Passey, D., Laferrière, T., Ahmad, M. Y. A., Bhowmik, M., Gross, D., Price, J., Resta, P., & Shonfeld, M. (2016). Educational Digital Technologies in Developing Countries Challenge Third Party Providers. *Educational Technology & Society, 19* (3), 121–133.

Educational Digital Technologies in Developing Countries Challenge Third Party Providers

Don Passey[1*], Thérèse Laferrière[2], Manal Yazbak-Abu Ahmad[3], Miron Bhowmik[4], Diana Gross[5], Janet Price[6], Paul Resta[7] and Miri Shonfeld[8]

[1]Lancaster University, Lancaster, UK // [2]Université Laval, Quebec City, Canada // [3]Sakhnin College, Sakhnin, Israel // [4]UNESCO Bangkok Office, Bangkok, Thailand // [5]Global Citizen Educate, Myanmar // [6]University of Tasmania, Hobart, Australia // [7]University of Texas at Austin, Austin, USA // [8]Kibbutzim College of Education and MOFET, Ramat Aviv, Israel // d.passey@lancaster.ac.uk // Therese.Laferriere@fse.ulaval.ca // manalyazbak@gmail.com // mk.bhowmik@unesco.org // Diana@GlobalCitizenEducate.org // Janet.Price@utas.edu.au // resta@austin.utexas.edu // mirish@macam.ac.il

[*]Corresponding author

ABSTRACT

In this conceptual paper, we consider issues and challenges of third party and governmental organisations in planning and implementing access to and uses of digital technologies for learning and teaching in developing countries. We consider failures and weaknesses in the planning and implementation processes highlighted by research in developed countries (as well as successes supporting implementation). We problematise these issues and challenges, conceptualise them in order to focus on longer-term rather than shorter-term ones, and offer new alternative models and ways of conceiving these practices for future sustainability.

Keywords

Educational equity, Digital sustainability, Long-term implementation, Developing countries, Gaps and challenges

Introduction

This paper focuses on educational change and provision of opportunity, on changes involving digital technologies or information and communication technologies (ICT). While it is recognised that introducing ICT can affect teaching and learning, it is more specific implications for third party and governmental organisations (typically philanthropic foundations, consultancy, hardware or software company groups, or agencies with specific education and ICT remits) which we focus on here. In this paper, digital technologies or ICT are defined as the entirety of hardware and software systems accessed by learners or teachers, which might include desktop, laptop or handheld technologies, mobile technologies, networking tools, and online resources and software. Regarding change processes, terms used in this paper include innovation (a method, idea or practice developed by and new to a user), implementation (a process putting a plan into effect), and integration (combining something new into an existing system or practice).

Some national education systems (the United Kingdom, Denmark, the United States of America, and Australia, for example) have implemented ICT into teaching and learning over a period of 25 or more years (see Tatnall & Davey, 2014). In spite of such a long period for integration of ICT into educational practices, concerns continue to be raised; ICT has neither been accepted for teaching or learning on a wide scale (see OECD, 2015, for example), nor brought about the range of benefits expected from the investment (e.g., Selwyn, 2010). However, research has shown that ICT can bring about educational benefits (e.g., Passey, 2014; Tamim et al., 2011). A key difference between these apparently contrasting findings, identified by the latter authors, concerns approaches and roles of teachers, tutors, counsellors, policy makers, or parents supporting educational practices. ICT does not necessarily bring about change or benefit without appropriate support. In developed countries, even where ICT has become part of teaching and learning environments, sustainability can be identified as an issue, nevertheless. An absence of sustained classroom-based innovation with digital technology in both developed and developing countries is reported (Attewell, 2001). Digital tools and resources can be underused, given the pressures of curricular demands in developed countries (Cuban, 2015). For developing countries, these are important messages to consider; but contexts in which implementations might be undertaken may not be identical, so sustainability factors might not be the same.

In many developing countries, national policy makers and third party organisations currently focus on a number of desires: To introduce ICT to enhance teaching and learning; to promote educational opportunity (or equity); to learn from past experience so that implementation might be more effectively handled; and to generate capacity building in the use of ICT. To succeed, ICT-related educational programmes should be designed, adopted and implemented by

government and third party organisations to accommodate a number of recognised issues (detailed further later in the paper). Importantly, technology continues to change rapidly and is often repurposed, and time is needed to implement and recognise agreed outcome benefits (what we refer to here, and will detail later, as "the U-challenge"). Additionally, there are differences and complexities within the contexts in different countries (political, social, technological, linguistic, cultural, economic, local and religious). All three of these issues have significant implications for teaching and learning. If long-term integration is to be achieved, these issues must be considered appropriately. Long-term integration in this sense can be thought of as providing sustainability; however, even this concept needs to be considered appropriately within implementation contexts. Initially in this paper, we provide a background to this field; we then conceptualise issues and features in order to develop a starting framework for those working in the field, and then identify possible future approaches involving longer-term research and development agendas.

A key question we explore in this paper is, how can educational change involving digital technologies be problematised and conceived for governmental and third party organisations seeking to implement long-term sustainable practices. Problematisation of change issues is an essential process if third party organisations and others involved in implementation are to avoid key problems arising, by putting appropriate processes in place ahead of identifiable critical periods. From the conceptions we present, we offer new alternative models and ways of conceiving practices for future sustainability. We will consider the context, identify key issues and challenges, problematise underlying factors, derive an appropriate model of implementation, provide a planning framework, offer recommendations, and discuss implications for research.

Digital technology implementation and the context in developing countries

Integration of digital technology into teaching and learning is a double-edged challenge. While online distance education increases access without borders to a variety of subject and topic contents (Bakia, Shear, Toyama, & Lasseter, 2012), onsite formal education is facing rising expectations regarding the practices and nature of methodology (Griffin et al., 2012; UNESCO, 2011; Voogt & Knezek, 2008). Previous papers from Thematic Working Group 4 (TWG 4) of the EDUsummIT community (Resta, 2009; Resta, 2011; Resta & Laferrière, 2013), portrayed: the state of infusion of ICT in the world; aspects of digital equity that researchers have pointed to; initiatives taken; and persisting issues and challenges.

