Int J Edu Sci, 20(1-3): 49-63 (2018)
DOI: 10.31901/24566322.2018/20.1-3.07

Blended Learning and Educators' Digital Technology Literacy for the TV White Spaces Pilot Project in Mankweng Circuit, South Africa

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KEYWORDS E-learning. Face-to-face Didactics. ICT Literacy. Informatics. Knowledge Domains

ABSTRACT This paper examines the levels of information and communication technology (ICT) literacy among educators at three high schools in Mankweng Circuit where the TV White Spaces Pilot Project has been implemented since July 2013 to promote blended learning. The paper examines survey results among 24 educators in order to demonstrate that the TV White Spaces Pilot Project has not revolutionized teachers' confidence in computer and ICT literacy, e-pedagogies nor digital informatics. Beyond infrastructure resourcing, successful implementation of blended learning is largely dependent upon "computer and information literacy" among both students and educators, requiring therefore investments in time and energy for acquisition of instructional methodologies, strategies and skills. For this reason, the ubiquity and inevitability of e-learning in South Africa could potentially underestimate the complexities of establishing pedagogic abilities, skills and confidence in the attendant digital technology informatics among educators, who are challenged to blend digital informatics with conventional didactics.

INTRODUCTION

In recent decades digital technologies and social media have captivated societal imagination across the world, becoming "prevalent in the day-to-day life" of students who are variously characterized as the "Net Generation," "Y-generation" or "the digital natives" (Oyedemi 2015; Domingo and Gargante 2016; Salminen et al. 2016). Simultaneously, interest in the potential for using digital technologies and social media in education precipitated the notion of blending e-learning with conventional face-to-face didactics (Tower et al. 2014; Domingo and Gargante 2016; Salminen et al. 2016). However, blended learning environment is supposed to be facilitated by educators who, unlike the "Net Generation", were not born to be socialized into digital technologies, social media, computers and Internet (Oyedemi 2015; Domingo and Gargante 2016; Salminen et al. 2016). Educators are pressured to integrate digital technologies and social media in their instructional designs because students have positive perceptions of these tools' impacts, usefulness, enjoyment and excitement, to which they are socialized as part of normal life (Peck 2014; Hanus and Fox 2015; Salminen et al. 2016). Indeed, students already spend extensive time and energy in digital technologies, Internet and social media spaces (Zhang et al. 2015; Domingo and Gargante 2016; Salminen et al. 2016). Oz et al. (2015) showed statistically that there are positive correlations between computer and ICT literacy and attitudes towards adoption and use of digital technologies and Internet in the learning environment. Also, computer and ICT literacy is a significant determinant of attitudes towards technology-based and computer-assisted learning (Oz et al. 2015; Domingo and Gargante 2016; Salminen et al. 2016). To this extent, educators' ICT literacy and attitudes are critical to successful implementation of blended learning.

The aim of this paper is to examine the levels of computer and ICT literacy among educators at three high schools in Mankweng Circuit where the TV White Spaces Pilot Project has been implemented since July 2013. The project involves a partnership of the University of Limpopo, Microsoft South Africa, Centre for Scientific and Industrial Research (CSIR) and Multisource.

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Additionally, there are institutional collaborators that are involved in the project; and they are Independent Communications Authority of South Africa (ICASA), South African Broadcasting Corporation (SABC), Department of Basic Education and Department of Science and Technology. The partnership and collaboration highlight the significance of digital technology in efforts towards revolutionizing South African education. The increased demand to provide for digital participation, especially in the education system, motivated for the exploration of geolocation databases through the so-called TV White Spaces (Masonta et al. 2015). This digital model exploits vacant channels in the television spectrum to provide wireless Internet connection (Salminen et al. 2016; Siddiq et al. 2016). Broadly, TV White Spaces are the allocated spectrum in the TV and radio bands either unassigned or assigned to licensee, but are completely or partially unused across all geographic locations, therefore being available for alternative wireless communication services (Masonta et al. 2015). To this extent, the later arrangement in TV White Spaces provides for Local Area Network (LAN) (Masonta et al. 2015). This model is invaluable for developing countries such as South Africa in narrowing digital inequalities by providing opportunities for wireless Internet connections for formerly disadvantaged education systems through spectrum sensing of available channels in the geo-locational databases (Kearney et al. 2015; Masonta et al. 2015; Salminen et al. 2016; Siddiq et al. 2016). Whereas, the TV White Spaces Model provides low cost wireless Internet connections without interfering with the existing spectrum band usage and its installation involves costly infrastructure resourcing and operations (Boschman et al. 2015; Masonta et al. 2015; Hung 2016; Park et al. 2016). This paper examines the levels of computer and ICT literacy among TV White Spaces Pilot Project users, specifically educators, at three high schools in Mankweng Circuit, South Africa.

Effective Teaching and Learning: Face-to-Face Interactions, E-learning and Blended Pedagogies

In recent years, the pursuit of effective teaching and learning has been largely captivated by didactics of passive versus active learning (Gu et al. 2015; Kavanoz et al. 2015; Hung 2016; Salminen et al. 2016). The traditional educators' delivery of information to students was criticized for reinforcing passive learning and suboptimal knowledge acquisition (Gu et al. 2015; Kavanoz et al. 2015; Hung 2016; Salminen et al. 2016). Literature confirms that online learning is more advantageous than the traditional face-to-face offerings; however, integration of the two provides for the best instructional methods (Salminen et al. 2016). The challenge, though, appears to have been the dearth of knowledge and understanding of the proper usage of technology in teaching and learning as well as the levels of integration (Domingo and Gargante 2016; Salminen et al. 2016). Research has conclusively demonstrated that students "do not retain a significant portion of what is taught during lectures" from traditional didactic-ridden sessions of passive learning (Wolff et al. 2015: 85). Conversely, active learning shifts attention to students' learning, away from the educators' didactic delivery, in order to solicit their active participation in the process of achieving improved retention and deeper understanding of content (Gu et al. 2015; Kavanoz et al. 2015; Hung 2016; Siddiq et al. 2016). Hence, a variety of teaching techniques have been recommended, guided by the aspiration for fostering increased student engagement and inculcation of "self-directed learning" through effective delivery of core knowledge, contextualization and simplification of difficult concepts (Wolff et al. 2015: 85).

