From eMpela to Project DROID

A review of two ICT4E initiatives in South Africa

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JET EDUCATION SERVICES

'We welcomed the formation of the Joint Education Trust in 1992 …
as a move inspired by patriotism and vision.'

Former President Nelson Mandela, addressing the Joint Education Trust Annual General Meeting in 1996.

JET Education Services (JET) is an independent non-governmental organisation founded in 1992 which works with government, the private sector, international development agencies and education institutions to improve the quality of education and the relationship between education, skills development and the world of work. JET's focus areas in the education sector are: education research and planning; monitoring and evaluation of education and training programmes; school and district improvement; and Technical and Vocational Education and Training (TVET) College improvement and youth livelihoods.

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Acronyms and abbreviations

AI	artificial intelligence
DBE	Department of Basic Education
DTPS	Department of Telecommunications and Postal Services
EFAL	English First Additional Language
ICT	information and communications technology
ICT4E	information and communications technology for education
JET	JET Education Services
MOOCs	massive open online courses
NSC	National Senior Certificate
OECD	Organisation for Economic Co-operation and Development
PIRLS	Progress in International Reading Literacy Study
SACMEQ	Southern African Consortium for the Measurement of Education Quality
SMMEs	small, medium and micro-enterprises
TOM	Tacit Object Modeller
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development

Introduction

In many respects, South Africa has led the charge in integrating information and communications technology (ICT) into education in sub-Saharan Africa. South Africa was one of the first African nations to develop a specific ICT in education policy, which is more conducive to developing an achievable implementation framework than referencing ICT in other education policies. South Africa was also among the first to formally integrate technology into its national curriculum (Wallet, 2015). As early as 2002, the Presidential Advisory Council on Information Society and Development identified education as one of three priority areas for developing ICTs, together with health and small, medium and micro-enterprises (SMMEs). One of the eventual results of this investment was the National Integrated ICT Policy White Paper, which developed the initial framework to support the National Development Plan in actualising the perceived role of ICTs in eliminating poverty and reducing inequality by 2030 (Republic of South Africa DTPS, 2016).

As a global community, we are faced with the stark reality that we are inevitably becoming technology-dependent societies as digital technologies create new opportunities and challenges for skills development globally, in both developed and developing contexts. This paper will discuss the successes, potential leverage points, challenges and lessons learnt by JET Education Services (JET) through its involvement in two specific initiatives: first, in response to well-documented challenges in South African basic education, JET has developed and implemented the eMpela teacher training platform, which shows great potential in improving teacher content knowledge and pedagogical capacity; and then second, an initiative, referred to as Project DROID, that involves testing of a new form of artificial intelligence (AI) in education, targeted towards improving the strategic skills and information resources available across education systems.

A brief review of ICT4E

> Information and communication technology (ICT) plays an ever-important role in increasing economic productivity through digital economies, enhancing the delivery of public and private services and achieving broad socio-economic goals in education, health care, employment and social development. (Wallet, 2015: 5)

There can be no doubt of the esteem in which ICT is held by both national and international policy makers. Since the invention of the radio, efforts have been made to harness technological innovation to improve access to, equity in and the quality of education available across the world. Witnessing the swiftness with which international economies and high-level enterprises move to embrace and apply technological innovation, education systems are forced to face a growing concern: Is traditional education sufficient to fulfil its purpose? It is clear that the demands placed on the populace for employment are changing. Yet mass education remains a relatively static system, with little having changed in classroom structure or delivery in the last two centuries. Although there have been intermittent and even successful attempts to move towards more exploratory and learner-centred processes (for an account, see Lemann, 1997) and recurring conversations about student-led classrooms, educational reform, home schooling and, more recently, 'unschooling' (Rolstad and Kesson, 2013), there is a persistent reoccurrence of and reliance on what is commonly referred to as 'the traditional model of education'. This model is undeniably top-down, with a student being given directives and following them. Linda Darling-Hammond (2010) interrogates this approach in the context of the changing labour market, pointing out that the low-skill jobs this approach prepares learners for have largely been subsumed and advocating a need for classrooms to shift focus to the higher-skill jobs which permeate current job markets in the developed world. It is not surprising, then, that education as a system has also been pushed to embrace technology, both as a necessary skill for emerging economies and as a catalyst for improved instruction.

