A Conundrum Of Learning Theories And ICTS In Learning. Challenges And Possible Solutions

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Abstract

A learning needs analysis traditionally led to the identification of desirable ICTs. Lately, ICT and digital natives drive eLearning without much attention to learning theories. An ICT enters the market, students learn how to use it, and then instructional designers adopt and adapt it to learning.
Although expectedly ICT adoption should and has been evolving, ICT adoption is at crossroads between designing programs to sort learning and teaching problems and designing learning to suit an ICT. The digital divide between the haves and not haves exacerbates the cross of roads.
In this paper, I argue that, although the roads are not mutually exclusive, ICT adoption faces challenges and possibilities of lecturer roles being taken over by computer technologists.

Key words: *ICTS In Learning, Learning Theories, eLearning, ICT adoption*

Introduction

Besides the different theories, learning is viewed differently by digital residents and immigrants (Sims, 2006). The cultural variables mostly found in developing countries are often excluded on account of the digital gap (Dijk, 2012). Some of the emerging learning ICTs now common to digital natives attempt to take into account the specific students' learning needs, preferences and styles including the multiple intelligences. Expectedly, then learning practitioners seem to equate the provision of, or access to, electronic resources of learning to student-centeredness (Muwanga-Zake, 2007), and do not see a need to follow the processes of ICT adoption (or of Instructional Design [ID]). Besides, technological innovations and their youthful residents to who technology is a way of life increasingly challenge educators to shift teaching strategies (Sims, 2006). However, such a trend tends to make technology the problem, and starts with a technology (e.g., blogging), and then finds ways of using a technology to enhance learning; hence practitioners are worried about locating the most appropriate learning theory for online learning instead of finding the most suitable technology for sorting a specific learning problem.

Indeed to some, it is enough to provide electronic study materials and web-based resources to students with the assumption that digital citizens (Lloyd, Lipu & Kennan, 2010) or even technology have the capacity to miraculously convert information into knowledge. Such and related cases makes technologists leaders in facilitating learning, contrary to traditional Instructional Design (ID) (e.g., Dick & Cary, 1990), by which technology is used to solve specific instructional problems. Nonetheless, traditional ID is basically meant to solve teaching problems in a systemic way. So, ID is not so much tuned to learning – it is focussed on teaching or instruction. So, ID is to some extent static as it faces tensions against the emerging blends of pedagogies.

This paper reviews literature and research of over fifty years that relates learning technology to learning theories, showing that, although eventually some use is found, the current dissonance between ICTs and learning is due to the trial and error approach, when technology enters learning institutions without a clear idea of how or for what such technology should be used. ICT adoption is at crossroads to the extent that Learning Technology, Instructional Design and/or eLearning might have to be redefined, especially in regard to the advancements in technology.

CHALLENGES TO INSTRUCTIONAL DESIGNERS

There is no doubt that ICT and in particular web-based or online technology has enhanced student-centred learning and has made searching for information and of researching nebulous. While access to information might increase the chances of learning, it is contentious whether information is necessarily transformed into knowledge. Specifically, what is the usability of electronic or web-based dissemination of information? For example, online, or digital inhabitants can be locally anti social, preferring to share knowledge virtually, oblivious, apparently, of physical realities such as the people and information in their surroundings. The competition for attention between lectures and these virtual sources is challenging when students or even lecturers chose virtual resources (Shimabukuro, 2005), which take over some of the lecturer roles.

While blogs, for example, could offer voluminous information, the ability for students to use that information to learn and to face-to-face debate issues is questionable. In that regard, Glogoff (2005) wonders whether virtual communication can lead to useful virtual communities. Such virtual realities and challenges are amplified by the digital gap, for example, in Africa.

LECTURERS AND ICT

Lecturers are the obverses of human capital production, in that they enable and improve public access to ICTs (e.g., BECTA, 2005; Chinn & Fairlie, 2006) while simultaneously role modelling ICT uses. Hence, lecturers must be able to use computers and to use them to teach, to produce computer literate workers required by the global economy. I.e., the digital competencies of lecturers or digital gap lecturers suffer permeates through society exponentially.

Minaidi & Hlapanis (2005) sum up citations of several authors with the view that adopting ICT in learning *can be influenced by technological, organisational, social, cultural, economic and teacher development factors.* Despite questions on the value of ICT specifically in teaching (e.g., Whittier & Lara, 2006), and reports of problems in the use of computers in lessons (e.g., Watson, 2001; the British Learning Communicational and Technology Agency [BECTA], 2005), lessons have been increasingly digitalised, and ICT skills are already basic for lecturers in the more developed economies because of the benefits to learning from ICTs (e.g., given in Pedro, Enrique, Ernesto & Lucio, 2004). Benefits include improving learning conditions, preparing students for the knowledge society, enhancing classroom and school information management processes, and equity, in connecting varied income groups and with learningal projects around the world. But Africa suffers the digital gap and is decades behind to realise these ICT potentials (Whittier & Lara, 2006).

However, the lecturers' digital gap seems to have persevered (e.g., Bybee & Ellis, 1988; Watson, 2001), being caused by curriculum problems (e.g., timetables and workloads), understanding theoretical frameworks and practicalities of teaching that are not teacher-centred, teacher incompetence in computer skills, and inaccessibility. Watson (2001) believes that the credibility or digital gap might block adoption of ICTs, and has observed lecturers rejecting ICTs that do not resonate with their traditional classroom practices with all sorts of excuses. Unaware of ICT potentials or alternative pedagogies, such lecturers fit technology into their usual pedagogic (Simpson, Payne, Munro & Hughes, 1999: Lloyd & Yellan, 2003).

Lecturers are likely to reject ICTs that are imposed upon them (Lloyd & Yellan, 2003) without their participation in the adoption. Lecturers should take ownership of ICT implementation but occasionally computer issues become loci of power relationships, which determine access and the time available for lecturers to explore ICT uses (Watson, 2001; Lloyd & Yellan, 2003). Ultimately, lecturers in Africa do not even recognise a need for ICT adoption. A simple survey in Ugandan learning institutions showed that most lecturers and lecturers do not know about ICT adoption.