Without installing the physical environment infrastructure, the use of e-learning would be improbable because it requires computers, reliable computer systems and applications, nonfreezing computer screens, live online connections and short download time spans (Orr and Kukner 2015; Park et al. 2016). But, as South Korean experience demonstrates, years of investment in technological infrastructure in education ended-up with trained educators, seldom using ICT during face-to-face contact sessions (Webster and Son 2015; Hung 2016; Park et al. 2016). Respectively, Boschman et al. (2015), Ninlawan (2015), Valtonen et al. (2015) and Park et al. (2016) report that in 5 countries, the Netherlands, Thailand, Finland and South Korea, where ICT resourcing in education is good, application has remained "very low" because most educators have low self-belief in their abilities and skills to use the technology in teaching and learning. Hence, this papers questions the levels of

educators' ICT literacy in a developing country, South Africa where the TV White Spaces Project (Masonta et al. 2015) is tested in a rurally-based university whose target beneficiaries are township and rural schools.

Among other requirements, educators should have the ability to teach creatively and for creativity by engaging in complex integration of pedagogical, technological and content knowledge to establish a conducive collaborative learning environment for group creativity, innovation, flexibility and adaptability of instructional design activities to the specific needs of the students, their in-the-moment interest pursuits and socio-emotional contexts. These competences are denoted elsewhere in this paper as "attitude" and "self-efficacy", in accordance with the constructs drawn from the pertinent literature (see, for example, Boschman et al. 2015; Kavanoz et al. 2015; Ninlawan 2015; Orr and Kukner 2015; Webster and Son 2015; Domingo and Gargante 2016; Hung 2016; Park et al. 2016; Siddiq et al. 2016). Also, there are different adoption levels that are dependent upon a variety of factors, including institutional strategies, structure and support to the notion of the learning management system (Boschman et al. 2015; Orr and Kukner 2015; Hung 2016; Park et al. 2016). To this extent, a variety of constructs, inclusive of creativity, flexibility, adaptability and innovativeness have been studied to determine their relationship with successful implementation of blended digital and conventional pedagogies (O'Brien 2012; Davies et al. 2014; Boschman et al. 2015; Orr and Kukner 2015; Domingo and Gargante 2016; Hung 2016; Park et al. 2016).

Blended Learning for Collaborative Environments, "Creativity Mindsets" and Innovation

As Park et al. (2016: 1) put it, "Blended learning (BL) is recognized as one of the major trends in higher education today". Students and educators serve a critical role in ensuring that teaching and learning activities are "adapted for blended modalities" (Dahlstrom et al. 2013 cited in Park et al. 2016: 1). In reality, a negligible number of institutions across the world have adopted "a unified approach" to blended and transformational learning, using the learning management system as an enterprise system (Orr and Kukner 2015; Hung 2016; Park et al. 2016). Blended learning is more than a mere act of educators transferring course content into the learning management system and using basic features such as posting syllabuses and uploading lecturer notes (Park and Jo 2014; Orr and Kukner 2015; Hung 2016; Park et al. 2016). Adoption of blended learning is deeply involved; and to this extent, it requires clarity of understanding of the instructional interventions adopted, sometimes at an institutional scale, as well as the approaches and support mechanisms for leveraging the various features of learning management system (Orr and Kukner 2015; Hung 2016; Park et al. 2016).

A variety of constructs, including creativity mindsets, innovation, flexibility and adaptability, are examined in the E-learning and blended modalities literature to determine their roles in enhancing student learning experiences. This paper focuses on one sphere wherein such constructs are intricately intertwined which is the educators' ICT literacy and self-efficacy. Indeed, the educators' ICT self-efficacy and beliefs in Technological Pedagogical Content Knowledge (TPACK) as well as Web-based communicative instructional designs are the strongest predictors of the potential for successful blended learning and establishment of an environment conducive for creativity mindsets, innovation, adaptability and flexibility (Kavanoz et al. 2015; Ninlawan 2015; Hung 2016; Park et al. 2016). According to Kavanoz et al. (2015: 95), TPACK represents the integration of knowledge, which is required of educators "for effective integration of technology into pedagogically appropriate teaching and learning activities", founded on the premise that classroom environments could be transformed into "collaborative and interactive spaces" for creativity, innovation, adaptability and flexibility by effectively combining technological, pedagogical and content knowledge. This observation is consistent with the call for blended learning (see, for example, Boschman et al. 2015; Ninlawan 2015; Orr and Kukner 2015; Domingo and Gargante 2016; Hung 2016; Park et al. 2016; Salminen et al. 2016).

Notwithstanding, its ubiquities and inevitability, e-learning has not been successfully implemented with strategic plans for blended learning, which refers to "a combination of face-to-face and online learning instruction" for their complementarity in enhancing the effectiveness of teaching and the students' learning experi-

ences (Park and Jo 2014; Boschman et al. 2015; Kavanoz et al. 2015; Orr and Kukner 2015; Hung 2016; Park et al. 2016). But there are "diverse instructional models and best practices of blended learning", drawing from various degrees of combinations of face-to-face modalities with digitally-mediated technologies (Park et al. 2016: 2). To this extent, the hope of having a single one-size-fits-all instructional model of blended learning is unrealistic. Thus, Garrison and Kanuka (2004 cited in Park et al. 2016: 2) observe that the apparent clarity and simplicity of the concept of blended learning could be misleading because "its implementation is complex and rather challenging since virtually limitless designs are possible depending on how much or how little online instruction is inherent in blended learning". Determination of this balance is specific to each instructional design; and each educator adopts a unique hybrid of blended modalities which is dependent upon a variety of determinants and constructs, including the ICT literacy levels. Hence, this paper places a high premium on educators' ICT literacy for the necessarily complex integration of pedagogical, technological and content knowledge to meet specific students' needs, in-the-moment interests, pursuits and socio-emotional contexts of teaching and learning. Instructional design for blended learning is itself complex as it includes models, strategies, best practices, implementation, and environment and course structure (Boschman et al. 2015; Orr and Kukner 2015; Hung 2016; Park et al. 2016) which remained unresolved without a single universally accepted norm, even for the same subject or discipline.

