

Why CYBER LABS can never replace traditional practicals

In the final story of our four-part series exposing issues about school laboratories, Gloria Nakajubi explores the effectiveness of cyber labs as alternative to hazardous chemicals used in science experiments

A big ray of light is projected on the wall. A student, with the guidance of a teacher, shows the rest of the class the results of chemical combinations. But different from the usual traditional laboratory, the practicals here are being handled using cyber technology – a computer, projector and software.

It is e-learning, where the syllabus for all students' practicals are just fed into a computer and at the click of a button, the chemical combinations or any other practical is relayed on the wall.

A cyber laboratory is an e-learning model, which according to proponents, is making learners understand and conceptualise the different subjects in a simple and visualised manner.

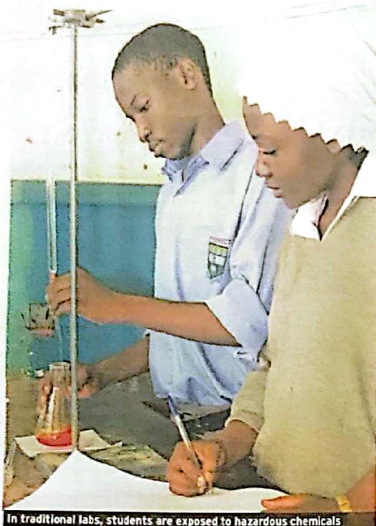
Unlike traditional laboratories, no chemicals are used in cyber labs. In a series of stories which started last month, *Mwalimu* has exposed the risks and massive costs which underlie traditional school laboratories. But, as a solution, the education ministry started cyber laboratories in schools since 2012.

The sh361b project financed through the Rural Communications Agency covered about 800 of the 1,200 government-aided secondary schools. Under the project, the education ministry has distributed 40 custom-made computers to the beneficiary schools, creating virtual learning centres.

This was premised on the fact that most schools, especially in rural areas, have failed to attract or maintain science teachers. But also, as seen from the national examinations results, sciences remain a challenge many learners.

However, the initiative has generated a mixed reaction from schools. Some praise it as a good innovation that has eased the teaching of practicals. Others have dismissed it as perpetuating theoretical learning and is likely to widen the performance gap between urban and rural schools that do not have electricity for cyber labs.

In defence of cyber labs
While constructing and equipping a conventional science laboratory



In traditional labs, students are exposed to hazardous chemicals

costs around sh150m, cyber labs will be cheaper in the long run since no chemicals are involved. They have also been found to be safer than traditional laboratories.

According to the director of the fund, Nyombi Thembo, the argument as presented by the education ministry was that with the limited science teachers, especially for rural schools, we need cyber labs.

The education ministry's Patrick Munda, who is also the co-ordinator of the project, explained that with this

software, schools will not only have to spend less on the usually costly science chemicals, but also reduce on the "pollution that comes with poor waste disposal."

Installation, according to Nyombi, costs about \$6,000 (about sh21.5m) per school, the software is aligned to the national curriculum and uses both 2D and 3D animations and quizzes to explain the otherwise complex topics.

"Other than doing the real practicals with chemicals three times a term, you can have students practice several

The Law Chemical use restricted

Though the responsible stakeholders seem unaware or are incapacitated, there is already legislation to this effect.

The Public Health Act, 2000 provides for prevention of diseases to the public arising from sewage, poor sanitation and pollution of the environment. It regulates the use of chemicals for public health and sets up the health inspectorate to ensure compliance.

"Section 105 of the Public Health Act imposes a duty on the local authority to take measures to prevent any pollution dangerous to health of any water supply which the public has a right to use for drinking or domestic purposes."

The National Environment Act, cap 153, also prohibits the discharge of hazardous substances into any part of the environment except with the guidelines of the National Environment Management Authority.

times on the computer and then do at least two practicals in the traditional laboratory. That is cost-effective," Nyambi argues.

Jasper Ogwang of St. Edwards Bukumi, one of the science teachers with about 30 years' teaching experience, says: "These cyber laboratories are safe. Students do not need strict monitoring during practicals because they are no hazardous. More so, you do not have wastes to treat before disposal." Bukumi is one of the cyber lab beneficiary schools.

