EdQual
A Research Programme Consortium on Implementing Education Quality in Low Income Countries

Using ICT to Support Science and Mathematics Education in Rwanda

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Teacher education key to quality education with ICT

Research suggests investment in ICT in Rwandan schools will only impact on education quality if young people are allowed student-centred hands-on learning with ICT, and teacher professional development is key.

This EdQual's research project addressed the challenge of how to use Information Communication Technologies (ICTs) in schools to enhance teaching and learning, with a particular focus on science and mathematics in basic education. It centred around the implementation and evaluation of a collaborative professional development programme, working with more than 65 teachers for four years.

Equipment and connectivity in education

The Rwandan government has identified the use of ICTs as the key tool in transforming the economy, with education playing an important role in achieving this goal. There have been a range of initiatives for providing basic ICT infrastructure and computers in schools. Whereas schools in urban areas may have internet connectivity, only a small number of schools in rural areas are connected to the internet.

Collaborative professional development

Within the project, teachers were supported through a series of workshops and school visits by staff from the Kigali Institute of Education (KIE). The study found that the support provided by the annual workshops was key in enabling teachers to start to use the available technology for teaching science and mathematics. Without such support, teachers and administrators tend to protect scarce ICT resources from regular access by students.

The collaborative professional development model focused on teachers developing innovative classroom scenarios through active 'hands-on' experimentation with ICTs and reflection and discussion with other teachers. Video data was invaluable in both sharing practice and for analysing teaching and learning.

Out-of-school use of ICT impacts on learning in school

The study also found that many young people are using ICT out-of-school, mainly though access in internet cafés, and this impacts on learning in schools. However, girls and young people in rural communities are less likely to use internet cafés and this can disadvantage these groups of students.

EdQual RPC and education quality

The Use of ICTs in Basic Education project is part of the EdQual Research Programme Consortium. EdQual's research focuses on how to improve the quality of basic education. Education quality is key to attracting and retaining learners in basic education and ensuring education contributes to other areas of development.

Key Policy Messages

Teacher professional development networks should be promoted throughout Rwanda, building on the model developed in the EdQual ICT project and supporting teachers to:

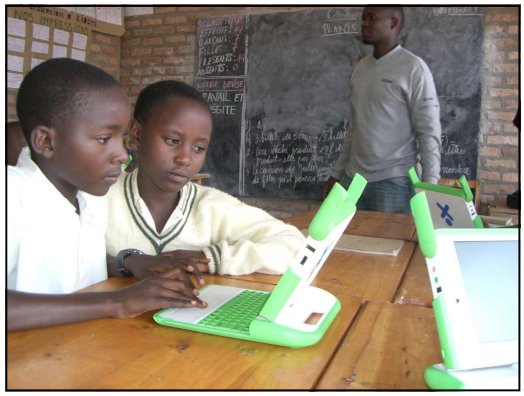
- **Allow student-centred learning with ICT.**
- **Exploit available technology, including mobile technology (e.g. "One laptop per child").**
- **Understand how out-of-school use of ICT impacts on learning in school and develop positive strategies to address this.**
- **Contribute to quality education by communicating innovative classroom practices.**

Research findings at a glance

- Provision of ICT in schools is only the first step towards its embedding in teaching and learning.
- Teachers' interpretation of the ICT curriculum and desire to protect scarce resources often leads to a teacher-led focus, with very little opportunity for hands-on learning.
- Project teachers rapidly became confident in using ICT to develop innovative classroom environments, with relatively small amounts of external support.
- Access to ICT out-of-school is mainly through internet cafés, where young people are able to gain hands-on experience of ICT.
- Unequal access to ICTs in the community could exacerbate gender differences as well as a rural and urban divide.

ICT, education and the Vision 2020 plan in Rwanda

The EdQual ICT project was grounded within the Rwandan national development vision that the country will achieve middle income status by 2020. The Vision 2020 plan centres around creating 'a prosperous knowledge-based economy' based on information and communication technologies, thus hoping to make Rwanda the ICT hub of Africa. ICT in education has emerged as one of the pillars of the country's National Information and Communications Infrastructure Policy and Plan. Moreover, cultivating the interest of students in science and technology is also emphasised (Republic of Rwanda 2006).



Given this background, the overall aim of the EdQual ICT project was to investigate the ways in which ICT can be used in schools in Rwanda to enhance teaching and learning (for more information see back page). Research questions included:

- How can ICT be used to support teachers and students in teaching and learning of mathematics and science?
- How can collaborative enquiry and intervention centred on the use of ICT in science and mathematics improve the quality of education in disadvantaged schools?
- What is the current status of ICT infrastructure and application in schools in Rwanda, especially in disadvantaged schools in both rural and urban settings?
- What level of ICT know-how exists in schools among teachers, learners and school administrators?
- Can the use of ICT narrow the gender divide and change attitudes towards the teaching and learning of mathematics and science?