Educators' ICT Literacy and Teaching for Creativity in Blended Learning

According to Noh et al. (2014: 145), "Although teachers may believe that computers can lead to improved teaching and learning, they may choose not to use this technology if they have low confidence in their abilities to use computers." E-learning is indeed associated with the "so called twenty-first century skills" at a global scale (Ahonen and Kinnunen 2014; Valtonen et al. 2015; Ninlawan 2015; Park et al. 2016; Salminen et al. 2016; Siddiq et al. 2016). But the practice of blended learning remains a complex challenge and undertaking for all countries alike (Boschman et al. 2015; Orr and Kukner 2015; Park et al. 2016). Educators are, therefore, expected to have in-depth understanding of blended learning because they are, among other things, expected to "create technology-rich lesson modules" by designing specific instructional activities for their classroom for each theme (Boschman et al. 2015; Kavanoz et al. 2015; Ninlawan 2015; Orr and Kukner 2015; Park et al. 2016). There is a specific way in which educators' "knowledge of technology, pedagogy and content interact during instructional decision-making" (Boschman et al. 2015: 251) which they should understand in order to create high quality teaching for blended learning environment (Kavanoz et al. 2015; Orr and Kukner 2015; Hung 2016; Park et al. 2016). For instance, there is a distinct body of knowledge, denoted Technological Pedagogical Content Knowledge (TPACK), which "is a form of situated knowledge about the affordances of technology on teaching specific subject matter in a certain context" (Boschman et al. 2015: 251). Drawing from pertinent literature, Kavanoz et al. (2015: 95) describes TPACK as a theoretical framework that *"refers to the intertwined relationships that combine teachers' technology use, instructional methods, and understanding of the subject matter …. (wherein) content affects the pedagogical goals, methods and the technologies to be used …. (whilst) reciprocally, the technology used exerts several limitations and requirements that in turn might affect both the content and the way it is transferred to the learner"*.

Importantly, the TPACK involves educators' "understanding of the difficulties students encounter when they have to learn a particular subject matter domain" (Boschman et al. 2015: 251). This form of situated knowledge derives from integration of at least three knowledge domains, which are: technological knowledge, pedagogical knowledge and content knowledge (Boschman et al. 2015; Kavanoz et al. 2015; Ninlawan 2015; Orr and Kukner 2015; Park et al. 2016; Siddiq et al. 2016). Exclusion of any one of the three domains would limit integration to either pedagogical content knowledge, technological content knowledge or technological pedagogical knowledge rather than Technological Pedagogical Content Knowledge (Boschman et al. 2015; Orr and Kukner 2015; Park et al. 2016). None of these incomplete integrated forms would, alone, be adequate for creating a high quality blended learning environment (Boschman et al.

2015; Ninlawan 2015; Orr and Kukner 2015; Park et al. 2016; Siddiq et al. 2016). The latter is thus complex and involved with sophisticated integration of various domains and forms of knowledge (Boschman et al. 2015; Kavanoz et al. 2015; Orr and Kukner 2015; Hung 2016; Park et al. 2016). In practice, the pedagogical content knowledge provides the fulcrum of the TPACK, because "each content area is unique on its own, and (it) requires instruction peculiar" to its specification (Kavanoz et al. 2015: 95). Thus, teaching content and pedagogy cannot be treated as "two distinctive entities" because pedagogical content knowledge is "the particular form" that embodies "aspects of content most germane to its teachability" (Kavanoz et al. 2015: 95).

Therefore, successful implementation of blended learning requires knowledge about teaching and learning, socio-emotional development of students, literacy concepts such as phonological awareness, book-reading and vocabulary development, application of general instructional strategies for developing literacy, technology such as computer and email operations, transformation of specific subject matter literacy, stimulation of cooperative learning, and the appropriateness of uses of the affordances of TPACK to specific literacy content and contexts (Boschman et al. 2015; Kavanoz et al. 2015). In blended learning, educators are therefore involved in more than just sharing of information because they have to ensure that they create a conversational and collaborative learning environment wherein "design decisions are made in collaborative inquiry" and "technology-rich activities" are designed for student learning whilst taking into account "external priorities, practical concerns and existing beliefs" (Boschman et al. 2015; Kavanoz et al. 2015; Orr and Kukner 2015; Hung 2016; Park et al. 2016). For this reason, generic instructional design activities would not be appropriate for all pedagogical, technological and knowledge contents and contexts. Hence, educators are required to creatively establish an online and offline blended teaching and learning environment that engages student learning for group creativity mindsets, innovation, adaptability and flexibility.

Literature confirms that "Collaborative inquiry processes are intelligible in conversations" between the two levels of depth, which are: shallow and deep (Boschman et al. 2015; Orr and Kukner 2015; Park et al. 2016). The former involves "cumulative talk" for information sharing whereas the latter refers to "exploratory talk" which solicit collaborative engagement for critical discussion and reflective inquiry (Boschman et al. 2015; Kavanoz et al. 2015; Orr and Kukner 2015; Hung 2016; Park et al. 2016). Based on the learning objectives taxonomy, four levels of depth in collaborative educator conversations are identified as follows: "No inquiry"; "Sharing and Reacting"; "Analyzing and Generalizing"; and, "Planning and Problem-solving" (Henry 2012 cited in Boschman et al. 2015: 252). According to Boschman et al. (2015: 252), "Problem solving entails both analysing as well as planning activities and is therefore a form of deep inquiry". Educators, who plan blended learning activities, continuously try "new and innovative forms" of instructional activities because they are tacitly involved with deep inquiry (Boschman et al. 2015; Kavanoz et al. 2015; Ninlawan 2015; Orr and Kukner 2015; Park et al. 2016; Salminen et al. 2016). The educator has to determine at all times, what form of integration of knowledge is appropriate for each of the planned level of inquiry. Collaborative inquiry involves deeper levels, which are analysing and planning (Boschman et al. 2015; Kavanoz et al. 2015; Ninlawan 2015; Orr and Kukner 2015; Hung 2016; Park et al. 2016; Salminen et al. 2016), and a mere access to digital resources would be inadequate. Indeed, analytical and planning domains in blended learning would be highly demanding on the educators' efforts.

