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This endeavour is a contribution to help the **Matthew Goniwe School of Leadership & Governance (MGSLG)** understand the level of preparedness (e-readiness) and level of technological implementation of Phase 1, Phase 2, Phase 3 and Phase 4 target schools. MGSLG understands the importance of technical competence and computer literacy among teachers and learners in order to make meaningful investments and create appropriate interventions to increase uptake of ICT in schools. This will contribute to Gauteng Department of Education (GDE) achieving a universal ICT access and services as pronounced in the National Development Plan (NDP).

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Human Resources	**Roles**	**Qualification**
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INTRODUCTION

With the widespread belief that Information and Communication Technologies (ICTs) have an important role to play in the modernization of education systems and ways of learning, the Gauteng Department of Education Pillar 6 'ICT in Education' acknowledges that a fundamental transformation in education is needed. This is to ensure that new skills and competences are in place in order to grasp new opportunities brought by ICT affordances. The digital agenda demands innovations and creativity in education to improve learners' attainment. However there is lack of scientific evidence of the concrete contributions of ICTs to the learning domain, despite the efforts of the last decades being made by governments and non-profit making organizations.

Hence, there is a need to bring distributed evidence together on the state and impact of ICT on education in South Africa, especially the Gauteng province whereby 'ICT integration in schools' is a priority. The background of this research focus has been on understanding the level of ICT integration in schools, the state of ICT infrastructure in schools and the ICT practices in teaching and learning. The ICT implementation in Gauteng has been influenced by policies at national and provincial level, but not at the school and individual teacher level. The integration of ICT in schools has been driven by the political vision and in some circles the reason has been partly based on the MEC enthusiasm for creativity in pedagogical activities and to shift towards paperless schools. This will have long-term effect to the reduction of early school leaving [drop-out] and increasing tertiary education attainment.

The key here is to position ICT based on educational needs, instead of technological possibilities. In phase 2 'School-Based ICT Committees' were constituted to develop ICT integration master plans. In fact majority [70%] of the 133 schools that participated in the project did not have a 'School-Based ICT Committee' and an ICT masterplan to create an enabling environment to pedagogically integrate ICT. In fact 6% of the schools did not have basic ICT infrastructure in some instances there were mobile classrooms. The principals in those schools allowed researchers to come, but quickly revealed that they did not have proper building structures to accommodate ICT infrastructure. They even explain that their priorities are to keep the lights on, water running, and ensuring that teaching and learning is taking place.

In our observation, those schools with thin resources had different priorities and not objecting to the idea of bringing technology in the classroom. However, we could not get an opportunity to engage with teachers beyond the principals' offices to understand their thoughts and perspectives about ICT use in general and in their profession. In other schools where there was basic ICT infrastructure such as computers, researchers held semi-structured focus groups and individual meetings. Among those participating teachers, researchers purposively invited teachers from different subject areas to interview and observe their classes. According to the results, the majority of the participating teachers were positive about having access to digital tools in their classrooms. While teachers insisted on the value of having access to Interactive Whiteboards and computers in the classroom and being able to use them for teaching, it was observed that the vast majority of teachers perceive Interactive Whiteboards as display systems or projection systems. Thus, the use of Interactive Whiteboards though dominating the classrooms was mostly limited to presenting power-point slides and playing videos. It was also obvious that Interactive Whiteboards were mostly used by teachers in Science, Mathematics, Geography, and Languages.

The limited use could be attributed to social and cultural capitals as they play a crucial role in the ICT integration process. In fact some teachers pointed to the limited access to e-content and digital materials. This became clear that some teachers are aware of the digital resources available to them for teaching and learning. During the school visitations it also became clear that the influence of culture on individual-level beliefs must be recognised as a crucial factor in the process of integrating ICT in schools. Due to socio-economic incongruences particularly in South Africa, context is crucial in ensuring that educators are not marginalized. In line with Bourdieu's vision of cultural capital, the possession of ICT can be seen as an indicator of economic capital, the appropriation and use of ICT in accordance with its specific purpose as an indicator of cultural capital (Bourdieu, 1986). Once knowledge and skill to use ICT is mastered, educators can collaborate and share ICT best practices to unlock information access by learners beyond the physical spaces. That means more opportunities must be made available to teachers so that they continue to build their capital resources.

In developed economies, research has demonstrated some key drivers and mechanisms for improving standards in schools by making effective use of technology (National Research Council, 2011; Roehrig et al. 2007; Hardman, Abd-Kadir, & Smith, 2008; Scheerens, 2000). The National Integrated ICT Policy White Paper (2016) envisions that by "2030, ICT will underpin the development of a dynamic and connected information society and a vibrant knowledge economy that is more inclusive and prosperous". Government view innovative use of ICTs in education as a panacea to assist in addressing inequalities in education across South Africa and facilitate ongoing improvement of educators' skills. The gaps in conceptual understanding of the role of ICT in teaching & learning, school level values and pre-existing practices must be closed. The implementation gap among teachers is due to both social and cultural capital. Therefore in all ICT implementations there must be a change process to shift teachers' perception of ICT in the classroom.

This e-Readiness research was an attempt to document, discuss and elaborate on the state of ICT integration in schools and the state of ICT infrastructure. Moreover it shows how teachers are implementing ICT in different subjects in basic education and the pedagogical use of ICT in teaching and learning. This work was correlated with other studies to enrich the ICT integration activities taking place in schools. This work contributes to the new education sustainable development goal for 2030 which has been set to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all".

The state of ICT infrastructure is another challenge and those with access to ICT infrastructure complained about lack of interactivity between their laptops and the Interactive Whiteboards. Though this issue seems to be technical at the initial look, however it was clear those teachers did not have the technical know-how to ensure that their devices are in sync with the Interactive Whiteboards. With regard to access to laptops, 92% of teachers have access to them, while 44% indicated having access to Interactive Whiteboards at schools. In spite the fact that 44% indicated having access to Interactive Whiteboards, it was noticed during classroom observations that the usage was very low. Based on the interviews and the questionnaire data teachers do have interest in the use of ICT, but do not have the confidence. This was due to their limited technical knowledge and skills. 72% of participating teachers cited computational skills as key to succeeding in the ICT integration project, while 58% cited confidence as important.

Below are the districts and number of teachers who participated in this study.

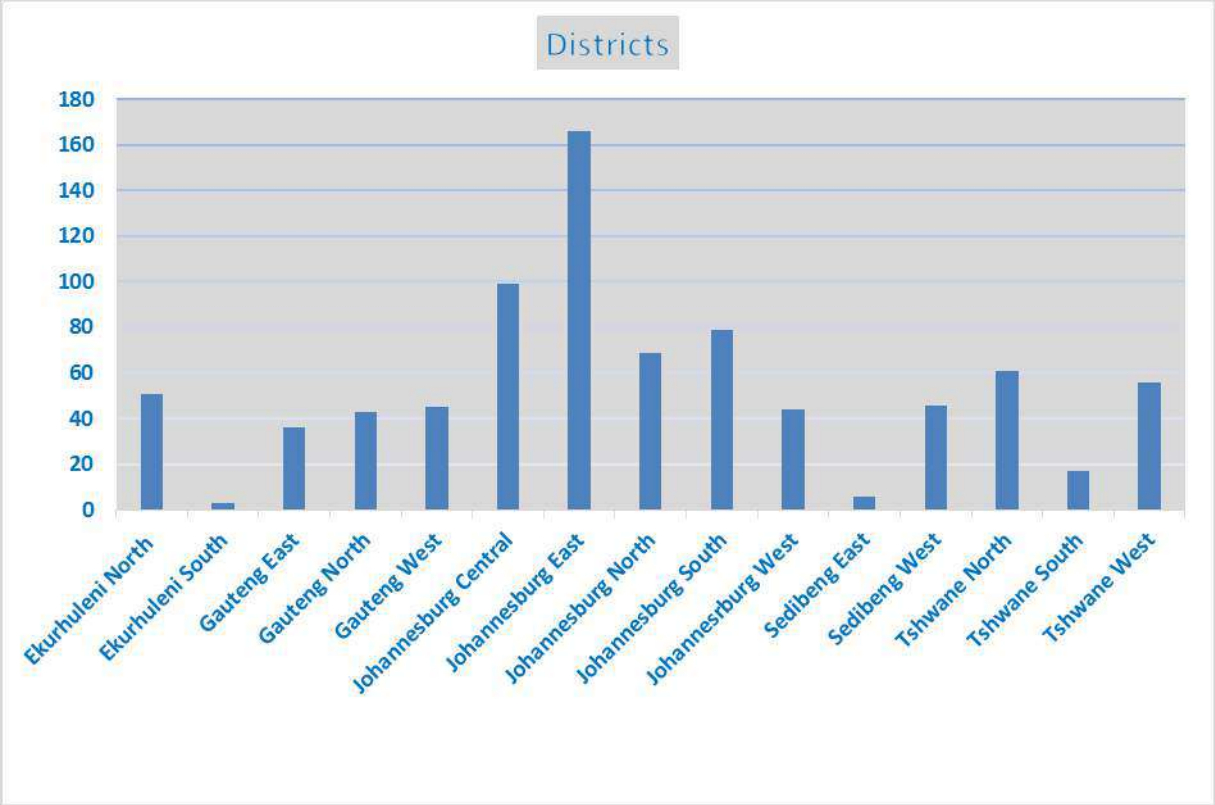

Figure 1: Presenting the 15 Districts Represented in the Research

We conducted an empirical research to determine the level of technical competency and computer literacy among teachers. This work informs a meaningful and realistic ICT Investments and Teachers ICT Development Strategic Plans. The project gathered data from various schools in the 15 Districts presented in Figure 1 in the Gauteng province. The report provides insights on the state of ICT integration, teachers' ICT perception, and computing infrastructure across the province. The experience of teachers' use of different technologies was fairly distributed demonstrating that teachers do have access to basic computing infrastructure in their schools especially desktop computers, laptops, and display technologies such as Interactive Whiteboards.

