



# TASTE

The African Science Truck Experience

## Project overview

As in many African countries, science education in Ugandan schools is held back by a lack of hands-on experimental equipment in secondary schools. Students' first experience of conducting an experiment is often in the exam room. The consequences for Uganda are stark: pass rates for scientific O-levels are under 50% as compared to over 75% in humanities. Without the chance to carry out experiments, students see science as abstract and boring. The cleverest and most ambitious opt for humanities. Only 20% of Ugandan undergraduates study science subjects. Without action, Uganda faces a spiral of decline in science and technology with fewer qualified teachers facing increasing numbers of students.

TASTE aims to reverse this trend by providing a mobile teaching laboratory to give students practical experience of scientific experimentation. Participating in experiments will inspire students and bring complex, abstract theories to life. TASTE hopes to dramatically change how students in Uganda perceive science, and to equip them with skills needed for careers in research, medicine and industry.

The initial project will involve a single van which will reach 3000 students from 11 schools, as well as providing teacher training for potentially hundreds of teachers from across Uganda during school holidays. This pilot project will provide a model for improved practical science teaching that is applicable both in other regions of Uganda and in other African countries.

## Why is TASTE needed?

Practical science education in Uganda (and many other African countries) is almost universally inadequate. For a number of students, their first hands-on experience of science is during the O-Level practical exams. As a result, they lose interest and score poorly on exams — chemistry, physics and biology have the lowest pass rates out of all major subjects in O-level examinations<sup>1</sup>. This means Africa loses many potential doctors, engineers and researchers.

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The majority of A-Level students take arts due to poor science teaching. If the project reaches [this school], we expect more numbers for A-Levels... Many students in private schools do not even see a conical flask [before sitting the O-Level practical paper].

Deputy Headmaster, Mbirizi

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The Ugandan school system is similar to that of the UK: seven years of primary (P1-P7) and six of secondary (S1-S6), with O-levels taken at the end of S4 and A-levels at the end of S6. Results for O-levels (including the compulsory subjects English, mathematics, biology, chemistry and physics) are frequently the only criteria for admission to S5. For many students, failing in science subjects bars them from continuing their studies. Others score highly enough in other subjects to be allowed to progress to A-levels, but due to their previous results they only have the option of studying arts and humanities. The ratio of arts to science graduates at the top universities in Uganda is 5:1.

It is hardly surprising that so many students fail science subjects. The old-fashioned teaching styles used in most Ugandan schools consist of the teacher reciting notes or drawing diagrams on the board, and the students copying them down into notebooks. They then learn the notes verbatim to reproduce in exams.

When questioned, students show very low comprehension of the material, even if they ‘know’ it well. But how can students be expected to understand a chemical reaction, for example, if they have never seen any of the chemicals and never watched or carried out a reaction themselves? A report commissioned by the World Bank reported that:

*Importantly, **active learning approaches** that characterize effective modern pedagogy, value the existing knowledge of the learner and stimulate the integration [of] new knowledge with it. Very little of this is reported to take place at this moment in secondary classrooms in Uganda and **yet it is a cornerstone for creating the kind of competencies demanded by the 21st century changing workplace and roles in society.***

Clegg, A., Bregman, J. & Ottevanger, W. (2008). Uganda Secondary Education & Training Curriculum, Assessment & Examination (CURASSE) Roadmap for Reform. Washington: World Bank

Many of the concepts students learn are entirely abstract to them. Inevitably they quickly lose interest in scientific subjects. The danger for Uganda is that it enters a spiral of decline in which successive generations produce fewer science graduates to teach the next generation, with the consequence that the country becomes increasingly reliant on importing expensive science skills from overseas.

By giving students the chance to do a wide range of scientific experiments themselves, TASTE will deepen students’ understanding of science and make the concepts real and engaging.