As Boschman et al. (2015: 252) put it, the "difference between sharing and planning" is that "no decision is explicated" in the former whilst in the latter "the decision is explicit and on details of the learning activity". Thus, blended learning without collaborative design conversations would be non-existent because of the absence of an inquiry process that integrates knowledge domains of technology, pedagogy and content (Boschman et al. 2015; Kavanoz et al. 2015; Ninlawan 2015; Orr and Kukner 2015; Park et al. 2016; Siddiq et al. 2016). Blended learning involves iterative processes and reflective activities, pointing to the complexity of instructional design problems wherein educators may as well rely on "unsystematic and intuitive" approaches (Boschman et al. 2015; Ninlawan 2015; Orr and Kukner 2015; Hung 2016; Park et al. 2016).

Hence, even TPACK is criticized for not providing "sufficient information for the integra-

tion" of digital technologies into instructional designs and practices (Kavanoz et al. 2015). Internet and World Wide Web are thought to provide for several technologies that could be used simultaneously; and, TPACK does not equip educators with sufficient "technological content knowledge" and instructional settings that would enable them to "create optimal and natural environments for learning" (Kavanoz et al. 2015: 95; Ninlawan 2015: 1733). Thus, Kavanoz et al. (2015: 95) proposes the construct of Web Pedagogical Content Knowledge to cover for the shortfall of the TPACK in Web pedagogical knowledge, which focuses on "perceived self-efficacy and attitudes towards using Web for pedagogical purposes" (Kavanoz et al. 2015: 95). Drawing from social cognitive theory, "the significance of self-efficacy as a critical variable for the prediction of individual behaviour" is extended to ICT education to capture students' and educators' Web or Internet "self-perceived confidence in and expectations of successfully executing Internet actions" necessary to undertake the required activities for blended learning (Kavanoz et al. 2015: 95).

Conceptions and typologies of blended learning involve "a broad spectrum both in the delivery modalities between offline and online and the pedagogies between instructor-led and student-centered approaches" (Park et al. 2016: 2). Park et al. (2016) represent the spectrum diagrammatically to isolate four possible combinations and types of blended learning, thus: "mostly face-to-face class with substantial online activities"; "mostly online class with student offline group meeting"; "mostly face-to-face lecture with online resources"; and, "mostly online lecture with optional face-to-face meeting". The attendant adaption levels do not occur through osmosis, they require planned behavior. Institutions and educators alike, have to be aware of the phases of transition from lower to upper levels of blended learning in order that "high quality teaching and learning environment" may be secured through specific strategy, structure and support (Boschman et al. 2015; Orr and Kukner 2015; Hung 2016; Park et al. 2016). In the absence of such institutional learning management systems that guides and supports adoption of blended learning environments, educators' attitudes towards blended learning become a key determined. The latter observation accurately describes the South African context.

Besides instructional designs, which have already been identified in this paper, blended learning is complex (Boschman et al. 2015; Kavanoz et al. 2015; Orr and Kukner 2015; Hung 2016; Park et al. 2016); and, it can be examined through a variety of underlying constructs. Broadly, ICT education is associated with constructivist learning environments wherein educators consciously integrate digital technologies to support and enhance "collaborative instructional strategies" and students enjoy "distinct, interactive, individualized and inquiry-based learning activities", as well as the opportunity for meaningful knowledge construction and innovation (Kavanoz et al. 2015: 95).

However, blended learning is complex because its implementation involves understanding of other constructs, such as hybrid, blended, flipped and inverted, out of which a framework of two dimension could be established (reading from Margulieux et al. n.d. cited in Park et al. 2016). Four types of blended learning are identified through learning experience taxonomy, which are: "face-to-face mixed" (course with laboratory); "lecture hybrid" (part face-to-face, part online lecture); "practice hybrid" (part face-to-face, part online praxis); and, "online mixed" (Boschman et al. 2015; Orr and Kukner 2015; Park et al. 2016). Depending upon the depth of inquiry that the educator envisages for a specific disciplinary content, appropriate instructional pedagogical designs have to be conceived with one of these learning experience taxonomies in mind. Such a balancing act cannot be dictated from a generic source material because creativity mindsets, innovation, adaptability and flexibility would be stifled. Note has to be made, for the sake of emphasis that the potential for "disciplined improvization", creativity and innovation in education exists for all individuals and groups, rather than being a preserve of a special breed of persons (O'Brien 2012; Boschman et al. 2015; Ninlawan 2015; Orr and Kukner 2015; Hung 2016). However, educators are responsible for designing instructional activities that would facilitate such a teaching and learning environment wherein group creativity mindsets, innovation, adaptability and flexibility run supreme. Hence, this paper examines educators' ICT literacy and command of the abilities required for integration of technological, pedagogical and content knowledge in blended learning.

Given this degree of complexity of blended learning, it should be evident that educators would inescapably be required to teach "more creatively" in order to stimulate the students to be equally creative in learning content (Boschman et al. 2015; Kavanoz et al. 2015; Ninlawan 2015; Orr and Kukner 2015; Park et al. 2016; Salminen et al. 2016). According to Orr and Kukner (2015: 69), educators' "creativity mindsets and their abilities to improvize within their own disciplines" integral to encouraging students to be creative in learning content, are dependent upon literacy strategies. Besides, there are different disciplinary content literacies, relevant to disciplines which involve "the ability to draw upon prior knowledge, general and specific content-related literacy practices to learn about new content in a subject area" (McKenna and Robinson 2014 cited in Orr and Kukner 2015: 70). Therefore, creativity mindsets refer to the ways in which educators and students in specific disciplines interact with text of all forms, inclusive of print, digital, media and visual, to learn course content which could be tenably construed as an outcome of "intentional infusion of literacy" (Boschman et al. 2015; Kavanoz et al. 2015; Ninlawan 2015; Orr and Kukner 2015; Domingo and Gargante 2016; Hung 2016; Park et al. 2016; Siddiq et al. 2016). To this extent, computer and ICT literacy among educators is integral to the successful facilitation of different levels of blended learning, inclusive of analysis and planning.