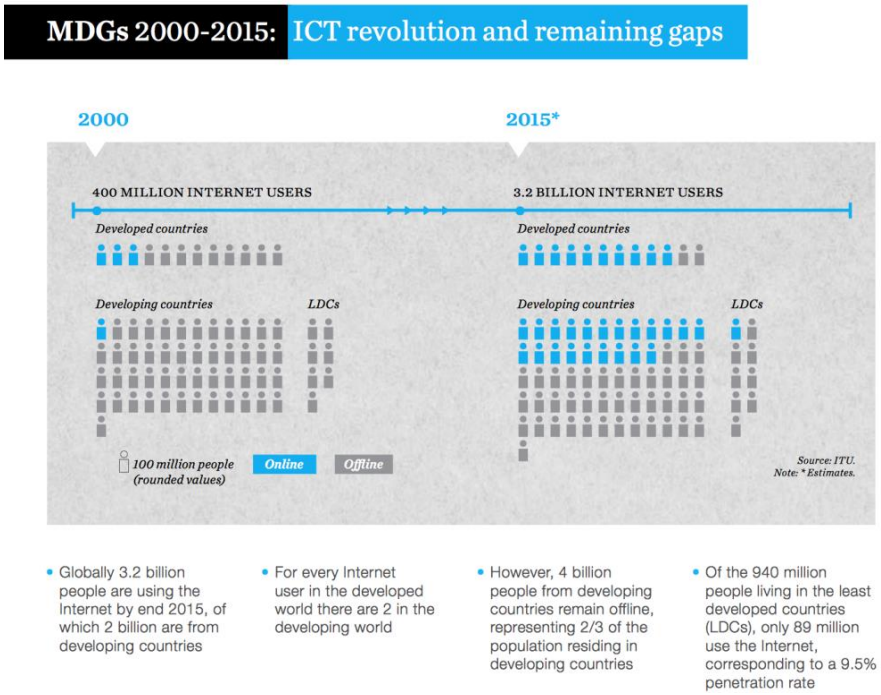

Figure 1. ICT revolution and remaining gaps (ITU, 2015)

At the latest EDUsummIT conference 2015, TWG4 focused on onsite sustainable implementation with digital technology, primarily in classrooms. Absence of sustainable innovation and implementation with digital technology was identified as a "new situation" requiring noteworthy attention. This critical gap needs to be overcome before substantive progress can be made in supporting educational equity concerns through digital technology approaches.

While digital equity inside classrooms during mandatory schooling years is a key concern of third party initiatives, digital equity outside the classroom is also a factor to consider. As shown in Figure 1, the United Nations specialised agency for ICT (the International Telecommunications Union) indicated in a recent report (ITU, 2015) the impressive global progress in penetration of Internet-based information and communication; but the penetration rate is only 9.5% in the least developed countries.

In terms of the efficacy of access for educational purposes, research indicates it is essential to access broadband to derive full benefits from the Internet. Figure 2 shows population proportions accessing the Internet through landline and mobile telephones. As noted in the World Economic Forum (Dutta et al., 2015), the widening divide in broadband access between the most developed countries and the least developed countries is a discouraging trend.

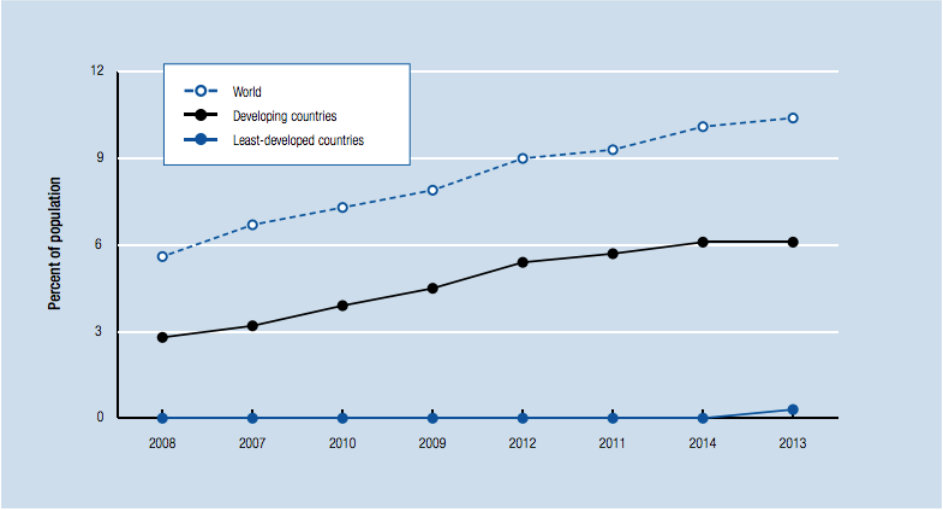

Figure 2. The widening digital gap: Fixed-line broadband penetration (ITU, 2014)

Seeking to address this digital divide for education, the World Summit on the Information Society (WSIS) set the target of 2015 for connecting all secondary and primary schools with ICTs (ITU, 2014). This target is an ideal but mammoth undertaking:

> Evidence shows that LCRs ["learner-to-computer connected" ratios] are generally decreasing across many countries, while school Internet rates are increasing – both generally and for fixed broadband specifically. However, change is not uniform and occurs at different rates in different countries. Typically, countries that have strong policies and set targets for ICT in education with high-level government and sector-wide support show the most rapid change. (ITU, 2014, p. 75)

Where schools use technology, research (e.g., Becker & Riel, 2000; Tamim et al., 2011) continues to find that the pedagogy in use makes the difference: technology used as "support for cognition" has greater effect than technology used for "presentation of content." Bringing the Internet to schools and classrooms – whatever money, time and energy it may require – is only part of the equation. As Kozma (2005) stated, reviewing impacts of ICT in schools in developing countries: "changes in curriculum, pedagogy, assessment, and teacher training is likely to result in widespread use and learning" (p. 18). Technology must do more than reinforce the "teacher effect" (an expression used in quantitative studies measuring variables affecting student outcomes). It is here defined as "the teacher's unique contribution to student learning" (Kupermintz et al., 2001).