ICT ADOPTION

There are several conceptions of ICT adoption. ICT adoption can be viewed as a Process; as a Discipline; as a Science; as Reality; as a System; as a Technology; and as Development. Hence, Wilson (1995) notes that there are instructional designers who suggest that ICT adoption may be independent of learning-theories. Besides, Ely (1999) argues that improved learning due to ICT adoption is not related to the hardware and software that is used. That is, learning design is a more powerful influence on learning than the system that delivers the instruction.

Alternative views by Wilson (1995) posit that theories of learning serve as foundations for adopting ICTs in learning although theories might be inadequate as guides for eLearning. Gagné & Briggs (1979) as well as Gagné (1985) directly relate learning theories with ICT adoption and use. Thus, there is a relationship between psychology and designing eLearning, and this relationship is probably implicit noting arguments in Hannafin & Rieber (1989) and Thompson, Simonson & Hargrave (1993). An example is the Collins-Brown cognitive apprenticeship model that is tightly linked to cognitivism (Wilson, 1995b). Hannafin et al. (1996) show developments in ICT adoption alongside psychology of learning in tandem with improvements in

ICTs. Wilson suggests that we should all look for praxis (interface between theory and practice), with psychologists providing knowledge on how learning could happen through technology, and designers looking at the best ways of instruction (Young, 2003).

A behaviourist ICT adoption approach

E-learning models may be defined as the visualized representations of the main elements or phases, and their relationships. Thompson, Simonson, & Hargrave (1993), Wilson (1995) as well as Rieber (1991) argue that historically ICT adoption was assumed to be consistent with an instructivist, behaviourist, objectivist, and knowledge transmission, mainly borrowing from information systems processes. Behavioural models are procedural or programmed instruction based on behavioural learning theories, for example of Skinner, Gagne and Rowntree, shaped the first generation ICT adoption, roughly during 1960-1975 (Hannafin, Hannafin, Hooper, Rieber, & Kini, 1996: 379; Wilson & Cole, 1996; Mergel, 1998; Jacobs, 1992: 117-118). Gagne (1985), Hannafin & Rieber (1989), Reeves (1994), as well as Burton *et al.* (2001) articulate some of the ICT adoption behaviourist models. A similar behaviourist–objectivist instructional design approach seems to be recommended in Gagné (1985), supported by Thompson *et al* (1993) who concluded that behaviourism is the most practical approach in ICT adoption. An example of such ICT adoption is the Dick & Carey model (Analysis, Design, Development, Implementation, and Evaluation) (ADDIE). Among others, Rieber (1991), Perkins (1991), Wilson (1995), Thompson *et al* (1993), Savery & Duffy (1995), White & Purdom (1996), and Greening (1998) summarise the weaknesses of that traditional ICT adoption and what prompted the shift from behavioural to include cognitive and constructivist approaches in ICT adoption (Hussain, 2012).

The designer writes behaviourally specific learning objectives, classifies those objectives according to a taxonomy of learning types, and then arranges the instructional conditions to fit the current instructional prescriptions. Learners start from easier to skills or concepts that are more difficult or complex (Wilson & Cole, 1991). Tinker & Papert (1988) claim that such programmes are relatively easy to create, and easy to integrate into curriculum. Examples of this include simulated actions used to train aircraft pilots as well as simulated science experiments (Linn, 1988). In this way, designers can design instruction to successfully teach a rule, a psychomotor skill, an attitude, or piece of verbal information (Wilson & Cole, 1991). Lecturers can possibly manage a behaviourist ICT adoption since it resonates with their common classroom practices. Thus, a small number of faculty viewed technological tools as a replacement for pedagogy, this being likely related to teaching and learning orientations, as manifested in course goals, objectives and activities as manifested in course goals, objectives and activities (Phillips, Wells, Ice, Curtis & Kennedy, 2008).

Among others, Alexander (1997), Greening (1998), as well as Rieber *et al.* (1998) summarise the weaknesses of behaviourist 'instructivist' pedagogy. They point out objections to, more importantly, the assumption that the lecturer can see further than and the learner; that it is only effective for low-level learning such as rote recall; and that each step presented is the best one to take in order for every user. Regardless, Tinker & Papert (1988) argue that behavioural approaches such as simulations, tutorials, drill-and-practice are still useful in ICT adoption. Hannafin & Rieber (1989) concluded that behavioural models are efficient.

Evolution of ICT adoption is not new

Wilson & Cole (1996) show three stages of ICT adoption development which directly correspond with the three major learning theories, behaviourism, cognitivism, and constructivism. However, Winn (1993) thinks that there are four generations of ICT adoption evolution. All models might be represented in a single programme.

A cognitive ICT adoption approach

Hannafin *et al.* (1996) and Wilson & Cole (1996) state that cognitive perspectives gained increased acceptance because of the desire to inculcate cognitive processes, including assisting learners to form new concepts. Another essential for learning process is problem-solving (Wilson & Cole, 1991). However, according to Hannafin *et al.* (2004), there are some similarities between behavioural and cognitive programmes. For example, content is broken down and ordered in hierarchy to meet externally determined objectives, and knowledge and skills are conveyed through structured formats.

However, unlike behaviourist models, the focus is on the individual, and how that individual selects, perceives, processes, and learns information (Hannafin & Rieber, 1989). The model stimulates cognitive processing instead of teaching. For example, Lepper & Chabay (as cited in Wilson & Cole, 1991) note that some cognitive models accentuate learner-initiated inquiry, exploration, cooperative learning, and empathy, which traditional behavioural ICT adoption models do not emphasise.