Hence, as Hung (2016: 121) put it, educators should be more responsible for "practicing self-discipline", "using cognitive strategies", "time management and organizational skills" as well as "for participating in social interaction" within the blended online and offline learning environment. Therefore, the misconception that the use of digital technologies in education is easy and "relatively free from effort" on the part of educators has to be dismissed (Boschman et al. 2015; Kavanoz et al. 2015; Ninlawan 2015; Orr and Kukner 2015; Domingo and Gargante 2016; Hung 2016; Park et al. 2016; Salminen et al. 2016). Indeed, it could be deduced that creativity mindset is a function of the level and depth of inquiry and integration of technological, pedagogical and content knowledge in the blended online and offline learning environment. As already argued, such a blended learning environment is dependent upon the educator's attitude and decision-making about instructional designs for collaborative reasoning, group creativity, innovativeness, adaptability and flexibility. This paper argues, therefore that blended learning that is devoid of the conditions entailed in these constructs would remain a sterile and passive information sharing environment for both students and educators.

Constructs and Complexities of Blended Learning for Educators

Whereas "teaching creatively and teaching for creativity" are integral to each other, as already argued, they are not synonymous; and, they are in practice mediated through the constructs of "disciplined improvization and adaptability" because creativity "as a concept or characteristic has social and economic implications" at individual and group levels activities (Orr and Kukner 2015: 70). Importantly, "creativity is not a static feature" (Orr and Kukner 2015: 70). According to O'Brien's (2012: 331) conception of "creativity mindsets" is that it prepares students' "for unknown and rapidly changing futures", among other things, deepening "knowledge growth", informing "innovation", developing "new scientific knowledge" and supporting "problem-based learning". As a result, O'Brien (2012: 331) conceives creativity mindsets as:

"*Sophisticated perceptions of learning; a willingness to see teaching as a process of collaborative learning and the careful orchestration of multifaceted learning experiences in which the teacher is not always central; and most importantly, the kind of open-minded, open-hearted, courageous visions of self-as-teacher that casts the students into lead roles and teachers as occasional director and frequent understudy*".

All the qualities of creativity mindsets as described by O'Brien (2012) cannot be prescribed as a set of universally adopted instructional activities. Prescription of instructional activities for each disciplinary content literacy would stifle the realization of "disciplined improvization and adaptability" as well as the creativity mindsets design itself.

For these reasons, educators have to learn how to "teach for creativity", beyond their "teaching creatively" (Orr and Kukner 2015: 70), through among other things, "unsystematic and intuitive" approaches (Boschman et al. 2015;

Hung 2016), rather than relying solely on a prescribed set of instructional activities and predetermined and inflexible designs. Being "a process of higher order thinking and engagement" (O'Brien 2012: 331) that is intricately interlinked with "innovation" (Boschman et al. 2015; Orr and Kukner 2015; Park et al. 2016), creativity would not be amenable to rigid prescriptions of instructional activities and designs. Educators have a duty to "develop innovative approaches" in the processes of inquiry and "response to issues they encounter in their practice" (Cochran-Smith and Lytle 2009 cited in Orr and Kukner 2015: 71). That is, instructional activities design should define contested educational spaces of evolving processes of adaptability and innovation involving "ideas, practices and materials" (Boschman et al. 2015; Ninlawan 2015; Orr and Kukner 2015; Park et al. 2016).

The notion of "disciplined improvization", as conceived by Sawyer (2004 cited in Orr and Kukner 2015: 71), affirms the centrality of innovation in "teaching creatively and teaching for creativity" wherein the educator is the "facilitator for the entire group's creativity". In as much as the educators' "disciplined improvization" is entailed in responses to a combination of various situations such as "curriculum outcomes, materials available, and students' questions and reactions", they "must have a high degree of pedagogical content knowledge" in order that their creativity may open spaces for students to react creatively (Sawyer 2004: 13, 15, cited in Orr and Kukner 2015: 71). That is, educators require "creative performance skills" to "effectively facilitate a group improvization with students" (Sawyer 2004: 17 cited in Orr and Kukner 2015).

In this way, educators are required to "open spaces within curriculum" in order to, as it were, "scaffold" learning for creativity and innovation (Vaughn and Parsons 2013: 89). That is, adaptation is more effective than adoption because general literacy strategies are less potent than those adapted "to fit" the disciplinary content-specific strategies. The latter involve "disciplined improvization" or cultivation of the ability to skillfully adapt literacy practices and integrate them into specific disciplinary content which ensures that literacy is "used as a tool for learning so that students improve their literacy and content knowledge simultaneously" (Gillis 2014: 616, 618). Evidently, flexibility in the teaching and learning environment encourages student-centered activities as well as group-led creativity and innovation (Boschman et al. 2015; Kavanoz et al. 2015; Ninlawan 2015; Orr and Kukner 2015; Hung 2016; Park et al. 2016; Salminen et al. 2016). Educators' creativity mindsets should inform design of their pedagogical activities because "pedagogic environment" relating to the organization of teaching and learning is a critical requirement in relation to "teaching for creativity", beyond mere "considerations of the physical environment" necessary for supporting "creative learning" (Davies et al. 2014: 35).

Teaching effectively and creatively for "group creativity", innovation, adaptability, flexibility and students active learning places a momentous challenge on the design of instructional pedagogical activities for blended learning (Boschman et al. 2015; Kavanoz et al. 2015; Ninlawan 2015; Orr and Kukner 2015; Hung 2016; Park et al. 2016). Given the positive correlation of self-efficacy relating to Web or Technological Pedagogical Content Knowledge and attitudes towards Web-based instructional designs and activities (Boschman et al. 2015; Ninlawan 2015; Orr and Kukner 2015; Hung 2016; Park et al. 2016), blended learning requires the educators to exhibit "the ability and willingness to combine technological, pedagogical and content knowledge" (Kavanoz et al. 2015: 94). Therefore, the educators' ICT literacy should be of paramount significance in creating effective high quality blended teaching and learning environment. However, there is negligible insight into the educators' perceptions of the "usefulness" and "ease of use" of ICT in learning as well as their own personal self-efficacy and attitude towards blended pedagogies which collectively bear "greater influence" on the conception of instructional practices appropriate for deep inquiry, creativity and innovation (Zhang et al. 2014; Hanus and Fox 2015; Ninlawan 2015; Domingo and Gargante 2016; Siddiq et al. 2016).