Issues and challenges

We need to initially consider how forms of implementation (such as pilots, projects, sequential adoption models, or whole-school developments) are being approached, how successful they are, identifying weaknesses and gaps (e.g., Wagner et al., 2005). With little or no concern for sustainability from day one, initiatives can promise results that will not be achieved (Gichoya, Hepworth, & Dawson, 2006). In developing countries where digital access is still rare, once a project is over, use of technology, if any, becomes more difficult: hardware and software become obsolete; connectivity can be too expensive; technical support and professional development are lacking (Trucano, 2015). So, more often than not, capacity building comes to a stop, and scalability does not occur (Breuleux et al., 2002 Looi & Teh, 2015).

Many innovative and implementation practices do take place, both inside and outside classrooms (Steyn et al., 2011; Voogt et al., 2015; see also the French website *Adjectif,* at http://www.adjectif.net). EDUsummIT 2015 TWG4 reviewed eleven examples of such case practices from five continents, using ISTE's (2009) essential conditions to leverage technology effectively for learning. These essential conditions are: (1) shared vision; (2) empowered leaders; (3) implementation planning; (4) consistent and adequate funding; (5) equitable access; (6) skilled personnel; (7) ongoing professional development; (8) technical support; (9) curriculum framework; (10) student-centred learning; (11) assessment and evaluation; (12) engaged communities; (13) support policies; and (14) supportive external context. Case writers estimated all these conditions as being more than half-present, with levels of presence estimated from 62% to 85%. These conditions appear to be important, but how they fit into longer-term processes for sustainability, involving third party and governmental organisations, is an important concern, which we focus on in subsequent sections of this paper.

Potential users of an innovation must accurately determine how to adapt and implement an innovation to their setting and whether sufficient conditions to make adaptation successful exist (Looi & Teh, 2015, p. ix). But, short-term studies demonstrate initial successes in adoption of digital technology are not enough (Ahmad, 2015; Labonté-Hubert, 2013). Long-term implementation studies reveal that conditions change, and new challenges arise (Laferrière, Hamel, & Searson, 2013; Passey, 2011; Sandholtz et al., 1997). Therefore, innovation and implementation need to be monitored regularly, in ways that match user and technology adaptation over time. For sustainability and digital equity to be achieved, long-term adaptability from technological, pedagogical, cultural, social and learning perspectives all need to be considered and in place.

Third party providers and policy makers should give special attention to curriculum frameworks outlining or enabling uses of ICT, and their alignment with implementation (e.g., ICT uses supporting student-centred learning), assessment and evaluation. In spite of abundant access to technology in developed countries, curricula and testing measures are both perceived by teachers as limiting uses of ICT (Fu, 2013). Developing curricula and testing measures, so that ICT use in teaching-learning processes becomes increasingly perceived as necessary, is a long-term challenge facing all education systems.

Regarding digital content to support country curricula, educational software and applications (apps) are widely developed in western countries, the content often reflecting those cultures. As a result, users in non-western countries must often learn and understand western culture to gain educational value from the resources. Developing resources by, or in conjunction with, individuals from regions in which they will be used, could remove one barrier to achieving educational equity. Additionally, this practice would potentially increase employment within this industry in regions where software/apps would be implemented. Similarly, language can act as a technological barrier. Most resources are in English, with non-English websites usually appealing to stereotypes to achieve marketability (Kalyanpur & Kirmani, 2005). Thus, it is important to build local communities of developers who can take forward continuity of resource innovations.

Factors affecting long-term implementation and sustainability

When issues and challenges influencing unsuccessful implementation are known, these need to be problematised. Digital gaps evolve because of gaps in access, adaptability, literacy and concerns held by some communities (see, for example, Hilbert, 2014). Fundamentally, introducing an element such as ICT into practice, to support both teaching and learning, is effectively concerned with change and its management. Conceptualising that change is clearly

important, as the form of conception chosen or developed can determine the nature of processes to support that change, both in the short- and longer-term. Key factors need to be considered also, if that change is to be successful. Weick and Quinn (1999) distinguished between two types of change, "episodic" and "continuous." In education, if digital technology introduction and implementation is considered an "episodic" change, then support and development might be more heavily focused on identified "episodes" occurring at intervals. On the other hand, if it is considered a "continuous" change, then support and development would be more consistently focused. Even taking these two different patterns into account, there are clear implications for education and its development by third party providers, since the pattern of change is then distinguished or determined by the perceptions or approaches of those implementing ICT into practice. In this context, Pennington (2003) distinguished between change that could be considered "radical" (perhaps implying more short-term focus) or "incremental" (implying longer-term focus) versus "core" or "peripheral"; again, there are implications for development and successful sustainability (also concerning maintaining the right to free education, stated by Article 28 of the UN Rights of the Child (UNICEF, n.d.), for those who can largely only access this through technology-based media).

Patterns of change involving ICT need to consider fundamental elements or factors. These factors may concern the ICT itself. Major hardware changes occur about every 5 years (Passey, 1999). Most recently, a major change occurred around 1995 when Internet use initially increased, and other major hardware changes since then have included interactive whiteboard technologies from the year 2000, mobile technologies from 2005, robots from 2010, and 3-dimensional, video and peripheral equipment such as printers from 2015. Software changes occur about every 18 months (discussed also in Passey, 1999). These changes not only include software updates and upgrades, but the emergence of new software. More recent significant software changes have included wider access to video editing, simulation and virtual world software, and video game editing and creation software.

