HEART
HEALTH & EDUCATION ADVICE & RESOURCE TEAM

Helpdesk Report: Learning gains from ICT use in education

Date: 22 April 2016

Query: Produce a report looking at the evidence that online education programmes/tools/apps lead to measurable gains in learning. Evidence should be on low- and middle-income countries. Level should focus on basic education.

Content

1. **Overview**
2. **Key papers**
3. **Further resources**
4. **Additional information**

1. Overview

Very little evidence that online programmes lead to measurable gains in low- and middle-income countries was identified within the scope of this review. Section 2: Key papers, includes stronger evidence. Section 3: Further resources, includes more grey literature or background on the topic.

The strongest evidence comes from a randomised control trial in Malawi. The research reports on a maths tablet intervention that shows significant effects when analysing pre- and post-test data (Pitchford, 2015). Another experiment reported in a journal looked at self-organised learning systems in India (Mitra & Dangwall, 2010). A public computer facility was used by village children with little or no access to school and achieved results comparable to those at state school. A USAID evaluation assessed an intervention where teachers were provided with tablets or pupils were provided with e-readers against a control (Piper & Kwayumba, 2014). Intervention groups scored significantly higher on key educational outcomes than the control.

Evaluations reported in grey literature include:
- Children watching educational videos on mobile phones in India had statistically significant improved learning for Science and English (Carlson & JBS International, 2013).
- Statistically significant post-test results were found following literacy learning games on mobile phones in other interventions in India (Carlson & JBS International, 2013; Spencer-Smith & Roberts, 2014).
- Higher Early Grade Reading Assessment (EGRA) and Early Grade Maths Assessment (EGMA) results are found compared to a control in Zambia where tablets are used for learning (Spencer-Smith & Roberts, 2014).
- A pilot where Sudanese children were using games on a tablet to learn maths were found to have positive results on learning post-test in a small-scale study (Radford, undated).

- Use of cell phones and digital technology in the Bridge*it* programme in Tanzania improved maths and science test scores compared to a control (Enge, 2011).
- Valk et al (2010) report improvement in post-test spelling scores were found for short messaging service (SMS) interventions in the Philippines, Mongolia, Thailand, Bangladesh and India.
- An online learning environment for science, OLabs, in India was found to improve learning (Nedungadi et al., 2013).

2. Key papers

Development of early mathematical skills with a tablet intervention: a randomized control trial in Malawi
Pitchford NJ (2015) Frontiers in psychology, 6.
http://journal.frontiersin.org/article/10.3389/fpsyg.2015.00485/full

This study reports a randomised control trial to evaluate the effectiveness of a tablet intervention for supporting the development of early mathematical skills in primary school children in Malawi. A total sample of 318 children, spanning Standards 1–3, attending a medium-sized urban primary school, were randomised to one of three groups: maths tablet intervention, non-maths tablet control, and standard face-to-face practice. Children were pre-tested using tablets at the start of the school year on two tests of mathematical knowledge and a range of basic skills related to scholastic progression. Class teachers then delivered the intervention over an 8-weeks period, for the equivalent of 30-min per day. Technical support was provided from the local Voluntary Service Overseas (VSO). Children were then post-tested on the same assessments as given at pre-test. A final sample of 283 children, from Standards 1–3, present at both pre- and post-test, was analysed to investigate the effectiveness of the maths tablet intervention. Significant effects of the maths tablet intervention over and above standard face-to-face practice or using tablets without the maths software were found in Standards 2 and 3. In Standard 3 the greater learning gains shown by the maths tablet intervention group compared to both of the control groups on the tablet-based assessments transferred to paper and pencil format, illustrating generalisation of knowledge gained. Thus, tablet technology can effectively support early years mathematical skills in developing countries if the software is carefully designed to engage the child in the learning process and the content is grounded in a solid well-constructed curriculum appropriate for the child's developmental stage.