While school administration is an important component of the enabling environment for technology use to be effective, the classroom technology component is arguably the most emphasised. The classroom is at the crux of education, and ultimately, for many learners, it is within this space that skills related to the social, economic and political participation of South African citizens will be instilled. Classroom technology interventions generally have a focus on teachers, learners and/or resourcing and can be applied in various ways to the elements of a 'traditional' classroom learning cycle of teacher – content delivery – learner – assessment.

In some information and communications technology for education (ICT4E) interventions, the teacher is either replaced or subsumed by technology. This is the most flexible of approaches and, in terms of teacher-centred applications of technology, it can be used in one of two ways: first, in the complete absence of an instructor, either to augment or act in place of a teacher; and second, by a teacher as part or all of a lesson. In either case, the role of the teacher is subsumed, either partially or completely, by the technology, which delivers the content. Therefore, learners themselves are interacting with technology as well in some capacity. In this use, the curriculum is still developed and determined externally to the closed system of the classroom and teacher–learner–technology triangle, and the content delivered will be linked to a specific programme with measurable outputs. Evaluation, in this instance, may not be specifically linked to technology and rather be based on the content delivered through the medium. Examples of this type of classroom technology intervention would be interactive home school curricula or massive open online courses (MOOCs) such as those provided by Coursera and similar initiatives. Teacher replacement technology is also prevalent in ICT-based interventions designed for conflict or refugee situations, in which a teacher is unlikely to be available consistently to teach.

Impact in the education space is most frequently measured at the learner level as the intended, ultimate change envisaged by most educational interventions is improved learning outcomes at the learner level. However, it can be difficult to draw concrete conclusions from the literature surrounding ICT in education. A number of rigorous studies, including meta-analyses, have found negative results.

- An analysis by Higgins, Xiao and Katsipataki (2012) indicated that technology-based interventions showed lower levels of attainment than other interventions and were best applied as short-term, targeted, remedial interventions.
- Wainer et al (2008) studied technology in education in a developing country context and found that results showed only a small overall association between technology and attainment.
- Vogel et al (2006) determined that enthusiasm for games-based education was underlined by a lack of evidence of educational gains.
- The OECD (2015) concluded that learners who use computers more than six hours a day outside of school are more likely to feel isolated and have poor attendance at school.
- A number of studies (Meng and Li, 2001; Shih, Kraemer and Dedrick, 2008) show that ICT investments improve macroeconomic productivity growth in developed countries, but not in developing countries.
- Krcmar, Grela and Lin (2007) showed that 'screen time' is not the most effective method of instruction by demonstrating the video deficit or the greater propensity of children to learn from real-life counterparts than from television, although whether this deficit extends to more interactive technology (such as instructional games on tablets) remains unclear.

On the other side, there are a number of researchers and educationalists who elucidate the benefits of technology in education:

- Early research into technology in education showed mainly positive results (see for example Kulik, 1994; Schacter, 1999).
- A meta-analysis by WestEd (2002) indicated that technology can effectively teach 'basic skills' and improve test scores. Success factors implicated in WestEd's research included adequate teacher training, reliance on multiple platforms in addition to technology and integration with the curriculum.
- Pro-ICT educationalists also cite improvement in 'intermediary goals' such as communication between schools and parents, learner engagement and attendance (see, for example, Grinager, 2006).
- A number of educational interventions have been shown to have positive results, for example, the Bridges to the Future Initiative SA2 which showed significant improvements in early literacy skills of Grade 2 and 3 Northern Sotho-speaking learners after a technology-based literacy intervention (Shiohira, 2017).
- The OECD (2015) concluded that students who use computers 'moderately' or for less than two hours a day on average had better results than those who 'rarely' used computers. But those who used computers 'very frequently' had the lowest outcomes, even when controlling for demographics and social factors.
- Ham et al (2002) found that use of ICT in education increased the range of skills practised by learners, improved the technical ability of learners, increased cognitive difficulty of tasks and creative ability demonstrated by learners and improved student collaboration.
- Piper et al (2017) conducted a study on the implementation of the National Tablets Program in Kenya to establish the effects of this large-scale education technology intervention. The study examined whether the programme led to increased classroom observations by coaches and improved student learning outcomes. The findings were encouraging and demonstrated both increased accountability and improvements in learning outcomes.

