Kumasi Metropolitan Education Directorate decided to assign a project coordinator (a local Ghanaian ICT teacher) to provide the necessary and consistent technological assistance each school needed to keep their labs running.

During the three years of the project, the schools encountered a myriad of issues associated with setting up and maintaining their computer labs. These include but are not limited to incongruent Internet providers and plans; high costs associated with Internet and electricity use; high susceptibility to viruses; systematic hacking of the schools' Internet plans and the high risk of

theft of computers and electrical wires. As these different issues presented themselves the project coordinators worked with the teachers and head teachers (principals) to troubleshoot, problem solve and determine the best way to address the issues. This support and symbiotic relationship was crucial for the project to continue and for the math and science teachers to get the opportunity to learn, practice and use the computer and Internet. It increased the number of stakeholders in the project. By the end of the first year the number of participants doubled in size, going from just 30 to 60 teachers.[5] After three years, a community of project supporters developed within and around the schools, without the endorsement of whom, the project would have never lasted three years.

While schools were working hard to make their computer labs a reality, 30 math and science teachers (one math and one science teacher from each of the 15 schools) were learning how to use the computer, explore the Internet, discover new resources for their classrooms and how to incorporate those new resources into their lessons. These teachers were slowly introduced to the computer, with an introduction to its individual parts and to the functions of the keyboard. The teachers' lessons then moved onto the basic functions in Microsoft Word such as typing, opening and saving a file and copying and pasting text and images.

Next, teachers were introduced to the internet. They set up emails, explored different educational websites and learned how to use search engines online. To assist teachers in their understanding of the different types of educational information they could find online, and to help make their searches easier and less costly, the project provided them with a website dedicated to Ghana's national math and science curriculum for this level of student. This website, the *Kumasi ICT Website*, built with wikispaces, provided 8-15 different online resources each month that addressed one topic each from the math and science curricula.
The Kumasi ICT Website gave teachers one online location where they could find lessons, activities and information that directly addressed their teaching and learning. It also slowly introduced them to all that can be found online. Through this project, teachers were given the freedom to choose the information, lessons and activities that they wanted to try in their classrooms. They were then asked to share their experiences with the group. This sharing created a learning community among the teachers where they learned from each other what worked and what didn't in their classrooms. Working with teachers regularly who teach the same subject and grade level was not a common practice in the Kumasi schools. This new experience

[5] Including 15 math, science, ICT and head teachers.

motivated teachers to try new things. Once one teacher tried out a lab or activity and shared his experience with the group, others were more willing to try themselves.

The Kumasi teachers were not only sharing their experiences with each other, but also with partner teachers in New York City. Each school chose one of their two participating teachers, either the math or science teacher, to be a lead teacher who would connect with a NYC teacher. The project started with 5 NYC and 15 Kumasi teachers, with each NYC teachers assigned to work with a group of three Kumasi teachers, each from a different school, so as to create a team experience. By the end of the three years, there were four NYC teachers and 11 Kumasi teachers. Teachers in both cities came and went during the three years for various reasons, family obligations and school transfers being the most common.

During the first year, communication centered around "Getting to Know You" activities during which the teachers exchanged questions and answers about each other, their countries, schools and cultures. These questions and answers were sent using a second website, the *S2S Global Partnership* website, created specifically to facilitate the international communication between teachers. During the beginning of the second year, teachers exchanged videos, using the central website, sharing more information about themselves and their schools.[6] In the second half of the year, teachers created lessons that addressed both their school curriculum and one of the Millennium Development Goals. Teachers then shared their lessons and experiences with their groups. The final year centered on student communication. Students first created PowerPoints, introducing themselves and their schools. Next, in preparation for an online conversation, students filled out a survey on the Millennium Development Goals (MDGs) that was created by the teachers in NYC and Kumasi. Once all students had completed the survey, students in NYC and Kumasi read the results, discussed them with their teachers and came up with questions to ask their partner school. The exchange focused mostly on issues of education and health care. It was a perfect way to end the final year, as it was a reflection of all that the project wanted to accomplish – the uses of technology and the internet for educational purposes, as well as collaboration, both locally and international, on projects relating to the Millennium Development Goals.

[6] At the beginning of the project, each Kumasi school received a webcam from MCI. Some of the Kumasi teachers were able to use the webcams to create videos; in other cases, the project manager took the videos.

GOAL 1: TO BE ABLE TO USE THE COMPUTER AND THE INTERNET TO EFFECTIVELY AS EDUCATIONAL RESOURCES

One of the main goals of the original design was to provide teachers from each school in the uses of the computer and Internet in their educational settings. This goal can be broken down into the following:

a) **Provide teachers with training on basic computer software – Microsoft Word, Excel and PowerPoint.**
b) **Provide teachers with basic training in the uses of the Internet – email, navigating the Internet and searching for content.**
c) **Assist teachers and schools in acquiring and then developing knowledge and skills in utilizing the computer and Internet as school resources.**
d) **Provide teachers with continuous support in using the equipment, practicing what they learned and in developing and implementing new lessons**

RESULTS

a) Teacher progress in basic computer and Internet understanding and development

At the beginning of each school year, teachers were surveyed on their basic ICT skills. The topics surveyed fall under the following four topics: File Management, Word Processing, Email and Internet. The chart below shows how many teachers felt they knew these topics well during each of the three years of the project.

Teacher Basic ICT Skills	2010	2012	2013
File Management	68%	93%	97.4%
Word Processing	57.5%	82.75%	92.4%
Email	54.7%	91%	87.8%
Internet	59.1%	88.3%	89.58%

Some of the specific skills on which the teachers assessed themselves are shown in the table below, which shows how many teachers felt they knew these topics well during the three years of the project.

Teacher Basic ICT Skills	2010	2012	2013
Typing a basic document	6.7%	63%	83.3%
Opening a file	42.2%	81%	100%
Copy and paste	40%	73%	83.3%
Connecting to the Internet	31.1%	100%	100%
Sending an email	28.9%	87%	100%
Navigating the Internet	24.2%	74%	75%

By the time the project ended:
- **100%** of teachers felt confident connecting to the Internet.
- **83.3%** of teachers felt confident typing.
- **75%** felt confident navigating the Internet.

b) Internet Usage

Throughout the project, schools received routers that provided access to the Internet for their teachers and students. Schools were responsible for purchasing Internet credit so that they could connect. To pay for the credit, schools charged each students family two Ghana cedis a year, approximately one US dollar ($1). Since only 2-3 teachers at each school were trained through the program, it was difficult for schools - head teachers (principals), non-participating teachers and parent-teacher organizations - to see the benefit in purchasing credit. Thus the two Ghana cedis did not always go toward the purchase of Internet credit, an outcome that remained a struggle for the duration of the project.

- By the end of Year 1, **31%** of teachers spent **3 or more hours** a week on the Internet.
- By the end of Year 2, **56%** of teachers spent **3 or more hours** a week on the Internet.
- By the end of Year 3,
  - **28%** of teachers spent 3 hours or more hours on the Internet in school.
  - **64%** of teachers spent 3 or more hours on the Internet outside of school.

Time spent on the Internet	June 2011	June 2012	June 2013	
			In school	Outside
0-2 hours	69%	44%	72%	36%
3-5 hours	22%	43%	18%	45%
6 or more hours	9%	13%	10%	19%

The reason teachers were spending more time online outside of school instead of in school during the third year was because the majority of the participating schools' routers were hacked, leading to their Internet credit disappearing in a day. This occurred for approximately four straight months. The project coordinator and manager eventually learned that the SIM card in the router needed to be changed every six months to a year. If it was kept any longer, it was more susceptible to hacking.

c) Teacher use of the Internet as a resource

During the first year, the project team created an educational platform utilizing wikispaces to provide the Kumasi teachers with one website that would direct them to educational material addressing their subject matter and the national curriculum appropriate to their students' grade level. The wikispace was updated monthly with a new topic throughout the three years, when school was in session.

The wikispace was created to ease the path for teachers into understanding the vastness of the Internet. It provided them a centralized website to visit when they were first learning what the Internet could provide, when they did not have much Internet credit and/or when they had poor signal strength.

Below are the statistics from the last three years, showing the number of times per month the Kumasi teachers visited the Kumasi ICT wikispace:

Visits to Kumasi ICT Wiki			
Month	**2010-2011**	**2011-2012**	**2012-2013**
September		79	140
October		179	125
November	152	316	170
December	144	75	28
January	312	120	23
February	751	93	52
March	600	34	365
April	154	41	110
May	103	81	48
June	107	131	45
July	181	32	29
August	43	37	8
Total	2,547	1218	1,143
Average per Month	**255**	**102**	**92**

In an attempt to explore how connecting to the Internet may influence teachers, the project collected data about Kumasi teachers' lesson planning processes.

Teacher Surveys

During the second and third year of the project, 15 teachers, one from each school, were surveyed and asked about the amount of time each week they spent on lesson planning.