Limits to self-organising systems of learning—the Kalikuppam experiment
Mitra S, & Dangwal R. (2010). British Journal of Educational Technology, 41(5), 672-688.
http://www.hole-in-the-wall.com/docs/paper13.pdf

What and how much can children learn without subject teachers? In an attempt to find a limit to self-organised learning, the authors explored the capacity of 10–14 year old Tamil-speaking children in a remote Indian village to learn basic molecular biology, initially on their own with a Hole-in-the-Wall public computer facility, and later with the help of a mediator without knowledge of this subject. They then compared these learning outcomes with those of similarly-aged children at a nearby average-below average performing state government school who were not fluent in English but were taught this subject and another group of children at a high-performing private school in New Delhi who were fluent in English and had been taught this subject by qualified teachers. The authors found that the village children who only had access to computers and Internet-based resources in the Hole-in-the-Wall learning stations achieved test scores comparable with those at the local state school and, with the support of the mediator, equal to their peers in the privileged private urban school. Further experiments were conducted with unsupervised groups of 8–12 year-olds in several English schools using the Internet to study for GCSE questions they normally would be examined on

at the age of 16. They conclude that, in spite of some limitations, there are opportunities for self-organised and mediated learning by children in settings where they would otherwise be denied opportunities for good, or indeed any, schooling. They also show that this approach can be enhanced by the use of local or online mediators.

USAID/Kenya Primary Math and Reading (PRIMR) Initiative: Kisumu Information and Communication Technology (ICT) Intervention. Endline Report.
Piper B & Kwayumba D (2014) Research Triangle Institute (RTI), USA
https://www.eddataglobal.org/documents/index.cfm/FR_Kenya%20PRIMR%20ICT%20Endline_081914_Final_DEC.pdf?fuseaction=throwpub&ID=664

This study assessed three interventions against a control:
1) **PRIMR + TAC tutor tablet.** Teachers' Advisory Centre (TAC) tutors were provided with a tablet that contained educational materials on efficient and effective teacher support. This also included PRIMR materials for the TAC tutors.
2) **PRIMR + teacher tablet.** Teachers were provided with a tablet to supplement their PRIMR instruction. The tablet contained multimedia lesson plans; supplementary pedagogical aids, including letter flashcards and the Papaya application, which had audio capabilities to practice letter sounds; and the Tangerine:Class application, which contained various pupil assessments.
3) **PRIMR + pupil e-readers.** E -readers were provided to pupils and teachers. They contained the PRIMR reading textbooks in English and Kiswahili, relevant textbooks from Kenyan publishers, and hundreds of age-appropriate stories related to the Kenyan curriculum including English and Kiswahili dictionaries.

Pupils in all three treatment groups scored significantly higher statistically on key outcomes compared to pupils in the control group. The effect size for e-readers, the teacher tablets, and the TAC tutor tablets was .35 standard deviations (SD), .47 SD, and .44 SD, respectively. Though all three treatment groups showed large impacts on achievement, there were no statistically significant differences in the magnitude of the impact between the three treatment groups. This is notable given that the TAC tutor group is very similar in practice to the non-ICT base PRIMR program.

Using technology to deliver educational services to children and youth in environments affected by crisis and/or conflict
Carlson S & JBS International (2013) USAID
https://www.usaid.gov/sites/default/files/documents/2155/ICTs%20in%20Conflict%20Compendium%20FINAL.pdf

This document reports on two case studies from India.

The India BridgeIT programme had three components: hardware, software, and training/support. The hardware is a Nokia mobile phone with TV-out port, a pre-paid SIM card, TV-out cable, TV monitor or LCD projector, and cloud-hosted Nokia Education Delivery (NED) server. NED is free, open-source software. The content is a curriculum-based catalogue of approximately 400 educational videos, 90-100 videos for each grade and subject. Evaluation found the programme had a strong, positive, and statistically significant effect on student learning for both Science and English. (For more information see: http://www.educationinnovations.org/sites/default/files/BridgeIT%20India%20Endline%20Report%202011-12.pdf)

In another programme, literacy learning games were developed for Andhra Pradesh aligned with the state curriculum for fifth grade English, and carefully adapted to the culture and learning styles of rural children. Learning content targeted phonetics, letters, oral vocabulary

knowledge, and word reading, considered as "literacy sub-skills." First, for each sub-skill (e.g., vocabulary, letter-sound correspondences), a series of screens were designed to familiarise the learner with that sub-skill. For example, the screens sequentially explain word meanings using pictures and explanations in the native language, then display letters and words that contain these graphemes while playing voiceovers of these words. Second, for each sub-skill, one or more games were designed in which the player had to rely on their mastery of the given sub-skill in order to win the game level, after which a "congratulations" screen would be displayed. The screens and games were sequenced, based on when the sub-skills were expected to be learning during the academic year. Thirdly, revision modules were designed, so as to reinforce and consolidate knowledge of English literacy after the games.