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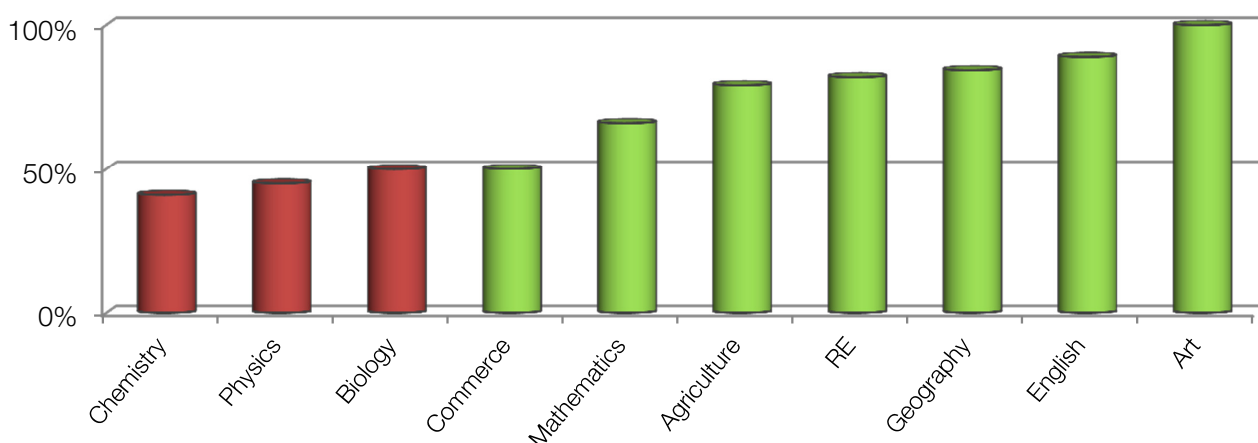
We would like to do more practicals. We understand science better when doing practicals

Christine  
S2 student, Kyetume

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## Measuring performance

Practical work makes up 40% of the O-level exam, but many schools do not have any laboratory equipment. Some have a small amount, but it is often broken, out of date, or simply never used because teachers do not know how to use it. The Ugandan National Examinations Board (UNEB) commented in 2010 that “Performance in practical science examinations reflect that the candidates have not been exposed to practical science teaching. They exhibited a lack of skills in handling apparatus, making observations, recording data in tabular forms and plotting graphs from such data.”<sup>1</sup> The series of experiments offered by TASTE will be designed to allow students to develop all these skills, increasing the number that are able to continue studying sciences at higher levels.



Pass rates for O-level in all major subjects in Uganda in 2010<sup>1</sup>

A scientific education is about more than just getting results in exams. Carrying out experiments and investigations encourages critical thinking, creativity and problem solving. These skills will be useful in many careers, as well as preparing students well to become “job creators” in the future - particularly important in Uganda where the population is expected to increase almost four-fold by 2050<sup>2</sup>. The Innovation for Development Report 2010-2011<sup>3</sup> argues that the “most important” factor in development is “the extent to which societies are able to harness the latent creative capacities of their populations.” We hope that students who participate in TASTE’s programmes will be able to use all the skills they acquire to contribute to the development of Uganda, moving it up from its current position of 106th out of 130 on the Innovation Capacity rankings. Furthermore, the UN places Uganda 161st out of 187 countries in its Human Development rankings<sup>4</sup>, with 65% of the population living on less than \$2 per day. A generation of scientifically literate and enthusiastic school leavers have the potential to transform the country.

## Area of operation

TASTE will initially operate in Lwengo District, Uganda. The district is rural, but has reasonable transport links, lying on one of the main roads in the country. Despite having an estimated 264,900 residents, most of them agricultural labourers, the district has no hospital.

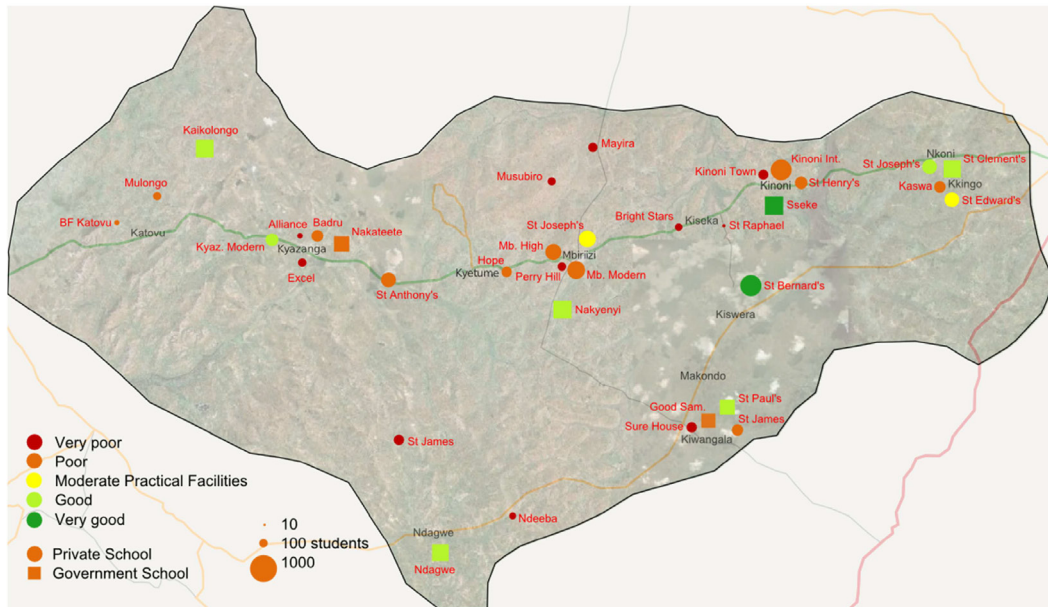
Preliminary surveys in September 2011 and July 2012 found strong support for the idea of a mobile lab and teacher training. The district currently has extremely poor science facilities, and students and teachers all responded enthusiastically to the idea of doing more practical work.