Other factors affecting change concern how teachers support educational practices. Initial implementation of ICT into teaching practice leads to a downturn in performance. Mevarech (1997) described this as a U-curve, and she considered the implications that this has for teaching, learning and the appropriate timing for the identification of learning benefits. Leung, Watters and Ginns (2005) studied teachers in a case study school, with younger teachers reporting perceptions of their ICT abilities and self-efficacy decreasing during the first year of a project, and lowering of uses of ICT during the second year. These study findings paralleled those of a study conducted by the lead author, exploring how mathematics teachers in 20 schools integrated ICT into their practices; the teachers reported challenges during the first year of the project, and their uses of ICT decreased during the second year when professional development support was reduced. Benefits accruing after a period of time, once the downturn has been overcome, will not arise if implementation is not maintained to that second year. However, identifying forms of benefit needs to match forms of technologies and their uses. As stated elsewhere (Higgins et al., 2012; Passey, 2014), there is a need to consider what a technology does (in terms of its affordances, uses and outcomes for teaching and learning) before trying to identify its benefits and impacts. Regular changes in technologies and their appropriation for teaching and learning require regular updating and professional development. The "U-challenge" in this context refers to those time periods that teachers are implementing uses of technologies when their performance decreases, due initially to the need to accommodate new practices (Mevarech, 1997), and finding the most appropriate ways to benefit from these practices, then later, having to grapple with technologies that become increasingly obsolete or incompatible as time goes on.

Yet other factors affecting change concern the wider range of stakeholders who both influence educational practice and are influenced by educational practice. Change occurs within a system, and all actors in that system need to be involved and to understand what is happening and its consequences. Parents, students, teachers, school managers, third party providers, regional and national policy makers, educational advisers and researchers, and politicians are all stakeholders in the system; their values and concerns need to be known if change is to be managed successfully. These are factors concerned with national and cultural context. Context affects change, and contextual factors can hinder or support that change. Hence, political, social, technological, linguistic, cultural, economic, local and religious factors can affect change by being what have been described in some research studies as "drivers" or "barriers."

Long-term change requires a concern for sustainability. However, sustainability in this sense should not be considered as stability, or lack of change; it should be considered as a way to manage and handle ongoing and successive change. Long-term sustainability requires adaptability on the part of the actors involved, including third party providers. If technologies alone are the main agents that change over time, then even so, users require periods

of adaptation to those changes, to become familiar with differences, with additional benefits or disadvantages, or with practices that enable effective outcomes.

These factors mean that third party providers implementing ICT for educational purposes need to consider the future very carefully. Such "next-generation alignment" (aligning what is provided in a current context to also fit and match future needs) requires third party providers to take on board both desired future practices and estimated future changes in education and ICT. For regional and national developments, this suggests that governments should generate partnerships with universities, philanthropic foundations, teacher and parent associations, and businesses, in order to draw on their expertise and desires in this regard. In taking forward implementation of ICT informed by such expertise and desires, successive cycles of data-driven discussion and decision-making will then be necessary.

Third party organisations (e.g., foundations) that want to make a contribution (in terms of resources, funding, time, or energy) toward educational digital equity processes should be encouraged to work with policy guidelines that target sustainable innovation in settings of their choosing. They will need to manage their own expectations, as well as the expectations of those they want to support. They will have to choose between long-term commitments that in some settings keep improving the level of presence of the essential initial conditions identified by ISTE and effectively leveraging technology for shorter-term learning (termed "spikes" of innovation by Florida, 2005). Spikes of innovation refer to technology use for learning concentrated in some areas where teachers, administrators and learners come together, grow an understanding and develop skill regarding its uses for learning. It is important for third party organisations to understand the relevance of such spikes of innovation. Otherwise, short-term actions are likely to first seduce and later disappoint teachers and learners. In this respect, managing the "U-challenge" (periods when teachers are implementing uses of technologies, when their performance initially decreases due to the need to accommodate new practices and later when upgrading and review of practices occur) is vitally important.

Models of implementation and integration

How third party providers can model integration of ICT into educational practice is important, taking on board both the issues and challenges, and the factors that influence change. We consider initially the usefulness and applicability of existing and new models of implementation and integration. Traditionally, models of technology integration have focused on an implementation through stages or phases (such as the model developed by Hooper & Rieber, 1995), even when considering pedagogical implementation or change (see, for example, Puentedura, 2013). Conceptual approaches that focus more on the context of the change have also been developed (such as that of Corbett & Rossman, 1989), and uses of this form of approach have identified important factors beyond the technologies themselves (including political and cultural factors). Indeed, taking this point further, some authors (for example, Oliver, 2011; Pannabecker, 1991) have argued that implementation models need to move away from concerns with technological determinism. Other models have focused more on the factors that influence individual take-up of technology uses, such as the widely considered Rogers's (2003) Diffusion of Innovations Model, and the Technology Acceptance Model (TAM) of Davis (1989). While these models consider the individual user and their initial acceptance, other models have taken a perspective that is more concerned with ongoing adoption, such as the Concerns-Based Adoption Model (CBAM) of Hall, Wallace and Dossett (1973) and the post-acceptance model of Bhattacherjee (2001).

In contrast to models based on the elicitation of factors or features, Todnem By (2005) discusses the crucial importance of conceptualising change when considering its management. Factors identified in the previous section in this paper (technological, teacher practice, stakeholder, and contextual factors affecting long-term integration and sustainability) suggest that approaches for educational change with ICT should adopt management of continuous and incremental change with ongoing changing ICT. These factors support a visualisation of the conception of change as one having periods of downturn followed by benefit, then short periods of time where performance again dips (explained further below) prior to successive cycles arising. Figure 3 shows this as a long-term process, flowing across a period of perhaps 10 years.

