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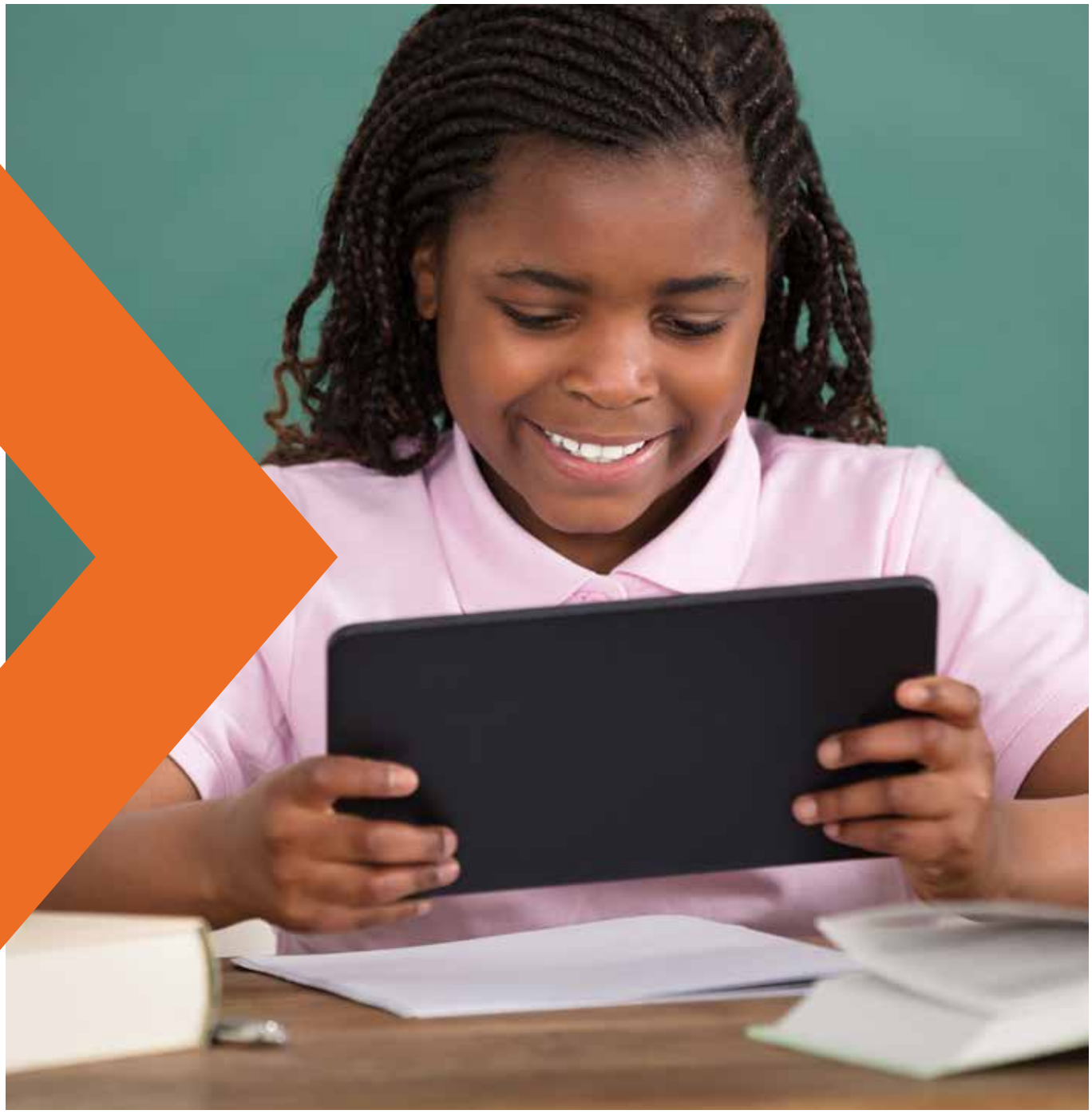

Learning with technology in low-income households in times of disruption

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Foreword

The role of information and communications technology (ICT) in mitigating inequality in teaching and learning has been discussed for a long time. The effects of strict lockdowns, school closures and rotation learning caused by the Covid-19 pandemic has brought this discussion back under the spotlight as South Africa's dual education system revealed, once again, that many learners are unable to access learning during disruptions in schooling.