Though the use of ICT was promoted across all subjects as a lever for pedagogical innovations, it was evident that science and mathematics teachers were the popular in adopting ICT. In some of those classes where it was used there was no shift in pedagogical practices meaning real transformational change remained elusive. Instead of teachers using

ICT to change the learning experience they replicated their passive practices with technology used to project the content in text form.

There were minimal innovative digital pedagogies being practiced to reap the benefits of the ICT affordances. The study represents a wide spread of teachers' experiences as presented in Figure 2. The majority of participants have 20+ years of experience followed by those with between 6 and 10 years of experience. This provides meaningful insights based on different years of working experience.

Figure 1: Teachers Working Experience

Figure 2 presents a wide range of working experiences for teachers in schools which confirms the multidimensional insights on the conceptualization of ICT in teaching and learning. The working experiences are fairly distributed which provides rich ICT pedagogical landscape to help understand what it means to go for a system wide adoption and integration of ICT in schools. The need for training is great, given that the majority of teachers that participated in the survey indicated that they have not received ICT training prior to becoming teachers, see Figure 3. As a way of improving ICT skills among teachers there must be a systematic approach to ignite teachers' passion for digital pedagogies, which are invaluable in the 21st century classroom. This will help put teachers within a controlled environment whereby their progress can be monitored and evaluated as they go

through development levels outlined in the White Paper on e-Education[1]. Figure 18 presents a picture that demonstrates that there is progression on the use of ICTs as teachers are fairly distributed in the different levels. The majority are at the 'Adaptation Level' whereby they are using ICT to support their everyday classroom activities.

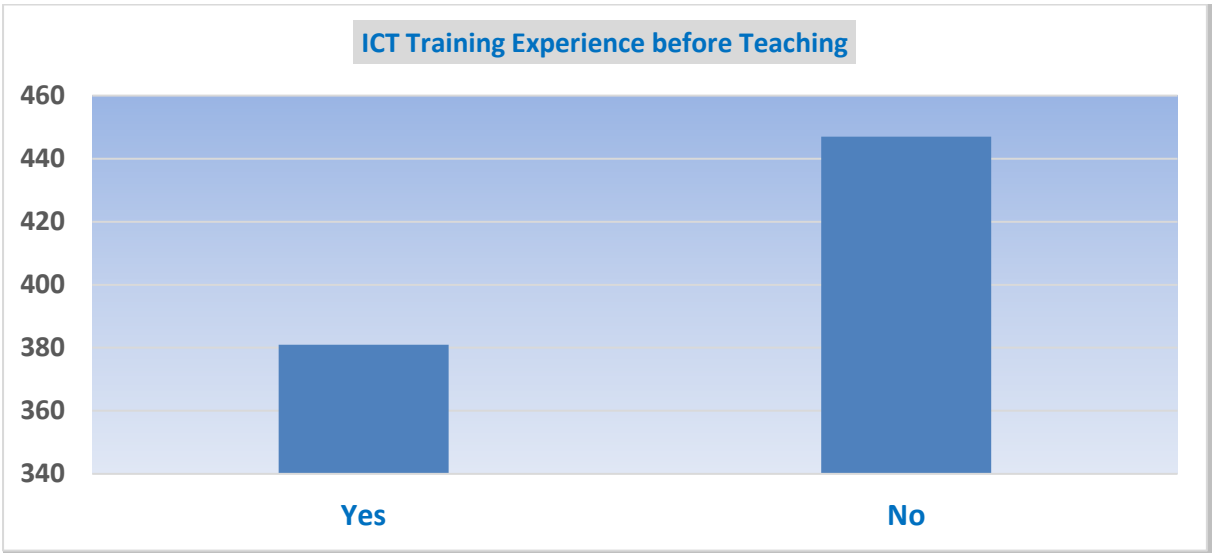

Figure 2: ICT Training Experience before Teaching

Finally, our hope was that the data collected could contribute to the provisioning of meaningful ICT teacher development activities and the systematic integration of ICT in schools.

OUTCOME OF MULTILEVEL ANALYSIS & KEY FINDINGS

The findings presented in this research report have the potential to inform a systematic design of engaging effective ICT intervention programmes that use innovative digital pedagogies. The varying understanding and preparedness to integrate ICT into teaching showed the lack of ICT conceptual understanding and awareness in schools. There was considerable diversity in apparent understandings of ICT tools. The wide range of ICT conceptual understanding and interpretations were problematic. We considered various levels of ICT integration ranging from simple power-point presentation to using Interactive Whiteboards (IWB). In our view, the Gauteng province needs to develop the following,

[1] http://www.sahistory.org.za/sites/default/files/white%20_paper_on_e-education_2004.pdf

- A scalable scenario-led design process for developing digital pedagogy;
- ICT classroom toolkit accessible through web-based environments [online & offline]; and
- Classroom perspectives supported by case studies of ICT teacher pedagogical adoption, appropriation, and integration in specific subjects.

Through the research teachers seemed to believe that the development of digital fluency should not be divorced from the realities of their socio-cultural context. There was continuous reference to being 'born before technology' which expose their lack of ICT technical know-how. There was little evidence that schools provided supporting structures or opportunities for teachers to experiment with new ICT tools like the Interactive Whiteboards (IWB). Given the scenario in Figure 3 the education system needs to provide continuous support to bridge the gap. Some teachers felt that the training was inadequate and it was of technical nature and had nothing to do with how to teach their subjects using it.

Figure 4 provides detailed information about various constructs in relation to schools in Gauteng. It is clear that there are gaps in the schools and GDE needs to swiftly develop a systematic approach to ICT integration to bridge those gaps and ensure that learners in all schools have access to digital literacies. In order to bridge ICT gaps in the education system teachers need to participate in initiatives that are guided by the principles of upholding ICT access as a right to make sure that all educators operate at the 'Innovative Level' whereby learning becomes collaborative and interactive.

This ensures that all learners have an equal chance of developing digital fluency as aligned with the global development agenda[2]. To achieve this all learners and educators should be ICT capable, create new information, and invent new ICT applications to enable economic growth and social development. The challenge in Gauteng schools was the uneven distribution of computing infrastructure and digital fluency among teachers. To make sure that the digital skills' gap among teachers is overcome, the initiatives must include specific targets so that there are no teachers and schools left behind. This will also facilitate

[2] https://sustainabledevelopment.un.org/post2015/transformingourworld

monitoring of specific targets at individual and cohort levels. DBE's progress with ICT integration in schools describes being ICT capable as follows[3]:

- "ICT capable people are able to access information in the digital era, manage information effectively, interpret and integrate the results of research" (p.1)
- "They are also able to evaluate the quality of these results, and create new information by adapting, applying, designing, inventing or authoring information" (p.1)
- "ICT capable people use ICT, invent new ICT applications, and demonstrate improvement in attaining learning outcomes and 21st century skills" (p.1)

The trainers must command excellent ICT skills in order to ensure that teachers are meeting all three bullets above. The successful implementation of ICT in schools is dependent on the participation of all stakeholders to ensure that schools are ICT equipped and teachers have access to continuous ICT development programmes and support. Digital pedagogies and the role of the teacher are central and multidimensional approach embraced which include multiple role players and teachers' level of ICT integration into their practice. In the absence of clear, integrative ICT masterplans the progress will continue to be fragmented. Based on our analysis, four enablers, ICT skills, ICT Governance, System-wide Change Management, and Secured & Shared Infrastructure were identified in order to increase adoption, integration, and innovation in the classroom. The ICT masterplans must encompass the following constructs: access, capacity, governance, cybersecurity, e-content, and applications.