The wastes of traditional laboratories, if not treated and disposed in the environment, can easily cause heart, kidney and cancer ailments.

Ogwang says: "In traditional laboratories, chemicals can expire. The gadgets (in cyber labs), if well-used, can last for decades."

He also notes that teaching in a cyber lab encourages students to study sciences. "Students easily understand what you are teaching and they enjoy these kinds of practicals."

Another beneficiary school is

Makerere College School, where the headteacher, Maria Muringu, says: "The laboratories have made the teaching of sciences cheaper. You are never worried that you will find out of chemicals."

He notes that just as these cyber laboratories cannot fully replace the traditional laboratories, they are of great value to the teaching of sciences.

A student at Makerere College, Alice Ankanda, says: "We now find sciences easier to do than ever before, thanks to the cyber laboratories."

The same view is expressed by John Baptist Mugume, a student at Uganda Martyrs SS in Kibale. "I partly did sciences at Alevel because of these laboratories. It is a good initiative, much as it can never replace the traditional laboratories and more science teachers."

Andrew Epila, the head of science department at Dr. Ohono College in Lira district, described the software as "the assistant science teacher."

Demerits
Other teachers have, however, punched holes in cyber labs, but only as a scheme likely to further inequality but also that their consent is irrelevant.

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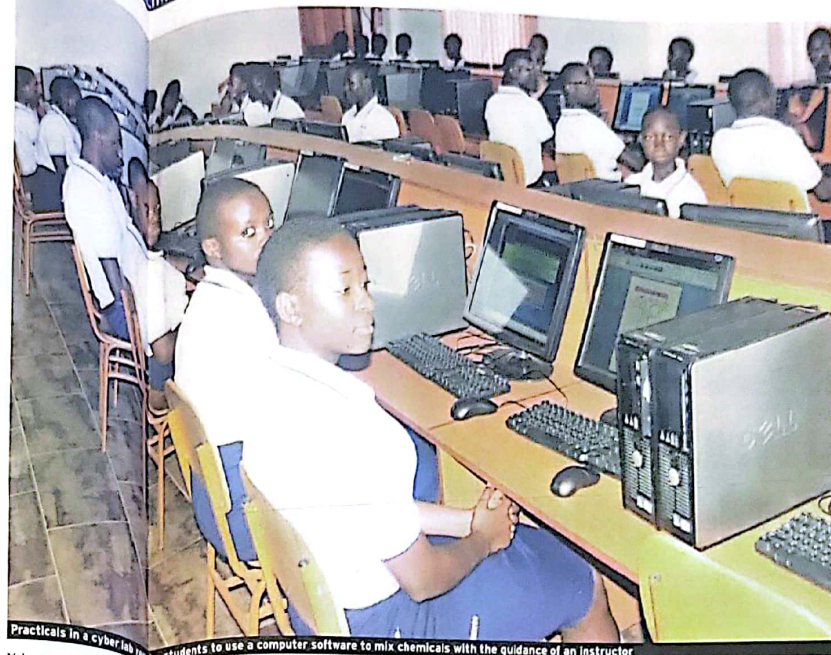
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Practicals in a cyber lab where students use a computer software to mix chemicals with the guidance of an instructor



Teachers in cyber labs use a projector to display the lesson on the screen for students instead of physically mixing the chemicals

Constantine Mpuuga, the headteacher of Namliyango College and a science teacher, says: "At times, you would find topics on the cyber technology syllabus, which is not tailored to our syllabus. This complicates learning. It was a good project, but needed upgrading."

Mpuuga explains: "He adds that the cyber labs are between the practical traditional laboratories and the theoretical syllabus."

He says much as these cyber labs are cheaper, can allow more practicals and are convenient, "the traditional laboratories are the best."

"A student needs to have a real feel of the apparatus and mixing of the chemicals. The laboratory, in which apparatus is more important than the one on the computer."

For this reason, some teachers say there is need to develop traditional laboratories first, before the Government can invest in such technologies.

Ahmed Kijambu, the dean of studies at Kibuli Secondary School,

one of the beneficiary schools, says: "When you go out of school, you will be expected to mix the different chemicals and come up with a product. You cannot just click all the time."

Another headteacher in Mubende district, on condition of anonymity, says, such laboratories are meant for first class schools.