For the vast majority of learners in our country, the effects of the pandemic have been devastating: most families have experienced hunger, caregivers have succumbed to the virus, and many learners have experienced huge learning losses. According to Mohohlwane, Taylor and Shepherd (2021), learning losses amounted to 50 to 75 per cent of a year amongst Foundation and Intermediary Phase learners in resource-constrained schools. Finding options for dealing with the ever-increasing inequalities in the school system and giving learners from poor communities every chance at success has never been more urgent.

Technology as a learning tool was also endorsed by President Cyril Ramaphosa in his 2019 State of the Nation Address (South African Government, 2019). He proposed that every South African school child would own a digital workbook on an electronic tablet, beginning with those in the most historically disadvantaged communities. The planned roll-out was six years. Regrettably, the advent of the pandemic brought all these national initiatives aimed at advancing learners from low-income households to a halt as priorities shifted to the safety of the nation. This, at a time when the provision of alternative learning tools, such as technology devices, was becoming increasingly important.

These developments, and our current context, necessitated us to understand technology as a learning tool and explore under which conditions it enhances learning so we can use this knowledge to inform future programming. The Zenex Foundation therefore appointed a team of researchers to explore and identify mechanisms that could use technology to enhance home learning.

This paper firstly investigates the role and impact of technology on education and, secondly, it identifies the properties or affordances of technology and possible interventions for designing and sustaining learning under challenging circumstances. Finally, it aims to stimulate conversations around and developing models for using technology in home learning.

What becomes apparent through this paper is that ICT, if designed appropriately, can play an important role. There is growing evidence that, in well-resourced schools, the impact of Covid-19 has been minimal, and this must in part be attributed to their access to ICT options. While there are many hurdles to overcome in getting ICT into poor communities, it must become a weapon in our arsenal to address learning inequity.

Gail Campbell
Chief Executive Officer

Abstract

The value of technology in the classroom has been under investigation for decades and researchers continue to find contradicting evidence on its impact on learner performance.

Mostly, comparative studies are conducted in well-resourced and stable learning environments that do not interrogate results in under-resourced settings like low-income households. This paper seeks to provide evidence on how, what and when these technologies enhance or impede learning in challenging circumstances such as those experienced by low-income households during a lockdown when children cannot go to school. An assessment of theories and frameworks used in the reviewed literature were used to identify two possible interventions – the Technology Acceptance Model and self-directed learning – for learning with technology in low-income households.

The role and impact of technology in education

Whole-school benefits of using technology

- a tool for management
- an administration tool to increase productivity
- a resource for curriculum integration
- a communication tool
- a collaborative tool for teachers and learners
- a learning environment that advances creativity, communication, collaboration and engagement.

While plans have been underway to provide learners with technology (South African Government, 2020), we need to understand what role it could play in alleviating the current challenges facing children from low-income households whose chance of getting a quality education are compromised.

The available literature generally acknowledges the role technology can play based on its manufacturer-perceived (what the device was produced to do) or actual (what the device actually does) qualities. The evidence provided in the literature is based on empirical data from case studies and findings are unfortunately not conclusive and depend on many factors.

Chauhan (2017) reviewed 122 publications from peer-reviewed journals on the impact of technology on learning. She found that technology has a moderate effect on the learning of primary school children. Her study identified variables such as the subject taught or learnt, type of application, intervention duration and learning environment to determine to which extent technology enhances teaching and learning.

More studies alluded to the role that technology plays in enhancing learner understanding of abstract concepts (Bakırcı, Bilgin & Simsek, 2011; Koong & Wu, 2011) and the success of the experience is based on how and under what conditions it is used. Mayer (2003) cautioned that using multimedia may not achieve the desired learning goals if applied

in such a way that there is cognitive load. He therefore concurred with John Sweller's (1988) cognitive theory principles that categorised cognitive load into intrinsic, extraneous and germane cognitive load[1]. The consideration of these constructs in the development of digital content determines the learners' reception to it. Mayer (2003) emphasised the need for an instructor to design and present content so that the germane cognitive load contributes to the understanding of abstract concepts; otherwise, their use is disruptive to the learning process.