Initiative 1: eMpela

> eMpela has been proven to efficiently improve teacher content knowledge and teaching confidence by up to 30% in only one year, at a lower cost per teacher than a return ticket to Cape Town (JET internal monitoring results for the period 2016–2017).[1] (JET, 2017)

In South Africa, there is a particular need for improvement in learner achievement in the subjects of Mathematics, English First Additional Language (EFAL) and Science. In spite of the importance of Mathematics and Science as subjects, both for a country's economic and broader social development and an individual citizen's employment opportunities, Mathematics is the most problematic subject for learners: according to Umalusi, the Quality Council for General and Further Education and Training which oversees the National Senior Certificate (NSC) school leaving examinations, in 2015, 80% of learners performed at less than 50% after pass adjustments, and one-third of learners performed at below 20%. Physical Science is also one of the subjects learners find most difficult to pass, with over 40% of learners attempting the subject unable to attain 30%.

Over 25 years of educational experience, JET has come to understand that teachers are the gate-keepers of educational attainment. According to the 1996 report of the National Commission on Teaching and America's Future, the most important influential factor on what students learn is teacher knowledge and application of knowledge. International research confirms that effective teachers are the most important factor in student learning outcomes (Hanushek and

1 An external evaluation of eMpela is planned.

Rivkin, 2006; Sanders and Rivers, 1996). Furthermore, that high teacher quality results in better learning outcomes has been proven by both economic modelling and experimental and quasi-experimental research. Over the past three decades, this research has shown that above and beyond easily-observed characteristics such as age, gender, education and years of teaching, it is teacher content knowledge that influences learning outcomes. This all raises the question: can teachers themselves confidently and capably perform at or above what is expected of learners?

Recent research using Southern African Consortium for the Measurement of Education Quality (SACMEQ) data suggests that in sub-Saharan Africa, the answer is a resounding no (Piopiunik, Bietenbeck and Wiederhold, 2016). It has been found that, on average, teacher content knowledge in four sub-Saharan countries was below that of eighth grade learners in developed countries. The reasons for the low performance of teachers are numerous and varied, but, particularly in the context of Mathematics and Science, it has to do with labour market incentives operating primarily through wages that offer differential rewards to individuals based on the job/career they choose. An individual with high capacity in Mathematics and Science can attain a much more lucrative career than teaching, which leaves the instruction of these two subjects in the hands of the occasional philanthropist and, more generally, those with lower capacity.

To address these problems, JET, in collaboration with the MRP Foundation, developed an innovative ICT-based approach to the teaching and learning of Mathematics, EFAL and Science, referred to as *eMpela*.[2] eMpela is a blended e-learning programme that seeks to support teacher development by providing weekly e-tutorials aligned to the national curriculum without the need for the teacher to lose any teaching time. Teachers' progress is tracked and monitored in order to give feedback, encouragement and support. The theory is that if the results were to indicate that the teachers were benefiting from the curriculum and pedagogic content within the e-tutorials, there could be a direct impact on the teachers' classroom practice, leading to a change in teacher self-efficacy.

eMpela uses a systemic, blended learning methodology where teachers and managers receive content training which is accessible online, using mobile phones, tablets and computers. This online content is augmented by ongoing remote support through WhatsApp, SMS and other such platforms as well as in-person, quarterly training sessions facilitated by a programme manager and specialists. Training topics are based on areas of low performance across participants, who are tracked while they use eMpela. The programme so far covers teaching of: EFAL and Maths for Foundation Phase (Grades 1 to 3); Maths for Grades 4, 6, 9 and 11; Natural Science for Grades 6 and 9; and Physical Science for Grade 11.