## The wider picture

As far as we are aware, there are currently no comparable projects in other countries considered by the UN to have Low Human Development. TASTE’s first mobile lab will act as a prototype with potential for expansion throughout Uganda and ultimately the rest of Africa. In South Africa, which has Medium Human Development, there are two similar projects, the Emasondosondo project in Guateng which focuses on physics and chemistry, and the Mobile Science Laboratory in Grahamstown. Both of these projects reach large numbers of students and are very successful. In some schools visited by the Emasondosondo project, science results have improved by up to 25%<sup>5</sup>. In India, the Agastya International Foundation has been running for 10 years and now operates 47 mobile labs across the country. We hope that by sharing ideas and practices with these projects, we can achieve comparable results in Uganda and elsewhere.



The project will initially operate in Lwengo District, located near Lake Victoria in southern Uganda



Map showing all secondary schools in Lwengo District and their status, size and practical facilities

## Goals and objectives

### Our Vision

To create a generation of scientifically literate and enthusiastic school leavers with the potential to transform Africa.

### Our Mission

To increase the standard of practical science education in Uganda, and later the rest of Africa. This will be achieved by combining a well-equipped mobile teaching laboratory for secondary pupils, with a training programme for local teachers

### Objectives of this project

- i. To provide regular practical science lessons to 3000 students in the Lwengo District of rural Uganda
- ii. Over a period of 4 years to increase the pass rate in O-level examinations in scientific subjects from less than 50% to more than 70% in the schools we visit
- iii. To teach students a comprehensive set of practical skills, as defined by the Uganda National Examinations Board's syllabus
- iv. To empower science teachers across Uganda in their delivery of practical lessons
- v. To promote interest in science in schools as well as the wider community
- vi. To increase the proportion of students from Lwengo District advancing to science-based A-levels, higher education courses, and careers
- vii. To encourage community involvement in the project and so ensure a lasting improvement in practical science education
- viii. To develop a model for a mobile teaching laboratory that can be deployed elsewhere in Uganda and beyond

# Programme design

## Mobile laboratory

The chief purpose of TASTE is to operate a mobile teaching laboratory. We have identified two reasons for the current lack of experimental science in Ugandan classrooms: expense and lack of experience among teachers. The capital cost needed to equip a teaching laboratory to an adequate modern standard is too great for many individual Ugandan schools to meet. This means that teachers and students have no familiarity with practical work, so they see experiments as a secondary consideration rather than a fundamental part of science. In terms of both experience and expense, TASTE will be different because of the scale at which it operates.

TASTE will only need to purchase enough equipment for one well equipped school laboratory, but will be able to regularly offer this equipment to students in eleven schools. A team of locally recruited staff with comprehensive training in teaching practical science will travel with the laboratory. With low staff to student ratios in each class, they will be able to introduce teachers and pupils alike to practical experimental techniques. Teachers will have the chance to learn about protocols in advance so that they can, if they wish, take the leading role in the lessons.

The mobile laboratory will consist of a van containing a core set of equipment (folding tables, basic lab equipment, a gas supply and solar panels) and also a number of modular experiments which will vary depending on the day's lessons. There will also be a small headquarters which will serve as a base for the van and a storage space for various experiments. It will include a small workshop for maintenance and cleaning of equipment.

Each day the mobile laboratory will visit either one or two schools. The equipment will be set up in the school buildings. Students will first be introduced to the experiment, and how it relates to the theory they have studied in previous classes, with appropriate multimedia presented using a projector. In pairs or small groups, they will carry out the practical work by following a supplied worksheet. Staff will be available to help with inevitable difficulties which students encounter during the lesson. At the end, the group as a whole will analyse the results obtained by the class and cooperatively arrive at an interpretation.