Time spent on lesson preparation	June 2012	June 2013
Less than 1 hour	22%	18%
1-2 hours	56%	36%
3-4 hours	11%	28%
5-6 hours	11%	18%
More than 6 hours		10%

The amount of time teachers spent on lesson planning increased over the three years.

- By the end of year 2, **22%** of teachers spent 3 or more hours a week preparing their lessons.
- By the end of year 3, **56%** of teachers spent 3 or more hours a week preparing their lessons.

The chart above shows that by the end of the third year, teachers were spending much more time preparing their lessons. When asked why, teachers directly referenced having the Internet as a resource.

> **KT1:** *It's become a part of my teaching. Before, I only used books and the syllabus and did a lot of lecture. Now I do research and find better information and practical activities to help my students better understand, before going into the classroom.*

Teacher Interviews

In October 2010, at the beginning of the project, when 45 teachers were asked to "Describe the process you typically take to create a lesson," themes that stood out in the teachers' answers were:

- Refer to books (40%)
- Refer to textbooks (96%)
- Refer to the national syllabus (91%).

KT4: *I check the syllabus for the right topic, read the school's approved Math textbook and any Math textbook that might have the information I need and make a teaching aid if necessary.*

In July 2013, after the third year, when 15 teachers were asked to "describe the process you typically take to create a lesson," themes that stood out in their answers were:

- Textbooks (95%)
- National syllabus (94%)
- Internet (85%)
- Wikispaces (93%).

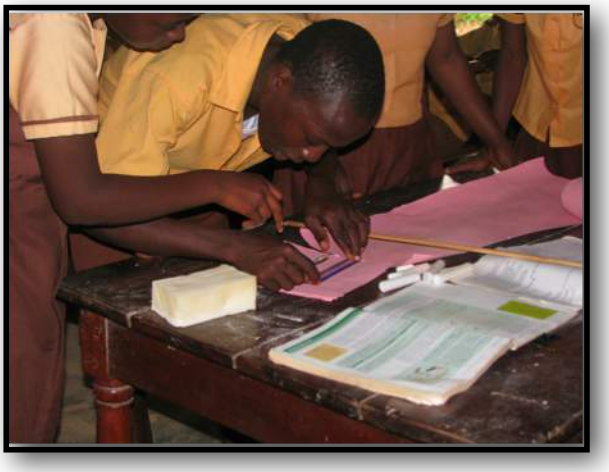
By the end of the project, **85%** of teachers considered visiting the Internet as part of their lesson planning process.

KT9: *My process is that I read the national syllabus and the textbooks the government gave us. I also use my own books -- the government textbooks are not very good. Now I use the wikispaces and other websites to find better information and practical lessons.*

In July 2013, 11 teachers were interviewed about their experiences with the project. Below are some of their responses verbatim:

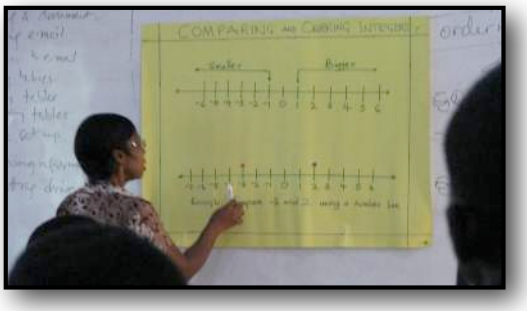
Q: Have you learned anything about teaching your subject area using technology?

KT2: *One is the respiratory system that I teach. Before that, we were teaching it, and sometimes we used the personalized experiments, allowing the pupils to breathe in and out and those things and we also used charts, but upon all I got from the websites that was given to me during this project, I was able to use the transparent models, balloons, straws, to construct the respiratory system as a model so the students would understand it better, so that is a one practical area and an interesting area that I learned because of teaching.*



Q: Can you describe one specific experience when you were teaching a class that you used one of these methods?

KT3: *I was teaching the integers, and at first, I was teaching it raw -- I just put some questions on the board, what is (-2 +3), and then I just write the answer for them. But when I went to the website, I learned how to use the number line to add, subtract and then multiply. I got all this from the Net.*



Q: How did the students respond?

KT3: *It was so easy for them to understand, better than the previous years.*

Q: Are there any new strategies you learned for introducing or teaching math topics?

> **KT4:** *For instance, just two weeks ago I was teaching my students about shapes and space, that is, what is a cylinder, a cone and a cube. Before, it was very difficult -- I drew them on the board and identified the parts, then I gave them the formula. But this time, it was easy, with the Internet. I went online and found pictures and nets to build the shapes. I brought the students to the lab, and they drew the shapes and nets on poster board. The students used the nets to build their own shapes.*

Q: So how did the students respond? Did they enjoy this activity?

> **KT4:** *They really enjoyed it. I grouped them into six groups, and each group was supposed to make those shapes from the Net. But that day, it was fun in the classroom. And the one thing I've realized is that the students, they enjoy making things themselves, more than doing their calculations.*

Q: Describe one lesson where you used technology both to prepare and present your lesson.

KT5: *When I was discussing vegetable production, here in Ghana, we don't have a lot of the vegetables; here we have the common ones, but there are many we haven't even heard about and haven't seen before. But with the help of [the Net], they display more than more than 20 samples of vegetables, so [the students] would just come and look at the different types we can't find here.*

Q: Have you gotten a chance to assess their understanding? If so, how?

> **KT5:** Yes, the questions they ask and the way they answer my questions tell me that with the help of these pictures, they understand the topic well.

Q: Have they done better than other classes?

> **KT5:** Yes -- I will show some of their exercises to you. I have taught vegetable production for five years. Students know much better than in the previous years.

d) Teacher and school support

Teacher development and technology integration take time and require teacher pedagogical support and school technical support. The literature is replete with studies, reports and documents stating that the introduction and use of ICT in education proceed in broad stages that may be conceived as a continuum or a series of steps. It won't happen after a two-week training, and it won't happen after a year.

In July 2013, head teachers of the 15 schools were asked, "How important is technological support to your school's participation in the project?"

Level of Importance	2013
Necessary	73%
Important	27%
Not Important	0%

In July 2013, the 15 schools were asked, "How important was on the ground support to your school's participation in the project?"

Level of Importance	2013
Necessary	86.7%
Important	13.3%
Not Important	0%

e) Unexpected Outcomes

1) Teachers purchase their own equipment

Due to their participation in the MCI S2S program and the technical problems teachers and schools encountered, many of the participating teachers ended up purchasing their own equipment. Below is a comparison of the different types of equipment the teachers purchased in the course of the program.

Teachers found the Internet and computer to be so valuable that they decided to buy their own equipment. By 2013:

- **40%** bought their own desktop
- **70%** bought their own laptops
- **70%** bought their own pen drive
- **90%** bought their own Internet modems.

2) Teachers and schools develop learning community amongst themselves.

Teachers need opportunities both to reflect on and to discuss their evolving ideas with mentors and peers, and to collaborate with others as they try out their new ideas about teaching and learning with technology. Throughout the three years of this project, the same groups of teachers worked together, meeting every three months to learn something new and to reflect on their experiences since the last workshop. This approach created a network of support beyond the presenters from overseas. The Kumasi teachers developed relationships with other Kumasi teachers teaching the same subject at different schools within their own city. They shared and reflected on their experiences, cultivating a community of trust and thus learning from each other.

Teachers were surveyed in July 2011, after the first year, and then again in July 2013, after the third year.

- The percentage of teachers communicating by email at least once a month went up from 50% after the first year, to 70%, by the end of the third year.
- The percentage of teachers who shared lessons with each other went from 38.5% after the first year to 86.4% by the end of the third year.
- In July 2013, 100% of the New York City teachers stated that they felt working with their Ghanaian counterparts enhanced their understanding of the material presented.

GOAL 2: INTERNATIONAL COMMUNICATION

The second goal of the project was to connect Kumasi mathematics and science teachers to their counterparts in New York City, so that they might –

- share lessons and experiences
- work collaboratively to create lessons that address both their schools' curricula and the Millennium Development Goals.

The project experienced both successes and failures in attempting to achieve this goal. Lessons learned include the importance of :

- coordinating school schedules, as school breaks and exams can have a dramatic impact on any international project activity.[7]
- working collaboratively to create lessons that address both their schools' curricula and the Millennium Development Goals.
- Having Internet does not mean instant communication; it can still take up to 2-3 weeks to get a response from a partner school.
- Teachers need specific entry points when beginning communication. For the first few projects, teachers, on both sides of the ocean needed very specific direction, guidance, and support regarding what to communicate about and how to communicate.
- International calls involving large groups of people, such as several classes of students, need to be planned ahead of time, with a shared understanding among those participating of what will be discussed and how.