[3] http://www.nstf.org.za/wp-content/uploads/2015/10/Progress.pdf

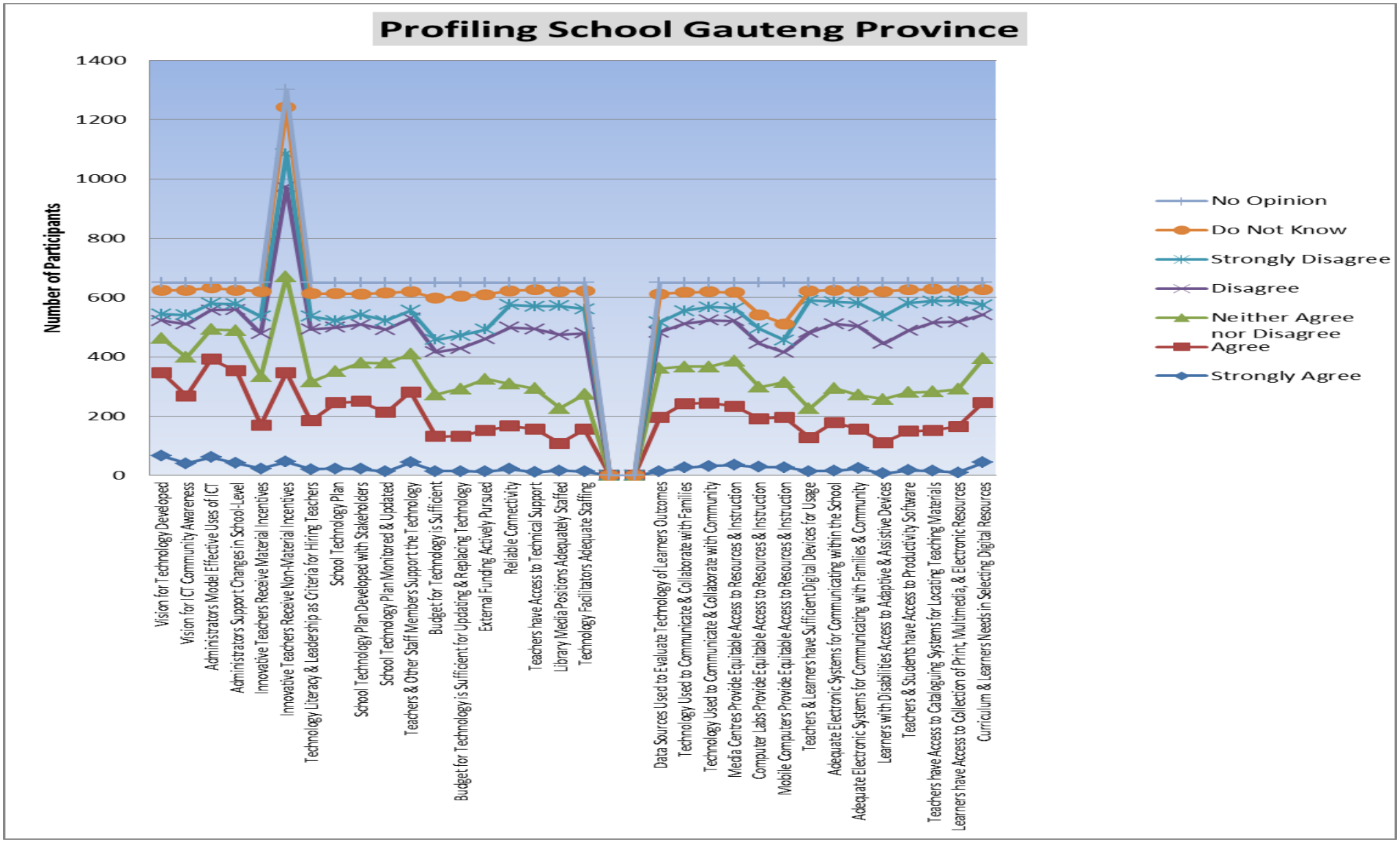

Figure 3 Profiling Sampled Gauteng Schools

In fact those who recently graduated felt that Universities did not adequately prepare them for the contemporary classroom. Universities did not provide sufficient opportunities for them to see or use ICTs in their teaching. They raised the issue of modeling by academic staff to students on the process of integrating ICT in their teaching. The unavailability of opportunities to use ICT tools at Universities is evident in Figure 6.

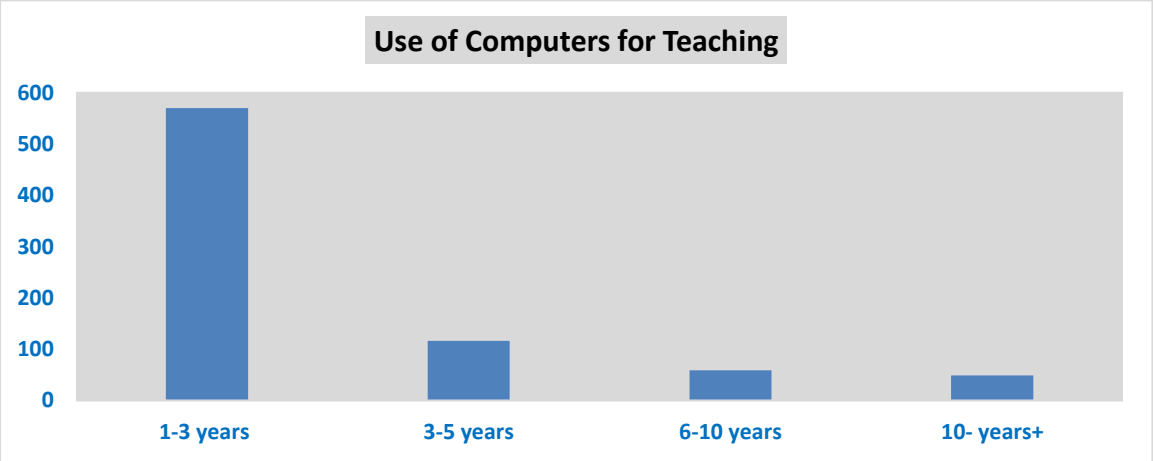

Figure 4: Use of Computers for Teaching

Figure 5 is skewed signifying that preparedness to incorporate ICT in teaching is very low. Therefore, preparedness is dependent on ICT aptitude, entry-level computing skills, and access opportunities both at schools of education and in schools. In fact it was clear there is lack of developed ICT capabilities in schools to enable entry level teachers to develop interest. The issue of access to computing infrastructure was another factor let alone the foundation to build classroom appropriate ICT skills and pedagogies. Figure 6 demonstrates the need on the ground. However a significant number of teachers seemed to own their own laptops and various mobile devices with different capabilities.

Evidently there are smartboards in classrooms. However the extent of usage and distribution is still skewed given that some schools in the Gauteng provinces lack physical structures as they use mobile classrooms. Lessons are still conducted in mobile classroom. The technology device ownership in Figure 6 is not translating to ICT integration into teaching and learning. In fact teachers felt that the government should provide them with digital devices despite the fact that the majority of those who participate own a laptop or a smartphone. This signals the mindset on the ground divorcing their digital devices to their professional growth. Again if government does provide such devices to teachers it is not

sustainable so the issue is not buying laptops for teachers but helping them to understand that the devices they have at their disposal could enhance their professional and personal growth. Thus any intervention must have a 'Theory of Change' to shift teachers' perspectives and attitude of entitlement. Figure 6 demonstrates that they are already in possession of digital tools or computing devices; however they look at it as theirs instead of positioning it in their teaching profession to enhance their work and learners' experience.

Interactive Whiteboards Affordances

Interactive Whiteboards (IWB) dominated the classroom environment and lessons observed during the research. The study sought to identify how teachers used features of ICT to enhance teaching and learning. Interactive Whiteboards helped to stimulate, structure and support activities in most of the classrooms observed during the research. The IWB was used to present concepts which required scaffolding through videos, animations, various representations of information, displaying of teaching objects, and in some cases used as writing boards. The IWBs have edge over technologies as they seem to be effective in gaining learners' attention, keeping their attention longer, stimulating thinking as they ask questions continuously, and maintaining a focus on the lesson being presented. Teachers suggested that the large visual display could be the main factor as learners become more attentive once it is switched on. This is congruent with DfEE (1998) list of actions supported by ICT:

- **Speed**: making processes happen more quickly than other methods (p. 231).
- **Automation**: making previously tedious or effortful processes happen automatically (other than changing the form of representation) (p. 231).
- **Capacity**: the storage and retrieval of large amounts of material (p. 231).
- **Range**: access to materials in different forms and from a wider range of sources than otherwise possible (p. 231).
- **Provisionality**: the facility to change content (p. 231).
- **Interactivity**: the ability to respond to user input repeatedly (p. 231).

