Teaching Science in Rural Africa

Holly Rees

Since 2006 the villagers of Gyetiase, a hilltop village in the Ashanti region of Ghana, have witnessed three welcome changes to their domestic landscape. The first is the presence of the 'Clinic', a large, two-storey building built to be a regional centre for eye-surgery. The second is that next to every house stands a 'VIP' (Ventilation Improved Pit) latrine and thirdly the school boasts a library. This is all thanks to the 'Ashanti Development', (www.ashanti-development.org) a charity committed to the promotion of education and sanitation; the charity is based in Gyetiase, but also works in many neighboring villages.

The villagers do not yet enjoy clean running water and, while functioning street lamps are a new addition to the area, only one house in the village has electricity. Child mortality before the age of 5 is very high: 63.5 per 1000 children in Ghana in 2009 (11.5 times higher than in the UK), and this figure is considerably higher in rural areas like Gyetiase . The vast majority of villagers are subsistence farmers, and many children suffer from malnourishment. Access to basic healthcare is very limited; although some families have national health insurance allowing them free access to a doctor and medication for common illnesses such as malaria, most cannot afford this.

In August 2011 I arrived in Gyetiase for the second time. Having worked there for a short time two years before as a volunteer Maths, French and English teacher, I was now returning to teach science. Even though I knew what to expect, I was moved by the smiling cheers from the villagers - their shouts of 'akwaaba oberuni' ('welcome, white person') in the local language, Twi.

The aim of the Science Summer School was to focus on children from 8-12 years of age and to improve the students' understanding of science by showing demonstrations and allowing them to complete practical experiments. With no electricity, gas or running water available it was a challenge to devise practicals that would be relevant, understandable and easy to conduct. I also wanted to help improve the students' English. All teaching from Primary 3 and above, aged 6-9, is supposed to be carried out in English. However, as English is the second language of both students and teachers, lessons are usually in Twi so that the children can understand.

> "Innovative thinking from scientifically literate local individuals would decrease poverty, famine and disease"

In 2009 just 10% of Ghanaian graduates held degrees in a scientific discipline, and only 29% of these were women . Increasing female participation in science has been shown to improve economic and social development . Innovative thinking from scientifically literate local individuals would help decrease poverty, famine and disease . Encouraging pupils from poor, rural areas to study science is particularly important as these children are acutely aware of the problems faced by their communities, and so best placed to help solve them. Improving scientific understanding within these communities can also foster better sanitation and farming practices.

Having observed the local teaching style during my first visit, I knew that the children were accustomed to very strict rules. Questioning is not allowed; rote learning and copying from the board is the order of the day. Although the Ghanaian science syllabus recommends two periods per week dedicated to practical work , the lack of traditional equipment in rural areas makes this task impossible for teachers, who encounter huge difficulties in obtaining money to buy even the simplest items for demonstrations. They are also not given any training or advice on how best to use the materials available. Consequently primary school

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The school where the teaching took place.

children can give word-perfect definitions of anything from photosynthesis to magnets. However, any attempt to get them to apply their knowledge to new situations, or to make connections between topics invariably results in an embarrassed smile or a blank expression.

Filtration apparatus.
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We started by demonstrating filtration using filter paper, dirty water and a plastic bottle cut in half. The children then, for the first time in their lives, undertook their own experiments and were amazed to see the water change from dirty brown to colourless. Having done the experiment once, they wanted to do it again! However, it was important to emphasise that colourless did not mean clean, and when they collected water from the local stream for drinking, it would still contain potentially harmful bacteria.

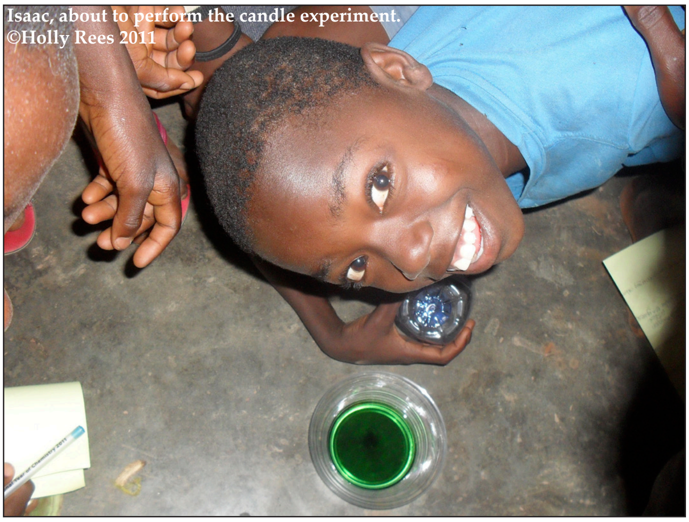
Our next experiment was designed to show that burning a candle requires a gas from the atmosphere. Since there is no glass in the school window panes nor doors in the door-frames, we conducted the experiments huddled around candles on the floor to prevent the wind blowin them out. The children covered the candles with the severed plastic bottles which allowed them to see the flame going out as the available oxygen was used up. This introduced the idea that invisible gases allow the candle to burn. Most children had heard of oxygen before so this practical worked well. For the pupils, the practical seemed to change the concept of atmospheric gases from a very abstract one to something that can be related to.