There are a series of constructs that explain the complexities of participation in the E-learning environment with the stated purpose of blending with the conventional face-to-face didactics (Park and Jo 2014; Boschman et al. 2015; Orr and Kukner 2015; Hung 2016; Park et al. 2016). Having a computer or Tablet and e-book is far from being a sufficient condition and cause for active and effective teaching. The educator has a duty to investigate the different instructional design pedagogies for mediation of such

blended learning in ways that create an environment of collaborative reasoning, group creativity, innovation, adaptability and flexibility. If the educators cannot plan instructional activities creatively, then students would not engage creatively because the teaching would not be designed for "creativity and innovation". Equally, the students graduating from such a teaching and learning environment would most probably have fragmentary technological knowledge that would be inadequate for their participation in the global knowledge economy where creativity mindsets and innovative applications are primed resources. As already discussed, Hung (2016) suggests that educators have, among other things, to plan instructional activities for discipline-specific course content, to be available "in the online-learning environments", to learn as students, "to deal with or balance multiple roles", to be self-disciplined in managing time and organizational skills for their participation in social interactions, to apply cognitive strategies and to exhibit "significantly higher levels of critical thinking" because the use of digital technologies in education is not free of effort.

Kavanoz et al. (2015) and Ninlawan (2015) discuss the responsibilities and amount of work that educators are confronted within the teaching innovation and educational technology of the 21st century. According to Kavanoz et al. (2015: 94), effective and successful integration of technology in education depends on the educators' "pedagogical and personal beliefs". Educators have a responsibility to ensure that their teaching is designed for "group creativity", wherein courses are tailored according to the students' needs and in-the-moment pursuits whilst simultaneously adjusting the same needs and interests, in order to encourage them to learn creatively (Kavanoz et al. 2015; Ninlawan 2015; Hung 2016). Educators have to achieve this balancing act successfully through complex processes of integrating basic knowledge in seven areas: field of their teaching, science of education, curriculum, content and classroom management, students and their characteristics, outcomes, objectives and values as well as knowledge in context (Ninlawan 2015; Boschman et al. 2015; Orr and Kukner 2015; Park et al. 2016). From the study of Thailand education system, Ninlawan (2015: 1733) recommends that educators have to be disciplined as facilitators of blended learning in the digital environment and to effectively manage classrooms by exhibiting the following constructs and characteristics: "Spirit of being a teacher", "Skills in developing integrated courses", "Ability to come up with innovation, teaching techniques, and an ICT-based classroom", "Enthusiasm to help the students, based on psychology", and "Ability to use English to communicate". These expectations of educators in the 21st century teaching innovation and educational technology in Thailand are consistent with the observations made by Boschman et al. (2015), Kavanoz et al. (2015), Orr and Kukner (2015), Hung (2016), Park et al. (2016) and Siddiq et al. (2016), concerning the facilitation of blended learning. As Ninlawan (2015: 1733) puts it, "Innovation and educational technology always change", which renders the educators' role even more complex and protracted.

The ICT literacy, in general, can be described in what Kavanoz et al. (2015) denotes self-efficacy which is dependent on an individual's personal "judgment" of own "ability to apply Internet skills in a more encompassing mode" as well as what they believe they could achieve through online resources in teaching and learning. Internet self-efficacy goes beyond mere computer skills to embrace a diversity of digital skills "such as navigating the WWW, downloading/uploading files, creating bookmarks" and so on as well as the educators' attitude towards the Internet as one of the most important constructs of the Web Pedagogical Content Knowledge (Kavanoz et al. 2015: 95). Siddiq et al. (2016: 1) establish that educators' adaption and use of digital information and communication skills is "positively related to ICT self-efficacy, the frequency of ICT use, and perceived usefulness of ICT". Beyond quantitative frequency of use, educators' ICT literacy involves qualitative aspects and "digital skills such as accessing, evaluating, and sharing and communicating digital information" (Siddiq et al. 2016: 1). Indeed, educators' "computer knowledge previous experience, awareness and proficiency" shape their "perceived self-efficacy in using various forms of technological tools" (Kavanoz et al. 2015: 95). It is this self-efficacy in the Web Pedagogical Content Knowledge that would fundamentally determine the successful integration required through the TPACK. This paper examines educators' ICT literacy in respect of a few of these constructs, which are associated with self-efficacy in using the TV White Spac-

es Pilot Project in three Mankweng schools in South Africa.

Evidently, educators who doubt their Internet skills or are not satisfied with them, would perceive the Web and/or Technological Pedagogical Content Knowledge as difficult to use, therefore exhibiting low levels of confidence in their abilities and "self-efficacy beliefs" (Kavanoz et al. 2015; Ninlawan 2015; Hung 2016; Park et al. 2016; Siddiq et al. 2016). Reciprocally, such low confidence and self-efficacy beliefs would strengthen negative attitudes against the use of Internet. In this way, the lack of Web or TPACK capacity would in itself drain potential for building ICT literacy among educators because attitude is a powerful determinant for predicting behaviour. Citing Fishbein and Ajzen (1975: 6), Kavanoz et al. (2015: 95-96) define attitude, from a social cognitive theory, as "a learned predisposition to respond in a consistently favourable or unfavourable manner with respect to a given object". Additionally, the user commitment theory and continuous adoption of technology asserts that the wide adoption of social media is a direct function of its perceived "usefulness, ease of use, personalization" and immediacy (Zhang et al. 2014; Hanus and Fox 2015; Domingo and Gargante 2016; Salminen et al. 2016; Siddiq et al. 2016). Therefore, educators' Internet self-efficacy is paramount in the successful facilitation of blended learning.

In the same light, self-efficacy and higher levels of confidence in the Internet is correlated with the opportunity to participate and contribute "useful knowledge", enjoyment, happiness, adaptability and flexibility in collaborative learning (Zhang et al. 2014; Zhang et al. 2015; Domingo and Gargante 2016; Salminen et al. 2016; Siddiq et al. 2016). Relevant literature identifies "self-efficacy, perceived usefulness, perceived ease of use, teaching beliefs, ICT anxiety, and general attitudes towards computers" as fundamental determinants of educators' ICT integration (Siddiq et al. 2016: 2). To be sure, determinants of educators' ICT integration are a direct function of their "perceptions of their ICT skills and the usefulness of integrating ICT in teaching and learning" (Siddiq et al. 2016: 2). That is, educators' "motivation and willingness" to integrate digital technologies and Internet in teaching and learning will largely depend upon their attitude towards Web-based instructional practices (Kavanoz et al. 2015; Ninlawan 2015; Hung 2016). Attitudes towards Internet determines the behavioural intentions in the blended learning; hence, Kavanoz et al. (2015: 96) argue that "appropriate attitude towards the Web is a pre-requisite for positively embracing web-based instruction", thereby rendering insights into educators' self-efficacy and attitude towards Internet and Web Pedagogical Content Knowledge crucial to efforts designed for their professional development in preparation for the ubiquitous and inevitability of educational ICT. Therefore, educators "need more knowledge on how to evaluate the pedagogical usability of digital learning material" as well as the ethical considerations involving the digital learning environment, social media, the pedagogical advantages and disadvantages together with the learning styles of the "Net Generation" (Salminen et al. 2016: 355).