Cognitive-based ICT adoption aims at learning that occurs as individuals construct 'schemata' that represents the world for them, and incorporates the notion of accommodation and assimilation (Gardner, 1983, 1993), and at matching learning to the individual's needs and style of learning (Cronbach & Snow, 1977; Tobias, 1976, 1989). Thus, the second generation is based on 'exogenous constructivism', by which the programme just helps learners with activities or exercises that makes them cognitively active towards new concepts and to better capacities to solve problems (Dalgarno, 2001). The programme scaffolds the understanding each individual learner needs to create new knowledge (Madden, 2018).

The cognitive model deals also with content (as in textbooks) as domain knowledge (conceptual, factual, and procedural), but considers it insufficient to enable learners to approach and solve problems independently. The model also provides heuristic strategies that help narrow solution paths, for example, through repeated problem solving practice. However, the learner controls most of the activities. The cognitive model recommends situated learning: that is, learning that reflects the way the knowledge will be useful in real life or authentic contexts. Collins (as cited in Wilson & Cole, 1991, and in Wilson *et al.* 1993), as well as Duffy & Cunningham (2001) advise that situated cognition should be based upon problem-solving situations. Collins gives an example in mathematics where learning could encompass shopping in a grocery store. A computer can be used to model such a situation, and the learners would be asked to articulate reasons for phenomena in the model. A teacher or an intelligent tutoring system gives hints to help (i.e., coaches) the learner when they are failing to solve the problem or if they are getting off-course. Cognitive ICT adoption strategies offer possibilities for transforming a learner's conceptual understanding, in a similar way practical work might.

Another important aspect of cognitive ICT adoption is that it can incorporate exploration, which encourages learners to try out different strategies and hypotheses and to observe the effects their trials. Collins (as cited in Wilson & Cole, 1991) claims that through exploration, students learn how to set achievable goals and to manage the pursuit of those goals - they learn to set and try out hypotheses, and to seek knowledge independently. Real-world exploration is always an attractive option; however, constraints of cost, time, and safety sometimes prohibit instruction in realistic settings. Computers offer additional advantages such as the ability to change the complexity or diversity of a situation instantly – this enables further challenges and offers grounds for testing concepts.

From about 1989 (Wilson & Cole, 1996), third generation ICT adoption started and incorporates the learner's inputs and control of the direction of learning. It is a generation in which the constructivism aspect in the cognitive theories ("Cognitive Complexity Theory", and the "Anchored Instruction" theory) as well as the "Instructional Transaction Theory" advocating for interaction (transaction) between learner and program are applied for discovery and experiential learning in computer "micro worlds"(Rieber, 1992; Wenger, 1987; Merrill, 1991, 1993). Learners chose what to learn. Papert used Piaget's psychology in his development of the

LOGO (*logos* is thought in Greek) programming language. LOGO could be an example of a third generation programme (Logo Foundation, 2019); it provides different forms of activities in a non-linear format, creates exploratory environments, providing guided discovery and choices to the learner at any time (Linn, 1988; Sullivan, 2017). Lecturers would find the cognitive paradigms rather challenging to apply in ICT adoption because their class practices are rarely cognitivist.

Beyond cognitivist models, the ICTs cater for Multiple Intelligence (MI) (as defined by Gardner) in third generation ICT adoption, providing instructional designers with many approaches to a topic.

It is not clear where the third generation ends (and whether that is important), but beyond the third generation, use of computers in learning focused attention on interactive multimedia (BECTA, 2001), in which learners control what they do in a constructivist framework (Alexander, 1997), with the assumption that learners know best their needs. These seem to be cognitive constructivist models, which Papert (1993) argues are "dirty" (holistic and authentic), as opposed to behavioural approaches, which Papert terms "clean" teaching (isolate and break down knowledge to be learned). Cognitive-constructivist models view truth and knowing as local events, and highlight the importance of context and multiple perspectives in making meaning (Willis, 2000: 5), all of which can be disorganised (dirty). Again, lecturers would not ordinarily incorporate constructivist cognitive models in their classes.

Fourth generation ICT adoption and micro-worlds

The fourth generation rejects cognitive science as the **only** (my emphasis) basis for ICT adoption in learning, and abhors the exclusion of the learner from planning or designing the learning experience. It relies on 'endogenous constructivism' by which learners discover and explore virtual environments (Dalgarno, 2001). Constructivist experiences help learners to understand what they are studying (Salviati as cited in Cunningham, 1991), because, through participation, such experiences embody iterative use of knowledge and skills for further experiments and experiences (Winn, 1997). The design permits learners any kind of interaction the system is capable of (Jacobs, 1992; Merrill, 1993; Young, 1989), instead of prescriptions. The importance of context, and of social construction imply that **any** (my emphasis) model made by learners is just one of the many possible constructivist ICT adoption models (Willis, 2000; Kozma, 2000). The fourth generation ICT adoption ushers in the use of micro-worlds and open environments into ICT adoption, and offers opportunities for a wider range of learning strategies including constructivism.

Micro-worlds, virtual environments, and virtual realities

Jonassen *et al.* (2003) state that Papert and the MIT Media Lab started the use of the term 'micro-world'. A micro-world is an exploratory learning environment that simulates phenomena, thus offering opportunities to learners to manipulate, explore, and experiment. A micro-world is also known as a simple domain, focussing on the quality of a few interrelated constructs (Hannafin *et al.*, 1996). Computer micro-worlds offer virtual environments and realities in which one can do many things, some of which are beyond reach in real worlds (Bharathi & Tucker, 2015). Other examples of micro-worlds or "phenomenaria areas" appear in Perkins (1991), and include "aquariums", "SimCity", and "physics micro-worlds". Another example is MicroWorlds EX is a coding environment that empowers students to create and share interactive games, perform mathematical experiments, explore science simulations and write multimedia stories.

Wilson *et al.* (1993) explain that manipulating the equipment, the task, and the environment control the complexity in a micro-world. Thus, *successful micro-worlds rely on learners regulating and controlling their own learning* (Jonassen *et al.,* 2003). For example, micro-worlds can incorporate cognitive apprenticeships, which provide *opportunities for modelling, reflection, exploration,* and for a learner to reflect on his/her knowledge

(Wilson *et al.,* 1993). Or can *contain adventure games, where players master each environment before moving on to more complex environments* (Jonassen *et al*., 2003).