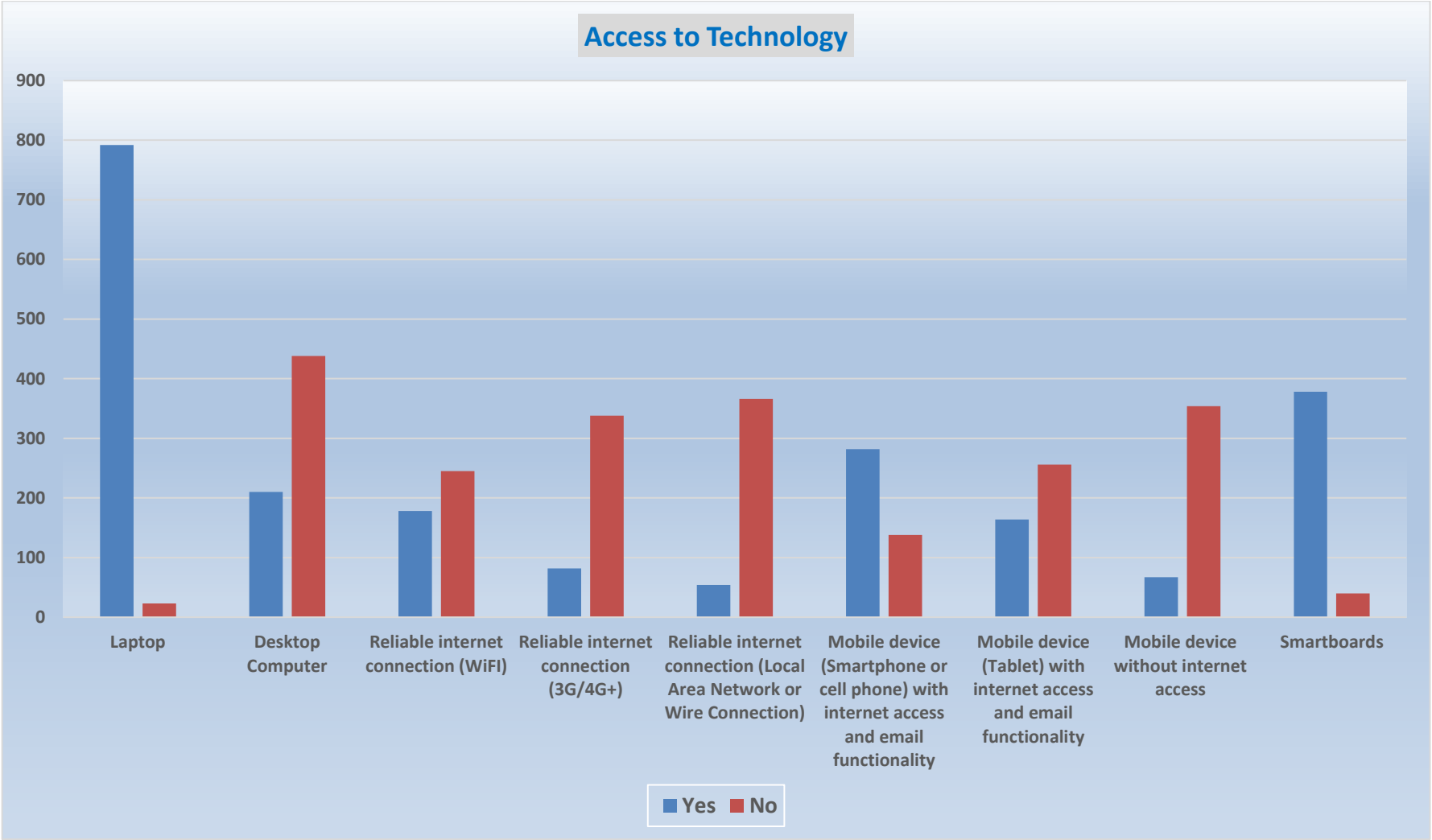

Figure 5: Access to Technology

It is clear that school leadership should consider putting structures in place and also make sure that there is continuous support. The need is great on the ground and teachers in Figure 6 are in agreement of what is needed for them to effectively use ICT in their teaching.

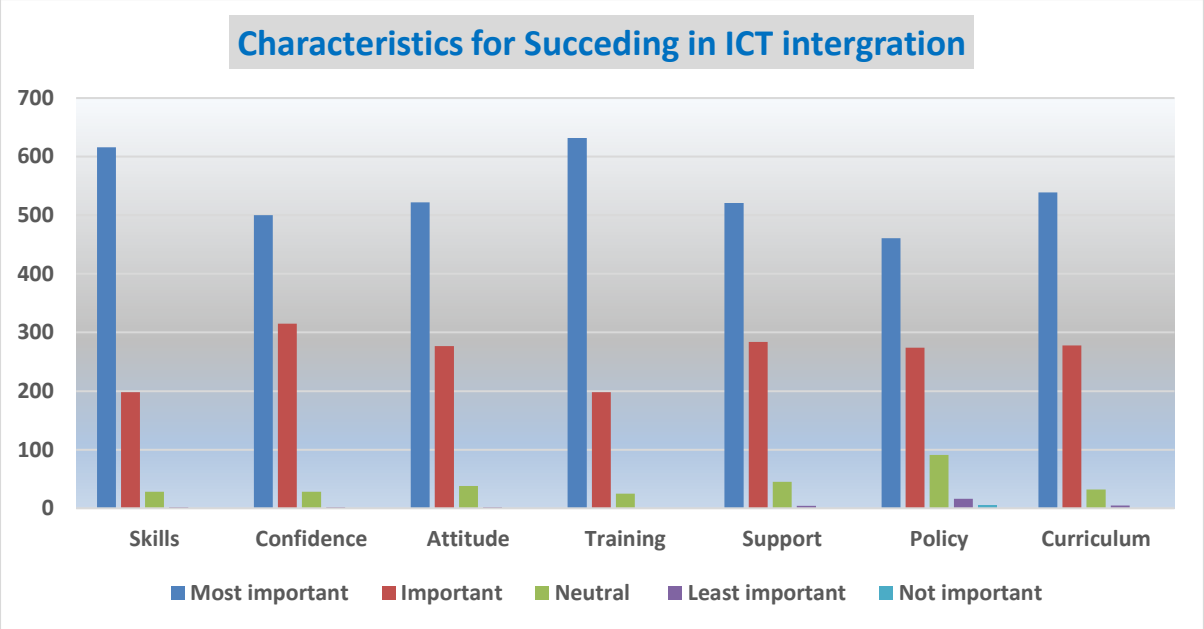

Figure 6 Characteristics for Succeeding in ICT Integration

Figure 7 demonstrates that there are agreements that the constructs presented are important in the effort to appropriate, adopt, and integrate ICT into teaching and learning. Given such constructs, schools may consider developing a culture of collaboration with other schools or educators that are excelling in the effort to integrate ICT in their profession. This will allow teachers to establish and maintain connections with colleagues in a supportive environment to share and jointly develop digital and pedagogical knowledge and skills in a professional community. The professional communities will provide teachers with opportunities to take greater responsibility for their development of digital fluency and pedagogies.

Professional communities can shift the burden of 'workshopping' teachers away from the government as they become partners rather than normal workshop participants. Teachers would develop new ways of designing their lessons and managing the learning process in a professional community and in the process become creative on the most effective use of emerging digital tools to produce desired learning outcomes. The development of Professional Learning Communities (PLCs) will enable innovations based on the classroom

experience to create multiple pathways to develop cognitively. The IWB affordances have the potential to transform the structure of what happens in the classroom. During observations, teachers were able to use the IWB for "labelling, highlighting, colour coding, classifying."[4] There were activities whereby the teacher would kick-off the lesson and learners were moving up and down on the board to present their ideas and drag them into an appropriate place. This demonstrates a high level of engagement for learners in the presence of an interactive environment. On the IWB teachers could compose, edit, select, retrieve, transform, share, store, annotate, undo, and prompt. The advantage of such technology was its ability to combine visual, aural, textual display, and to set out a choice of resources. In addition, this technology presents a unique opportunity and unmatched ability to present information in various modalities.

In this case, there is no doubt about the IWB technology with its applications like combining visual, aural, file sharing, and textual displays. The education sector must take full advantage of the power of IWB to transform education and the classroom experience for all learners. However, it is all about the implementation strategy to ensure that teachers are taking full advantage of the IWB features that present various affordances to support the education system. In a country ranking low in Mathematics and Science this technology has the potential to revitalize the disciplines and stimulate interest among learners and in the process boost the chance for achieving the United Nations Development Goals and the National Development Plan.

[4] DfEE (1998). Initial Teacher Training National Curriculum for the use of information and communications technology in subject teaching, Circular 4/98 Annex (London, Department for Education and Employment).