ICT access and use in Rwandan schools

Equipment and connectivity

The baseline study carried out in 2006 found a huge variation in terms of the ICT equipment and infrastructure available in schools. Lack of connectivity in schools means the vast majority of teachers and students are not yet able to access the wealth of resources and digital tools available via the internet.

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In general, secondary schools were better equipped than primary schools, with the least equipped 'project' school having 11 functional computers in a population of more than 400 students, and the most equipped having 40 functional computers, in a population of more than 500 students.

By contrast, the least equipped primary school had two functional computers in a population of about 500 students and the most equipped had seven functional computers.

By 2007 most of the secondary schools in Rwanda had each been supplied with ten new computers from the government. These computers had basic Microsoft Office software and could handle graphics especially for computer simulations. In addition, individual schools are sometimes provided with computers by donors as a result of their own initiatives or by chance.

For a number of schools in Rwanda there is a lack of electricity to power computers. Whereas schools in the urban area of Kigali may have internet connectivity, only a small number of schools in the rest of the country were connected to the internet in 2009.

POLICY RECOMMENDATIONS

Young people need to have hands-on experience of using ICT in schools if they are to learn the knowledge, skills and capabilities that can contribute to the Rwandan economy.

Resource availability

During the field survey in 2007, data from the questionnaires administered to students showed that, whereas just over half (52%) of students had access to computers for a period of one hour per week, less than 30% of respondents had accessibility of up to 3 hours a week. This very low level of access to the available equipment suggests that schools and teachers are restricting students' access to computers, possibly because they are prioritizing the use of computers for administrative purposes.

Some schools were actually found to be restricting students' access to computers in order to 'protect' them:

"When the MOE supplied us with these computers they did not provide us with extra funds for maintenance. Now we spend a lot on repairs whenever they break down, we have to bring private technicians from town and they are very expensive. So we have to restrict student access to them, they only come to the lab when there is a teacher to supervise them."(Headteacher)

Research carried out in the NEPAD e-schools, which are well-equipped with computers, also found that administrators are relatively possessive of the NEPAD-supplied ICT equipment and restrict use by students (Were et al., 2010).

More recently, in 2008, with the introduction of ICT as a subject in the school curriculum, schools have had to provide students with more access to computers. Each class at secondary school level is allocated two hours a week on the school timetable for ICT lessons.

The ICT curriculum can constrain ICT teachers to 'teach theory' before allowing students hands-on engagement with the technology.

This has created a new tension between those teachers who use computers for teaching and learning ICT skills and those who want to use ICT for the teaching and learning of other subjects, such as mathematics and science. The latter group is increasingly finding it difficult to access the computers, since the use of ICT to teach other subjects is not yet seen as a priority, given the relatively scarce ICT resources in schools.

The limited access to computers and other ICT resources in schools is impacting on how students are using ICT, with students not being able to exercise control over technology and content. The ICT curriculum can constrain ICT teachers to 'teach theory' before allowing students hands-on engagement with the technology.

Out-of-school use of ICT and the impact on learning in schools

The availability of ICTs in the community, whether at home or in other public places such as internet cafés, has facilitated the out-of-school use of ICT among young people, especially in towns and cities in Rwanda. Through the baseline survey conducted in partner schools in 2006, it was found that young people are resourceful in accessing computers outside school, with 79% having used computers for various activities including reading about sports, sending and reading emails, reading news on the internet, listening to and searching for music, playing games, watching films, and looking for information concerning schoolwork. Asked where they access ICT, the vast majority (90%) of young people indicated that they access it in internet cafés.

However, there is also evidence to suggest that out-of-school use of ICT may exacerbate gender differences, as well as the rural and urban divide that already exists in Rwandan society. The majority of young people interviewed suggested that boys have better ICT skills than girls. Young people explained that boys learn these ICT skills in internet cafés, which they frequent more than girls:

Student: Boys usually do better on the computer, the practical part….
Interviewer: Where do boys learn this?
Student: Boys interact with other people or go to internet cafés, whereas girls are usually at home

This may further be understood in the context of Rwanda, where girls' movements outside the home are usually restricted; girls stay at home and take care of household chores, while boys are more likely to be free to spend time outside the home. It was also found that, whereas many students in the city are able to use a computer at home or in an internet café, rural students on the other hand may have no such privilege because their families cannot afford computers or there is no electricity supply in the area and there are no internet cafés in their neighbourhood (Rubagiza et al, forthcoming).

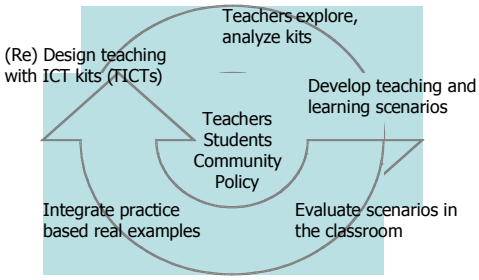
Young people who are able to use ICT out-of-school will be gaining hands-on experience which is being denied to the majority of students in school. However, this aspect of out-of-school ICT use is currently unrecognised in the design of school curricula and in the professional development of teachers.