In this model, downturns occur regularly, likely to arise because of technological shifts (referred to earlier as happening perhaps every 5 years for hardware and 18 months for software). After a time, different technologies and resources, redundancy of technologies, and difficulties associated with backward and forward compatibility and processing capacity, all mitigate a reduction in the ability of the teacher or user with the facilities afforded. Whilst

those facilities would be entirely usable at the outset, so there is a need to update, upgrade or replace, if the user is to maintain their performance. At the same time, this updating, upgrading or replacement needs to be considered in terms of necessary associated professional development and the way that abilities to use at the time of change allow the user to focus on adaptability. In Figure 3, base performance does not increase over time. The reason for showing performance in this way is to indicate that individuals need to accommodate change and retain their base performance. In reality, performance might change and increase over time, but this is an aspect where we need more research, to establish what happens at individual and group levels.

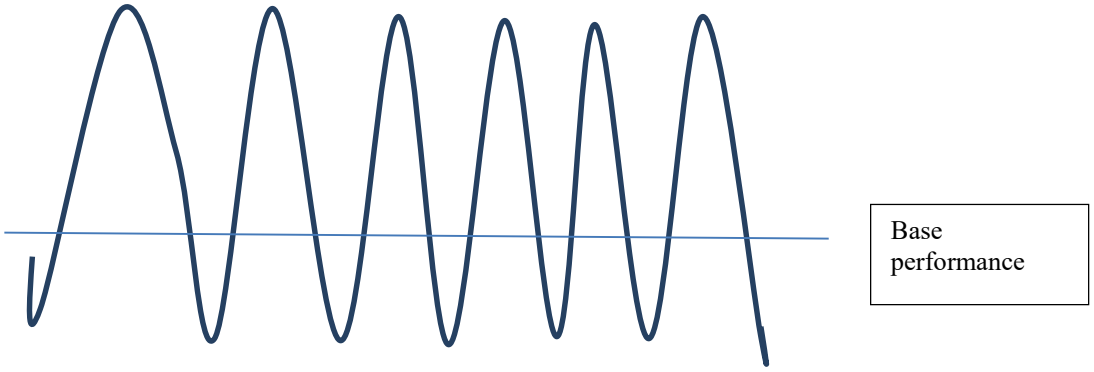

Figure 3. Successive cycles of ICT-determined change

Planning for sustainability

With a suitable model identified, plans emerging from this model can be detailed. If long-term integration of ICT is an aim of third party and government organisations, then a key concern needs to revolve around the planning elements of the process (as suggested by Figure 3 above), including a timeline integrating the elements identified and considered above. For example, considering a 10-year plan (shown in Table 1) that also integrates ISTE's (2009) essential conditions to effectively leverage technology for learning:

- implementation starts in year 0
- major hardware changes are shown every 5 years, even though the exact nature of them is unlikely to be known in advance
- software changes are shown every 3 years, even though some will happen every 18 months, and again their nature is not likely to be known in advance
- performance downturn is assumed to occur over a one-year period, every five years when major hardware changes occur
- benefits are assumed to occur after the one-year downturn has been overcome
- regular updating is determined by hardware changes, software changes, and challenges arising during periods following downturns being overcome
- systemic actors need to be identified at the outset, and there needs to be a regular check for changes that might occur and the implications these have in terms of those involved
- contextual factors need to be identified at the same intervals, to ensure that barriers and drivers are adequately considered
- adaptability concerns need to be integrated with initial and regular updating

When considering the ways in which features for planning (identified in Table 1) need to be integrated to enable sustainability as far as is possible, the feature of adaptability (a key factor identified by Rogers (2014), as more critical than intrinsic motivation itself), clearly needs to take account of previous experience in building new knowledge concerned with content, pedagogical and technological features for teaching and learning (Mishra & Koehler, 2006). In this case, the visualisation of the conception of change being considered here should perhaps be concerned more with a looping cyclical form of development (identified initially from case studies described in Passey, Capstick, & Poole, 1997), and shown in Figure 4, across years 0 to 11 from Table 1. Again, no increase in baseline performance is shown; the same reasoning as that in Figure 3 applies here.

Table 1. Planning for sustainability

Factor	ISTE essential conditions to review	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Starting phase	(1); (2); (3); (4); (5); (6); (7); (8); (9); (10); (11); (12); (13); (14)	■										
Hardware changes	(4); (5); (6); (7); (8)	■					■					■
Software changes	(4); (5); (6); (7); (8)	■			■			■			■	
Performance downturn	(6); (7)		■					■				
Benefits arising	(11)			■	■	■	■		■	■	■	■
Regular updating needed	(6); (7); (8); (9); (10); (11)			■		■		■		■		■
Systemic actors involved	(1); (2); (12); (13); (14)	■			■			■			■	
Contextual factors identified	(1); (2); (12); (13); (14)	■			■			■			■	
Adaptability concerns supported	(6); (7)	■		■		■		■		■		■

Note. (1) shared vision; (2) empowered leaders; (3) implementation planning; (4) consistent and adequate funding; (5) equitable access; (6) skilled personnel; (7) ongoing professional development; (8) technical support; (9) curriculum framework; (10) student-centred learning; (11) assessment and evaluation; (12) engaged communities; (13) support policies; (14) supportive external context.

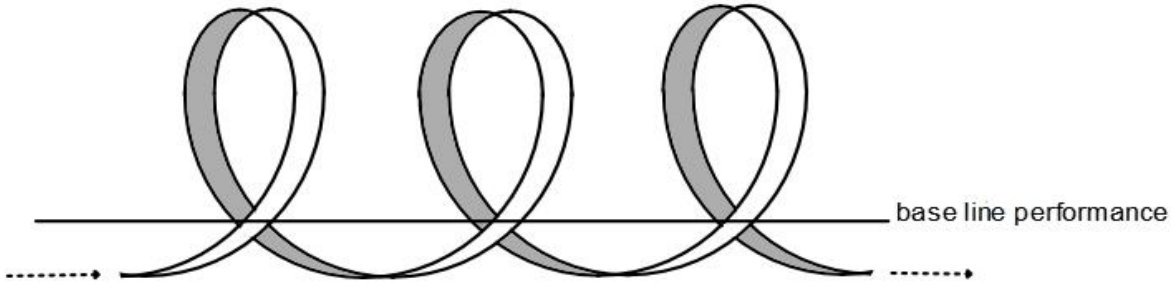

Figure 4. Looping cyclical form of ICT-determined change

Recommendations to third party and governmental organisations

If plans to implement ICT for education are to be successful, governmental and third party organisations need to be aware of key issues. From this conceptualisation and visualisation of implementation, recommendations at a policy level are:

- Be aware that change is inevitable, and that sustainability has to embed adaptability (Rogers, 2014). Examine innovation on a sustainable path towards digital equity by considering long-term adaptability, as well as referring to the ISTE initial "essential conditions" for project conception, implementation, and evaluation.