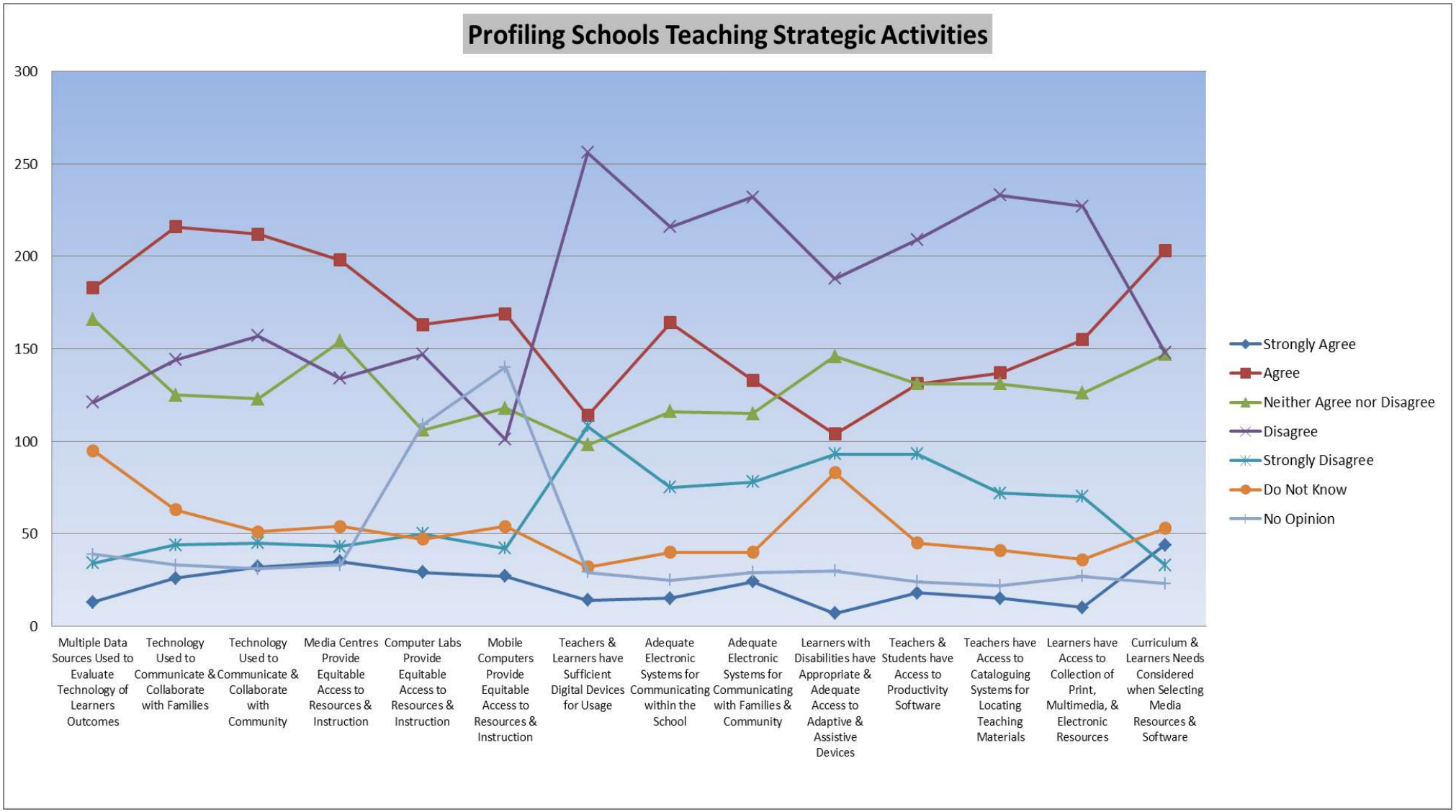

Figure 7 Schools Teaching Strategic Activities

Figure 8 demonstrates the need to develop interventions that will bring teachers and technology together in the classroom. There is no normality in the distributions signifying the amount of work to be done on the ground. The integration of ICT in the classroom has nothing to do with computers, tablets, and smartboards; instead it revolves around teachers that have been side-lined. 72% of teachers that participated in the study were still sceptical about the value of Information and Communication Technologies in their professional space, when they have curriculum to finish and help learners to read and write at the appropriate level. In fact some teachers have no doubt about the demands of the contemporary classroom whereby learners have access to information in multiple pathways. It became clear that there is lack of a systematic process in the integration of ICT as some asserted that you come to school the next thing digital devices are being delivered with expectations that teachers will adopt and appropriate them in their lessons. In the current environment teachers are not prepared and the support is limited especially those who have been trying to integrate technology in their classroom. In the current environment 'the cart is put before the horse' thus it is necessary to address ICT skills and pedagogies, and put in place a change management process to help shift teachers' mind-set.

The sample of teachers that participated might look small given that there are thousands of teachers. However, the findings give a glimpse of what is happening on the ground and the findings cannot be ignored. The issue of ICT integration demands a closer look, given that the findings in this research are congruent with other studies conducted by the British Council in collaboration with the Department of Basic Education and Vodacom. Figure 7 presents the results of a study conducted in 2016 by the British Council. Similarly, 78% of the schools that we surveyed do have the basic ICT infrastructure, with at least 22% without. In this case, we sampled from a database with schools labelled as ICT equipped schools. There was no 'diffusion of innovation strategy' in place, yet computing infrastructure was provisioned. For example the majority of teachers in schools express their frustrations in classroom management and sharp decrease in learners' attention and limited understanding of how to use technology in teaching. The 'diffusion of innovation strategy' could map ICT affordances with pedagogical activities at different levels. The distribution of digital devices should be aligned with teachers' level of preparedness to

integrate technology so that there is enrichment in the classroom through interactive lessons.

From our experience and observation there are major obstacles holding back schools from maximizing the use of technology in the classroom and these are congruent with international factors [access, demographic factors, educational factors, teachers self-efficacy, and incentives & support] (Hennessy and Wamakote, 2010; Hew and Brush, 2007). This research found the following factors as barriers to ICT integration:

- ICT infrastructure was not fairly distributed and teachers' technology skills were limited. Figure 8 demonstrates the need to develop interventions that will bring teachers and technology together in the classroom. There is no normality in the distributions signifying the amount of work to be done on the ground. The integration of ICT in the classroom has nothing to do with the availability to computers, tablets, and smartboards, instead it revolves around teachers.
- African Research Agenda on the ICT Pedagogical Integration (2009-2012) revealed that the level at which the township schools in Gauteng are integrating ICTs was low and this was due to complex challenges. There is truth in the uneven distribution of computing infrastructure in schools and ICT competencies among teachers. Despite the growing number of computers in schools, the pedagogical integration of ICT into teaching and learning is still very slow. This could be attributed to social and cultural capital to develop ICT competencies within teachers' networks.
- 58% of teachers sited confidence as a determining factor in the use of ICT in the classroom. In South Africa research reports paint a fairly homogeneous picture on the limited use of ICT in schools, particularly where there is limited previous experience in the use of ICTs to support teaching and learning.
- In 133 schools we visited those teachers at the forefront of technology integration in their teaching and these were not recognized for their creativity. We suggest that those ICT savvy and innovative teachers be at the center of ICT teacher professional development and be recognized as ICT champions. These teachers are using ICT tools as pedagogical devices to enhance learners' classroom experience and improve learners' attainment.

- 92% of teachers have access to laptops; however they lack knowledge to conceptualize those digital devices in their teaching to transform learners' experiences.
- 78% of the schools that we surveyed do have the basic ICT infrastructure which is a desktop computer, projectors, and interactive whiteboards, but skills to pedagogically integrate them into the classroom continues to be a challenge. Marcinkiewicz (1994) found that self-competence and innovativeness were most closely related to the level of computer use.
- Teachers are not participating in PLCs to share knowledge and experiences are a contributing factor.

These factors result in too many inconsistencies on how ICT is being used in schools. Marcinkiewicz (1994) found that self-competence and innovativeness were most closely related to the level of computer use. Therefore, side-lining teachers is not helping the situation because teachers are the human part of the technological equation in the classroom. In order to experience new innovation in the classroom teachers must have access to digital pedagogies. Teachers in schools that have access to computing infrastructure with a ICT strategic plan and policies are encouraged by the level of support they receive from the leadership and the school environment. In these cases, there is institution-wide technological support on the pedagogical use of the available ICT infrastructure. These cases were very few and teachers were encouraged to experiment with various technologies to improve learning. The majority of schools suffered from inadequate ICT facilities and in some cases with outdated computing infrastructure.

In fact nearly all factors identified by this report have been identified in a number of recent studies and publications (Odendaal, 2017; British Council Study, 2016; Stoltenkamp, Kabaka, & Braaf, 2013; Ndlovu & Lawrence, 2012). Given the poor preparedness of teachers to handle the influx of ICT tools we can safely conclude that teachers are not fit for the new demand for the 21st century classroom. In fact, teachers were frustrated at the sharp decrease in learners' attention during class. 48% of teachers cited high level of need to develop ICT skills in a particular context; this was to engage learners with the available digital tools especially mobile phones. Further, the study reports that teachers describe

themselves as inadequately prepared and supported to effectively integrate technologies in their teaching. In the end we categorized teachers according to Evan-Adris' (1995) three patterns of technology use among teachers:

- "Avoidance", teachers who assign computer time to the learners but do not use the technology in their teaching. This is an indication that some teachers are not adequately prepared to use ICT tools in their classroom. With 58% citing confidence as a determining factor to integrate ICT it is clear that as long as they are not confident on the use of computers in their teaching, they would rather allow learners to use those computers.
- "Integration", teachers spending time experimenting with and learning to use ICT tools to promote effective and increased use of technology by their learners. This speaks to the bottom-up school-wide adoption of ICTs in teaching and learning activities. Teachers are allowed to experiment and given school-wide technology support.
- "Technical specialization", teachers with strong computing skills and their use of digital tools are more organized and purposeful than average teachers. These teachers could be identified as ICT champions in schools and recruited to be part of the trainings to help teachers develop digital fluency so that they adopt digital pedagogies in their teaching.