Year 1

During the first year, 15 Kumasi teachers and 5 NYC teachers participated in international communication. Each of the NYC teachers had been assigned to work with a group of 3 teachers from different schools in Kumasi, to create a team experience. The partnerships were created this way in case a Kumasi teacher was unable to participate for a period of time, ensuring that communication will continue. (The NYC teachers were paid to participate in their partnership; therefore, their ability to participate was not questioned. However, our assumption that payment would be an incentive and create accountability for participation was not correct. We had a difficult time keeping NYC teachers involved, due to their schedules and the wait time between communications with the Kumasi teachers. The electricity and Internet issues in Kumasi were problems for all.)

7 See Appendix E, for a comparison of the Kumasi and NYC school schedules.

By February 2011, the 15 Kumasi teachers and 5 New York City teachers were introduced to the iEARN platform,[8] the medium through which the teachers communicated during the first year and were starting their communication.

The first communication was a "Getting to Know You" project, where the Kumasi teachers sent their NYC counterparts questions they wanted to know about teaching in the US. The NYC teachers responded with their answers, as well as with their questions for the Kumasi teachers. This project then extended to the students. Some of the questions have been sampled below.

Questions from Kumasi Students	Questions from NYC Students
1) Do they have blacks student in their classroom? **NYC:** Yes, we have many different types of students in our classes. **Kumasi:** Yes.	1) Do you have a lot of students in your class? **NYC:** My class has 25 kids. **Kumasi:** My class has 54 students.
2) Do they punish students when they make mistakes? **Kumasi:** We get caned, or we have to kneel for some time, or we have to weed the school grounds. **NYC:** We don't get caned here. We feel badly that you get caned. Some kids' parents hit their kids at home, but teachers aren't allowed to (it's illegal). Some parents don't believe in hitting at all, but punish by taking away privileges.	2) Do you speak the same language at school and at home? **Kumasi:** Our classes are taught in English, but my teacher sometimes talks to other teachers in Twi. At home we only speak Twi. **NYC:** When I am at school I speak English, and at home I speak French and Madigo.

[8] iEARN is a non-profit organization, created in 1988, that has pioneered on-line school linkages. The organization is made up of over 30,000 schools and youth organizations in more than 140 countries. http://www.iearn.org/

This project began at the end of February and was not completed by all groups until the end of June.

Obstacles:

- Kumasi teachers had limited access to the Internet and to electricity.
- Kumasi teachers were not confident when working with the computers.
- Teachers in Kumasi and New York City are busy professionals, with other commitments (coaching, other jobs, family, etc.) and events (weddings, funerals, pregnancies and serious illnesses such as malaria); although all the teachers were eager, they tended to underestimate the time and commitment needed for the project's success.

Year 2

During the second year the project worked with 15 teachers from Kumasi and three NYC teachers, with three new NYC teachers replacing three who had left.

The iEARN platform proved difficult to navigate and upload. Thus, a transition was made from the iEARN platform to Wikispaces w as the teachers' primary source of communication. Wikispaces was chosen because the Kumasi teachers were already familiar with the format and because it sent email updates to members when new posts were made on website. Both NYC and Kumasi teachers were introduced to this new platform in October 2012.

Teachers began the year introducing themselves and their schools by creating and uploading videos. Teachers then uploaded and shared lessons on topics taught in both countries. Finally, all teachers in New York City and Kumasi created and taught a lesson introducing the Millennium Development Goals to their students, which were then uploaded onto the wiki.

MDG-related lesson topics included:[9]

New York	Ghana
Communicable Diseases – Combat HIV/AIDS and other diseases	Oral Rehydration – Reduce Child Mortality
Energy Design – Environmental Sustainability	Respiratory System – Reduce Child Mortality, Combat HIV/AIDS and other diseases and Environmental Sustainability
Virtual Water – Environmental Sustainability	Teaching Percents – Eradicate Extreme Poverty and Hunger
Solar Powered Cars – Environmental Sustainability	Infections and Diseases - Combat HIV/AIDS and other diseases
Teaching Correlations – Reduce Child Mortality	Teaching Percents– Universal Primary Education and Gender Equality

[9] See Appendix F, for an example of a MDG-related lesson.

Obstacles:

- Kumasi teachers had limited access to the Internet and to electricity.
- Teachers in Kumasi and New York City do not teach the same topics, and if they do, they teach them at different times of the year and at different levels. Therefore, teaching the same lesson at around the same time during the school year turned out to be extremely difficult. One pair of teachers was able to accomplish this, but it was not a MDG-related lesson. Students learned about currency exchange rates by comparing the prices of things like bread and milk in the U.S. and Ghana.
- Some teachers were more active then others in the project, both in the New York and Kumasi groups. There was a great deal of disappointment and frustration when a teacher in one city was significantly more active then her counterpart.

Year 3

During the third year, the project worked with 11 Kumasi teachers and 4 NYC teachers.

For the final year, teachers decided to put student communication first, as they had been unable to do so during the two previous years. The first project required students to create PowerPoints, introducing themselves and their schools by discussing what they do each of the 24 hours in a day. They agreed on PowerPoint as the means of communication because it had been difficult for the Kumasi teachers to download and view the videos from the year before.

During the second part of the year, all teachers in NYC and Kumasi had their students fill out a survey on the Millennium Development Goals.[10] Students then compared their answers to their counterparts, discussed them with their teachers and came up with questions to ask their partner school, during an online conversation, about what they had read.

[10] See Appendix G, for the Student MDG Survey.

Of the four teacher teams, three were able to conduct successful online conversations.[11]

Conversation 1: Team 4
NYC: The School at Columbia
Kumasi: Adiebeba Basic 1, Bantama Presbyterian ("Bantama Presby"), Opoku Ware.
Topics addressed:

- Maternal Healthcare
- Education
- The importance of the MDGs to each country


Adiebeba Basic I


The School at Columbia

Conversation 2: Team 5
NYC: The School at Columbia
Kumasi: Santasi and Akosa
Topics addressed:

- Poverty
- Environmental sustainability
- Maternal health care
- School uniforms
- Student discipline

Conversation 3: Team 1
NYC: Simon Baruch Middle School
Kumasi: State Experimental I, Danyame and Oforikrom B.
Topics addressed:

- Cost of education
- What students learn in schools
- Health care


Simon Baruch Middle School

[11] Initially, the conversations were to take place over Skype, but "Google hangouts" proved much more successful, as they allow for 3-4 participants to join in from different locations, which enabled more students to participate.

Obstacles

- Every six years, Ghanaian teachers are transferred to a new school. MCI had originally made an agreement with the Kumasi Metropolitan Education Directorate (KMED) that teachers participating in the project would not be transferred during the three years of the project. However, at the end of the second year, a new Director of KMED was appointed, and the agreement was effectively null and void, as four of our lead teachers were transferred to other schools. Since the project was in its final year, it was decided that the transferred teachers would not be replaced.
- In the final year, only four of the New York City teachers rejoined the project.[12] Again, because it was the final year of the project, it was decided that the fifth teacher would not be replaced.
- Kumasi teachers had limited access to the Internet and to electricity.
- It took four months to realize that hackers had gotten ahold of the school Internet credit accounts. Every time a school uploaded credit for the Internet, it would all disappear in a day. After this happened a few times, schools became discouraged and stopped trying.

Suggestions for future international calls

- A moderator should be chosen on each side.
- The topic that the students will discuss should already be selected and students should be prepared for the call with questions and presentations.
- Test calls should be conducted a week before, on the exact day and time in which the call will happen.
- A backup plan should be made in terms of technology, e.g.:
  - There should be at least two computers, in the event that one breaks down, runs out of battery, develops a virus, etc.
  - An option of more than one Internet provider should be available. During all international conversations, the participants in Ghana had to try out at least two providers before they found a strong connection.
  - An option of more than one platform to connect on should be available. We planned to talk on Google Hangout, but during one conversation, we were forced to switch over to Skype, due to poor connectivity.

[12] The fifth teacher from the year prior was no longer teaching a STEM subject.

Teacher Communication Online Results

Below are statistics associated with the communication between the Kumasi lead teachers and their New York City partners over the last three years.

S2S Partnership Platform Activities			
	2010-11	**2011-12**	**2012-13**
Messages – discussions, comments, etc	42	134	71
Lessons - both MDG- and non-MDG-related lessons	0	41	31
Pictures	0	5	15
Videos	0	18	1
Conference Calls	0	0	3
Introductory PowerPoints			23

Below are the statistics from each month of the project's last two years, showing how often teachers from both NYC and Kumasi visited the online platform they used to communicate.[13]

	2011-12 Total	% from Kumasi	% from NYC	2012-13 Total	% from Kumasi	% from NYC
September						
October	285	15%	**85%**	430	45	**55%**
November	119	30%	**70%**	600	70%	30
December	118	49%	**51%**	85	30	**70%**
January	156	42%	**58%**	100	35	**65%**
February	140	**52%**	48%	180	**60%**	30
March	42	19%	**81%**	250	**90%**	10
April	38	20%	**80%**	81	**70%**	30
May	40	**80%**	20%	80	**65%**	35
June	59	**68%**	32%	125	**85%**	15
July	31	**95%**	5%	37	**90%**	10
Total	1028			1968		
Average per month	102.8			179		

[13] We do not have statistics from Year 1, 2010-11, as we were using the iEARN platform at that time.