The importance of micro-worlds is that they are more open for learning than, for example, laboratories, that are defined by pre-specified objectives. With these features, micro-worlds can qualitatively alter a learner's conceptions (Hannafin *et al.,* 1996: 393). Playing games in such micro-worlds is an example of applications of radical constructivism (Rieber, 1992; Rieber *et al.,* 1998).

McLellan (2001) notes that 'virtual' *denotes the computer-generated counterpart of a physical object,* and Rieber (1992) describes VEs as … *computer-based learning environments* ... Jonassen *et al.* (2003) describe VR as … *a type of micro-world that provides learners with an interactive 3-D experience by surrounding them with a moving simulated world.*

However, I take virtual environment as the space in which virtual realities happen or exist. A micro-world generated by a computer then has space, which I refer to as the virtual environment (VE), and objects as well as activities, which I refer to as virtual realities (VR). Learners enter into an artificial micro-world, which has VEs (Hannafin & Sullivan, 1995; Winn, 1997). The advantage of VE micro-worlds is that they cannot be provided by any other means (Winn, 1993). For example, computers can enrich VEs and extend our perceptual, tactile, and visual insight into concepts (Kiboss, 1998). VEs can be used to teach science concepts, which are difficult to teach in real laboratories because learners interact iteratively with virtual objects in conditions, which are possible only in a virtual laboratory (Perkins, 1991; Ramsey, 1975; Dede, 1995; Winn, 1997; Geelan, 2000). Overall, access to knowledge and interactions are unrestricted in VEs, and offer open environments, possibly as described by Doll (1989), that are useful for modelling (Stratford, 1997), and encourage what Yore (2001) refers to as interactive constructivism. However, there are complaints that VEs have suffered prevalence of technology and aesthetics rather than promoting knowledge – they simply supply information without knowledge-building processes (Barbera, 2004).

Open learning environments (OLEs)

It seems that the notion of an open learning environment, as described by Doll (1989), Hannafin, Hall, Land, & Hill (1994), Hannafin *et al.* (2004), as well as Hannafin, Oliver & Land (1999), is constructivist since such an environment grants learners their wishes, but allows inputs from a facilitator and/or the programme. The constructivist design anchors learning activities to the learner's long-term or larger problems, but in a form authentic, and therefore open, to a learner (Savery & Duffy, 1995). Rieber (1992), Hannafin (1999) as well as Savery & Duffy (1995) explain further that an environment is open if it allows a learner to choose interactions, goals, and /or the way to pursue those goals. The focus is on an individual's understanding, needs, perceptions, and experiences. Thus, Hannafin (1999) adds that OLEs guide learners to recognise or generate problems that relate to their needs.

Constructivist OLEs are chaotic

Openness brings with it multiple demands, since each learner might have different desires and methods of learning. Thus, Wilson (1996) believes that among the difficulties with open environments is the possibility that they might be fuzzy and ill defined, but argues that an environment that is good for learning cannot be fully packaged and defined. Learners might chose activities, pace and direction, to the extent that the end outcome is uncertain and uncontrolled. Thus, Winn (1997) as well as Hannafin (1999) point out that strategies for providing guidance, feedback to actions and collaboration, are not so straightforward.

Wilson (1996), Dede (1995), and Perkins (1996) note differences in the amount of guidance or direct instruction found in learning environments, and observe that varying degrees of guidance pose different instructional challenges. According to Wilson, the teacher or instructional designer has to be tentative to accommodate learner freedom. Learners can be provided with perspective-setting or -altering contexts that help to activate relevant prior knowledge, experience, and skill related to the problem and to potential strategies to be deployed (Hannafin, 1999).

Wilson observes that the same chaos (desirable in OLEs) is also characteristic of poorly designed OLEs – i.e., it might be difficult to know whether the chaos is intended or is a result of poor design. For example, when learners get lost or stranded, one need to find out whether this is designed to help them solve a problem or it is due to lack of support.

Virtual reality

The advent of virtual reality (VR) boost the fourth generation programmes (Winn, 1993, 2002). Computer-generated micro-worlds provide VR in which there are opportunities for exploration (Cohen, Tsai, & Chechile, 1995) of phenomena that would be difficult, or intangible under usual laboratories. Additionally, traditional lessons sometimes lack real-life analogies on which to build mental models, because there are no such events in the real world (Dede *et al.,* 1997).

Jonassen *et al.* (2003) explain that an outstanding feature of a good VR is 'immersion'. Dede (1995), (Osberg, 1997), as well as Moshell, Hughes, & Loftin (1999) add that immersion in VR can provide the subjective impression that one is participating in a "world" comprehensive and realistic enough to induce suspension of disbelief. That is, the user becomes isolated from the real environment and interprets the images in the VR as being real. This makes the user interact intuitively like an inhabitant of the VR.

According to Dede (1995), Zeltzer (1992), and Dede, *et al.* (1997), VR improves learners' understanding relative to other technologies because VR accommodates autonomy, presence, and interaction (Dede, Salzman, Loftin, & Ash, 1997). That is, VR can engage learners with experiences, which facilitate perceptual experiences. Thus, VR supports constructivist learning (Greening, 1998). The theorists in this paragraph also believe that another useful characteristics of VR for learning is that it motivates a learner by inducing him/her to spend more time and to concentrate on a task. I think these are ways the designers of Zadarh used VR.

VRs face difficulties of cognitive load. For example, there is a difficulty of *switching attention between the different senses for various tasks* (Dede, 1995). Hence, Dede (1995) advises for taking care of speed.

Games in VE and VR micro-worlds

Various authors (E.g., Linn, 1988: 128; Leutner, 1993; Tinker & Papert, 1988; Greening, 1998; Dede, *et al.*, 1997; Rieber, 1996) elaborate on constructivist microworlds that include games. The process of playing the game is constructivist in that the learners are co-designers (design to learn kind of approach), but should be guided (Rieber, Smith, & Noah, 2002). These authors advise that the game should be interesting with graphics that is appealing and music.