Our priority when selecting experiments will be to illustrate important parts of the syllabus in interesting ways. For the lower grades, practicals will cover broad scientific principles to help students better understand the theory they are learning in that term's science lessons. In S4 (the O-level year) the focus will shift to include preparation for the practical exams.

In a number of these sessions there will be opportunities for students to devise their own experiments, and to learn how to test their results for statistical significance. Understanding how to use data to judge the merits of a proposal is a key skill in many careers other than pure science.

## A typical day

(Exact times will vary based on consultation with individual schools)

06:00	Staff begin preparing van
07:00	Van departs
07:30	Van arrives at first school, set up of lab begins
08:30	Lesson with S1 - separating pigments from leaves using ethanol chromatography
10:00	Lesson with S2 - constructing basic electrical circuits, and measuring current and voltage
11:30	Lesson with S3 - investigating the optimal pH and temperatures for biological enzymes
14:00	Lunch
14:30	Lesson with S4 - carrying out titration to determine the concentration of a chemical.
16:00	Van is packed up and departs
16:30	Return to HQ, wash equipment and prepare van for next day

Trial experiments conducted during the trustees' research trip in July 2012 were popular with students



## Teacher training

Many science teachers in Uganda report that even when they have access to some equipment, they do not feel confident teaching practical lessons. Often this is because they have never carried out the practicals themselves, so the cycle of poor education continues.

TASTE does not want to undermine local science teachers in any way, so we will not simply take over lessons. Instead, we will hold training camps for the teachers within Lwengo District before the project starts and during each school holiday, to demonstrate all the practicals for the coming term. Individual teachers can then decide whether they would prefer to lead lessons or take a supporting role. TASTE staff will offer support throughout the lessons, either teaching the whole class or working with small groups of students as needed. Ultimately we hope to empower the teachers to lead practical lessons independently.

To maximise the use of our facilities throughout the year, we will also provide training during school holidays to teachers from beyond Lwengo District. We will introduce them to experiments and demonstrations which require minimal resources, but nevertheless help to bring a particular subject to life.

## Community involvement

We hope that TASTE will make an impact not just in the classroom, but also in the community.

In Uganda the secondary school year ends in December and the university year starts in late August. The eight month gap is designed so that students have time to earn money for tuition fees. TASTE will employ two students as lab assistants to provide them with useful scientific work experience during this time.

TASTE will organise science fairs at which students present experiments to their families and wider communities, providing a rare opportunity to develop presentation skills and allowing them to share their new experiences with others.

## Online experiment database

A great deal of effort will be put into planning inspirational, instructive but inexpensive experiments for students to perform. We want these experiments to be useful for science teachers in other less developed countries around the world. We will establish an online database (at [www.experibase.org](http://www.experibase.org)) with details of each experiment we offer. This will list the equipment and consumables needed and show a video of the experiment in action. We will provide the worksheets we use and offer advice to teachers on how to lead the experiment.

All this information will be released under Creative Commons licenses so that any teacher anywhere in the world can consider whether an experiment would work in their lab and use it, adapt it, or improve it and share it with others.



## Evaluation

We aim to continuously assess the work we will be doing in Uganda to ensure that we are making the biggest difference we can to the students, teachers and communities we work with.

During July and August of 2012, the trustees of TASTE UK conducted a research expedition in Uganda, together with colleagues from TASTE Uganda. We compiled a comprehensive list of the schools in Lwengo District (now available on our website) and assessed the current state of practical science teaching at each, as well as interviewing students on their view of science and experiments. This has allowed us to prioritise which schools we most need to visit, and it will also be a baseline level against which we can measure achievement.

Ongoing assessment will be an important part of the evaluation process. We will take regular surveys, not only of students, but of families and teachers too, focusing particularly on the areas listed above. TASTE staff will assist by monitoring students' performance during lessons, and their ability to think and engage as scientists.

A more quantitative analysis will be provided by exam results and the number of students continuing their study of scientific subjects into A-level education and university. These statistics can be compared to other areas of Uganda, which will act as control groups.

We will keep in contact with some of our students, and hope that they will provide case studies to demonstrate how TASTE has affected the lives of individuals.

## Management of the Charity

### TASTE in Uganda

TASTE is registered in Uganda as a Community Based Organisation (CD/LDLG/429).