Smith and Hardman (2014) conducted a comparative study of South African schools and proved that the use of technology for teaching and learning does not necessarily improve student performance. The study compared schools that have had access to computers since 2001 with those that introduced them five years later. The technology used was software designed to supplement the teaching of mathematics through drill and practice (Hardman, 2008), and both groups performed the same.

Louw, Muller and Tredoux (2008) conducted a similar comparative study and found that information and communication technologies hold promise for use in education in developing countries but relied on the strength of and exposure time to the intervention. Their evaluation of the Khanya Technology in Education Project, a Western Cape Province project that equipped over 1000 selected schools with ICT infrastructure to be used for curriculum delivery in mathematics, concluded that the more time learners spent using the software, the more improvement they showed from one year to the next.

An analysis of over 350 articles published from 2000 to 2007 on the impact of ICT in United Kingdom schools, found that there were inconsistencies in its impact on learning (Condie & Munro, 2007). The review highlighted that the irregularities depended on contexts, learner characteristics and subjects.

Beyond that, the researchers could not find evidence to draw a firm conclusion of how technology advanced learning. The investigation had been conducted in schools with adequate resources whose usage should have produced explicit evidence that technology has learning benefits. These findings demonstrate that, as much as there may be educational value when using technology, it is not determined by the quality of technology, the learning context, subject or abundance of technology, but by how it is used in any given learning environment. Understanding this is key when considering interventions to promote learning in low-income households. The design and development of the learning package should be such that there is learning development.

The South African ICT in education policy, the *Draft White Paper on e-Education* (Republic of South Africa, 2004) supplements the national curriculum and it serves to guide educators on how best to deliver content with and through technology. The policy (2004: 14) also identified the whole-school benefits of using technology such as:

- "a tool for management;
- an administration tool to increase productivity;
- a resource for curriculum integration;
- a communication tool;
- a collaborative tool for teachers and learners; and
- a learning environment that advances creativity, communication, collaboration and engagement."

While these are high-level benefits, they reiterate the role that technology could play in education. However, we need to understand which technology can do what in a teaching and learning context.

Laurillard's (2002) categorisation of technology into five media forms was based on the possible learning experience that learners may have as they learn with and through technology.

[1] *Intrinsic cognitive load is determined by the intellectual complexity of the instructional material to the topic taught. Extraneous cognitive load is how instructions are presented (Chandler & Sweller, 1996). Germane cognitive load is organising content to promote retention (Wiley Educational Services, n.d.).*

The identified media forms are narration, interaction, collaboration, adaptation and production. Laurillard (2002) recognised that educational technologies or the media forms that she referred to can be digital or non-digital, and they may be used separately or be integrated into the presentation of content to enhance learning. She illustrated how these technologies can be grouped and used to create desired learning experiences (Table 1):

Table 1: The grouping of technologies and their use to give desired learning experiences

Learning experience	Methods/technologies	Media forms
Attending, apprehending	Print, TV, video, DVD	Narrative
Investigating, exploring	Library, CD, DVD, web resources	Interactive
Discussing, debating	Seminar, online conference	Communicative
Experimenting, practicing	Laboratory, field trip, simulation	Adaptive
Articulating, expressing	Essay, product, animation, model	Productive

Source: Laurillard (2002: 90)

The achievement of learning outcomes therefore depends on how and what media or combination thereof is used. The advantage of considering this view for learning in any context is that it is not centred on technology and has its focus on learning. In cases where the ICT infrastructure is not adequate and only allows limited access, other technologies may be used or integrated into the learning tasks. For instance, the technology (through the internet) could be used to access content and submit tasks to preserve battery power on the devices. Such an approach to adopting technology in low-income households is plausible and not likely to disrupt learning associated with the inaccessibility of technology. Padayachee (2017) adapted a guideline for technology-enhanced learning from Padayachee and Mbati (2016), where he grouped them as:

- *Sharing information and ideas*
- *Experiential dialogue*
- *Reflective dialogue*

When the role of technology is confined to these three groups, children in low-income homes can cope with learning with and through it. For instance, digital technology could be used to share information or documents through the use of Web 2.0 tools once learners have engaged with the content offline. Web 1.0 to 3.0 can be used by learners to provide them with experiential learning where they engage in learning experiences through interactive and adaptive media tools[2]. Learners can be provided learning experiences where they can engage in reflective dialogue as they use Web 2.0 tools. What differentiates these tools are what they can do and their ability to enhance or constrain the learning experience.