Students were found to have achieved statistically significant post-test gains on spelling skills.

Landscape Review. Mobile Education for Numeracy. Evidence from interventions in low-income countries
Spencer-Smith G & Roberts N (2014) GIZ
http://www.meducationalliance.org/sites/default/files/giz_landscape_review_long_version_final_1.pdf

There are a number of case studies in this review. Three are summarised below:

The **Play 'n Learn** project in India used mobile phone games aiming to improve learning outcomes. A monitoring and evaluation study applied a pre- and post-intervention design using control and intervention groups. The quantitative learning outcomes were not impacted through the tablet but there have been qualitative improvements in the classroom environment and children's learning experience. Children enjoy the games thoroughly and look forward to the tablet sessions as has been consistently seen during this assessment study (resulting in improved school attendance). The tablet sessions were conducted through the group work method, which is a welcome change for the children from the normal chalk-and-blackboard method of learning. It also makes learning colourful and attractive to them with the use of characters and audio and video elements. The intervention has also built the capacities of the teachers. Some unique learnings include how to integrate digital based learning in the classrooms, an improved understanding of using tablets, smartphones to access different types of content and in using multiple media to engage children in classrooms.

The **iSchool** project in Zambia uses tablet based cross curricular learning for the whole primary age range with lesson plans and learning content for the children that is developmental and structured. E-learning content is multi-media interactive and localised across the entire Zambian primary school curriculum. The programme is monitored twice a year using EGRA. Impact findings show iSchool students are outperforming control students in four (number identification; quantity discrimination; addition; subtraction) of the six math skills identified by USAID and measured by the EGMA tool. iSchool management have noted a number of positive spin-offs from their intervention: teachers now understand what they should be teaching, often for the first time; they are in school more as the lessons are planned for them and they just need to deliver them; they are better able to deal with the large class sizes as the lesson plans split the children into three groups; they are developing their professional skills and are excited by the impact that this is having on their classroom practice; and they are proud of their achievements and consequently keen to continue improving. Similarly, the iSchool management has noted that learner engagement is very high, and therefore attendance at school is almost 100%; and the learners find the lessons are more enjoyable and consequently teachers no longer need to resort to shouting and violence to control the learners.

Unlocking talent in Malawi uses digital educational technology (DET) – the Masamu tablet – which has been loaded with Ministry of Education Science and Technology curriculum-aligned content. For the pilot, this content was used for 30 minutes daily for 8 weeks. Evaluation showed that a tablet-based intervention, delivered over an 8 week period for 30 minutes per day, significantly improved mathematical ability compared to normal classroom practice. Children using the Masamu tablet tripled their specific mathematics curriculum knowledge, with Standard 2 children raising attainment levels to a higher level than the average shown by Standard 4 children with normal pedagogical practice. The Unlocking Talent intervention was just as effective at supporting the development of mathematical skills in girls as it is for boys. The intervention was effective in raising mathematical standards even in low achievers. Over the 8 week intervention period, 78% of low achievers who received the Masamu tablet improved their Maths ability to a level typical for their standard, whereas only 17% of children who received normal tuition raised their mathematics attainment to within the normal range.

School-based professional development in a developing context: lessons learnt from a case study in Zambia
Haßler B, Hennessy S, Cross A, Chileshe E, & Machiko B (2015) Professional development in education, 41(5), 806-825.
http://www.tandfonline.com/doi/abs/10.1080/19415257.2014.938355?journalCode=rjie20

This paper reports on the development and outcomes of the second phase of OER4Schools, a school-based professional development programme supporting interactive forms of subject teaching in conjunction with Open Educational Resources (OER) and technology in Zambian primary schools. Worked with partners the needs of school-based continuing professional development adapted to the local context were identified; the programme was based on participatory, collaborative and inquiry-based pedagogies for both classroom learning and teacher development. Over a one-year period with four experienced teachers were worked with in two basic (primary) schools serving disadvantaged communities. Data were collected from observations, interviews, surveys, lesson planning/review meetings and team workshops. All participants integrated OER and technology into mathematics and science lessons and developed more interactive practices, including collaborative learning. Professional dialogue, quality conversations, reflective practice, cultural sensitivity, peer learning and cooperation were pivotal mechanisms through which teachers shifted their focus from teaching (and teacher exposition) to student learning. Seeing students as capable individuals, teachers raised their expectations and developed insight into interactive practices such as group work, providing meaningful opportunities for student collaboration and active learning by all.