ISSUES OF CONTENTION

Sims (2006) concludes that we do not need traditional ICT adoption, and recommends constructivist student-centred environments for online learning. Online is similar to CD-ROM-based learning computer programmes (ECPs) in that learning could happen away from the designer. For both, I argue that traditional ICT adoption is not necessarily undesirable; what matters are the objectives and context.

Of the traditional ICT adoption format, this paper looks at analysis and design in the contexts of African disadvantaged institutions that are poor and depend upon donated technology, with technologically challenged lecturers and students.

Instruction and construction?

It is notable that instruction and construction appear to be antagonistic such that there could be tension between classical (traditional) ICT adoption and the newer radical constructivist approaches in ICT adoption.

Hannafin *et al.* (1996) as well as Hannafin, Hannafin, Land, & Oliver (1997) discuss this apparent tension at length. For example, Hannafin *et al.* (1997) argue that Gagne's instruction model takes *reality as objective and independent of the individual learner*. On the other hand, constructional design creates environments in which a learner can design his or her own tasks and constructs. Thus, *the term 'instruction' is considered a pejorative to some in describing emerging learning systems* (Hannafin *et al.,* 1996).

Hannafin *et al* (1997) and Schuman (1996) advise inclusion of aspects of each learning theory because each theory has strengths and weaknesses. In support, Ertmer & Newby (2008) and Davidson (1998) point out that learning theories are compatible with ICT adoption, such that Scott, Dyson & Gater (1987) talk of the application of constructivism in instructional design with reference to games.

THE CROSSROADS

There is no doubt that ICT, and in particular web-based or online technology has enhanced and redefined the way students and lecturers look for information and do research. While access to information might increase chances of learning, it is contestable whether the increased access to information necessarily improves learning and acquisition of knowledge. This is besides the arduous task of evaluating the quality of knowledge; for example, usability of such knowledge. Inhibiting factors against usability of such knowledge is the observation that online, or digital inhabitants are characteristically locally anti-social. Watch students absorbed into their podcasts oblivious, apparently, of people they are sitting with to engage them in a knowledge contest. Put a computer in front of a student, and you compete with virtual phenomena on the computer for attention. Digital inhabitants demand instant gratification. Alas, they socialise over distance or in virtual spaces perhaps, but seemingly rarely share their information with individuals in their physical spaces for face-to-face debate. So with whom would this kind of student share information to solve local problems? Additionally, digital inhabitants demand instant gratification, offered by for example blogging (Muwanga-Zake, 2007). Virtual realities have tended to redefine teaching towards:

- No rules or procedures / processes. ICT is used by a trial and error approach;
- Students becoming co-designers albeit without experience of ICT applications and curricula in transforming information into knowledge;
- Technology playing a leading role in determining pedagogy; and
- Pedagogy being redefined at a rate commensurate with technological change.

But ICT developments are not static, and now have emerged into IoT, Machine Learning & Robotics, Big Data & Analytics, Biometrics, etc., all of which are leading to the Fourth Industrial Revolution.

Countries like Uganda are stuck in the second industrial revolution, and seemingly, similarly, ICT adoption in learning is being inhibited by the digital gap.

THE DIGITAL GAP EXPERIENCED AT SAMPLED UGANDAN UNIVERSITIES

Figure 1 represents the digital gap experienced at some sampled Ugandan universities. Digital Gap 1 – ICT culture and Indigenousness: Most ICT are imported into Uganda, and therefore staff and students are not culturally acquainted with it. This could also represent lower understanding of ICT due to the English and technical language.