[2] *Web 1.0 tools provide access content that can only be read with no interaction with the reader. Web 2.0 allows the reader to also write, modify and update online content (Nath, Dhar & Basishtha, 2014). Web 3.0 tools allow the internet to be more personalised, accurate and intelligent. The technology can mimic some human behaviour or actions as it can learn and understand semantics (Lal, 2011).*

The affordances of technology

Salomon (1993) described affordances as perceived and actual characteristics of the technology. Actual characteristics are those that we experience as we use the technology and the outcome of these may be destructive or productive.

Conole and Dyke (2004) developed the classification of ICT affordances: accessibility, immediacy, diversity, communication and collaboration, multimodal and non-linear, reflection, risk, fragility and uncertainty, monopolisation and surveillance, and speed of change. The first six relate directly to teaching and learning, and Ndlovu (2016) used five affordances to align with the pedagogical value (Table 2).

While teachers in this same study (Ndlovu, 2016) perceived technology to have the first five affordances, not all of them provided their learners with successful learning experiences. It was therefore not about the affordances but how they were used to create favourable learning environments. When designing learning experiences for low-income homes, materials developers should be driven by the learning benefits of the technology affordances in creating learning environments that will not only help to achieve learning outcomes but create a desire in learners to sustain their engagement with materials.

Table 2: The affordances of ICT technology aligned to pedagogical value

Media forms	Affordances	Evidence	What pedagogical value does it add
Narrative	Non-linear	Multimodality	Apprehensive structure/ connections
Interactive	Immediacy	Immediate feedback	Exploration: misconceptions amended
Communicative	Collaboration	Discussion: class/group	Re-descriptions of concepts
Adaptive	Diversity	Reproduction: experimental/role play	Concretising theory: practice
Productive	Articulation	Product: animation/model	Knowledge construction

Source: Ndlovu (2016: 100)

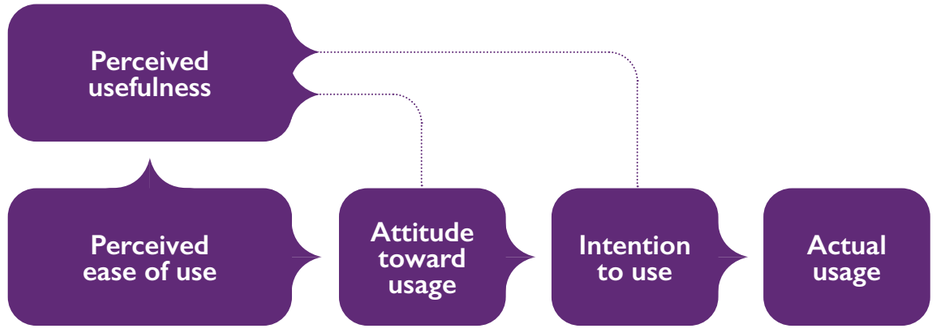
Possible technology interventions for designing and sustaining learning under challenging circumstances

The Technology Acceptance Model for sustaining learning

Learners in low-income households tend to receive inadequate support and monitoring from their parents (Heymann & Earle, 2000). As a result, their progress with learning depends on the extent to which learning materials regulate their engagement. The Technology Acceptance Model (TAM), coined by Davies (1989), has been used in many studies aimed at understanding how user behaviour is related to technology adoption (Prieto, Migueláñez & García-Peñalvo, 2014; Shambare, 2014; Teeroovengadum, Heeraman & Jugurnath, 2017; Guner & Acarturk, 2020). The model, depicted in Figure 1, illustrates how perceived usefulness and the perceived ease of use have the tendency to change one's attitude towards usage and thus intention to use it to accomplish an activity.