3. Further resources

Innovative e-learning: Learning mathematics in Sudan with an applied game
Radford K (undated) War Child Holland
https://www.warchildholland.org/sites/default/files/bijlagen/node_7209/16-2015/e-learning_sudan_english_15-06-15.pdf

Six hundred Sudanese children, without access to schools or teachers, are now learning mathematics. In the comfort of their own village. With an educational computer game, based on the Sudanese curriculum that they play on a tablet. The project is called e-Learning Sudan (eLS).

Small scale testing was carried out in an early stage pilot 2012-13. There were Sixty-six children (57% boys and 43% girls) in three remote villages, plus a control group of twenty

children. The results were remarkable and showed that all children have learned and greatly improved their mathematic skills. Also children with the lowest scores on the pre-test made the greatest progress.

Results from a larger trial are not yet published.

Elimu Kwa Teknolojia (A BridgeIT Program) Summative Evaluation Executive Summary
Enge K (2011) USAID
http://www.meducationalliance.org/sites/default/files/bridgeit_case_study_tanzania_program_evaluation.pdf

The International Youth Foundation (IYF) is implementing Bridge*it* in 17 districts in Tanzania. The goal of the Bridge*it* programme is to significantly increase the educational quality and achievement among students at primary school level in mathematics, science and life skills through the innovative use of cell phones and digital technology.

Test scores of students in BridgeIT and BridgeIT+Life Skills in both math and science showed significant gains during the 2010 academic year in comparison to test scores of students in the control school who did not benefit from BridgeIT. On average, test scores pf students in the control schools was in the range of 10-20 percentage points higher, representing very positive results.

Mobile Learning and Numeracy: Filling gaps and expanding opportunities for early grade learning
Strigel C & Pouezevara S (2012) GIZ
https://www.rti.org/pubs/mobilelearningnumeracy_rti_final_17dec12_edit.pdf

The present study on Mobile Learning and Numeracy examines how mobile learning (m-learning) could influence and improve numeracy education at early grade levels (ages 4-10) especially in low-income countries. Key questions to guide the research include: 1) What are the benefits and challenges of integrating mobile learning into early grade numeracy education? 2) What is the role of a teacher with regard to mobile learning and numeracy education? 3) How can the community and the parents actively contribute to/participate in the child's numeracy education with the use of mobile devices? and 4) How can mobile technology be used effectively in measuring/assessing numeracy gains?

Effectively describing the potential use of m-learning for early grade numeracy in developing countries requires untangling a web of knowledge, theory, and experience from the domains of math instruction, early childhood education, ICT for development, and mobile learning. There is no doubt, though, that the increasing levels of "access" to mobile phones even in the poorest and most rural communities acts as a powerful driver for mobile learning and offers a greater chance, although not without challenges, for longer term sustainability of interventions. Further, the authors review of research on early grade mathematics and developmental progressions of what children learn and how, and existing experiences from computer- and game-based approaches, has identified "pedagogical" drivers making a case for mobile learning for numeracy.

However, there is very little practical and rigorously evaluated experience to date in mobile learning for early grade numeracy in the developing world. Existing initiatives are more dominant in the higher grades and particularly in the US and Europe, with a focus on using tablets and smartphones and a variety of educational games and tools for reading and mathematics. However, contextual factors play such a strong role that the same program or software may yield significant effect sizes for mathematics achievement in one implementation, and no impact in the next. Furthermore, few initiatives to date maximise the

convergence of features provided for in smartphones and tablets for new pedagogies. There are also issues related to safety and privacy that need to be carefully considered, especially when working with very young children, but also adults. At the same time there are a few promising examples, even using most basic mobile phones, for teacher professional development, parental engagement and advocacy, and early mathematics diagnostics and student assessment. In addition, there are opportunities for new pedagogies made possible by the mobility of the devices, their multi-functionality integrating image, audio and video; or icon- and touch-based interfaces that warrant further exploration for learning.