Monitoring results show improvement in all areas of study, with, in most cases, dramatic improvement. On average, participants improved overall by 16% per quarter and the results clearly show that the teachers are improving their content knowledge each term, as indicated by the improvement in their termly pre-assessment and post-assessment scores for both 2016 and 2017 (Gibbs, 2017).

Besides the programme's proven efficacy, there are several key benefits to a blended learning methodology, including:

- Cost-effectiveness: The model reduces personnel and material development costs and is therefore more efficient than a face-to-face tuition model. Using the platform, it is possible to have facilitator ratios of up to one facilitator per 80 participants in the blended learning programme, at a lower overall programme cost per participant.
- Increased scope: Due to both reduced costs per participant and the mobility of the delivery model, the maximum number of individuals can be trained and supported, leading to increased benefits across the districts involved.
- Scalability: The fully developed platform and delivery model can be replicated across provinces without the expense of re-development in each area.
- Continuity: As the programme engages learners and their teachers, the knowledge gained by learners during the programme can be supported by the increased capacity of their teachers in the classroom, and there will be no disjuncture between information gained in the programme and information taught in the classroom.
- Holistic support: Through the engagement and strengthening of school leadership and curriculum advisors as well as teachers and learners, a complete system of school improvement is delivered and buy-in procured at all levels of the system. Targeted training to each participant group creates a multifaceted approach to solving challenges faced by the system.
- Sustainability: As the model engages teachers, cohorts of learners will continue to benefit from the skills taught in the programme long after the programme's conclusion. Additionally, hardware installed for this project will remain in place and curriculum advisors trained in its use; thus at the conclusion of the programme, districts will have the option of continuing the programme at the minimal costs of per-user licensing fees.

Initiative 2: Project DROID

A free public initiative to leverage and scale human experts by explicitly modelling their decision-making processes using artificial intelligence (AI) – for application in situations where such capacity may be low due to historical factors and also external conditions such as extreme poverty and instability.

The 2016 Progress in International Reading Literacy Study (PIRLS) results were released in December 2017. They indicate that eight in ten South African Grade 4 learners (78%) cannot read for meaning in any language. South Africa has the lowest reading scores of the countries tested (and the highest

2 The name eMpela is linked to JET's impellor logo, and draws on the isiZulu interpretation of impela, which means being definitive, doing something for good and being confident. The 'e' emphasises that it is an e-learning platform.

incidence of bullying) (Mullis et al 2017). What is worse is that the South African trend is opposite to that of the rest of the world, where reading scores are improving. It is clear that our current attempts and interventions to improve the education system are having very limited impact. We need an intervention now that is disruptive and exponential, or else we'll be plunged into a crisis that will have a devastating impact on this country and from which it is unlikely that the economy can recover.

While Project DROID has been conceptualised and designed in South Africa, it clearly also has possibilities for other countries. Based on a public good, non-profit model, the intervention has the potential to improve education for many vulnerable people in the world, including refugees and populations in resource-poor areas. The intention is to make the application available as a free resource.

The idea of democratising expert knowledge within the basic education sector originates from discussions between JET and Barbara Dale-Jones (representing Thunderbay Collective, a reseller and partner of Merlynn Technologies), who identified an innovative and potentially disruptive technology that could impact positively on education systems performance and who approached JET in this regard. Merlynn Technologies' Tacit Object Modeller (TOM) software was identified as a way, through the use of artificial intelligence (AI), of codifying and scaling expert knowledge within the education sector. The dissemination of this expert knowledge to 'non-experts' would enhance decision-making across multiple departments and functions within the basic education sector.