GOAL 3: KUMASI SCHOOLS' TECHNOLOGY ACQUISITION AND MAINTENANCE

As stated above, this piece of the project was not a part of the original design. It was added due to the fact that the acquisition and maintenance of computer labs were required for teachers and schools to participate in the program. This element of the project provided:

a) Assistance in helping schools set up and test new equipment – computers, routers, projectors.

- A response to donated computers missing several necessary components such as cables, converters, wireless cards, etc.
- A response to schools leaving new equipment in the corner or storage rooms for reasons such as the inability to set them up, lack of understanding of how to use them, etc.

b) Assistance in negotiating and navigating Internet plans.
A response to the original Internet provider not working at every school, due to location and cost. [14]

- A response to school personnel's lack of experience with the Internet, determining which provider would best fit their respective situations, considering signal strength, cost, etc.
- A response to schools' Internet plans being hacked in Year 3. Once schools uploaded Internet credit to their accounts, the accounts were hacked and their credit stolen. It took four months of the project's final year to figure this out.

c) Opportunities to participate in technical training.

- A response to a myriad of problems ranging from electrical spikes to viruses, dust, heat, and normal wear-and-tear that can stop all computer activity.
- A response to continuous virus infection when connecting to Internet, as well as when using pen (USB) drives.[15]

d) Assistance to schools in developing a computer lab maintenance protocol involving lab upkeep, logbooks to monitor computer use, assigning and/or hiring lab assistants, etc.

- A response to schools' computer labs with more than 10 computers continuously breaking down. The general response to this dilemma from Kumasi teachers was that they have other responsibilities and not enough time to keep up with the maintenance. This statement falls in well with our own observations. For example, with no one assigned to maintain the labs, it becomes an extra responsibility for the ICT teachers, who seem to be able to handle 8-10 computers but seem overwhelmed

[14] Appendix H: MOU Shortcomings

15 Since teachers do not have their own computers, they tend to work with any computer to which they can gain access and to save their work to pen drives, which readily pick up and spread viruses.

by more, making it difficult for them to handle the maintenance of the lab as well as their own work.

RESULTS:

- At the end of the first year, GlaxoSmithKline PULSE Program (GSK) volunteer Michelle Staben-Wobker created a computer lab maintenance manual for all schools. In addition, she set up and paid for a computer maintenance workshop, conducted by Wesley College in Kumasi, for an ICT teacher from each school.
- At the end of the second year, GSK PULSE volunteer Stacie Calad-Thomson, along with Mr. Acquah, created a computer lab maintenance protocol for schools to follow on a weekly and monthly basis. The protocol provides information for what to do when a computer breaks down, how to check Internet credit, steps to organizing the lab, how to keep track of computer usage, how to check for and eliminate viruses and to handle a number of other things. The protocol comes with a checklist for the Kumasi School2School Coordinator and head teachers to use when visiting and checking the labs.
- Because of the manual and protocol, schools grew able to acquire more equipment and to maintain it. The project did not give the schools computers; rather, schools took the initiative and found other avenues to help them acquire computers, including banks, parent and teacher organizations, government organizations, etc.

School	Sept 2010	Feb 2012	June 2013		
	Computers			Routers	Projectors
Adiebeba 1 and 2	4	9	10	2	4
Akosa	4	5	5	1	5
Bantama Presbyterian	6	12	9 (24 laptops)	2	2
Danyame	7	14	14	2	3
Martyrs of Uganda	13	25	20	2	2
Oforikrom A	6	8	10	2	2
Oforikrom B	8	13	12	2	2
Opoku Ware	2	57	57	2	2
Sacred Heart	7	15	12	2	2
Santasi	4	16	16	2	3
South Suntreso	3	4	9	2	2
State Experimental 1 and 2	11	17	17	2	4
State Girls	7	7	9	2	2

Note: The data above only show information on the technology that was working at the time of collection.

Computer Labs

Below is an example of a computer lab that expanded from 2 to 16 computers.

Before

When Santasi first received their two computers from the KMA, their lab was not yet ready, so they stored the equipment in an office.

After

Three years later, Santasi had a separate building for a computer lab with barred doors and windows, fans and air-conditioning. In this lab they had 16 computers, 2 projectors, 2 routers and a MDGs poster at the back of the classroom!

Projectors

Through the program, each school earned two projectors. The first projector, a small Optoma Pico PK320, was provided to the schools at the end of the second year, after they had successfully completed the computer lab maintenance protocol for three straight months. This battery-operated projector was able to work from a USB drive and so could be used in classrooms without electricity and by teachers without a computer or laptop. However, there were issues surrounding the projector's brightness, and, in addition, it was such a new piece of technology that when it broke down, there was no one to fix it.

The second projector was provided to each school as a commemorative gesture for finishing the project. This projector was bought in Kumasi and required both electricity and a computer.

Computers

Each of the 15 schools received two computers at the beginning of the project. Over the three years, all schools succeeded in procuring computers with support from other donors. They used them in different ways to teach their students.

LESSONS LEARNED

1. When dealing with technology, the needs assessment must go beyond the equipment and infrastructure and **consider the human element**. Needs assessments should also consider who will be using the computers as well as who will be maintaining them.

2. When providing schools with computers, whether from an outside organization or the local district, **technical training and support are essential**. With a myriad of problems ranging from electrical spikes, to viruses, dust, heat and normal wear-and-tear, able to stop all computer activity, computer maintenance workshops should be given to at least one if not more teachers/school personnel at each school when the computers first arrive, and then again at least once a year, since technology is constantly evolving. Schools also need training in how to maintain their computer labs.

3. **Locate and utilize local resources.** This applies to all areas of a technology integration project, from buying the appropriate technology in-country, to using local organizations to provide technology training, to utilizing the ICT teachers at each school not only to teach their students, but their colleagues, as well.

4. Wireless Internet is now accessible worldwide. However, different countries have **different Internet providers and different plans**. Therefore, before working within a given developing country, on-the-ground comparison research should be conducted, specifically concerning topics such as the cost of Internet; Internet plans (for example, Ghana does not have options for unlimited usage); signal strength (the S2S partner company did not have 3G access for the schools in all areas, for example), required Internet paraphernalia (e.g., in Ghana, both routers and modems are needed), etc.

5. Computers and the Internet are luxuries in many developing countries and have not been fully integrated to the point of being economically accessible to the majority. Therefore, without a doubt, there will be **underlying costs** that anyone from another country would not be able to predict. The recurring monthly costs for this program have been estimated at 300 Ghana cedis ($200), to cover electricity, Internet credits, maintenance and security. The project organizers should have further researched costs, discussed them with participating schools and together created a plan for dealing with predictable extra costs.
   In addition, **since computers and the Internet are considered luxuries, schools and teachers may restrict their usage**. We learned, as the project continued, that a number of our head teachers (principals) did not want the computers to be damaged or to use up all the Internet credit, so they only allowed teachers into the computer labs once a week for about an hour.

6. Professional development of teachers sits at the heart of any successful technology and education program. Teachers will make the critical difference in any educational program, as they are the ones who will get the students on board and excited. It is essential to remember that, particularly in a program introducing unfamiliar and unintegrated technology, teachers not only need formal training, but also **sustained and ongoing support,** to help them progress in their learning and understanding of the Internet and technology and of how these tools can be used to enhance their teaching. This program provided teachers with 2-3 trainings a year, a website giving the Kumasi teachers new content and teaching methods for their classes, as well as capable American volunteers to help out. In addition, the Kumasi Metro Education Directorate (KMED) decided to assign a project coordinator (a local Ghanaian ICT teacher) to the participating schools, to provide both technical and pedagogical support. Without the coordinator the project would not have been as successful as it was.

7. "Appropriate technology" is a phrase used to describe technology that best fits the context of the situation. Before entering into a technology integration project, **one should consider which type(s) of technology might be best utilized in the school culture and environment.** A typical classroom in Kumasi, Ghana, contains about 40-50 students, with 2-3 students sitting together at a desk. It has one teacher, no electricity and is open to all elements of the weather. By the end of the project, we found that a computer or laptop and a projector allowed the science and math teachers to share what they have learned and created with students more easily then bringing them all to a computer lab, even one outfitted with 50 computers.

8. **Link your initiative to government organizations and/or to the community.** Without the support of the KMED and the parent and teacher associations (PTA), our project would have never gotten started, let alone made it to the end of the projected three years. KMED showed its support by hiring one teacher trained by the project to be provide "on-the-ground" technological and pedagogical support to each of the 15 schools. The PTAs of each school agreed that each parent should pay two Ghana cedis ($1 a year) to assist with the schools electricity and Internet costs. However, it's important to make sure the money is actually being spent on the internet. This did not happen for all our schools.