#### **President - Amy Buchanan-Hughes**

Amy trained as a biochemist at the University of Cambridge. She travelled to Uganda in summer 2011 to teach science. It was there that she first entertained the idea of running a mobile laboratory, having seen firsthand the state of practical science education. She will return to Uganda in 2013 to implement and manage the project, as well as being the link between the UK and Uganda branches.



#### **Treasurer - Elizabeth Kyewalabye**

Elizabeth was the third woman in Uganda ever to qualify as a vet. She holds a PhD in parasitology and has extensive experience both of education and non-profit work. She became treasurer of TASTE Uganda in September 2011.



#### **Secretary - Ivan Bwowe**

Ivan is a law student at Makerere University in Kampala and has volunteered regularly for the Uganda Rural Fund, working to improve education in rural Uganda. He is passionate about promoting the development of Uganda.



#### **Assistant secretary - Obed Sensalo**

Obed grew up in Lwengo District and has worked as a biology and chemistry teacher in one of the village schools. He is invaluable for his knowledge of the winding tracks around the district.

## TASTE in the United Kingdom

TASTE is a registered charity in England and Wales (no. 1147251) where it undertakes fundraising and aims to build relationships between schools in the UK and Uganda. To make best use of our resources we have no employees in the UK. Instead a board of trustees volunteer their time to administer the UK side of the charity and raise funds.

**Amy Buchanan-Hughes** is also a trustee of the UK organisation and in this role is responsible for ensuring that the two sides of the organisation are constantly in communication with each other.

**Aaron Barker** is chief fundraiser and secretary. He has in the past been involved in running Cambridge Hands-On Science, a programme which tours schools in the UK in an effort to involve students with practical experience of science. He is now working towards a PhD in geology at the University of Aberdeen.

**Theo Sanderson** manages TASTE's online presence, including the database of experiments, and deals with other logistical issues. He is an enthusiastic scientist and currently works as a researcher at the Wellcome Trust Sanger Institute.

**Lina Munro** is the newest addition to the team. She recently completed an 11 month internship in the UK Civil Service. Lina developed a passion for inspiring the next generation with science as a STEM (Science, Technology, Engineering and Maths) ambassador during a Physics Education placement, while she was reading for her degree in Physics and Experimental Psychology.

## Budget

A detailed budget for the running of the van for the first four years is available on request. A summary of the projected costs for the first four years of operations is shown below.

	2012	2013	2014	2015	2016
Equipment & Chemicals	£2,880	£1,638	£1,638	£1,638	£1,638
Vehicle & Fuel	£10,000	£2,860	£2,860	£2,860	£2,860
Headquarters	£34,581	£1,500	£0	£0	£0
Office Expenses	£100	£2,021	£1,721	£1,721	£1,721
Salaries	£0	£5,870	£5,870	£5,870	£5,870
Monitoring & Evaluation	£3,600	£1,200	£1,200	£1,200	£1,200
Fees	£160	£255	£255	£255	£255
Upkeep	£0	£3,070	£3,070	£3,070	£3,070
<i>Subtotal</i>	<i>£51,321</i>	<i>£18,414</i>	<i>£16,338</i>	<i>£16,338</i>	<i>£16,338</i>
				<b>Grand Total</b>	<b>£119,577</b>

Based on our expectation of reaching 3,000 students with the lab, starting from January 2013, this budget gives an overall cost of less than £10 per student per year for 9 experiments. This sum actually goes much further than one student, since it also allows us to provide teacher training during school holidays.

In addition to financial donations we would be grateful to receive in-kind donations of microscopes or electronic equipment, including laptops and projectors.

## Summary

TASTE will unlock the potential of a generation of students in Lwengo District, allowing them to gain the skills and qualifications needed for employment in medicine, engineering, industry and scientific research. More than 3,000 students will get a chance to experience scientific experiments from the mobile teaching laboratory at least three times per term. It will cost us less than £10 per student per year to provide this service. Hundreds of teachers in other areas of Uganda will get access to teacher training, and through them the programme will benefit thousands more students. These scientifically literate and analytically skilled young people will provide a foundation for Uganda's continuing development.

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## Contact Details

Website [www.tasteforscience.org](http://www.tasteforscience.org)

Email address [info@tasteforscience.org](mailto:info@tasteforscience.org)

Telephone number +44 (0) 7861 464 201

Mailing Address  
**TASTE UK**  
71 Margravine Gardens  
London  
W6 8RN