- Design projects inclusive of adequate time to build a reflective process that anticipates the dynamics of the "U-challenge" (time periods when teachers are implementing uses of technologies when their performance decreases, often during the first year, due initially to the need to accommodate new practices). Establish and nurture "spikes" of innovation perhaps every two years (see Table 1). For innovation to be sustained, innovation must be adapted to local contexts (which may need to be considered at institutional, local, regional or national

levels), reviewed every three years. The initial implementation phase must be followed by a long-term monitoring phase that identifies key points every two years. The formation of implementation and monitoring practices, including committees, is essential.

- Ensure understanding of what it is within a context that can gain systemic commitments in various contexts. It is important to be aware that digital educational resources reflect the culture of the country/region in which they are conceptualised and produced, and thus may inadvertently create barriers for reaching global educational equity.

- Commit resources and partners to long-term professional development of educators. Building a local community of developers, that will continue the innovations when the support is gone, should be established from the outset. As a part of this concern, materials in local languages should be available. Build in systemic and synchronous top-down (such as national and regional policies and support) and bottom-up (such as teacher and parent interest and commitment) processes that will assure sustainability.

Implications for research

Research has a major role to play in supporting sustainable digital technology implementation. Long-term planning for educational integration of ICT using a form of cyclical visualisation such as that shown in Figure 4 is not fully researched. Many studies have looked at the uses and outcomes of ICT in the short-term, perhaps over a period of 1 year, or 2 years at the most (see Passey, 2014, for example). Studies that look to explore the planning over long periods need to be instigated, and monitoring needs to be introduced over a period of years. Design-based implementation research is especially suited for such implementation and monitoring (Penuel et al., 2011). Initially, such studies and implementations can look at the experiences of the past, and consider how these might be projected to the future. For example, from the planning shown in Table 1, it would be possible to consider undertaking a study in a country to explore and identify more exactly the nature and implications for users of:

- hardware changes in education since 1995
- software changes since 1995
- experiences of learners, teachers, trainers or employers in their performance following ICT introductions
- benefits they have experienced from particular uses
- how these actors' uses have been updated
- who the systemic actors have been within their individual contexts and the roles they have played
- the contextual factors that have been present, and which favour or hinder changes with ICT
- how sustainability has been and is being considered
- how adaptability has been and is being introduced

This form of study could be undertaken initially through a Delphi or phenomenological approach, interviewing teachers, learners, parents, school managers, third party organisation managers, national policy makers, politicians, advisers and researchers, and employers. To achieve longer-term concepts of these past changes and experiences, perspectives could be gathered across the compulsory, post-compulsory, training and employment arena.

Taking forward this initial form of research, short-term studies can then be conducted and findings can be integrated into the context of the wider and longer-term picture that a longer-term study provides. It is not just implementation and planning that needs to be considered in the longer-term, and strategically; this also needs to be the case with research that is conducted in this field.

Conclusions

This paper has explored issues and needs of those third party and government organisations seeking to implement ICT into teaching and learning practices in developing countries. For all concerned, it is vitally important that the processes involved are as successful as possible in leading to long-term integration and sustainability. In considering patterns of support for those working in developing countries, viewed through outcomes from developed and developing countries, it should be recognised that long-standing integration of ICT into teaching and learning

practices in developed countries has not been achieved at any identifiable widespread level. This paper has considered fundamental reasons for this, problematising these in order to explore alternative conceptions and approaches. It is clear that context is important when looking at change, integration and sustainability; context needs to be fully understood and accommodated if integration is to be successful. Yet current models of integration are very largely based on research and practice arising from applications in developed countries, which do not take sustainability factors fully into account. In view of these limitations and their implied constraints, a new conceptual model is proposed in this paper.

Any new model needs to be trialed and researched, to identify the extent to which it might be applicable within one or more situations. While a single case study is likely to be useful as a starting point, other cases will also need to be considered, so that variations and commonalities can be understood much more fully. In this respect, the role of research in supporting third party and government organisations seeking to integrate ICT in teaching and learning practices is clear; it is important that a research agenda, to enable concepts and outcomes to be fed into the processes and practices of those undertaking integration, is established. This agenda needs to fundamentally explore how long-term rather than short-term needs can be fully identified, accommodated and aligned to support those undertaking and intending change in these areas.

Acknowledgements

A special thanks to: other participants who submitted cases, Mar Mbodj (Université Gaston Berger de St-Louis, Sénégal), Julie Hoffman (Curtin University, Australia), Assetou Kouraogo (Ministry of Education, Burkina Faso), and Allan Yuen (University of Hong Kong); and Jonghwi Park, UNESCO Bangkok Office, for her support.

References

Ahmad, A. K. (2015). *A Delphi study: Technology leadership network's perceptions of ISTE essential conditions for technology integration in professional learning communities* (Doctoral dissertation, Brandman University, Irvine, CA). Available from ProQuest Dissertations and Theses database. (UMI Number: 3700228)

Attewell, P. (2001). The First and second digital divides. *Sociology of Education, 74*(3), 252-59.

Bakia, M., Shear, L., Toyama, Y., & Lasseter, A. (2012). *Understanding the implications of online learning for educational productivity*. Washington, DC: U.S. Department of Education Office of Educational Technology.