> *"... the distribution of resources to children should not be the only focus. Attention should be given to how the content helps them to engage and deal with their everyday social relations."*

Figure 1: The Technology Acceptance Model



Source: Davies (1989)

In their case study of three public schools in the UK, Valentine, Holloway and Bingham (2002) demonstrated that it is not just the social factors that can prevent access to technology, but the quality of the material as well. In their conclusion, they emphasised that the distribution of resources to children should not be the only focus. Attention should be given to how the content helps them to engage and deal with their everyday social relations. By doing so, children and their parents will perceive the technology as useful and meaningful and thus value it for the role that it plays in their lives.

A South African study conducted by Mathipa and Mukhari (2014: 1213) found that factors that impede the use of technology in teaching and learning, among others, are "insufficient number of computers and lack of application programmes, teacher generation gap, inadequate teacher training, lack of ICT skill and lack of confidence, teachers' beliefs, poor school leadership and lack of public support." These constraints related to teacher attributes, leadership, support and access to the technology. They included time, that Smith and Hardman (2014) argued, is not a factor for improved learning. In addition, the study did not involve learning, and its focus was on access at school. There is a need to understand how the actual learning happens and to determine if it is enhanced through the use of technology in learning contexts with challenges of connectivity and poor parental involvement in the children's home learning. A teacher in Mathipa and Mukhari's (2014) study highlighted that when parents were asked to lend their children their cell phones, they bought them digital resources as they realised their educational benefit. These parents were made to perceive technology as useful in their children's education, and that led to them making sacrifices to ensure access to education was sustained.

In his study of student adoption and use of technology, Shambare (2014) found that simplicity and user-friendly features influenced their attitudes and behavioural intentions to use the technology for learning. The question then is how materials should be designed so that learners use the technology to the extent that their interest is not just on technology but that their interest is aroused and their quest for knowledge is quenched. This process should facilitate development in learning at the desired pace.

Ojo and Adu (2018) conducted a questionnaire survey in the Eastern Cape, South Africa, comprising 450 students and 150 teachers on how they viewed the effectiveness of

technology in teaching and learning. Cell phones were the most used form of technology. They were used to download relevant information on their subjects and exchange ideas and knowledge with other learners. The affordances of the technology were thus perceived as easy to use in the context of the tasks to be performed.

Before users reach a point where they find technology easy to use and can use it productively, they need to acquire the operational skills. Dube, Nhamo and Magonde (2018) found that physical education (PE) teachers' lack of access to adequate ICT hardware, poor training, negative attitudes, lack of PE specific ICT training, lack of PE specific ICT software, and computer self-efficacy were the major factors that negatively affected the use of ICT in the Johannesburg East Cluster primary schools in Gauteng Province, South Africa. The implication, in this case, is that ease of use comes about with training on the technology to be used. Yet this may not always be possible, especially when dealing with large numbers of children who may be living in sparsely populated areas, far away from community centres. It may be necessary to adopt approaches to acquiring these skills that facilitate independent learning.

Self-directed learning as an approach to designing learning

Self-directed learning has traditionally been associated with adult learning. However, an Indian professor found that it applies to digital technology learning for younger people as well. When young people are exposed to the technology tools over time, they eventually figure it out.

Sugata Mitra, Professor Emeritus at the National Institute of Immunology University, in 2012 performed the famous experiment called 'The Hole in the Wall'. His experiment demonstrated the power of self-directed learning. A computer was built into a wall next to a slum. Children from six years upwards found their way with the technology, and they were able to teach themselves and each other without any formal guidance. These children used a pad installed next to the computer to navigate and eventually used the internet to teach themselves English. The researcher expected that someone from the community would come and remove the devices and sell them, but no one did. After six months the children were computer literate and their teachers discovered that they had improved their "English vocabulary and usage, concentration span, problem-solving skills and working collaboratively and self-regulation" (Mitra, 2012: 8). This experiment showed that children from any situation can learn on their own with technology.