POLICY RECOMMENDATIONS

- Policy makers and practitioners need to be aware that the ways in which young people use ICT out of school impacts on school learning.
- Unequal access to ICT out of school could be addressed through community centres set up to support disadvantaged groups to develop knowledge, skills and capabilities.

Collaborative professional development model

The research design was based on an evolutionary model for teachers' professional development. Within the annual workshops, teachers worked with the KIE team to develop learning scenarios for mathematics and science. The starting point for this development was what we have called "Teaching with ICT Kit" (TwIK).



The TwIK is built around a simple PowerPoint presentation that can be used by individual teachers or groups to illustrate the sort of applications and lessons which teachers have been trying out in project schools.

The TwIK consists of video extracts of lessons with supporting information and commentary, as well as details of software used and other resources. Using classroom video enabled teachers to see ICT being used in real Rwandan schools and encouraged them to try out similar activities for themselves.

The idea of the TwIK is an innovative approach to providing support for teacher professional development which might also be appropriate in other African contexts.

POLICY RECOMMENDATIONS

- ICT can be used to enhance the teaching and learning of mathematics and science.
- Professional development should involve teachers in working collaboratively and engaging with the realities of their practice. Teacher networks could be promoted throughout Rwanda, using digital video to share ideas in order to transform teaching and learning.

Importance of follow-up visits in schools

Follow-up visits in schools were also important in provoking teachers to start using ICT for teaching and learning:

"When we get training, we are shown how to do this and this; visiting us in schools makes us more conscious and more skillful. When you know that you are being visited, you say to yourself they will find me with nothing, so you are obliged to produce something. You will observe that teachers in non -visited schools have done nothing. If for example EdQual members do not have time to visit a school, they can organise teachers to visit others in their classes, because when you have visitors you do your best. And you can exchange ideas on how a lesson can be taught in the best way." (Teacher in project school)

Overall 65 teachers participated in the project, and just over half of them agreed that ICT has changed the way they teach. For example, teachers in partner schools said that the use of science simulations enhanced the teaching and learning of science. The use of ICT was also seen to enhance participatory approaches and creativity in the mathematics classroom (Uworwabayeho, 2009).

In general, students in schools that participated in the project were positive about the use of ICT:

It is better to use a computer because we see directly what we are studying. It can play the role of a laboratory (as in science), it gives information, shows things directly. For science topics with diagrams and illustrations, when the teacher uses Power Point, you see clearly.

With computers it is easier and faster to illustrate something, for example, graphs in mathematics are clearer when drawn using sketch pad or excel than when drawn on a chalkboard…the difference is that when a teacher draws on the chalkboard he might forget something but on the computer we see everything.

However, students were also able to be critical of the way in which ICT was being used:

The computer sometimes prevents me from doing the work the way I like and the way the teacher taught me using the blackboard. Also, it does not provide enough explanation.

About the Research

The project centred around a large-scale collaborative professional development programme with mathematics and science teachers which built on the InterActive Education project (Sutherland et al, 2008), research and development work in Chile (Moenne et al, 2004) and the EdQual review of literature (Were et al, forthcoming). The research project involved 12 schools across Rwanda, selected against criteria which emphasised factors such as social deprivation, but also included basic minimum levels of ICT and associated infrastructure. Three of the schools were primary schools and nine were secondary schools, including both rural and urban schools.

Teacher partners attended an annual workshop at the Kigali Institute of Education (KIE), and worked with a team from KIE in-between the workshops. During the workshops, teachers not only received training on using ICT in teaching and learning, but also spent time sharing experiences, learning from each other and reflecting on their classroom practice. Methods of data collection included classroom observations, video recordings of lessons, and focus-group interviews with learners and teachers separately. Two baseline studies were carried out in the partner schools in 2006 and 2007, with data collected through the use of questionnaires administered to school administrators, teachers and students.

The large-scale project was complemented by three additional research studies. The first relates to the PhD study of Jolly Rubagiza and is aimed at understanding the gendered experiences of teachers and learners through exploring their views and practices of teaching and learning with ICT. The second relates to the PhD study of Alphonse Uworwabayeho and is aimed at using collaborative action research to investigate mathematics teachers' practices in implementing learner centred pedagogy with ICT as a tool. The third relates to an evaluation of the NEPAD e-school Initiative in the Promotion of Community Health and Poverty Reduction in Kenya and Rwanda (Were et al., 2010)

Further research is needed to investigate the potential of "Teaching with ICT Kits" for a scaled-up model of professional development in Rwanda. Some funding has been received for this from the Alan and Nesta Furguson Charitable Trust.

This policy brief was written by Rosamund Sutherland with input from the Research Team, plus design/ editing input from Terra Sprague & Nina Marshall.

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Further Reading

www.edqual.org/research/ict

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EdQual is a consortium of six higher education institutions in the UK and Africa funded by the UK Department for International Development (DFID) to carry out a five year (2005-2010) programme of research on education quality mainly in low income countries, focusing on sub-Saharan Africa.

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