> TOM is a unique approach to AI; instead of data, it leverages and scales human experts inside the organisation and explicitly models their decision-making processes for fast and wide use. TOM is applicable in high volume, high consequence environments. In financial services, this includes, for example, retention, acquisition and credit. TOM is currently deployed in the risk environment where we have now successfully demonstrated its role in transaction, payment, PEP and sanction screening. (B. Dale-Jones, personal communication, November, 2017)[3]

The idea of using AI to capture and share knowledge prompted the partners to consider additional collaborators working with disruptive technologies and existing education data initiatives in South Africa. The overall benefit of democratising expert data interpretation is based on two realities: (1) The capacity for evidence-based decision-making in the South African education system is weak, particularly at the school and district levels; and (2) while data on schools is increasingly becoming available, the interpretation of the data remains weak and limited to a small pool of experts. These problems are largely intractable in the current South African context, despite several initiatives underway to try and find solutions. These initiatives are varied, ranging from government-led support to school leaders and district officials, to development partners, non-governmental organisations and teacher unions that are working on various levels in the system.

3 PEPs (politically exposed persons) and sanctions checks are important to ensure compliance with financial regulations and mitigate the risks of dealing with a company that has been sanctioned or a politically exposed person connected to the company (Thomas, 2015).

Concluding comments

The USAID 2014 landscape review of *Mobiles for Reading* introduced the following salient considerations when applying an ICT solution:

> What problem is this [ICT] 'solution' trying to address, and for whom? Is the solution culturally and ecologically accessible to the target population? Can practitioners leverage their own skills and existing technologies with even better solutions? When is it appropriate to introduce technology into a setting that might overthrow previously well-adapted non-ICT systems? (Wagner, 2014: 8)

These are questions which should be asked before an intervention is put into place. While there are exciting possibilities in the world of technology, an ICT-based solution is not automatically the right response to every problem. Best practice in ICT4E begins with demand-side solutions to problems faced within and by the education system. If an ICT-based approach is identified as a solution to a set of problems, enabling factors must be in place. According to the World Bank, which has mapped the current knowledge base on Information and Communication Technologies in Education, these factors include 1) the school environment; 2) teacher attitudes; 3) teacher professional development; 4) adequate infrastructure; and 5) communities of practice (World Bank, n.d.).

The first enabling factor for technology has to do with the school environment. The school must be functional and possess problem-solving skills, either within the school or within the extended school community. Teachers should be strong in terms of pedagogy and skills such as lesson planning and assessment related to teaching. Functional schools must then be given a degree of autonomy and flexibility around the curriculum as schools with more autonomy tend to make better use of ICT. Furthermore, there may be challenges in measuring gains in ICT that do not reside with ICT itself, for example, there may be inadequate or inappropriate testing for the types of learning gains anticipated. It is therefore necessary for the curriculum to accommodate the entry of ICT into the classroom by providing guidelines for learning outcomes anticipated which incorporate ICT and/or the flexibility for schools to design these.

Secondly, the introduction of ICT in itself will not result in change. Teachers apply technology in line with their pedagogical philosophies, and those with a constructivist approach provide

more meaningful engagements with ICT. In order for technology to be successfully integrated into classrooms, a paradigm shift may be necessary with regard to a number of teachers. In addition to support in this area, teachers require ongoing capacitation and support in concrete technology skills and integrating technology into the classroom. Subject knowledge as well as knowledge of how ICT relates or can be related to their subject(s) also influences how teachers use ICTs. Results are best when teachers have content mastery and understand learner comprehension of the topic(s) taught. Teachers are then able to use ICTs to engage in self-learning in subject matter, especially if ICTs provide access to updated and additional learning resources.