This led us to Danner & Pessu, (2013) quoting Kirschner and Woperies (2003) highlighting some of the major ICT competencies teachers require in order to effectively integrate ICT tools and appropriate digital pedagogies in the classroom. The major ICT competencies teachers require (p. 36):

- Making personal use of ICT
- Mastery of a range of educational paradigms that make use of ICT
- Making use of ICT as mind tools
- Using ICT as a tool for teaching
- Mastering a range of assessment paradigms which involve use of ICT
- Understanding the policy dimensions of the use of ICT for teaching and learning.

Gauteng Department of Education needs to deal with the low level of skilfulness in the use of ICT among teachers. The training and development opportunities must expose teachers to how they can use ICT tools for personal use so that in the process they develop confidence in a wide range of educational technologies. The preparation of ICT usage by teachers must be modelled at the pre-service teacher education level to ensure that they keep up with the demands of the 21st century classroom. There must be meaningful professional development opportunities for teachers, principals and school administrators on using ICT effectively in the classroom. To operationalize the term "integrate technology into teaching and learning," the Technology in Schools Taskforce (2003) has offered this definition:

> Technology integration is the incorporation of technology resources and technology-based practices into the daily routines, work, and management of schools. Technology resources are computers and specialized software, network-based communication systems, and other equipment and infrastructure. Practices include collaborative work and communication, Internet-based research, remote access to instrumentation, network-based transmission and retrieval of data, and other methods. This definition is not in itself sufficient to describe successful integration: it is important that integration be routine, seamless, and both efficient and effective in supporting school goals and purposes.[5] The results from the British study in Figure 9 confirm the findings of this research as presented in Figure 8.

[5] Lawless, K. A., & Pellegrino, J. W. (2007). Professional development in integrating technology into teaching and learning: Knowns, unknowns, and ways to pursue better questions and answers. *Review of educational research*, *77*(4), 575-614.

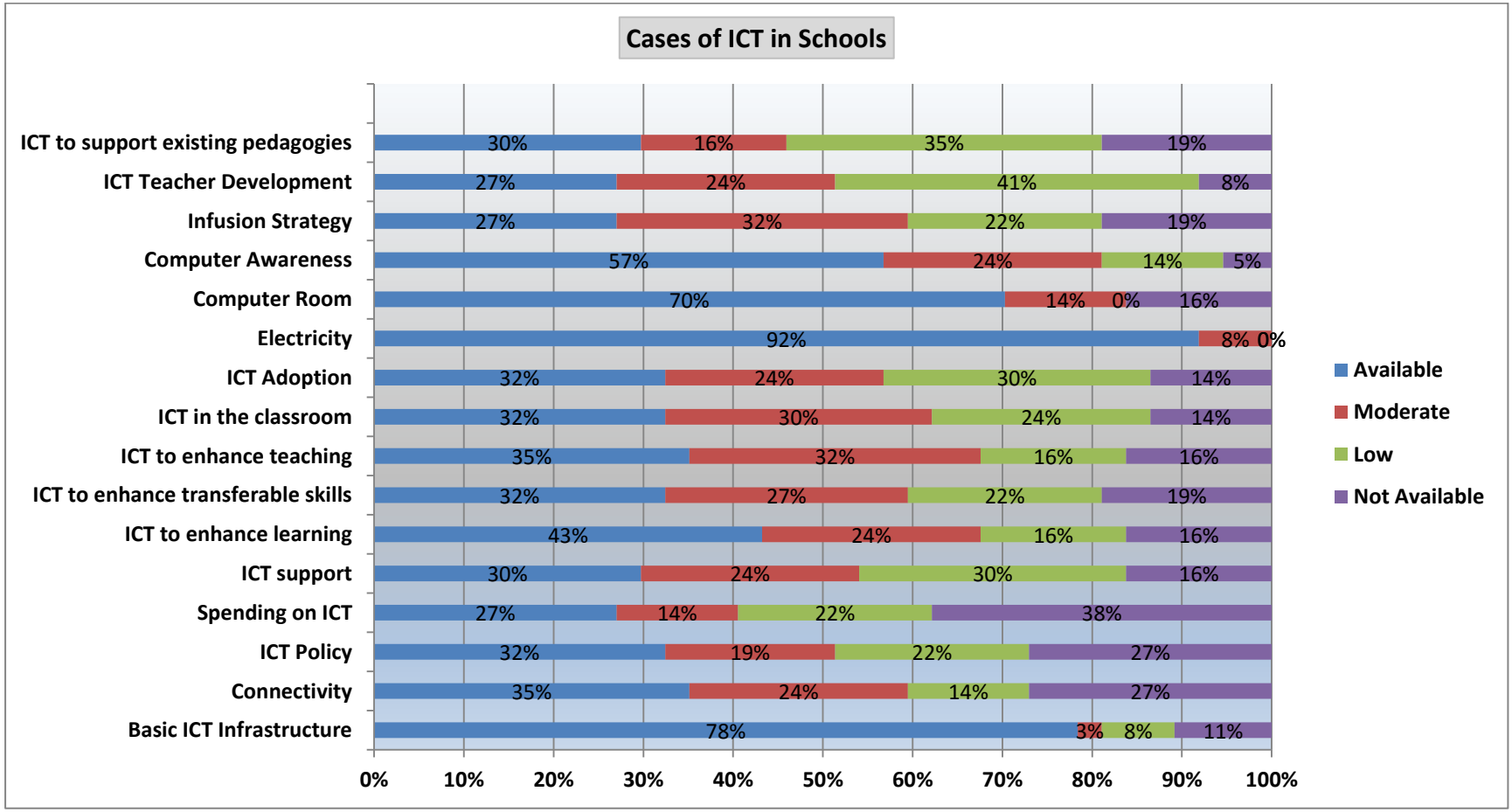

Figure 8 British Council ICT Status Research Report

OVERVIEW OF THE PHASES OF INNOVATION AND MODERNIZATION OF THE CLASSROOM

These phases coincide with Figure 9 demonstrating the three interacting worlds of teachers.

1. **Technological Phase [Digital Affordances]** – when schools are equipped with ICT tools.
2. **Content Phase [Digital Fluency]** – when intensively encouraged creation and preparation of modern eLearning materials by teachers [*education before technology*].
3. **Methodological Phase [Digital Pedagogies]** – when society understands that in order to elevate the quality of education it is simply not enough to technologically equip schools and adjust some learning contents to digital materials but that they have to completely change the concepts and paradigms of teaching in a planned and systematic way.

OBJECTIVES

- To understand teachers' perceptions towards the use of e-learning or the integration of ICT.
- To investigate the factors that affect positively and negatively the uptake of ICT in schools.
- To highlight why some teachers integrate ICT and others do not as well as measure the profile of implementation.

With those objectives in mind, the research examined the following research questions:

- Conceptual concerns ("What are educators' perspectives on ICT as a pedagogical tool? What types of skills are required by the teachers during the pedagogical integration of ICTs?")
- Pedagogical concerns ("How are computers used for teaching and learning? What are the best practices for improving quality in the context of pedagogical integration of ICTs?")
- Instructional concerns ("How are the available ICT tools used in teaching and learning to help learners learn in different ways? To what extent are Interactive Whiteboards (IWB) used in the classroom?")

- Evaluation concerns ("How are teachers using IWB to support the curriculum? How are ICT tools supporting educators teaching?")
- Technical concerns ("How do teachers use ICTs in the classroom? What kind of ICT support is available to teachers?")
- Logistical concerns ("To what extent are schools equipped with computing infrastructure?")
- Organizational concerns ("How do schools organize their classrooms to support the use of computers? How can computers be used as part of what we already do in the classroom?")
- Functional concerns ("How are computers enhancing teachers' classroom activities?")
- Affective concerns ("What are computer perceptions by teachers? What are educators' attitudes on ICT? What are the main barriers to the successful pedagogical integration of ICTs?")
- Professional Development concerns ("What are the professional development needs of educators that would support adoption, appropriation and implementation in school? What factors influence the effectiveness of ICT training for educators?")