Collectively, computer and ICT literacy for the application of blended E-learning involves issues of the user's "capacity" or "self-efficacy" rather than mere access (Boschman et al. 2015; Kavanoz et al. 2015; Ninlawan 2015; Orr and Kukner 2015; Hung 2016; Park et al. 2016; Siddiq et al. 2016). Whereas Noh et al. (2014: 144) argued that "Computers and computing technology are indicative of good teaching and student learning" and therefore that digital technology has revolutionized social networking, the norm has not held with the onset of educational ICT (Peeraer and Van Petegem 2015; Ninlawan 2015; Hung 2016). Perhaps, the low levels of applications of ICT in education, amidst excessive technological resourcing, is a function of the negligible "capacity" and "self-efficacy" among educators. Drawing, respectively, from Bandura's (1977) and Ford's (1992) conceptions of "self-efficacy" as "a person's ability to be successful in organizing and executing actions towards a specific goal", and "capacity" as beliefs about personal empowerment (both cited in Webster and Son 2015: 85), it can be argued that computer and ICT literacy involve the educator's ability to successfully use the E-learning environment for knowledge acquisition through analysis, application and evaluation. For this paper, the survey data collected in the TV White Spaces Pilot Project was scanned to identify information about educators' self-assessment of and confidence in their abilities and skills relating to computer and ICT literacy. The next section describes in brief the research design adopted for the survey conducted in the TV White

Spaces Pilot Project, from which the data analysed in this paper was drawn.

RESEARCH METHODOLOGY

Research Design

Survey material used in this paper is part of a broader TV White Spaces Pilot Project implemented in July 2013, hosted by the University of Limpopo in Mankweng Circuit, South Africa (Masonta et al. 2015). The primary goal of this project is to promote application of digital technology in teaching and learning among high school students and educators. The pilot project covers five high schools, which are: Mamabudusha, Doasho, Ngwanalaka, MountainView and Mphetsebe. Students and educators at these schools constituted the target population for the TV White Spaces Pilot Project questionnaire survey. The plan is that the initiative would be extended to other high schools in Mankweng Circuit if this pilot enhances the effectiveness of teaching and learning. For this reason, one of the first requirements was to establish the baseline data relating to infrastructure as well as the levels of computer and information literacy among the students and educators. For the pilot baseline data, the questionnaire survey was conducted among students and educators at only three conveniently sampled schools (MountainView, Mamabudusha and Doasho) during mid-2014. This paper focuses on the results of the survey among educators whose sample consisted of seven (7), nine (9) and eight (8) educators from MountainView, Mamabudusha and Doasho, respectively. That is, this paper analyses and interprets results from a total number of twenty-four (24) educators.

The three schools represented both the rural and township contexts: whereas MountainView is a township school, Mamabudusha and Doasho are rural. For the project survey, a sampling frame of 124 educators was compiled from lists provided by the three schools; and, a total of 24 educators were selected through simple random sampling techniques for administration of the questionnaire. This paper is focused on survey results relating to ICT competence among educators alone. The questionnaires covered a wide range of issues inclusive of the users' confidence in their technological abilities and skills which is the focus of this paper, to uses of TV White Spaces for learning and teaching. The questionnaires were loaded into android phones using the online data collection application, Open Data Kit (ODK). University of Limpopo Computer Science final year students were employed to administer the ODK-based questionnaires. This paper draws data from the frequency tables generated from the TV White Spaces Project survey through Microsoft Excel; and, it examines results of only two sets of questions on the educators' levels of computer and information literacy, necessary for TV White Spaces informatics and usage.

RESULTS AND DISCUSSION

TV White Spaces Model and Educators' ICT Literacy in Mankweng Circuit High Schools: Mountainview, Mamabudusha and Doasho

The survey results show that sixty-seven percent of the sampled educators were trained on the use of ICT for teaching and learning. Whereas the significance of the thirty-three percent of educators who did not receive ICT training cannot be underestimated, it is reasonable to examine the use or lack thereof in teaching and learning. Reliance on printed official curriculum resources has continued to be dominant because its frequency of use is daily and weekly compared to that for internet which is dominated by weekly and never (Table 1). It is interesting to note that most educators used internet resources weekly for both official curriculum and other general purposes; and, the same holds true for those who never used internet resources. Indeed, a significant proportion of educators use internet resources monthly. Apparently, most educators are not using internet as frequently, implying that the implementation of the TV White Space Model did not revolutionize digital teaching and learning. That is, its uptake appears to be minimal amidst training of sixty-seven percent of educators who could have been expected to promote the use of ICT on a frequent basis. This observation is however consistent with the trends in developed countries where the uptake of digital technology in pedagogy has remained low or even negligible as educators have continued to rely on face-to-face didactics interactions. Expectations of establishing active learning among students through the flexibility and collaborative opportunities provided by dig-

ital technologies have not drawn interest among the educators who have access to the TV White Space, almost 18 months after implementation. The first set of columns (Table 1) suggests that teaching and learning has in the three high schools remained business as usual because the traditional didactics of the face-to-face teaching have continued to be predominant. The implication is that the implementation of the TV White Space Pilot Project has not agitated for the incorporation of digital technologies in teaching and learning among the 67 percent of the trained educators. If blending had happened to any significant degree, the daily reliance on printed curriculum resources would have moderated downwards as a reflection of the incorporation of digital technologies.

Importantly, the survey results seem to suggest that, notwithstanding sixty-seven percent educational ICT trained educators, the low usage frequency could be a function of the limited literacy in computer and information management. A significant majority of educators are evidently capable of basic operations of computer technology and they are highly confident about it (Table 2). But the proportion of educators who are confident of their abilities and skills to use computers drops significantly when it comes to applications relating to the management of information.