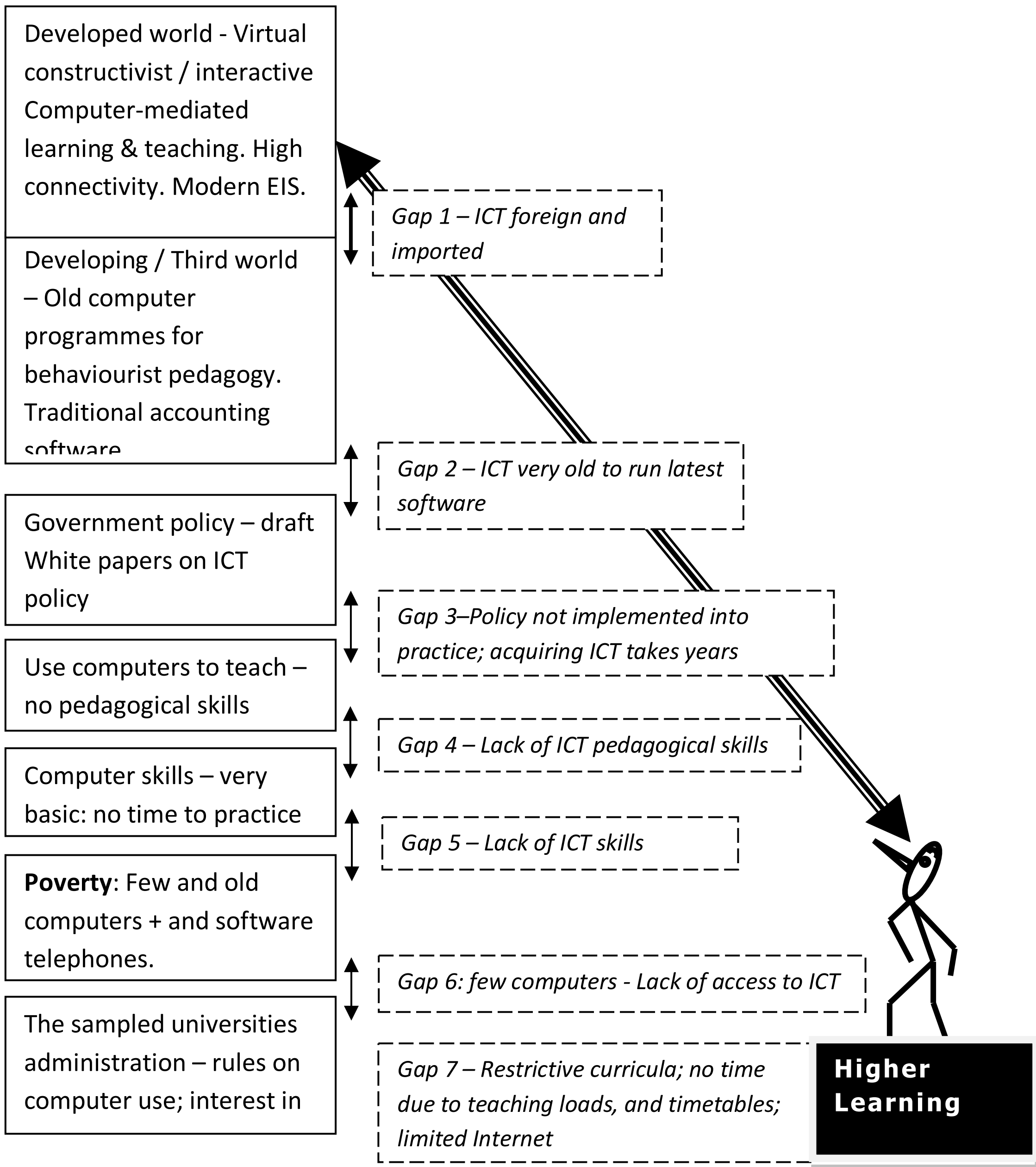

Figure 1: The Digital Gap between Institutions of Higher Learning in Developing Countries and those in the 1st World (Adopted from Muwanga-Zake (2007b))

Digital Gap 2 – Old hard and soft wares; sometimes second hand (related to Gap 1) and ICT policy (Gap 3): the sampled universities accepted 'gifts' of ICT, some of which are unable to run newer software such as accounting software. So ICT frequently need for repairs or upgrading, which the sampled universities cannot afford.

Digital Gap 3 – Policy and Practice: ICT policies in Uganda appear good but remain unimplemented. There are White Papers especially after a Ministry of ICT was created. Gap 3 represents the statement that *there seems to be a considerable gap between intentions expressed in learning policies and substantial changes on all three levels* (Ottesen, 2006).

Digital Gap 4 – Lack of knowledge on pedagogical and administrative applications of ICT: Lecturers have to know how to pedagogically use ICT (Bjørke, 2019). Very low adoption of newer software (such as Turnitin) due to high costs, especially against the nearly exponential ICT innovations in the First World. By inference, teachers in Australia were able to teach 95% of the students' basic computer skills by 1997 (Meredyth, Russell, Blackwood, Thomas & Wise, 2000).

Digital Gap 5 – Lack of ICT skills, especially computer skills: A considerable number of the sampled universities staff lack ICT basic skills (such as drawing using a mouse). Staff struggle to set their computers to connect and to log on to the Internet. Nearly all teachers had basic skills by year 1997 in Australia (Meredyth *et al*., 2000).

Digital Gap 6 – Inaccessibility to computers due to limited numbers and high cost: In Uganda, the majority of ICT users believed that hardware and software high costs were significant barriers against access to ICTs (Ssewanyana & Busler, 2007). At the sampled universities, the number of working desktops is much fewer than that of students. For example, just about 100 students use one computer. The gap is substantial against for example, 15 or less students per computer (Meredyth *et al*., 2000) in Australia in 1997 or 247 computers per school in 2004 or 18 students per computer in 1990 in the UK (Watson, 2001). Sustainability is expensive.

Digital Gap 7 – Inaccessibility to computers due to rules governing computer use: Computers at the sampled universities are not readily available as laboratories close, especially due to insecurity. Hence, students tend to feel removed from the ICT, and it is hard to fit lecture timetables into laboratory availability.

THE IMPLICATIONS OF THE DIGITAL GAP TO ICT ADOPTION

From the author's observations and staff interviews, this extremely low rate of adoption emanates from:

a) Old and poor ICTs
b) Poor and expensive connectivity
c) Shortage of skilled ICT and research staff
d) Lack of expertise in using LMSs
e) Negative attitudes towards ICT use

Issues of finance at the sampled universities indulge Nolan's model in highlighting a need for new and good quality computers. A foremost challenge is the prohibitive cost of new ICT and Internet connectivity. This is against the decreasing student enrolments and so inadequate revenue to acquire appropriate ICT. The Internet is slower, sometimes fails and is more expensive than for example, that at the University of Greenwich in the UK. In the UK, the cost is about $ 1/ MBps/ month and offers of unlimited Bandwidth are common; a fast Internet is taken for granted in the UK. Hence, a digital gap between the sampled universities and the University of Greenwich is predictable. More seriously, those digital gaps create inadequacies in ICT competencies expected of the sampled universities personnel to adopt and use ICT appropriately.

However, even with new hardware and software, lack of ICT-skilled personnel and researchers betrays the

ICT potential. For example, the file transfer speed is also related to the nature of file formats and the sizes of files, which have to be researched. Files that are easily downloadable on mobile phones are preferred. So, lecturers still have to acquire the knowledge of, and should research for, the most appropriate file protocols that would be easier to store, small enough for streaming, and qualitative enough for the kind of pedagogy desired, as well as for a particular subject.

Seventeen emails from a student body of 4326 students indicated that they had never used ICTs for learning. For example, Moodle is an open source Learning Management System which the sampled universities have failed to adopt due to lack of staff who can modify Moodle to suit the needs of lecturers. Additionally, Moodle is being used as a repository of study materials not as an interactive platform. Moreover, staff have to research for the most appropriate ICTs for each of their subjects. Hence, staff are apparently, perhaps expectedly, not impressed with ICT available at the sampled universities.