Evidently ICT integration demands a systematic approach and when meaningful appropriation is realized, the resulting enrichments can be manifold. As we travelled across the Gauteng province it became clear that issues of social and cultural capital must be taken into consideration otherwise being transformational can result in ideologically disruptiveness. Thus teachers must be given opportunities to conceptualize the disruptive nature of ICT and its role in their professional space to avoid reluctance to adopt and appropriate in their working environment. In Wang (2009),

> Laurillard's practical reminders are sobering, and they tend to make the glowing prophecies of the many ICT enthusiasts sound glib indeed. It should be remembered here that even at the Harvard Graduate School of Design architectural professors found the implementation of ICT as a pedagogical method extremely time consuming and labour intensive (p. 1137).

For Gauteng Department of Education to successfully integrate ICT in schools there is a need for developing epistemologies and cultures to shift the ideological thinking on the ground. In our effort to provide a meaningful report we considered the three interacting worlds of teachers as shown in Figure 10 [Teachers inner world (epistemological, pedagogical, and educational values); Physical world (the school environment); and Cognitive artefacts (ICTs as cognitive tools)].

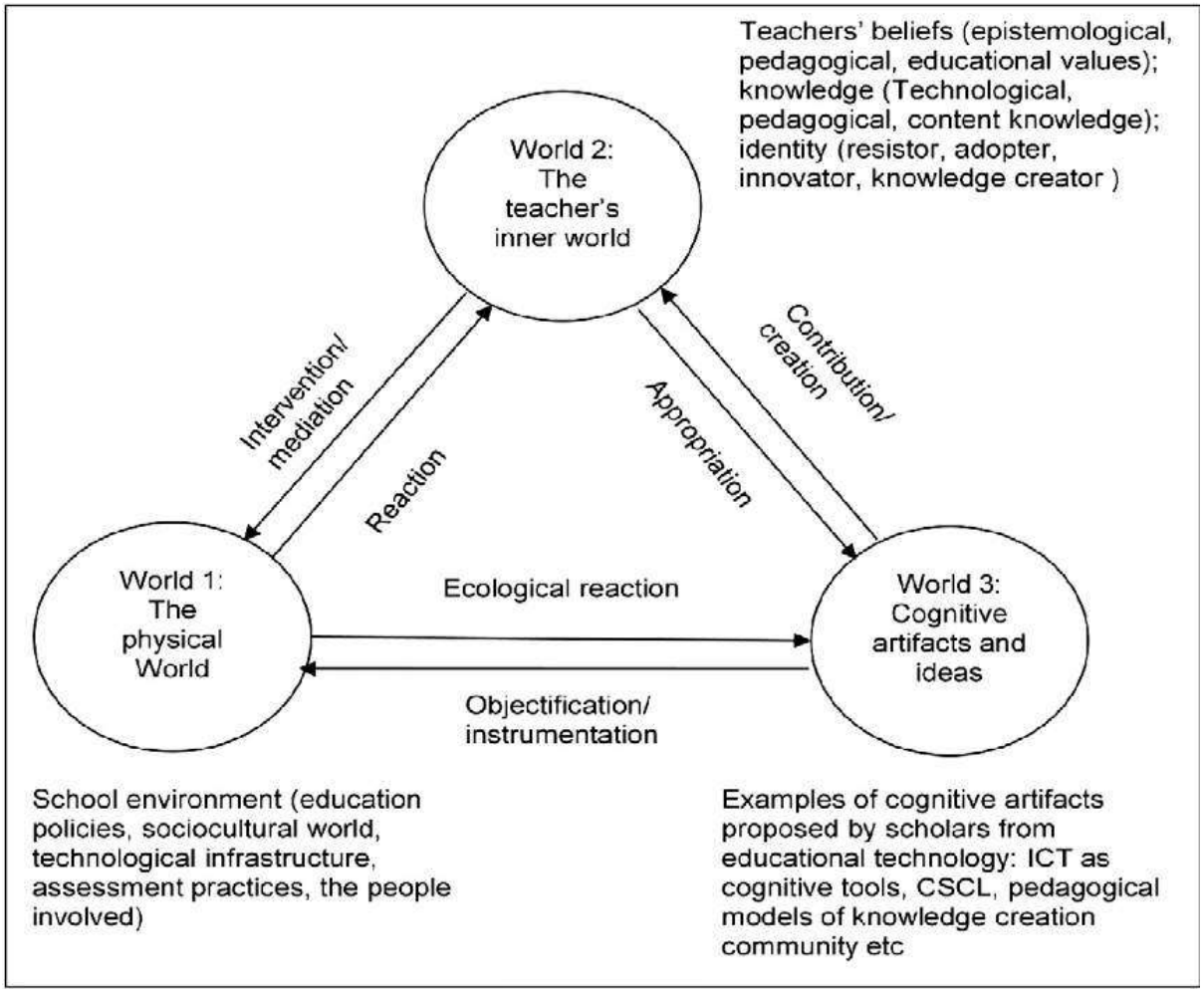

Figure 10 The three interacting worlds of teachers (Chai & Lim, 2011)

Figure 10 gave our research team access to developed world constructs to help us answer the research questions in the process of determining the state of ICT integration in education in the Gauteng province. Why the three interacting worlds of teachers in Figure 10 are so important?

- Three interacting worlds of teachers [Teachers inner world (epistemological, pedagogical, and educational values); Physical world (the school environment); and Cognitive artefacts (ICTs as cognitive tools)].
- ICT integration demands a systematic approach to experience manifold enrichments.
- Issues of social and cultural capital must be taken into consideration otherwise being transformational can result in ideologically disruptiveness.
- Teachers must be given opportunities to conceptualize the disruptive nature of ICT and its role in their professional space to avoid reluctance to adopt and appropriate in their working environment.
- For Gauteng Department of Education to successfully integrate ICT in schools there is a need for developing epistemologies and cultures to shift the ideological thinking on the ground.
- In Wang (2009),

> *Laurillard's practical reminders are sobering, and they tend to make the glowing prophecies of the many ICT enthusiasts sound glib indeed. It should be remembered here that even at the Harvard Graduate School of Design architectural professors found the implementation of ICT as a pedagogical method extremely time consuming and labour intensive (p. 1137).*

857 educators from different schools completed a questionnaire and the analysis illuminated teacher educators' access to ICT, their conception of ICT in their profession, and their use of ICT in the classroom. There was an evidence of teachers adhering to the constructivist approach to their teaching but the use of ICT applications in their teaching practice was limited. The consequence of limited use of ICT is retaining the status quo whereby the classroom is teacher-centred and knowledge-centred instead of allowing all three types of interactions [learner-learner, learner-content, learner-teacher] to happen (Miyazoe, & Anderson, 2010; Anderson, 2003a). In terms of educational theory, this represents the paradigm of social constructivism (Cottone, 2007; Kim, 2001). There is truth in Wang (2009) that ICT has the power to radically change classroom practice. However, the ability to change must be managed effectively and strategically (Wang, 2009).

There was clear evidence that the Gauteng Department of Education has invested a lot of money on those schools with ICT infrastructure. However the uptake is disappointing given

the well-documented ICT affordances to create learner-centred environments. With 92% of teachers having access to laptops and 44% indicated having access to Interactive Whiteboards the adoption of these technologies is low. This is not to say ICT integration is not happening, but the level of investment in ICT does not correlate with the level of uptake. Based on 'Guidelines for Teacher Training and Professional Development in ICT 2007'[6] ICT level of integration is fairly distributed and correlate with the observations on the ground:

- No Category – 19% not using ICT tools at all
- Entry Level -16% Teachers are computer literate, but lack confidence
- Adoption Level -12% Teachers are able to use various ICT tools, but during observations teachers opted for PowerPoint presentation.
- Adaptation Level -28% Teachers were using PowerPoint presentations and displaying with Interactive Whiteboards.
- Appropriation Level - 20% Teachers were using various technologies such as videos, PowerPoint presentations, and Interactive Whiteboards.
- Innovation Level -5% were teachers that went all out to develop entirely new learning environments, integrating all digital devices and ICT infrastructure at their disposal. These teachers leverage the power of digital devices to enhance learners' classroom experience.

The gap between school ICT access and teachers' readiness to pedagogically integrate ICT tools in their teaching and classroom management varied immensely as shown above. However, the categories above demonstrate that there are activities happening in schools. Leach (2005) asserted that ICTs need to be seen as "an essential aspect of teaching's cultural toolkit in the twenty-first century, affording new and transformative models of development." Its transformative nature stresses the use of ICT as a lever for instructional change (Vanderlinde & van Braak, 2010). However, a multi-layered approach must be developed to ensure 'institutionalised ICT use.'

[6] http://www.schoolnet.org.za/sharing/guidelines_teacher_training.pdf

THEORETICAL FRAMEWORK UNDERPINNING THE RESEARCH

We adopted a Bernstein's theory of pedagogic discourse which provides a very powerful language of description for systematically describing and investigating any pedagogic issues or practices. According to Bernstein (2000) any pedagogical practice is generated from the same fundamental rules but may vary in strength in relation to knowledge boundaries and boundaries between teachers and learners. Bernstein's theory of pedagogic discourse ability to provide language of description worked well with SITES (Second Information Technology in Education Study) and Level of Technology implementation (LoTi) framework.