"Just imagine you are in the village, no electricity and your students have never seen a real traditional laboratory. How is this cyber laboratory going to help your students pass examinations and face the work issues in future?" he wonders.

He says in his area, at times power goes off for a fortnight. Some of these projects are good, but may be serving the interests of few individuals, he observes.

The education ministry's 2016 annual sector review report shows that there is a shortage of over 4,000 science teachers. The teachers, studies show, are available, but the ministry has no wage bill to recruit more teachers.

2012
The year Ministry of Education started cyber labs in schools

800
The number of government-aided schools in which the cyber labs were piloted

Sh361b
The amount of money the ministry used to set up the cyber labs

Sh21.5m
The amount of money needed to install a cyber lab

In the medium term, the education ministry is requesting for an additional wage budget of sh18b to recruit at least 2,000 science teachers at an entry level of sh750,000 per term to address the crisis of inadequate science teachers in a phased manner.

Apart from inadequate teachers, with the looming danger of the poor disposal of chemical, not forgetting the cost implication of procuring reagents and laboratory equipment, cyber labs seem to come in handy.

Proper waste disposal

With cyber labs not eliminating chemical use in science practicals, the best option is to manage the proper disposal of chemical wastes. Since cyber labs are only in 20% of the over 4,000 secondary schools (government and private), it means a lot of chemical wastes still end up in the environment.

Moses Mugulire, an A'level science teacher at Jinja Secondary School suggests that the Government needs to come up with a system that schools must follow to dispose of waste in an appropriate manner, which is currently non-existent.

"These should be clearly spelt out guidelines and a prerequisite for opening up a school. A chemical waste disposal system should be one of the benchmarks for licensing a school," he said.

Mugulire recommends that since some of this waste is too complex to dispose of locally, the Government should have a recycling system for all chemicals that have not been used in schools.

This can either be taken back to the manufacturer or a well-established facility.

Environment protection How lab chemicals should be disposed of

Maria Mukeba Otaremwa, the managing director of Swift Waste Masters, argues that all chemical waste requires specialised handling and disposal.

She says all agencies that generate hazardous waste, as a requirement, should be issued with a destruction certificate confirming they disposed of their waste in a proper manner.

"I doubt whether schools are doing this because all chemical waste that goes to soak pits must first be treated," says Otaremwa.

"I think lack of proper chemical waste disposal is why we have all these strange diseases such as cancer on the rise. Such waste should first be treated before disposal. But may be we are waiting for disaster," she added.

Some schools, she says, because of the big chunks of land they own, opt to just dispose of waste into the environment, disregarding the environmental and human implication.

"Hazardous waste is supposed to be treated from plants in gazetted places devoid of human settlement. This should not be happening in schools," she warned.

All laboratories that use chemicals inevitably produce chemical waste that must be properly disposed of. It is crucial to minimise both the toxicity and the amount of chemical waste that is generated.

Here are the tips on how to achieve this the next experiment.

- Purchase chemicals in the smallest quantity needed.
- Use safer chemical substitutes such as chemicals which have been determined to be less harmful or toxic.
- Use microscale experiments.
- Chemical experiments using smaller quantities of chemicals.
- Recycle chemicals by performing cyclic experiments where one product of a reaction becomes the starting material of the next experiment.
- Consider detoxification or waste neutralisation steps.
- Use interactive teaching software and demonstration videos in lieu of experiments that generate large amounts of chemical waste.
- Perform classroom demonstrations.
- Use pre-weighed or premeasured chemical packets such as chemocapsules that reduce bulk chemical disposal problems (no excess chemicals re-main).

Proper disposal of chemical waste

The EPA has written a comprehensive set of regulations that govern the management of hazardous waste from the point of generation to ultimate disposal.

Generators of hazardous waste are responsible for ensuring proper disposal of their hazardous waste and can incur liability for improper disposal of their hazardous waste.

Disposal procedure

- Do not pour chemicals down the drain (unless authorised by local sewer authority).
- Do not treat hazardous waste onsite.
- Contact professional, licensed hazardous waste haulers/transporters that will ensure appropriate disposal.
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Source: School laboratory safety guide. (Centre for Diseases Control and Prevention)