The fact that an increased majority of educators might need technical support to perform information management using internet may be the reason that discourages most respondents from making frequent usage of ICT because high schools do not employ technicians. With this observation, it is important to note that incorporation of the digital technology in this case could entail added time and energy which is not necessarily acknowledged as overtime. The discrepancy of confidence about basic operations of the computer and its use to manage volumes of information appears to be a function of the specific use that is prominent among the respondents. As it would be expected, most educators use computers for typing and e-mails (Table 3).

Table 1: Frequency of usage of printed versus internet curriculum resources among educators

	Daily	*Weekly*	*Monthly*	*Occasionally*	*Never*
Printed official curriculum resources	11	8	4	1	0
Internet official curriculum resources	4	7	6	1	6
General internet resources	6	7	5	0	6

Source: TV White Spaces Project Survey

Table 2: Levels of confidence about computer and information literacy among educators

	Very confident	*Quite confident*	*Might need someone for help*	*Not confident*
Switch on, off and log in	19	3	2	0
Copying, moving, deleting, finding and downloading files	9	5	8	2
Downloading, installing, upgrading and using new program and applications	7	1	9	7

Source: TV White Spaces Project Survey

Table 3: Educators' confidence in abilities and skills to use the internet

	Very confident	*Quite confident*	*Might need someone for help*	*Not confident*
Searching internet for material	11	7	3	3
Downloading files from internet	8	3	7	6
Sending and receiving e-mails	12	6	6	0
Creating online accounts and logging into online services	7	2	2	13

Source: TV White Spaces Project Survey

Indeed, the majority of educators are confident about their abilities and skills to search the internet and less so about downloading files and creating online accounts. The observation made above implies that the educators are scarcely, if at all, involved in the E-learning environment. This point is affirmed by the low frequency of educators' use of the internet for official curriculum resourcing, especially given that the proportion of educators who never used digital technologies in this way is significant and only surpassed by that for weekly frequency (see Table 1). Reading the statistics on the use of internet for e-mails and general purposes, rather than official curriculum, should suggest that educators find the digital spaces to be a resource for social networking than for educational revolution.

Evidently, the majority of educators are confident about their abilities and skills in using MS Word and, to a limited extent, MS Excel, and even worse so, for MS PowerPoint (Table 4). These results should be read in the context that PowerPoint is one of the most basic expectations of the didactics applications of computer technologies to enhance the effectiveness of teaching and learning. That is, educators have continued to rely on the traditional didactics rather than incorporate computer technologies. The confidence in the use of MS Excel above PowerPoint too is understandable because educators would have found it efficient to administer students' marks using computer technologies rather than hardcopy material. However, the educators' low confidence in their abilities and skills to use PowerPoint, which has a direct bearing on the effectiveness of teaching and learning, should be a serious matter of concern about the uptake of ICT in the education system. It could implying that the provision of digital technologies in the TV White Space Model may have been scarcely understood by educators as a means of revolutionizing teaching. This observation is affirmed by the high confidence levels that educators have in their use of computer technologies in MS Word and e-mails than in managing information (see Tables 2, 3 and 4).

These results provide important leads in respect of the educators' computer and information literacy. Overall, it can be inferred that educators lack confidence in their abilities and skills in using computer and information technologies for teaching and learning purposes, especially because sixty-seven percent of them were trained in ICT usage. Notwithstanding the latter, it can be argued that educators' ICT literacy is low and that their understanding of digital technologies as teaching and learning tool is severely limited. Whereas most of them are able to operate computers at the basic minimum of typing and emails, they lack competence in relation to management of large volumes of information. Despite the awareness about the TV White Spaces resourcing, those educators who use it have found in it a digital tool for social networking rather than for teaching and learning.

It can be inferred that the implementation of the TV White Spaces Model has not necessarily revolutionized the use of digital technologies for teaching and learning. For this reason, this paper recommends that an educational campaign is mounted among the five high schools in order to unambiguously promote digital participation of educators in the online learning environment. This campaign would entail deeper involvement of all partners and collaborators, especially the Department of Basic Education, in order that digital participation is acknowledged as part of the education system and educators are provided with resident technical support at schools.

CONCLUSION

This paper has examined the theoretical justification for the incorporation of digital technologies in the enhancement of effectiveness of teaching and learning, affirming therefore the significance of training and promotion of the

Table 4: Educators' confidence in abilities and skills to use Microsoft office applications

	Very confident	*Quite confident*	*Might need someone for help*	*Not confident*
MS Word	15	5	4	0
MS Excel	11	4	5	1
MS PowerPoint	6	4	7	7

Source: TV White Space Project Survey

uptake among educators. Further, it drew and analyzed data from the three Mankweng Circuit high school participants in the TV White Spaces Pilot Project survey which consisted of 600 students and 124 educators. Being focused only on educators' confidence in their abilities and skills to use digital technologies in teaching and learning, the paper examined survey results among a sample of 24 educators, which were selected through probability sampling. The paper observed that the implementation of the TV White Spaces Model has not revolutionized digital technologies applications in teaching and learning at the three high schools. It therefore, recommends an educational campaign that promotes digital participation of educators in the online learning environment, as well as increased involvement of all partners and collaborators in order that digital participation is acknowledged as part of the education system and that educators are provided with resident technical support at schools. Importantly, this paper proposes that the implementation of educational digital technologies needs to be thoroughly discussed and explained to educators so that undue anxieties may be avoided.

RECOMMENDATIONS

The paper recommends the following interventions:

- Government should design and institutionalize a national learning management system for blended learning environments to supersede the current ad hoc provincial implementation;
- Department of Basic Education should progressively alter educators' attitudes towards the integration of digital technologies in teaching and learning through pragmatic campaigns that demonstrate usefulness and enjoyment of the E-learning environment;
- Government should provide for a complete geographic coverage of the e-infrastructure across rural South Africa, with the attendant requirements for reliable electricity, security and technical support;
- Government should provide for national mandatory requirements for blended learning by ensuring that educators are trained in digital technologies as part of pedagogical curriculum; and,
- Educational campaign should be mounted in order to promote digital participation of educators in the online learning environment, with attendant official acknowledgement and provision of resident technical support at schools.

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Paper received for publication on January 2015
Paper accepted for publication on December 2016