Becker, H., & Riel, M. (2000). *Teacher professional engagement and constructivist-compatible computer use. Teaching, Learning and Computing: 1998: National Survey. Report #7.* Retrieved from http://files.eric.ed.gov/fulltext/ED449785.pdf

Bhattacherjee, A. (2001). Understanding information systems continuance: An Expectation-confirmation model. *Management Information Systems Quarterly, 25*(3), 351-370.

Breuleux, A., Laferrière, T., & Lamon, M. (2002, April). *Capacity building: Research and development into the effective uses of ICT*. Paper presented at the Pan-Canadian Education Research Agenda Symposium "Information Technology and Learning'", Montreal, Quebec. Retrieved from http://www.cesc.ca/pceradocs/2002/papers/ABreuleux_OEN.pdf

Corbett, H., & Rossman, G. B. (1989). Three paths to implementing change: A Research note. *Curriculum Inquiry*, *19*(2), 163-190.

Cuban, L. (2015). *The Lack of evidence-based practice: The Case of classroom technology* [Web log post]. Retrieved from https://larrycuban.wordpress.com/2015/02/05/the-lack-of-evidence-based-practice-the-case-of-classroom-technology-part-1/

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319–340.

Dutta, S., Geiger, T., & Lanvin, B. (2015). The Global information technology report 2015 ICTs for inclusive growth. In *World economic forum*. Retrieved from http://www3.weforum.org/docs/WEF_Global_IT_Report_2015.pdf

Florida, R. (2005). The World is spiky: Globalization has changed the economic playing field, but hasn't leveled it. *Atlantic Monthly, 296*(3), 48-49.Retrieved from http://www.theatlantic.com/past/docs/images/issues/200510/world-is-spiky.pdf

Fu, J. S. (2013). ICT in education: A Critical literature review and its implications. *International Journal of Education and Development using Information and Communication Technology, 9*(1), 112-125.

Gichoya, D., Hepworth, M., & Dawson, R. (2006). Factors affecting the success and failure of government ICT projects in developing countries. In D. Remenyi (Ed.), *Proceedings of the 2nd International Conference on E-Government.* Pittsburgh, PA: Academic Conferences Limited.

Griffin, P., McGaw, B., & Care, E. (2012). *Assessment and teaching of 21st century skills: Methods and approach.* Dordrecht, The Netherlands: Springer.

Hall, G., Wallace, R., & Dossett, W. (1973). *A Developmental conceptualization of the adoption process within educational institutions (Report No. 3006).* Austin, TX: Research and Development Center for Teacher Education, University of Texas at Austin. (ERIC Document Reproduction Service No. ED 095 126)

Higgins, S., Xiao, Z., & Katsipaki, M. (2012). *The Impact of digital technology on learning: A Summary for the education endowment foundation*. Durham, UK: Education Endowment Foundation and Durham University. Retrieved from https://educationendowmentfoundation.org.uk/uploads/pdf/The_Impact_of_Digital_Technology_on_Learning_-_Executive_Summary_(2012).pdf

Hilbert, M. (2014). Technological information inequality as an incessantly moving target: The Redistribution of information and communication capacities between 1986 and 2010. *Journal of the Association for Information Science and Technology, 65*(4), 821-835.

Hooper, S., & Rieber, L. P. (1995). Teaching with technology. In A. C. Ornstein (Ed.), *Teaching: Theory into practice* (pp. 154-170). Needham Heights, MA: Allyn and Bacon.

International Telecommunication Union (ITU). (2014). *Final WSIS Targets Review – Achievements, challenges and the way forward.* Geneva, Switzerland: International Telecommunication Union. Retrieved from http://www.itu.int/en/ITU-D/Statistics/Documents/publications/wsisreview2014/WSIS2014_review.pdf

International Telecommunication Union (ITU). (2015). *ICT facts and figures.* Retrieved from http://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2015.pdf

ISTE. (2009). *Essential conditions*. Retrieved from http//www.iste.org/standards/essential-conditions

Kalyanpur, M., & Kirmani, M. H. (2005). Diversity and technology: Classroom implications of the digital divide. *Journal of Special Education Technology, 20*(4), 9-18.

Kozma, R. B. (2005). Monitoring and evaluation of ICT for education impact: A Review. In D. Wagner, R. Day, T. James, R. Kozma, J. Miller, & T. Unwin (Eds.), *Monitoring and Evaluation of ICT in Education Projects: A Handbook for Developing Countries* (pp. 19-34). Washington, DC: The International Bank for Reconstruction and Development/The World Bank.

Kupermintz, H., Shepard, L., & Linn, R. (2001, April). *Teacher effects as a measure of teacher effectiveness: Construct validity considerations in TVAAS (Tennessee Value Added Assessment System)*. Paper presented at the National Council on Measurement in Education (NCME) Annual Meeting. Seattle, WA. Retrieved from http://statweb.stanford.edu/~rag/ed351/tvaas.pdf

Labonté-Hubert, A. (2013). *Les manifestations de transformation dans l'activité d'intégration du Knowledge Forum et de VIA dans la classe pléthorique burkinabè* [The manifestations of activity transformation supported by Knowledge Forum and VIA in a bloated Burkinabe classroom] (Unpublished master thesis). Université Laval, QC, Canada.

Laferrière, T., Hamel, C., & Searson, M. (2013). Barriers to successful implementation of technology integration in educational settings: A Case study. *Journal of Computer-Assisted Learning, 29*(5), 463-473.

Leung, K. P., Watters, J. J., & Ginns, I. S. (2005, June). *Enhancing teachers' incorporation of ICT in classroom teaching.* Paper presented at the 9th Annual Global Chinese Conference on Computers in Education. Brigham Young University, Hawaii, USA.