I took a set of 30 magnets with me. Though able to define a magnet - "it attracts magnetic materials towards it" - they had never seen or used one before. Feeling the forces of magnetic attraction and repulsion generated such excitement that one boy danced across the classroom. The biggest thrill came from making a magnet placed on the top of the desk move by manipulating one underneath it. They also stuck the magnets to the rusty iron nails that held the desks together - this allowed them to differentiate between a magnetic material and a magnet.

> **"The practical seemed to change the concept of atmospheric gases from a very abstract one"**

A lesson on acids and bases came next. Isaac, one of the most able pupils, could give me a description of Litmus paper and how to use it despite having never seen any before. When I produced some, he ran out of the classroom, returning with various fruits of which we subsequently tested the pH. We were able to contrast acidic fruits with basic soap. I wanted to emphasise that acids and bases can react together, so I added bicarbonate of soda to vinegar in a large water bottle, hoping for an awed reaction to the violent fizzing. However, the children were more confused than impressed - I think perhaps the problem was that vinegar and bicarbonate of soda were not chemicals that were common in the village and so they found it difficult to relate to this experiment.

All the pupils made their own 'chromatography kit': they cut up strips of filter paper, added a spot of food coloring onto one end of the paper and stuck it through a thin wooden rod at the other. They then rested the rod on a cut-off water bottle with a little water in the bottom and were fascinated as the water-front rose up the paper, splitting the dye into its component colours. Black gave excellent results, splitting spectacularly into yellow, blue and red. Whilst the theory of chromatography was beyond most students' understanding, they were now able to appreciate that the dye was a mixture of the different colors that could be separated.



Isaac, about to perform the candle experiment.
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On a sunny afternoon we ventured out armed with magnifying glasses. Although I asked the children to search for interesting-looking plants, they were more interested in magnifying each other's noses and ears, generating delighted howls and shrieks. Because of the work of the eye clinic in the village, the children understood the relationship between a

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Hannah, writing an answer on the board during the acid and bases practical.

magnifying glass and a pair of spectacles. Later, we burned our names into balsa wood using a magnifying glass to focus the sun. While it required a lot of explanation and demonstration to show how to use the lens to get a focused spot of sunlight, some children eventually managed it very successfully, with impressive results.

> **"They were now able to appreciate that the dye was a mixture of the different colors that could be separated"**

I later taught about solids, liquids and gases. In order to demonstrate the three states of matter I had brought a balloon, a bottle of water and a small block of wood. When asked for definitions, I received good answers of 'can be compressed' for gas, 'no fixed shape' for liquid and 'fixed shape' for a solid. In order to demonstrate the differences between liquids and solids, and also that not everything fits into a fixed definition, I mixed cornflour with water to get the non-Newtonian fluid that results. If it is hit hard then it behaves like a solid, while if it is tapped very gently it acts like a liquid.

During the final lesson there was a competition. Each child was given a piece of tin foil and asked to make a boat with it. Never normally encouraged to do anything creative, this activity was met with some consternation, but after a slow start the pupils came up with a range of inventive structures. We began testing them in a bucket of water: coins were added and the number the boat could hold before sinking was recorded. The students crowded around the bucket, counting out the coins in rising decibels. The girl whose boat sank at 43 coins was the heroine of the day! Each student's score was recorded in a bar chart on the board.

Almost all of the materials used in the camp were locally available, and so the experiments I did could easily be undertaken in other developing countries. In Rwanda, a scheme for encouraging practical work in physics has been successful . By encouraging innovative thinking in schools, future generations may be better equipped to tackle problems of poverty, disease and diminishing food resources. ■

Holly Rees is a first year student at Clare College studying Natural Sciences. This summer, Holly demonstrated science practicals and taught basic science to schoolchildren at a school in a village in Ghana. Holly has kindly offered to share her experience with The Triple Helix, showing the importance of teaching science in developing nations.

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