Third, professional development must be viewed as a process, not an event. Implementers must recognise that the introduction of ICT into the classroom requires that *more* support is given to educators as their support and professional development requirements will increase. Effective teacher development should model effective teaching practices; the experiential learning model should be observed, particularly with regard to learning about ICT integration. The implication is that practical, interactive training with technology applications is a preferred training method. Training should further be divided into pre-service, with a focus on initial preparation and pedagogy, content knowledge, management skills and the use of teaching tools (including ICT); in-service, which provides structured face-to-face and distance learning which builds upon pre-service training; and ongoing, or formal and informal pedagogical support which enables teachers to use ICTs to solve teaching challenges.

Fourth, the school and/or teacher need functioning technological infrastructure which is regularly maintained and serviced as well as protected from vandalism and theft.

Fifth, functioning communities of practice can prove to be a vital support to teachers in the adoption of technology. The increased challenges and demands result in a greater need for peer as well as expert support. However, working with ICTs in professional learning communities is, by nature, less structured than traditional pedagogical approaches, and flexibility is a key to improved performance.

Finally, teachers remain central to the learning process. Even as teachers shift from instructors to facilitators, teacher leadership and traditional practices, particularly with regard to lesson planning, preparation, assessment and remediation are important. With the effective introduction of technology, the necessary preparation becomes more extensive, and teachers must engage in more robust forms of teaching than the 'transmission method' or didactic teaching.

JET is well positioned to identify key levers of change in the South African education and training system. With 25 years of experience and strong relationships with government, the private sector and also teacher unions, JET has been able to introduce eMpela into schools in four provinces in South Africa. Project DROID is at an earlier conceptual stage, but shows great potential for addressing the limitations faced in most developing countries where expertise is thinly spread. As a non-profit organisation, our commitment is firstly to the public schooling system and using our research, implementation and monitoring and evaluation capacity to make a difference where it is most needed, and least afforded.

References

Darling-Hammond, L. (2010). *The flat world and education: How America's commitment to equity will determine our future*. New York: Teachers College Press.

Gibbs, C.A. (2017). *An evaluation of a blended e-learning intervention to develop teachers' self-efficacy, pedagogic and content knowledge in mathematics in rural schools in South Africa*. Dissertation submitted in fulfilment of the requirements for the degree of Master of Science (Research), Department of Psychology, University of Portsmouth, United Kingdom (October 2017).

Grinager, H. (2006). *How education technology leads to improved student achievement*. Washington, DC: National Conference of State Legislatures.

Ham, V., Gilmore, A., Kachelhoffer, A., Morrow, D., Moeau, P. & Wenmoth, D. (2002). *What makes for effective teacher professional development in ICT? An evaluation of the 23 ICTPD school cluster programme 1993–2001*. Wellington: Ministry of Education.

Hanushek, E. & Rivkin, S. (2006). Teacher quality. In: *Handbook of the economics of education*, Volume 2, edited by E. Hanushek and F. Welch. Amsterdam: North Holland.

Higgins, S., Xiao, Z. & Katsipataki, M. (2012). *The impact of digital technology on learning: A summary for the Education Endowment Foundation*. Durham and London: Durham University and Education Endowment Foundation.

JET Education Services. (2017). Annual report April 2017 presented to MRP Foundation by JET Education Services on the progress of the e-learning intervention in five primary schools in the Ilembe district of KwaZulu-Natal. Unpublished report.

Keeton, M. (2016). Analysing the 2015 matric results – more trouble than 'progressed' students. *Times Live*, 10 March. 2016 https://www.timeslive.co.za/ideas/2016-03-10-analysing-the-2015-matric-results---more-trouble-than-progressed-students-ilive/

Krcmar, M., Grela, B. & Lin, K. (2007). Can toddlers learn vocabulary from television? An experimental approach. *Media Psychology*, 10: 41–63.

Kulik, J.A. (1994). Meta-analysis study of findings on computer-based instruction. In: *Technology assessment in education and training*, edited by E. L. Baker & H. F. O'Neil. Hillsdale, NJ: Lawrence Erlbaum.

Lemann, N. (1997). The reading wars. *Atlantic Monthly*, 280(5): 128–133.