Lecturers making a statement such as *'I have had endless trouble with the new system'* is indicative of lack of competencies even though the ICT Department has an open invitation to staff for PD. Another lecturer's statement that *'I do not have time to train in using Moodle'* shows that lecturers have yet to prioritise PD in Moodle. Indeed, it appears the ICT adoption has to be paternalistic to enforce deadlines for adoption. However, such enforcement is a managerial function, and possibly the inclusion of PD in ICT as part of work agreement: that staff must use ICT in their respective practices. This requirement is a challenge to enforce upon older staff whose practices are engraved in old non-ICT practices.

Students struggle to understand why only some courses are online. Hence, a student statement such as '*Problem for me has been getting used to this system …*' is expected. The inappropriate use of the Internet, where for example students occupy laboratory computers to engage with social networks such as Facebook, could be symptomatic of lack of students' use of ICT for learning. Lecturers use computers mainly to type, which leads to high costs of printing.

The need to prepare staff to be able to exploit and develop the opportunities afforded by computers (Mutton, Mills & McNicholl, 2006) cannot be over-emphasised. However, a specific concern is that staff are far from becoming *effective participants* in the use of computers (Pedro, Enrique, Ernesto & Lucio, 2004), and that the Uganda government apparently expects HE institutions to patch the bigger digital gaps. The sampled universities administration in turn seems to expect staff to patch the rest of the Digital gaps. This expectation then presents very serious challenges to the sampled universities staff as workers.

Training in ICT remains expensive because of the cost of ICT, and because experts in pedagogical applications of ICT seem to be scarce. The first has a lot to do with government policies on taxation on imported technology, and encouraging local industrial investments into ICT. The investment has to be supported by locally based academic research into ICT and pedagogical applications of ICT, involving educators. Action research is a must at the sampled universities.

The shortage of experts in ICT pedagogical applications has to do with the costs of training in ICT and lack of basic learning relevant to criteria to acquire bursaries. Besides, ICT employees are being lured to other industries by higher salaries. Moreover, timetables would have to be changed from old paradigms that define time for learning pre-determined amounts of content, and lecturers need to adjust from lecture-centred to constructivist paradigms, where ICT-based learning would require lengthy periods. The lecturer has to bear with some students who might be better at some ICT skills, and with the students' freedom to explore wide varieties of sources of information. Not only could these situations challenge the lecturers' conceptual understanding and knowledge but requires a life-long teacher learner.

E-Readiness – Progress in light of the Digital Gap

The Digital Gap and its reduction seem to resonate with e-readiness. However, the digital gap apparently, is more vivid between countries than between institutions. Thus, the achievements at the sampled universities can also be determined in terms of E-readiness, whose attributes are a lot more measurable at an institutional level. E-readiness is measured variously, although it mainly evaluates the relative advancement of areas considered important for the adoption of the ICTs and their applications (Dutta & Jain, 2005).

Nonetheless, The CID (2000) created e-readiness frameworks for developing countries which, apparently, the World Bank uses to measure e-readiness for nations. Furthermore, Kashorda, Waema, Omosa and Kyalo (2007) report e-readiness for institutions. The E-readiness of an institution is a measure of the potential for the institutions to participate in the networked world of higher learning and research. However, contextually appropriate e-readiness frameworks for Africa were necessary and were therefore designed by the Association of African Universities (AAU) in 2000. The AAU (2000) aligned e-readiness to nine major attributes (Appendix 3) (Machado, 2007). The adoption of ICT aims at developing in all of these 9 measures. So far the progress is as follows:

Planning and monitoring tools – Most universities in developing countries have strategic plans, and many include ICT policies. The challenge is that many of these are not benchmarked and take long through the red tapes including through regular managerial and Senate consultations, especially in relation to the speed of the ICT innovations.

Application of ICT in teaching and learning – all the three sampled universities adopted Learning Management Systems, technically managed by the ICT Department but specifically to be implemented by departments of distance learning. Lecturers had to be trained in all the three cases but without sandpits to practice. Professional development is continuous but unfortunately focuses on the academic and excludes administrative staff. Students have Internet access, are encouraged to bring their own laptops, which are configured to access network. Students' access is dangerous in that students do not need to log on to the networks. So, a culprit of a system damage or abuse cannot be easily identified.

Application of ICT in research – ICT research software were introduced to staff during workshops who in turn are expected to guide students with the objective of enabling a more efficient storage and processing of data. Most these unfortunately require expensive annual licences.

Application of ICT in academic information services (library) – the libraries are active hives with an increased number of e-resources, some in the Cloud as well as other collaborated libraries. Regular updates are communicated to staff and students.

Application of ICT in administration and management **(Use of the Enterprise Recourse Planning – ERP or MIS)** – at the time of submitting this paper, there were several MIS that were being tried such as the Sun and Zeenod. A challenge are the footprints and credentials left in each of the MIS after migration.

ICT infrastructure – The Internet is both through the Ethernet fibre cables and through wireless Access Points. The danger in the use of copper or any metallic Ethernet was demonstrated in one of the universities when lightning struck and burn most the Internet switches. But then fibre cables are expensive.

ICT organizational (support) infrastructure – Staff are responsible for ICT in their respective areas of work. However, there is a need to train staff in the use of all ICTs found in their offices.

ICT financing – Funding is a major challenge in that the sampled universities were private institutions and have faced lower student numbers. Developments in ICT are therefore phased and slow.

Training, research and development in ICT – Professional Development should be continuous but competes for time against other academic activities. Besides, ICT is not prioritised. Nonetheless, training materials were uploaded into Moodle sites in all the sampled universities specifically set for PD in ICT. Useful links to staff development were frequently emailed to staff.