Rashid and Asghar (2016) asserted that it is the interactiveness of technology that children find compelling to explore. The education sector can take advantage of this. Technology allows students to engage with content, and this improves their performance and motivation (Fonseca, Martí, Redondo, Navarro & Sanchez, 2014). Rashid and Asghar (2016) found that technology, student engagement and self-directed learning is a significant triad that promotes deep engagement and learning. Content delivery should, therefore, be designed so students are meaningfully engaged to yield deep learning.

Conclusion

While there is a dearth of empirical studies investigating what works under what conditions in the use of technology in low-income households, this paper identifies some strategies that could work in these environments.

Without the physical guidance of a mediator between the child and the content, this paper attempts to demonstrate how the following four characteristics of the interventions can make successful learning possible for children in low-income households:

Table 3: Characteristics for successful learning in low-income households

Description
Intervention characteristics: **APPROPRIATE DESIGN AND DEVELOPMENT OF MATERIAL**
Engaging • Multimedia usage – Reduce cognitive overload **Integration of non-digital technology** • To save battery power **Reference to children's social relations** • Perceived usefulness
Intervention characteristics: **TECHNOLOGY USE**
Learners should be given time to learn the technology • Self-directed learning **Type of technology** • Easy to use – the focus should be on learning and not on the technology **Affordances** • Learning outcomes to determine which and when affordances should be used

Table 3: Characteristics for successful learning in low-income households *continued*

Description
Intervention characteristics: **INSTRUCTIONAL DESIGN**
Teachers or content developers • Materials development to cater for learner contexts • Innovative ways to be used to sustain learner engagement with learning
Intervention characteristics: **QUALITY LEARNING**
Well-paced learning materials • Technology to have user-friendly features and ease of use **Quality learning materials** • To foster learning development in the children's context **Monitoring of learning through digital technology** • Maximise the utilisation of the technology – At learner level – At instructor (teacher) level – Use data to adapt content to allow for efficient learning progress

In a pandemic like the one we experienced in 2020 and 2021, the education sector is incapacitated. While the quality of learning for learners may be compromised, children from low-income households are the most significantly affected as they are excluded from education. Interventions that assist and support them tend to be driven by urgency and thus impulsively respond to the desperate need with low-quality instruction and little consideration for the learner's requirements, given their circumstances. This paper demonstrates, through the four characteristics listed above, that it is possible to provide successful, quality and sustainable learning experiences for learners in low-income households.

References

Bakırcı, H., Bilgin, A. K., & Simsek, A. (2011). The effects of simulation technique and worksheets on formal operational stage in science and technology lessons. *Procedia-Social and Behavioral Sciences*, 15, 1462-1469.

Chauhan, S. (2017). A meta-analysis of the impact of technology on learning effectiveness of elementary students. *Computers & Education*, 105, 14-30.

Condie, R., & Munro, B. (2007). *The impact of ICT in schools – a landscape review*. Coventry: Becta.

Conole, G., & Dyke, M. (2004). What are the affordances of information and communication technologies? *Research in Learning and Technology*, 12(2), 113-124.

Davis, F. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, 13(3), 319-340.

Dube, B. A., Nhamo, E., & Magonde, S. (2018). Factors affecting ICT integration in the teaching and learning of physical education in South Africa: A case of Johannesburg East cluster primary schools in the Gauteng Province. *International Journal of Sport, Exercise and Health Research*, 2(1), 88-92.

Fonseca, D., Martí, N., Redondo, E., Navarro, I., & Sanchez, A. (2014). Relationship between student profile, tool use, participation, and academic performance with the use of Augmented Reality technology for visualized architecture models. *Computers in Human Behavior*, 31, 434e445. At http://dx.doi.org/10.1016/ j.chb.2013.03.006.

Gigler, B. S. (2004). Including the Excluded: Can ICTs empower poor communities? Towards an alternative evaluation framework based on the capability approach. *Paper for the 4th International Conference on the Capability Approach*, 5-7 September 2004, University of Pavia, Italy.

Guner, H., & Acarturk, C. (2020). The use and acceptance of ICT by senior citizens: a comparison of technology acceptance model (TAM) for elderly and young adults. *Universal Access in the Information Society*, 19(2), 311-330.

Hardman, J. (2008). *New technology new pedagogy? An activity theory analysis of pedagogical activity with computers.* Unpublished doctoral dissertation, University of Cape Town: Cape Town.