9. **Project plans should leave room for local adaptation.** The success of our project hinged on its ability to adapt to what was needed on the ground. When the project was conceived, computer and computer lab maintenance was not one of its goals. However, early on we realized that without working computers and functioning computer labs, our original goals would never come to fruition.

APPENDIX A: MEMORANDUM OF UNDERSTANDING

This MEMORANDUM OF UNDERSTANDING is entered into on the 16th day of January, 2010.

Between

MILLENNIUM CITIES INITIATIVE of the Earth Institute of Columbia University, United States of America (hereinafter referred to as "**MCI**") of the first part;

ZAIN COMMUNICATIONS (GHANA) LIMITED, a limited liability company incorporated under the laws of Ghana having its registered offices at 8th Floor, Silver Star Tower, Airport City, Accra, acting by its Country Manager, Philip Sowah (hereinafter referred to as "**Zain Ghana**" of the second part;

ERICSSON GHANA LIMITED, a limited liability company incorporated under the laws of Ghana having its principal place of business at Gulf House, Accra acting by its authorised representative (hereinafter referred to as "**Ericsson Ghana**") of the third part;

And

KUMASI METROPOLITAN ASSEMBLY, a statutory body set up under the Local Government Act, 1996,(Act 459) having its offices at Adum, Prempeh II Street, Kumasi acting by its Metropolitan Chief Executive of the fourth part.

MCI, Zain Ghana, Ericsson Ghana and Kumasi Metropolitan Assembly are collectively referred to as "Parties" and individually as a "Party"

Preamble

The Parties enter into this MOU for the purpose of implementing the "**Furthering Student and Teacher Achievement through a Global Education: School-to-School Partnerships for Kumasi Project ("Project")**. Under the Project, senior high and junior high schools in Ghana will be connected to the internet and to partner schools in the developed countries. The pilot stage of the Project will cover 15 junior high and 3 senior high schools in 3 sub-metros of the Kumasi Metropolitan Assembly. The Project will be implemented through a four-way public-private-non-profit partnership.

Proposition: By being connected to the Internet and to partner schools in developed countries, 1) students will thrive, as evidenced by improved attendance, grades and wider horizons, and 2) teachers will further their own professional development , given increased access to the curricular materials, teaching tools and peer-to-peer relationships that connectivity, and carefully managed school-to-school partnerships, can provide.
The Parties herein are committed to realising the goals of the Project. In furtherance of this effort, this MOU establishes the framework for formal working relationship between the Parties and specifies the services and resources each commits to the Project.

The Parties Agree as follows:

1. Term

This MOU shall commence on 16th January, 2010 and remain in force for a period of three (3) years unless sooner terminated in accordance with clause 3.This MOU shall be subject to annual evaluations and may be extended by the written agreement of the Parties.

2. GENERAL RESPONSIBILITIES

2.1 Responsibilities Ericsson Ghana:

2.1.1 To furnish each of the 15 junior high schools and 3 senior high schools, selected by the MCI, with Ericsson Fixed Wireless Terminals (FWT);
2.1.2 To be available for consulting to ZAIN Ghana in the deployment of the Ericsson FWT for the provision of Broadband Internet Service in the schools as needed;
2.1.3 To analyse, document and report on data usage and traffic patterns in each of these schools over a given time period.

2.2 Responsibilities of Zain Ghana:

2.2.1 To provide Broadband Internet Connectivity using the Ericsson FWT for all 15 junior high and 3 senior high schools, in three sub-metro divisions of Kumasi Metropolitan area, selected by the MCI;
2.2.2 To provide training, at its discretion, via printed materials, on line resources or on site training by its designated staff to the schools in the proper use of the Ericsson FWT in the provision of Broadband Internet Connectivity;
2.2.3 To repair/replace FWT equipment, as needed based on their standard terms and conditions;
2.2.4 To establish a fixed rate, with uncapped usage, for the selected schools;
2.2.5 To provide to Ericsson for analysis data on the usage of the Broadband Internet Service by the selected schools.

2.3 Responsibilities of Kumasi Metropolitan Assembly

2.3.1 To furnish desktop-computers for 15 Junior High and 3 Senior High schools, in three sub-metro districts, selected by the MCI, enabling their participation in this Project;
2.3.2 To furnish (furniture, power points, Local Area Network) some computer laboratories, where schools are missing these;
2.3.3 Responsible for providing electricity and security for computer laboratories;
2.3.4 Responsible for guaranteeing Education Directorate leadership and accountability throughout this Project.

2.4 Responsibilities of Millennium Cities Initiative:

2.4.1 To seek and create partnerships with overseas schools;
2.4.2 To provide educational content, focused on the areas of science, math and technology, but also including cultural and historical information;

2.4.3 To participate in ZAIN training, and will serve as a resource to answer teacher and student questions, post-training;
2.4.4 To carry out research to document this intervention and its impact, along the following lines:

a. MCI will carry out a baseline survey, of students' grades, attendance rates, awareness of the outside world, interest in science, math, engineering & technology, and career aspirations, at the beginning of the Project;
b. MCI will also survey the global awareness, interest in science, math, engineering & technology, and career aspirations of participating teachers and administrators, at the start of the Project;
c. MCI will measure these same indicators on an annual basis;
d. MCI will write and publish, on the MCI website, an annual report, every year for three years, chronicling the intervention and results to date;
e. In each annual report, in addition to reporting on the major indicators, MCI will adopt a case study approach, to look more closely into usage, compliance and growth patterns;
f. MCI will provide a final report on the intervention and the partnerships after three years.

2.4.5 Will identify or select schools for the pilot Project.

3. TERMINATION
Any Party to this MOU has the right to terminate this MOU upon giving 90 days written notice to the other parties.

4. AMENDMENT
Any Party may request changes to this MOU. Any changes, modifications, revisions or amendments to this MOU which are mutually agreed upon by the Parties shall be incorporated by written instrument and signed by all Parties.

5. ENTIRETY OF MOU
This MOU represents the entire understanding between the Parties herein and supersedes all prior representations and agreements whether written or oral.

6. ENFORCEABILITY
This MOU is a general statement to show collaboration between the Parties. It is not a contract and contains no enforceable legal obligations on the Parties herein.

7. RELATIONSHIP
This MOU does not create a partnership or joint venture and no Party shall have the authority to bind the others.

APPENDIX B: ORIGINAL PROJECT PROPOSAL

Coordinator
Abenaa Akuamoa-Boateng
MCI Project Director,
Kumasi, Ghana

Chairman
Mr. Samuel Martin Owusu
Guidance and Counselling Coordinator
Metropolitan Education Directorate
Kumasi

Secretary
Mr. Eugene M. Asante-Bekoe
Headmaster,
Opoku Ware Junior High School
Kumasi

Members
Ms. Emelia Konadu
Science and Mathematics Coordinator,
Kumasi Metropolitan Education Directorate

Mr. Ernest Effah
Science/Mathematics Teacher
Opoku Ware Junior High School
Kumasi

Mr. Bismark Adu
Science/Mathematics Teacher
Martyrs of Uganda R/C Junior High School
Kumasi

Criteria for Selecting Schools

Sub Metropolitan Education Areas selected were based on

a. Number of Schools within the Sub Metro Education Area
b. School population

Circuits Selected within the Sub Metros were also based on the same criteria

Schools within the circuits that were selected were also based on

a. Availability of space
b. Availability of extra classrooms
c. Availability of electrical power
d. Manageable class sizes
e. Willingness of head teacher and staff to host the program
f. Parents' readiness, preparedness and willingness to host visiting students and teachers.

PROPOSALS FOR SCHOOL-TO-SCHOOL PARTNERSHIP AS OUTLINED BY THE MILLENNIUM CITIES INITIATIVE

Background

The Millennium Cities Initiative, an urban re-development project of the Earth Institute at Columbia University, aims at developing mid-sized Sub-Saharan cities to achieve the Millennium Development Goals (MDGs). To this end, the MCI proposes to promote a School-to-school partnership in which some junior and Senior High schools in Kumasi would participate by linking up with schools in the United States of America to make vital contribution to the realization and achievement of the some MDGs.

In July 2008, four senior high school students from Houston, Texas, in the company of one parent paid a fact finding visit to some schools in Kumasi, as a prelude to establishing a partnership. Opoku Ware Junior High School Kumasi, a beneficiary of the first visit, was visited again by two seventh-grade students of the Sidwell Friends School, in Washington, D.C. They spent four days teaching and conducting science experiments with the students and also setting up four laptop computers that they donated to the school. These visits have given the Metro Education Unit in Kumasi an insight into how such partnerships can enrich and enhance the learning of students in our basic schools in Ghana.

A committee of five was then carefully chosen by the Metro Education Director to team up with the MCI Project Director to draw up a proposal for the project.