Looi, C. K., & Teh, L. W., (Eds.) (2015). *Scaling educational innovations.* Heidelberg, Germany: Springer. doi:10.1007/978-981-287-537-2

Mevarech, Z. R. (1997). The U-curve process that trainee teachers experience in integrating computers into the curriculum. In D. Passey & B. Samways (Eds.), *Proceedings of the IFIP TC3 WG3.1/3.5 joint working conference on Information Technology Supporting Change through Teacher Education* (pp. 46-51). London, UK: Chapman and Hall.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A Framework for teacher knowledge. *Teachers College Record, 108*(6), 1017–1054.

Oliver, M. (2011). Technological determinism in educational technology research: Some alternative ways of thinking about the relationship between learning and technology. *Journal of Computer Assisted Learning, 27*, 373-384.

OECD (2015). *Students, computers, and learning: Making the connection*. Paris, France: OECD Publishing. doi:10.1787/9789264239555-en

Pannabecker, J. R. (1991). Technological impacts and determinism in technology education: Alternate metaphors from social constructivism. *Journal of Technology Education, 3*(1). Retrieved from http://scholar.lib.vt.edu/ejournals/JTE/v3n1/html/pannabecker.html

Passey, D. (1999). Strategic evaluation of the impacts on learning of educational technologies: Exploring some of the issues for evaluators and future evaluation audiences. *Education and Information Technologies*, *4*(3), 221-248.

Passey, D. (2011). Implementing learning platforms into schools: an architecture for wider involvement in learning. *Learning, Media and Technology, 36*(4), 367-397.

Passey, D. (2014). *Inclusive technology enhanced learning: Overcoming cognitive, physical, emotional and geographic challenges*. New York, NY: Routledge

Passey, D., Capstick, N., & Poole, P. (1997). *Managing IT in secondary schools*. Coventry, UK: NCET.

Pennington, G. (2003). *Guidelines for promoting and facilitating change.* York, UK: Learning and Teaching Support Network (LTSN) Retrieved from https://www.heacademy.ac.uk/sites/default/files/id296_promoting_and_facilitating_change.pdf

Penuel, W. R., Fishman, B. J., Cheng, B. H., & Sabelli, N. (2011). Organizing research and development at the intersection of learning, implementation, and design. *Educational Researcher, 40*(7), 331–337.

Puentedura, R. R. (2013). *The SAMR ladder: Questions and transitions*. Retrieved from http://www.hippasus.com/rrpweblog/archives/2013/10/26/SAMRLadder_Questions.pdf

Resta, P. (2009). *Global digital divide. Working groups panel session: Policy perspective* [Presentation file]. Retrieved from http://www.curtin.edu.au/edusummit/edusummit-archive/working-groups-2009.cfm

Resta, P. (2011). *Global awareness: Working Group 4 expanded paper*. Retrieved from http://www.curtin.edu.au/edusummit/local/docs/4_EDUsummIT_2011_global_awareness_expanded_brief_paper.pdf

Resta, P., & Laferrière, T. (2013). *Working Group 4: Digital equity and intercultural education. EDUsummIT: International Summit on ICT in Education*. Retrieved from http://www.curtin.edu.au/edusummit/local/docs/TWG4_Working_Summary_report.pdf

Rogers, C. (2014). Digital skills and motivation in young people in transition. In D. Passey & A. Tatnall (Eds.). *Key competencies in ICT and informatics: Implications and issues for educational professionals and management* (pp. 150-164). Heidelberg, Germany: Springer Verlag.

Rogers, E. (2003). *Diffusion of innovations* (5th ed.). New York, NY: Simon and Schuster.

Sandholtz, J., Ringstaff, C., & Dwyer, D. (1997). *Teaching with technology: Creating student-centered classrooms*. New York, NY: Teachers College Press.

Selwyn, N. (2010). Looking beyond learning: Notes towards the critical study of educational technology. *Journal of Computer Assisted Learning, 26*, 65-73.

Steyn, J., van Belle, J.-P., & Villanueva Mansilla, E. (2011). *ICTs for global development and sustainability: Practice and applications*. Hershey, NY: IGI Global.

Tamim, R. M., Bernard, R. M., Borokhovsi, E., Abrami, P. C., & Schmid, R. F. (2011). What forty years of research says about the impact of technology on learning: A Second-order meta-analysis and validation study. *Review of Educational Research, 81*(1), 4–28.

Tatnall, A., & Davey, B. (Eds.) (2014). *Reflections on the history of computers in education: Using computers and teaching about computing in schools from the late 1970s to the early 1990s.* Heidelberg, Germany: Springer.

Todnem By, R. (2005). Organisational change management: A Critical review. *Journal of Change Management, 5*(4), 369-380.

Trucano, M. (2015). *Surveying ICT use in education in Africa. EduTech: A World Bank blog on ICT use in education* [Web log post]. Retrieved from http://blogs.worldbank.org/edutech/surveying-ict-use-education-africa

UNESCO. (2011). *UNESCO ICT competency framework for teachers.* Retrieved from http://iite.unesco.org/pics/publications/en/files/3214694.pdf

UNICEF. (n.d.). *Fact sheet: A Summary of the rights under the convention on the rights of the child*. Retrieved from http://www.unicef.org/crc/files/Rights_overview.pdf

Voogt J., & Knezek, G. (2008). *International handbook of information technology in primary and secondary education*. New York, NY: Springer.

Voogt, J., Laferrière, T., Breuleux, A., Itow, R., Hickey, D. T., & McKenney, S. (2015). Collaborative (re-)design as a form of professional development: Teacher learning by design. *Instructional Science, 43*(2), 259-282. doi:10.1007/s11251-014-9340-7

Wagner, D. A., Day, B., James, T., Kozma, R. B., Miller, J., & Unwin, T. (2005). *Monitoring and evaluation of ICT in education projects: A Handbook for developing countries*. Washington, DC: infoDev/World Bank.

Weick, K. E., & Quinn, R. E. (1999). Organisational change and development. *Annual Review of Psychology, 50*, 361-386.