AN ICT ADOPTION THAT HAS WORKED

What does the Digital Gap and e-readiness imply in terms of modelling and adopting ICT? The following observations have worked:

- Lecturers prefer one-to-one training
- Lecturer skills and interests are varied and so require different training regimes
- A need to involve staff in choices of ICT tools
- A clear outline of lecturer responsibilities regarding ICT implementation should be made by management
- The ICT pedagogical use is rare – staff use ICT much more as delivery and administrative tools. There is a need to encourage and work with lecturers to introduce ICT in pedagogy
- ICT tools that have pedagogical relevance must be identified and prioritised
- A challenge is to decide which ICT to adopt on the basis of pedagogy versus modernist progressivism of ICT
- Lecturers must debate whether to change pedagogy in concert with changes in ICT or vice versa.

It is clear that each phase of ICT adoption should aim at solving such needs and should thus lead to specific objectives or outcomes. The following objective phases are envisaged and some of them have been planned at the sampled universities.

Phase 1 Establish preferred pedagogy.

Phase 2 Create awareness among staff (and students) about ICT pedagogical tools

Phase 3 Action research // Instructional Design (e.g., ADDIE model) – designing pedagogical environments with lecturers

- Demonstrate pedagogical examples of effective e-learning
- Evaluate current ICT pedagogical use
- Establish lecturer needs (Needs analysis)
- Design ICT pedagogical environments with lecturers
- Evaluate
- Repeat cycle

Phase 4 Production of ICT – based resources such as podcasts, Wikis, etc.

Phase 5 *Develop a model for introducing new ICT pedagogical tools*

The sampled universities adoption models allocate responsibilities to staff. Lecturers are practically supported to shift to ICT-based pedagogical frameworks (Sims, Dobbs & Hand, 2002), by the ICT Department. The allocation is now to be emphasised in work agreement that might have to be negotiated. It is planned that the administrative staff in each faculty is responsible for updating some records and materials in the LMS. Thus, PD includes faculty administrators, besides IT teams. Other duties of the IT team include helping in choosing the best versions of applications, preparing backups of lessons, archiving, and writing up procedures for preparing ICT-based lessons. The rationale is that a change from a paper-based to online environments requires the faculty administration to acquire new skills in organising and publishing online delivery. This entails the faculty administration to shift their skills from word processing to multimedia skills (an integrated word, audio, and video processing). Faculty administrators thus are responsible for determining user interface and maintaining uniform standards in their respective faculties. Additionally, these are duties that lecturers would rather be spared from, to apply their minds more on research, teaching and planning pedagogy.

Even experienced lecturers well versed with Curriculum Issues and the Subject Matter are often challenged when these two aspects are ICT-mediated. Obligations at a managerial level (the Deputy Vice Chancellor Academic, Deans, Heads of Schools) include pedagogical imperatives such as a re-examination of teaching strategies leading the change to e-Learning, in a manner that supports collaborative constructivist and active learning, for example, in virtual and open learning spaces (Shimabukuro, 2005). However, the PD in ICT use is essentially for the ultimate benefit to students, and so students' opinions and challenges (Muwanga-Zake, 2007a) are sought. For example, Moodle provides to lecturers a student's view of a course, and interactive tools in Moodle enhance the translation of information into knowledge.

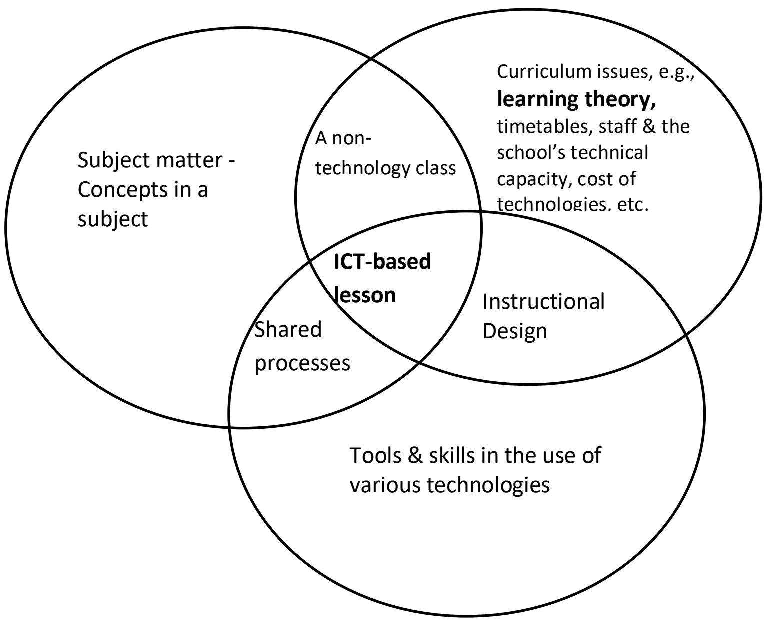

Figure 2. ICT development plan for lecturers

It is this ICT mediation where PD is often required in HE. Thus, ICT use in pedagogy comprises ICT tools and skills, curriculum considerations, which might differ for each ICT, and the subject matter (Figure 2). A summary of knowledge and skills, which various authors such as Whittier & Lara (2006), Minaidi & Hlapanis (2005), Muwanga-Zake (2007a), and Gredler (2001) believe lecturers should design and evaluate in an ICT-based lesson or resource is necessary in Step 4. The model allows iteration as indicated by the two-way arrows.

To ameliorate difficulties with Internet connectivity, Wellington's (in Lawson & Comber, 2007) model has been employed in that unaffordability and equity is mediated through the use of computer laboratories. Besides, the sampled universities provides wireless services to lecturers and students who are encouraged to use own tools to access the Internet as a matter of equity (Ciarncross & PÖysti, 2003).

CONCLUSION

The digital gap has inhibited much of the adoption and clearly, an institution would have to mitigate each gap in order to successfully adopt ICT for learning. It is reasonable to conclude that the digital gap has disabled considerations of learning theories in ICT adoption in developing countries like Uganda. That is, there are so many basic needs to mitigate the digital gap before lecturers in Uganda can start to worry about the integration of learning theories and ICT.

The solution is to quickly sort the digital gap and then immediately start to seriously identify ICTs to sort challenges in learning.

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