Needs identified

Within the Kumasi metropolis, one of the major weaknesses identified within the education sector has to do with resources for teaching the basic sciences, math and especially with regard to information and communications technology (ICT). The immediate causes fuelling this weakness were identified as follows:

i. Inadequate numbers of specially trained science teachers;
ii. Lack of designated and well equipped science laboratories for junior high schools;
iii. Lack of computers for effective teaching and learning of science, mathematics and related subject areas;
iv. Inadequate number of libraries largely stocked with out-of-date books and magazines, thereby limiting available sources of information.

Goal

The goal of this School-to-School partnership is to further progress toward the achievement of the Millennium Development Goals relating to education, public health, gender equality and environmental stewardship.

Broad Objectives

i. Create a platform that can enable science teachers to source information, update themselves and to teach science more practically and efficiently to students.
ii. Provide supportive teaching and learning environment, i.e., the provision of science equipment and materials for the effective teaching of science and related subjects.
iii. Bridge the digital divide by introducing and re-enforcing the use of technology in Ghanaian classrooms through the provision of computers.
iv. Support schools in Kumasi in a way that will foster mutually rewarding exchange of ideas with partner schools.
v. Support government's effort "to put in place a science and technology education policy think-tank to promote science and technology education at all levels in the education system" – (Government White Paper on Education Reform, Oct, 2004)

It is envisaged that the above will propel both teachers and learners to embrace the broader goal of ensuring quality teaching and learning of science and related disciplines across the Kumasi Metropolis.

Specific Objectives

It is envisaged that by the end of the year 2011,

i. Five junior high schools in three out of the 10 sub-metro areas of Kumasi will be enrolled in the school-to-school partnership programme.
ii. The 15 schools enrolled would have been visited at least once by a team from the US (or other) partner school.
iii. All science teachers in these schools would have established contact and have access to science teachers in counterpart schools.
iv. There would be a unified science and math curriculum that would guide interactions between the schools.
v. The required equipment and teaching materials would be provided, to ensure the smooth and effective teaching of science.
vi. All participating schools would have at least six computers to aid in the teaching of science and to facilitate communication between them.

Other Potential Partners

1. Banks and Telecommunication bodies within Kumasi;
2. Members of Parliament for the sub-metro areas in which schools are located

Benefits of the Partnership

i. Broaden the outlook of teachers, students and parents, and the nation as a whole, in math, the basic sciences and ICT.

ii. Demystify the notion that science is difficult through a practical and experiential approach to the subject.
iii. Benefit to partner schools. In terms of the exchange of ideas and the discarding of mediocre concepts about one another, especially with regard to preconceived notions about Africa.
iv. Benefit teachers, students and parents, within Kumasi, and in other cities and, ultimately, across the nation.

Conclusion

It is believed that if the partnership concept is given the necessary assistance, it will help introduce new methods of teaching and learning science and will encourage students and their teachers to communicate with their colleagues in other countries, which can only have long term benefits for the individuals, schools and nations involved. By enabling today's JSS students in Kumasi to perform complex scientific experiments under appropriate conditions and with careful guidance, such partnerships will not only help students grasp and retain sophisticated scientific concepts, but will also help set the stage for them to become the lead scientists of tomorrow.

APPENDIX C: PROJECT PERSONNEL

Project Participants
Kumasi Metropolitan Assembly
Kumasi Metropolitan Education Directorate
The Millennium Cities Initiative
Ericsson
Zain (Airtel - Ghana)

Co-Principal Investigators
Dr. Susan M. Blaustein – Director of the Millennium Cities Initiative
Dr. Ellen Meier – Co-Director of the Center for Technology and School Change, Columbia Teachers College

Project Design, Coordination and Implementation
Elizabeth Kubis – Project Manager, School2School Connectivity Project, Millennium Cities Initiative

Ghana Advisor
Abenaa Akuamoa-Boateng – West and Central Africa Regional Coordinator/Kumasi Project Manager, Millennium Cities Initiative

Kumasi School Support
Wilfred Acquah – Kumasi Project Coordinator, School2School Connectivity Project, Kumasi Metropolitan Education Directorate

GlaxoSmithKline PULSE Project Volunteers
Michelle Staben-Wobker, October 2010 – March 2011
Stacie Calad-Thomson, September 2011 – February 2012

Participating Junior High Schools

Kumasi (60 teachers)
Adiebeba Basic 1
Adiebeba Baisc 2
Akosa
Bantama Presbyterian
Danyame
Martyrs of Uganda
Oforikrom A
Oforikrom B
Opoku Ware
Sacred Heart
Santasi
State Girls
State Experimental 1
State Experimental 2
South Suntreso

New York City (5 teachers)
The School at Columbia
Simon Bruch Middle School
First-year participation
Westside Collaborative (MS 250)
Global Technology Preparatory (MS406)
New Heights Academy

APPENDIX D: TEACHER AND SCHOOL DEMOGRAPHICS

Kumasi Schools

The program worked with 15 junior high schools (JHSs) in Kumasi, Ghana.

- A junior high school contains three grades: JHS 1, JHS 2, JHS 3, which are equivalent to the 6th, 7th and 8th grades.
- Schools are usually located on a campus with another JHS or with an elementary school.
- The average number of students per school was 370; the average number of teachers was 18.
- The average number of classrooms was 8, with an average number of students per class 50.

Kumasi Teachers

The project worked with one math, one science, one ICT teacher and the head teacher at each school.

- 59% of the teachers have a teaching diploma and 31% an undergraduate degree [Note: A teaching diploma is received after finishing a two-year program at a teachers' college. The only requirement to attend a teachers' college is a high school diploma.]
- 38% of the teachers have been teaching for over 10 years, 28% two to three years.
- 55% of the teachers are female, 45% are male.

New York City Schools

The project worked with a total of five middle schools in NYC.

- A middle school contains three grades, 6, 7 and 8.
- Three of the five schools were public schools, one was a private school and one was a charter school (a publicly financed school separately organized according to its own priorities).
- The average number of students per school was 298.
- The average number of students per class was 22.

New York City Teachers

The project worked with a total of eight teachers.

- 25% (2) stayed with the program for three years;
- 25% (2) stayed with the program for two years;
- 50% (4) stayed with the program only for one year.

Of the eight teachers who participated in the project,

- 100% had both Bachelors and Masters degrees, and 25% had PhDs.
- 37.5% of the teachers had been teaching for over 10 years, 37.5% of the teachers had been teaching for 4-6 years and 25% had been teaching for 2-3 years when they joined the project.
- 100% of teachers were female.

APPENDIX E: PROJECT SCHEDULE

Below is an example of the schedule created for the project, based on the school schedules in both NYC and Kumasi.

Month	Kumasi	New York City	NOTES
September	• Schools Open: Mid-September - It takes about 2 weeks before schools computer labs are up and running. • Schools visited by Kumasi Projector Coordinator – Checks on all schools and their computer labs – Checks on all participating teachers	• Schools Open: Beginning of September –It takes about 2 weeks for schools and teachers to become situated. • Teachers' monthly meeting • Teachers plan communication and activities for the year. (Note: This is extremely important for American teachers. If it's not planned, it won't happen.)	Nothing should happen during the first month of school. Teachers and schools are just becoming situated.
October	• Project Manager Visit (3-4 weeks) – Provide workshops – Observe teachers and collect data – Teachers plan for and begin communication with overseas partners • Head teachers' monthly S2S meeting	• Teachers' monthly meeting • Teachers begin communication with overseas partners	Best time to start any program activities!
November	• Teachers continue communication with overseas partners – introduce themselves and their classes • Teachers practice skills acquired in workshops • Project Coordinator school visits • Head teachers' monthly meeting	• Teachers' monthly meeting • Teachers continue communication with overseas partners – introduce themselves and their classes	
December	▪ End of term exams occur during first 2 weeks of December. ▪ Ghana on school break for most of the month (approximately 25 days)	Thanksgiving just ended, Christmas to come. Not the best time for project activities.	Nothing will happen in either country in December.
January	▪ School starts the first Tuesday after January 1. ▪ Teachers start up communication again with overseas partners – plan next activity ▪ Teachers practice skills acquired in workshops ▪ Project Coordinator school visits ▪ Head teachers' monthly meeting	▪ Teachers monthly meeting ▪ Teachers start up communication again with overseas partners – plan next activity	Nothing should happen during this time period, as students, teachers and schools have just come back from major holidays.