Using Mobile Phones to Improve Educational Outcomes: An Analysis of Evidence from Asia
Valk J-H, Rashid AT, & Elder L (2010) The International Review of Research in Open and Distributed Learning, 11 (1)
http://www.irrodl.org/index.php/irrodl/article/view/794/1487

Despite improvements in educational indicators, such as enrolment, significant challenges remain with regard to the delivery of quality education in developing countries, particularly in rural and remote regions. In the attempt to find viable solutions to these challenges, much hope has been placed in new information and communication technologies (ICTs), mobile phones being one example. This article reviews the evidence of the role of mobile phone-facilitated mLearning in contributing to improved educational outcomes in the developing countries of Asia by exploring the results of six mLearning pilot projects. Projects in the Philippines, Mongolia, Thailand, and Bangladesh explored the use of SMS for distance learning for high-school or higher education level learning. A project in India explored the use of cellphone games for improving literacy in an after-school programme. Pre- and post-test assessment found a gain in spelling scores.

Improving Literacy in Developing Countries Using Speech Recognition-Supported Games on Mobile Devices
Kumar A, Reddy P, Tewari A, Agrawal R, & Kam M (2012) In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems
http://www.cs.cmu.edu/~anujk1/CHI2012b.pdf

Learning to read in a second language is challenging, but highly rewarding. For low-income children in developing countries, this task can be significantly more challenging because of lack of access to high-quality schooling, but can potentially improve economic prospects at the same time. A synthesis of research findings suggests that practicing recalling and vocalising words for expressing an intended meaning could improve word reading skills - including reading in a second language - more than silent recognition of what the given words mean. Unfortunately, many language learning software do not support this instructional approach, owing to the technical challenges of incorporating speech recognition support to check that the learner is vocalising the correct word. In this paper, the authors present results from a usability test and two subsequent experiments that explore the use of two speech recognition-enabled mobile games to help rural children in India read words with understanding. Through a working speech recognition prototype, two major contributions of this work are discussed: first,empirical evidence is given that shows the extent to which productive training (i.e. vocalising words) is superior to receptive vocabulary training, and discuss the use of scaffolding hints to "unpack" factors in the learner's linguistic knowledge that may impact reading. Second, what the results suggest for future research in HCI is discussed.

Enhanced STEM learning with Online Labs: Empirical study comparing physical labs, tablets and desktops

Nedungadi P, Raman R, McGregor M (2013) 2013 IEEE Frontiers in Education Conference (FIE) paper
https://www.computer.org/csdl/proceedings/fie/2013/9999/00/06685106.pdf

India's educational challenge includes a large school going population, shortage of science teachers and lack of science labs in many schools. To counter this challenge, the Online Labs (OLabs) pedagogy is designed as a complete learning environment with tutorials, theory, procedure, animations, videos and simulations while the assessment includes conceptual, experimental, procedural and reporting skills. The authors discuss two separate empirical studies using OLabs to study the performance gains, student attitudes and preferences while using physical labs, desktops and tablets. The first study was at a school that compared students who learnt individually with OLabs on desktops, to students who learnt with the traditional teacher led physical labs. The second study was at a science camp and compared OLabs on desktops to OLabs that were context adapted for android tablets. There were significant differences between the physical labs and the self-study mode using OLabs on desktops, but no significant differences between OLabs on desktops compared to OLabs on tablets.

Literacy Promotion through Mobile Phones
Miyazawa I (undated). The 13th UNESCO-APEID International Conference and
World Bank-KERIS High Level Seminar on ICT in Education presentation paper.
http://www.unesco.org.pk/education/documents/Project%20Brief%20Paper_ICT.pdf

This informal briefing paper reports on a pilot project. The project aimed to address the literacy retention problem among the youth and the problem of keeping them motivated to further consolidate their literacy skills. It found a solution in mobile phones, which have become the most desired daily means of communication among the young people.

Learners (semi-literate) were given mobile handsets to receive SMS messages in Urdu day and night. Learners enjoyed reading messages and copying these messages on their working books. They also created and sent messages for 4 months. As a result, their literacy skills were remarkably improved and they became more confident in themselves.

There is large potential in promoting literacy through ICT. People, especially youths are in nature motivated to be connected, communicate with and obtain information from others. ICT devices do facilitate them to be literate and get empowered. To make this happen at a large scale, the cooperation among private sectors, public sectors, NGOs and UN is essential.

4. Additional information

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