Heymann, S. J., & Earle, A. (2000). Low-income parents: how do working conditions affect their opportunity to help school-age children at risk? *American Educational Research Journa*l, 37(4), 833-848.

Koong, C. S., & Wu, C. Y. (2011). The applicability of interactive item templates in varied knowledge types. *Computers & Education*, 56(3), 781-801.

Laurillard, D. (2002). *Rethinking university teaching: A framework for the effective use of educational technology.* London: Routledge/Falmer.

Louw, J., Muller, J., & Tredoux, C. (2008). Time-on-task, technology and mathematics achievement. *Evaluation and Progress Planning*, 31, 41-50.

Mathipa, E. R., & Mukhari, S. (2014). Teacher factors influencing the use of ICT in teaching and learning in South African urban schools. *Mediterranean Journal of Social Sciences*, 5(23), 1213-1213.

Mayer, R. E. (2003). The promise of multimedia learning: using the same instructional design methods across different media. *Learning and Instruction*, 13(2), 125-139.

Mitra, S. (2012). The Hole in the Wall Project and the power of self-organized learning, E-book exerpt. Technology Integration. Eutopia. At www.edutopia.org/blog/self-organized-learning-sugata-mitra.

Mohohlwane, N., Taylor, S., & Shepherd, S. (2021). *Schooling during the COVID-19 pandemic: An update from Wave 3 of the NIDS-CRAM data*. National Income Dynamics Study and Coronavirus Rapid Mobile Survey 2020.

Ndlovu, N. S. (2016). *The pedagogical integration of ICTs by seven South African township secondary school teachers.* Doctoral dissertation.

Ojo, O. A., & Adu, E. O. (2018). The effectiveness of Information and Communication Technologies (ICTs) in teaching and learning in high schools in Eastern Cape Province. *South African Journal of Education*, 38(1), S1-S11.

Padayachee, K., & Mbati, L. (2016). A guiding vision of technology-enabled active learning: A South African perspective. In *2016 Annual Global Online Conference on Information and Computer Technology (GOCICT)*, Louisville, KY, USA.

Padayachee, K. (2017). A snapshot survey of ICT integration in South African schools. *South African Computer Journal*, 29(2), 36-65.

Prieto, J. C. S., Migueláñez, S. O., & García-Peñalvo, F. J. (2014). ICTs integration in education: mobile learning and the technology acceptance model (TAM). In *Proceedings of the Second International Conference on Technological Ecosystems for Enhancing Multiculturality* (pp. 683-687).

Rashid, T., & Asghar, H. M. (2016). Technology use, self-directed learning, student engagement and academic performance: Examining the interrelations. *Computers in Human Behavior*, 63, 604-612.

Republic of South Africa (2004) *Draft White Paper* on e-Education. No. 26734. At www.gov.za/sites/default/files/gcis_document/201409/267341.pdf.

Salomon, G. (Ed.) (1993). *Distributed cognitions—psychological and educational considerations.* Cambridge: Cambridge University Press.

Shambare, R. (2014). The adoption of WhatsApp: Breaking the vicious cycle of technological poverty in South Africa. *Journal of Economics and Behavioral Studies*, 6(7), 542-550.

Smith, G. S., & Hardman, J. (2014). The Impact of Computer and Mathematics Software Usage on Performance of School Leavers in the Western Cape Province of South Africa: A Comparative Analysis. *International Journal of Education and Development using Information and Communication Technology*, 10(1), 22-40.

South African Government. (2019). *State of the Nation Address by President Cyril Ramaphosa.* At https://sona.org.za/assets/downloads/SONA-June-2019.pdf.

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science*, 12, 257-285.

Teeroovengadum, V., Heeraman, N., & Jugurnath, B. (2017). Examining the antecedents of ICT adoption in education using an extended technology acceptance model (TAM). *International Journal of Education and Development Using ICT*, 13(3), 4-23.

Valentine, G., Holloway, S., & Bingham, N. (2002). The digital generation? Children, ICT and the everyday nature of social exclusion. *Antipode*, 34(2), 296-315.

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