February	▪ Project Manager Visit (3-4 weeks) –Provide workshops –Observe teachers, collect data ▪ Teachers continue communication with overseas partners –work on agreed upon activity ▪ Head teachers' monthly meeting	▪ Teachers' monthly meeting ▪ Teachers continue communication with overseas partners – work on agreed-upon activity End of February is Midwinter recess (1 week)	Best time to start activity for second half of the year.
March	▪ Teachers continue communication with overseas partners – introduce themselves and their classes ▪ Teachers practice skills acquired in workshops ▪ Project Coordinator school visits ▪ Head teachers' monthly meeting	▪ Teachers meet monthly ▪ Teachers continue communication with overseas partners – work on agreed activity	The majority of any work for the second term should be done here.
April	Ghanaian schools prepare for exams. School break (2-3 weeks)	Mid-April Spring recess (1 week) ▪ Teachers meet monthly ▪ Teachers continue communication with overseas partners – work on agreed activity	
May	▪ Teachers continue communication with overseas partners – introduce themselves and their classes ▪ Teachers practice skills acquired in workshops ▪ Project Coordinator school visits ▪ Head teachers' monthly meeting	American schools preparing for exams	
June	▪ Project Manager Visit (3-4 weeks) – Provide workshops – Observe teachers and collect data – school visits ▪ Teachers continue communication with overseas partners – Finalize project activities ▪ Head teachers' monthly meeting	▪ Teachers meet monthly ▪ Teachers continue communication with overseas partners – finalize project activities	Depending on the school, in the U.S., this could be a good time or a horrible time for project activity.
July	Ghanaian schools prepare for exams ▪ Project Coordinator school visits	American schools on break	
August	Ghana on school break	American schools on break	

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APPENDIX F: MDG-RELATED LESSON

Below is a lesson conducted by one of the Kumasi science teachers linking the study of the Respiratory System with the MDGs.[16]

Teacher Name:	**Subject:** Integrated Science
Week Ending:	**Day/Duration:** 70 minutes
Topic/Subtopic: The human respiratory system and Millennium Development Goals	
Objectives: By the end of the lesson the pupil will be able to: 1. Briefly explain the human respiratory system. 2. State at least two roles of the respiratory system to humans. 3. Model a sample respiratory system using the available teaching learning materials. 4. State at least two diseases associated to human respiratory system. **MILLENNIUM DEVELOPMENT GOALS OBJECTIVES** MDG 4: Reduce child mortality by preventing hazards to the respiratory system in the environment. MDG 6: Combat HIV/AIDS, malaria and other diseases by living in good and healthy environment. MDG 7; Ensure environmental sustainability by drinking good water, inhaling unpolluted air and living in a well ventilated rooms	
Prior-Knowledge: Pupils can explain how oxygen from the atmosphere get to the lungs.	
Teaching Learning Materials: **1.** Straws, Empty transparent bottles with lids, rubber band, balloons, knife, Selotape **2.** A chart showing the eight Millennium Development Goals. **3.** A well-labeled diagram of the human respiratory system. **4.** Reference websites: www.adprima.com/sci-respsystem http://42explore.com/repsyst www.teachengineering.org/view_lesson.php?url=	

[16] The teacher's write-up is in his own words.

Teacher – Learner Activities:

Introduction

The teacher introduces the lesson through questioning and answering based on the pupils prior knowledge, e.g.:
Teacher: How does atmospheric oxygen get to alveoli of the human lung?
Pupils: Atmospheric oxygen gets to the alveoli of the lung first through the nostril and to the nasal cavity. From there it moves to the pharynx where it moves to the larynx and oxygen, then moves to the trachea. From trachea, atmospheric oxygen then passes to the bronchus and finally it arrives at the alveoli of the lungs.

- Brainstorm the pupils to explain what is the respiratory system using the well-labeled diagram of the human respiratory system and website;
- Guide pupils to state some of the roles of the respiratory system of humans with reference to the functions of the various organs of the respiratory system through questions and answer method and website:
- Through group activity method, guide pupils to carry out the following activities using the available teaching learning materials in website:
- Discuss with pupils to describe some of the diseases and disorders associated to the respiratory system through brainstorming method and website:

Application

1. Assist pupils to discuss how the Millennium Development Goals 4 and 6 affect the diseases and disorders of the human respiratory system through the following activities

2. Use the website;
http://www.undp-gha.org/mainpages.php?page=MDG%20Progress and brainstorm with pupils on the need to prevent hazard to the respiratory system to reduce child mortality (MDG 4), the effect of combating human respiratory diseases and other diseases (MDG 6) and the effect of ensuring sustainable environment to aid proper respiration (MDG 7).

Core Points:

The human respiratory system is one of the systems of the human body, which helps the digested food substances that enter the cells in our bodies to be broken down to release energy.
The respiratory system consists of the *trachea*, *bronchi*, *alveoli*, and the *lungs* and is responsible for gas exchange between the environment and the body (delivery of oxygen from the lungs to the bloodstream and elimination of carbon dioxide from the bloodstream to the lungs). This system — along with the *heart* (located between the lungs; in fact, the left lung is slightly smaller to accommodate the heart) — is located in the thoracic cavity of the ribcage that provides protection.

Core points, continued

The diaphragm muscle separates this system from the abdominal cavity. Air first enters the body through the nose or mouth and then travels down the throat to the *trachea* (windpipe). Rings of cartilage protect the trachea from collapsing and subsequently blocking air from entering the lungs. The trachea then splits into two large tubes (one for each lung) called the right and left *bronchi*. The bronchi split into smaller bronchi and eventually become tiny *bronchioles* inside the lungs.

During inhalation, the *diaphragm* contracts downward and rib muscles pull upward, causing air to fill the lungs (increases the volume of the thoracic cavity and decreases pressure in the lungs so the air will flow from the higher-pressure environment to lower-pressure area in the lungs). The diaphragm then relaxes, and the lungs contract, which causes air to be pushed out from the lungs (exhalation).

Some common types of lung disease are:

- **Asthma:** When respiratory muscles have to work harder due to the bronchioles constricting, which creates smaller airways (see Figure 5). It is a response to an allergen or other irritant (e.g., animal fur).
- **Emphysema:** When respiratory muscles have to work harder due to the fact that the lungs have become stiff with fibers and are less elastic in nature.
- **Bronchitis:** When respiratory muscles have to work harder due to inflamed, narrow airways.
- **Pulmonary Edema:** A slowing of the gas exchange due to a build-up of fluid between the alveolus and pulmonary capillary (increases distance that the gases have to travel).
- **Pneumonia:** Bacteria or virus that affects the membrane (pleura) that surrounds the lungs.
- **Lung Cancer:** When malignant cells divide in the lung tissue, possibly invading nearby tissues or spreading through the blood stream; oftentimes caused by smoking. Figure 6 illustrates the presence of cancer in the lungs: the black areas are the lungs and the white patch on the right lung is cancer.

Evaluation:

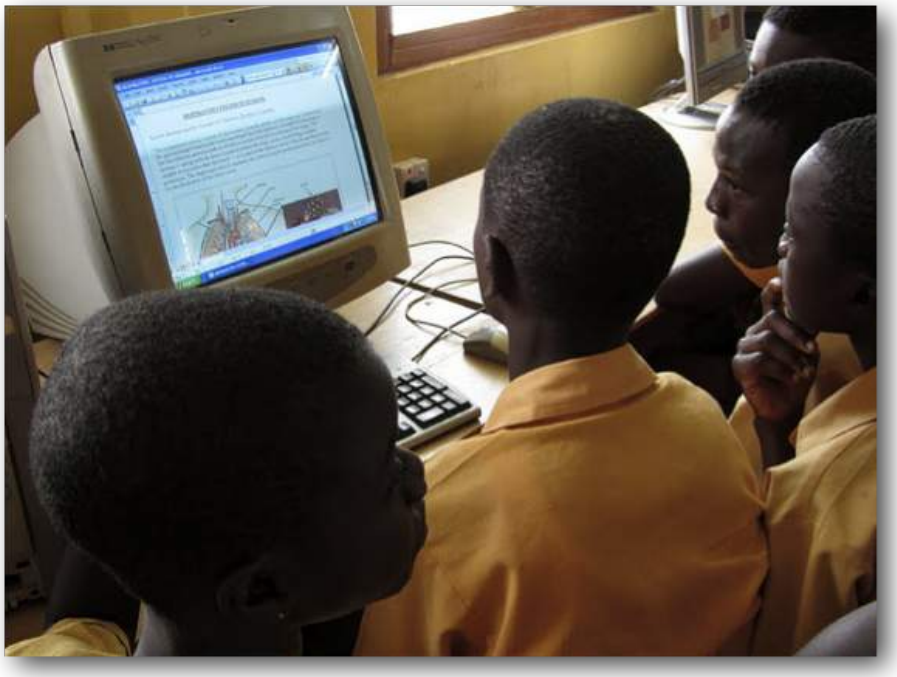
1 .a. What is respiratory system?
b. State at least two functions of the human respiratory system.
c. State any two respiratory diseases.
2 a. What are MDGs 4, 6 and 7?
b. Explain why each of these is important.

APPENDIX F (CONT'D)

MDG-RELATED LESSON: pictures from the lesson discussed above

Nana Adu Odefuor, the Kumasi science teacher, brought his class into the computer room, which consisted of 10 computers, with 6-8 students at each computer.

The lesson addressed the human respiratory system and relevant targets included in several of the targets under MDG 6 (see above).



The teacher had students visit websites so that they could read and learn about the respiratory system, as well as see visuals they wouldn't have had the chance to see before.