Meng, Q. & Li, M. (2001). *New economy and ICT development in China*. United Nations University, WIDER discussion paper No: 2001/76. https://www.wider.unu.edu/sites/default/files/dp2001-76.pdf

Mullis, I.V.S., Martin, M.O., Foy, P. & Hooper, M. (2017). *PIRLS 2016 international results in reading*. Chestnut Hill: TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College and International Association for the Evaluation of Educational Achievement (IEA).

OECD. (2015). *Students, computers and learning: Making the connection*. Paris: PISA, OECD Publishing.

Piopiunik, M., Bietenbeck, J. & Wiederhold, S. (2016). *Africa's skill tragedy: Does teachers' lack of knowledge lead to low student performance?* CESifo Working Paper Series No. 5470. Munich: CESifo Group. https://econpapers.repec.org/paper/cesceswps/_5f5470.htm

Piper, B., Oyanga, A., Mejia, J. & Pouezevara, S. (2017). Implementing large-scale instructional technology in Kenya: Changing instructional practice and developing accountability in a national education system. *International Journal of Education and Development using Information and Communication Technology*, 13(3): 57–79.

Republic of South Africa, Department of Basic Education (DBE). (2004). White paper on e-education (2004): *Transforming learning and teaching through information and communication technologies (ICTs)*. Pretoria: DBE.

Republic of South Africa, Department of Telecommunications and Postal Services. (2016). *National integrated ICT policy white paper*. Pretoria: DTPS. https://www.dtps.gov.za/images/phocagallery/Popular_Topic_Pictures/National_Integrated_ICT_Policy_White.pdf

Rolstad, K. & Kesson, K. (2013). Unschooling, then and now. *Journal of Unschooling and Alternative Learning*, 7(14). https://jual.nipissingu.ca/wp-content/uploads/sites/25/2014/06/v72142.pdf

Sanders, W.L. & Rivers, J.C. (1996). *Cumulative and residual effects of teachers on future student academic achievement (Research Progress Report)*. Knoxville, TN: University of Tennessee Value-Added Research and Assessment Center

Schacter, J. (1999). *The impact of education technology on student achievement: What the most current research has to say*. Santa Monica, CA: Milken Exchange on Education Technology.

Shih, E., Kraemer, K.L. & Dedrick, J. (2008). IT diffusion in developing countries. *Communications of the ACM*, 51(2): 43–48.

Shiohira, K. (2017). *The tablet teacher: Learning literacy through technology in Northern Sotho*. Dissertation submitted in partial fulfilment of the requirements for the degree of Master of Arts, Department of English Language and Linguistics, Rhodes University.

Thomas, C. (2015). Why do we need PEPs and sanction checks? Creditsafe. https://blog.creditsafeuk.com/why-do-we-need-peps-and-sanctions-checks/

Vogel, J., Vogel, D., Cannon-Bowers, J., Bowers, C., Muse, K. & Wright, M. (2006). Computer gaming and interactive simulations for learning: A meta-analysis. *Journal of Education Computing Research*, 34(3): 229–243.

Wagner, D.A . (2014). *Mobiles for reading: A landscape research review*. Rockville, MD: JBS International, Inc. for USAID.

Wainer, J., Dwyer, T., Dutra, R., Covic, A., Magalhaes, V., Ferreira, L. & Claudio, K. (2008). Too much computer and internet use is bad for your grades, especially if you are young and poor: Results from the 2001 Brazilian SAEB. *Computers and Education*, 51: 1417–1429.

Wallet, P. (2015). *Information and communication technology (ICT) in Education in sub-Saharan Africa: A comparative analysis of basic e-readiness in schools*. Montreal, Quebec: UNESCO Institute for Statistics.

WestEd. (2002). *The learning return on our education investment: A review of findings from research*. San Francisco: WestEd.

World Bank. (n.d.). *Teachers, teaching and ICTs: A knowledge map on information and communication technologies in education*. http://www.infodev.org/articles/teachers-teaching-and-icts.

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