Next, the teacher had students complete a lab that he found using the Kumasi ICT Wiki, where students can build their own lungs out of water bottles and balloons.

Here is the final product!

APPENDIX C: STUDENT MDG SCHOOL SURVEY

1) Name

2) Check the option that best describes your gender.

- ☐ Male
- ☐ Female

3) What is your age?

4) Choose the option that best describes your relationship to your school.

- ☐ Student
- ☐ Teacher
- ☐ Administrator
- ☐ Other

5) What is the name of your school?

6) In what country do you live?

7) Have you ever heard of the Millennium Development Goals?

Yes
No

Listed below are the Millennium Development Goals. Use this information to help you in answering the following questions.

Goal	Explanation
Goal 1: Eradicate extreme poverty and hunger	Ensure that all people have enough resources to live a healthy life.
Goal 2: Achieve universal primary education	Ensure that all children (boys and girls) receive education from ages 5-12.
Goal 3: Promote gender equality	Ensure that mean and women have the same rights, access to education and job opportunities.
Goal 4: Reduce child mortality	Minimize the number of children under the age of 5 that dies from illness or malnutrition.
Goal 5: Improve maternal health	Ensure that women have access to health care when they are pregnant.
Goal 6: Combat HIV/AIDS, malaria and other diseases	Ensure that people are educated about diseases and have resources to prevent them.
Goal 7: Ensure environmental sustainability	Reduce the human impact on the environment.
Goal 8: Develop a global partnership for development	Have countries work together to solve problems to improve economic conditions worldwide.

8) Which of the Millennium Development Goals do you think is most important?

8a) Explain your answer.

9) Which of the Millennium Development Goals do you think is easiest to achieve by 2015?

9a) Explain your answer.

10) Which Millennium Development Goal do you think is most important to people living in the United States?

10a) Explain your answer.

11) Which Millennium Development Goal do you think is most important to people living in Ghana?

11a) Explain your answer.

12) Rate the Millennium Development Goals from most important to least important.

- the most important would receive a 1, and the least important would receive an 8.

Goals	**Rate from 1 to 8**
Eradicate extreme poverty	
Achieve universal primary education	
Promote gender equality	
Reduce child mortality	
Improve maternal health	
Combat HIV/AIDS, malaria and other diseases	
Ensure environmental sustainability	
Develop a global partnership	

APPENDIX H: MOU SHORTCOMINGS

The MOU listed the technology and services project partners needed to provide. However, it did not take into account the inevitable possibility of technology failing. Below are some of the issues the project encountered and how the MOU might have been adjusted to assist in avoiding them.

1.1 Kumasi Metropolitan Assembly:

1.1.1 To furnish desktop computers for 15 junior high schools.

RESULTS

- Each school received two 2007 Dell desktop computers in October 2010. However, a number of the computers were missing several essential components, such as cables and converters. Therefore, those participating schools with faulty or incomplete equipment had to purchase each item that was missing.
- The donated computers did not contain ant-virus software. Therefore, while teachers were navigating the Internet, the majority of the computers picked up several viruses that affected the computers capabilities. This has been a constant problem throughout the years of the project. MCI addressed it by providing several trainings on how to download anti-virus software, how to use it and how to maintain a computer lab.

1.1.2 To furnish (with furniture, PowerPoints, Local Area Network) some computer laboratories, where schools are missing these.

RESULTS

- Each school had to pay for and build its own laboratory in order to be part of this project. This was a lengthy and expensive process. The last of the schools finished its computer lab in June 2011, when the project was already well underway. Previously, the computers they received from the KMA were locked in a storage room.

1.1.3 Responsible for providing electricity and security for computer laboratories.

RESULTS

- All schools are wired for electricity.
- Adiebeba was in the process of building its computer lab when two computer monitors were stolen.

1.1.4 Responsible for guaranteeing Education Directorate leadership and accountability throughout this Project.

RESULTS

- Gladys Amaning, Director of the Kumasi Metro Education Directorate (KMED),

was active and vocal throughout the first two years of the project, providing the required leadership and accountability.[17]

- In April 2011, Gladys Amaning hired Wilfred Acquah, an ICT teacher at State Girls Junior High School who participated in all trainings provided by MCI, as the Kumasi School2School Coordinator. His main responsibilities are to support the Kumasi School2School program and to provide technical support to all participating schools.

1.2 Ericsson Ghana:

1.2.1 To furnish each of the 15 junior high schools with Ericsson Fixed Wireless Terminals (FWT).

RESULTS

- Each school received a Fixed Wireless Terminal (FWT). However, before the end of the school year in July 2011, at least one-third of the FWTs were no longer functioning, for one reason or another. Ericsson replaced the first two FWTs, but after that, the schools had to purchase new ones when the donated ones failed.
- Each Fixed Wireless Terminal works with computers with wireless cards. If computers do not have these cards, then the FWT needs wires to connect to a maximum of four other computers. If there are more than four computers, then schools need to either purchase a wireless card for each extra computer, to buy another or to purchase a bigger FWT.

1.2.2 To analyze, document and report on data usage and traffic patterns in each of these schools over a given time period.

RESULTS

- Each of the 15 schools has taken the responsibility to keep a logbook of computer and Internet usage in its computer lab. It is not clear that Ericsson was involved in this effort.

1.3 Zain (Airtel - Ghana):[18]

1.3.1 To provide Broadband Internet Connectivity using the Ericsson FWT for all 15 junior high schools.

RESULTS

- The two computers for each school received a wireless card that allows it to connect to the Internet.

1.3.2 To repair/replace FWT equipment as needed, based on Zain's (Airtel – Ghana's) standard terms and conditions.

RESULTS

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17 At the end of the second year, Gladys Amaning retired and a new director took her place.

18 Note: Since the signing of the MOU, Zain has now become Airtel - Ghana.

- The schools have had to replace or repair all equipment on their own.

1.3.3 To establish a fixed rate, with uncapped usage, for the selected schools.

RESULTS

- Unlimited access to the Internet is not possible in Ghana. To connect, Internet access credits are required, and they are limited to a certain number of gigabytes. Once a school has reached the limit, the Internet is shut off. These cards are expensive and limited. Therefore, watching educational videos and downloading documents are too expensive for the schools.
- Zain was not prepared to provide the schools with the discounted Internet access that they had promised in their initial commitment, when they promised that schools would only need to pay 30 Ghana cedis (approximately $20) for a 60 cedi ($40) plan. For the first five months the schools had their computers, they were paying the regular price for the Internet. In addition, it wasn't until March 2011 that Zain figured out a way to provide the schools with this plan. However, the plan did not last long, and schools branched out on their own to find providers they could afford.
- Reliable Internet is crucial to the success of this project. However, half of the participating schools are suffering from intermittent access and a weak broadband signal. Internet reliability and signal strength vary from place to place and from provider to provider, just as they can in the U.S. Therefore, to fully participate in the project, many of the schools have purchased USB modems from the provider whose signal works best at each of their schools. It would have been good to test the different providers and to determine which ones worked best for which schools; however, the project was conceived as a partnership, and no other participating firms were considered or consulted.

1.4 Millennium Cities Initiative

1.4.1 To seek and create partnerships with overseas schools.

RESULTS

- In the first and second year, MCI connected 15 (8 Math and 7 Science) Kumasi junior high school teachers to 5 (3 Math and 2 Science) middle school teachers in New York City.
- In the third year, MCI connected 11 (6 Math and 5 Science) Kumasi junior high school teachers to 4 (2 Math and 2 Science) middle school teachers in New York City.[19]

1.4.2 To provide educational content focused on the areas of science, math and technology, but also including cultural and historical information.

RESULTS

19 At the beginning of the final year, the new director of KMED transferred four of our Kumasi teachers to schools not participating in the project. In NYC, due to personal problems, one of our science teachers had to leave the project.

- MCI created an educational platform utilizing wikispaces to provide the Kumasi teachers with internet-based lessons and resources that address their subject matter, national curriculum and issues relating to the Millennium Development Goals.
- Through the partnerships, teachers are in the process of creating lessons that address both their national curriculum and issues relating to the MDGs.

1.4.3 To participate in ZAIN training and to serve as a resource to answer teacher and student questions, post-training.

RESULTS

- Zain did not provide any training. Instead, the MCI School2School Coordinator conducted three different workshops throughout the year that addressed topics such as basic computer skills, navigating the internet, sending and receiving email, using Skype, etc. In addition, a volunteer from GlaxoSmithKline's PULSE program conducted two workshops for the head teachers that addressed the same material.

1.4.4 To carry out research to document this intervention and its impact.

RESULTS

- During the first workshop in Kumasi, teachers filled out questionnaires to capture baseline demographic data.
- All communication between teachers has been documented using the iEARN platform and wikispaces.
- During the last MCI School2School Coordinator's last visit to Kumasi in June 2013, classroom observations were conducted, and an end-of-year questionnaire regarding participant reaction to the program was administered, using an online survey application, Survey Monkey.