1. The analytic framework for SITES (Second Information Technology in Education Study) includes teacher characteristics, pedagogical practices & ICT use, school factors, and system & other external factors.

2. Level of Technology implementation (LoTi) - the framework uses a scale based on six levels comprised of Non-use (Level 0); Awareness (Level 1); Exploration (Level 2); Infusion (Level 3); Mechanical (Level 4a) and Routine Integration (Level 4b); Expansion (Level 5); and Refinement (Level 6). This framework has been aligned to several standards for an example International Society for Technology in Education (ISTE) - National Educational Technology Standards for Teachers (NETS-T). Several studies have used the framework to evaluate teachers' level of technology integration into classroom instruction and the extent of impact on student achievement. The LoTi framework can be used as lens through which one might determine how the teachers' usage level of various technology interventions impacts student learning potential.

This research project focussed mainly on different aspects of computer use by teachers in the classroom and the ICT infrastructure available in schools. The SITES analytical framework used aimed at investigating the factors contributing to the state of ICT in schools and the conditions on the ground influencing the adoption and appropriation of new technologies into teaching and learning. This work focused beyond the factors that influence the use of ICT in general, thus observations were conducted to ascertain the activities taking place in

the classroom with ICT infrastructure. We were focusing on assessing the current situation of ICT uptake in schools in Gauteng and to document the pedagogical practices in the classroom. This consideration led to the development of the general questions for the e-Readiness research:

- To what extent have schools adopted, appropriated, and integrated ICTs into teaching and learning?
- How are Gauteng province teachers integrating ICT in different subject teaching on the level of basic education?
- Which ICT infrastructure is available in schools?
- How do teachers' practices of technology use relate to internal factors such as ICT infrastructure available?
- Are there any meaningful differences between the various groups of teachers concerning their use and integration of ICT in their teaching?
- What support services exist with regard to ICT?
- To what extent is the school environment offering a supportive climate for the use of ICT in the schools?
- Are these differences mainly determined by individual factors (personal context) or by structural and organizational factors at school level?

Table 1 contains the district schools that participated in the study.

Table 1 Districts and Schools Covered in the Research

District	Schools
Ekurhuleni North District	○ Charlotte Maxeke Secondary School; ○ Chief Albert Luthuli Primary School; ○ Dinoto Technical Secondary School; ○ Phomolong Secondary School; ○ Tembisa Secondary School; ○ Tshepisa Primary School; ○ Tswelopele Secondary School; ○ William Hills Secondary School; ○ Winnie Mandela Secondary School; and ○ Zitikeni Secondary School.
Ekurhuleni South District	○ Eden Park Secondary School; ○ Fumana secondary School; ○ Greenfields Secondary School; ○ Illinge Secondary School; ○ Landulwazi Comprehensive School; ○ OR Tambo Secondary School;

	○ Sijabulile Secondary School; ○ Thuto-Lesedi Secondary School; ○ Vooslorus Comprehensive Secondary School; and ○ Zonkizizwe Secondary School.
Gauteng East District	○ Vezukhono Secondary School; ○ HB Nyathi Secondary School; ○ Lekamoso Secondary School; ○ BB Myataza Secondary School; ○ Dr Harry Gwala Secondary School; ○ Mammelong Comprehensive School; ○ Caiphus Nyoka Secondary School; ○ Amos Maphanga Secondary School; ○ Phandimfundo Secondary School; and ○ Rivoni Secondary School.
Gauteng North District	○ Chipa Tabane Secondary School; ○ Cultura Secondary School; ○ Dan Kutumela Secondary School; ○ Lesedi Secondary School; ○ Lingitjhudu Secondary School; ○ Mahlenga Secondary School; ○ Mpumelelo Secondary School; ○ Strauss Secondary School; ○ Wozanibone Secondary School; and ○ Zithobeni Secondary School.
Gauteng West District	○ Imfundo Secondary School; ○ Kgothalang Secondary School; ○ Letsatsing Combined School; ○ Magaliesburg State School; ○ Matla Combined School; ○ Randfontein Secondary School; ○ Relebogile Secondary School; ○ T.M.Letlhake Secondary School; ○ Thuto Kitso Secondary School; and ○ Wedela Technical High School.
Johannesburg Central District	○ Bhukulani Secondary School; ○ Dr Vilakazi Secondary School; ○ Eldomaine High School; ○ Jabulani Technical High School; ○ Klipspruit West Secondary School; ○ Lancea Vale Secondary School; ○ Moletsane Secondary School; ○ Nghunghunyani High School; ○ Protea Glen secondary school; and ○ Senaoane Secondary School.
Johannesburg East District	○ Alexandra Secondary School; ○ Allanridge Secondary School; ○ Bovet Primary School; ○ Denver Secondary School; ○ East Bank Secondary School; ○ Eqinisweni Secondary School; ○ Lyndhurst Primary School; ○ Noordwyk Secondary School; ○ Realogile High School; and ○ Sandown High School.
Johannesburg South (JS) District	○ Moses Maren Technical Missionary School; ○ Qoqa Secondary School;

	○ Daleview Secondary School; ○ Raphela Secondary School; ○ Sakhisizwe Secondary School; ○ Jabulile Secondary School; ○ Orange Farm Secondary School; ○ Nombulelo Baba; ○ Fred Norman Secondary School; and ○ Thamsanqa
Johannesburg West (JW) District	○ Kelokitso Comprehensive School; ○ Mokgome Secondary School; ○ Thutolore Secondary School; ○ Meadowlands Secondary School; ○ PJ Simelane Secondary School; ○ Sebetsa-O-Tholemputso High School; ○ Kwa-Mahlobo Secondary High School; ○ Orlando West Secondary School; ○ Anchor Comprehensive School; and ○ Letsibogo High School.
Tshwane North (TN) District	○ Rakgotso High School; Adam Masebe Secondary School; Ntswane Secondary School; ○ New Eesterus Secondary School; ○ Soshanguve High School; ○ Hlanganani Secondary School; ○ Kgomotso Comprehensive High School; ○ Botsebotse Secondary School; ○ Senthibele Secondary School; and ○ Maphutha Secondary School.
Tshwane South (TS) District	○ Seshegong Secondary School; ○ Himalaya Secondary School; ○ Lehlabile Secondary School; ○ Dr WF Nkomo Secondary School; ○ Flavius Mareka Secondary School; ○ Olievenhoutbosch Secondary School; ○ Tsako-Thabo Secondary School; ○ Hofmeyer Secondary School; ○ Edward Phathudi Comprehensive School; and ○ Saulridge Secondary School.
Tshwane West (TW) District	○ Fusion Secondary School; ○ H.L. Setlalentoa Secondary School; ○ N.M. Tsuene Secondary School; ○ Lotus Gardens Secondary School; ○ Mapenane Secondary School; ○ Rantailane Secondary School; ○ D.A. Mokoma Secondary School; and ○ L.G. Holele.
Johannesburg North (JN) District	○ Far Forth Secondary School; ○ Blue Eagle High School; ○ Cosmo City Secondary School; ○ St Ansgars High School; ○ Thaba-Jabula High School; ○ Diepdale Secondary School; ○ Bopasenatla Secondary School; ○ Lofentse Girls' High School; and ○ Bree Primary School.
Sedibeng East [Vereeniging] District	○ Leshata Secondary School; and ○ Qalabotja Secondary School.

Sedibeng West [Sebokeng] District	○ Fundulwazi Secondary School; ○ Botebo-Tsebo Secondary School; ○ Thuto-Tiro Secondary School; and ○ Sizanani Secondary School.

RESEARCH METHODOLOGICAL APPROACH

The research included quantitative research involving a survey of teachers in 133 schools and qualitative research involving interviewing of teachers and observation of 90 lessons. Quantitative research is useful for indicating what may be happening, and may provide statistical evidence of activities taking place on the ground, while qualitative approach gives us the deep and breadth of the actual activities through observations and discussions with teachers. Thus the observation and interviews provided us with rich contextual data that helped us to develop a deeper understanding of the context of the situation on the ground.

The research questions outlined above were addressed through the analysis of survey data collected in term three from 1333 teachers working in schools in the Gauteng Province. In particular, the analysis concentrated on data derived from both qualitative and quantitative, which involved the administration of a standardised questionnaire to teachers featuring items relating to teacher background, their ICT competences and use in class, professional development activities, and experiences. A hard copy of the questionnaire was developed and distributed to schools with the assistance of both principals and deputy principals in the sampled schools, who agreed to disseminate them amongst the teaching staff. A sample of 133 schools in Gauteng was selected. The schools were identified based on the list of schools in the ICT project presented by the Director of Teacher Development, Matthew Goniwe School of Governance and Leadership (MGSGL). Figure 12 presents the research approach.

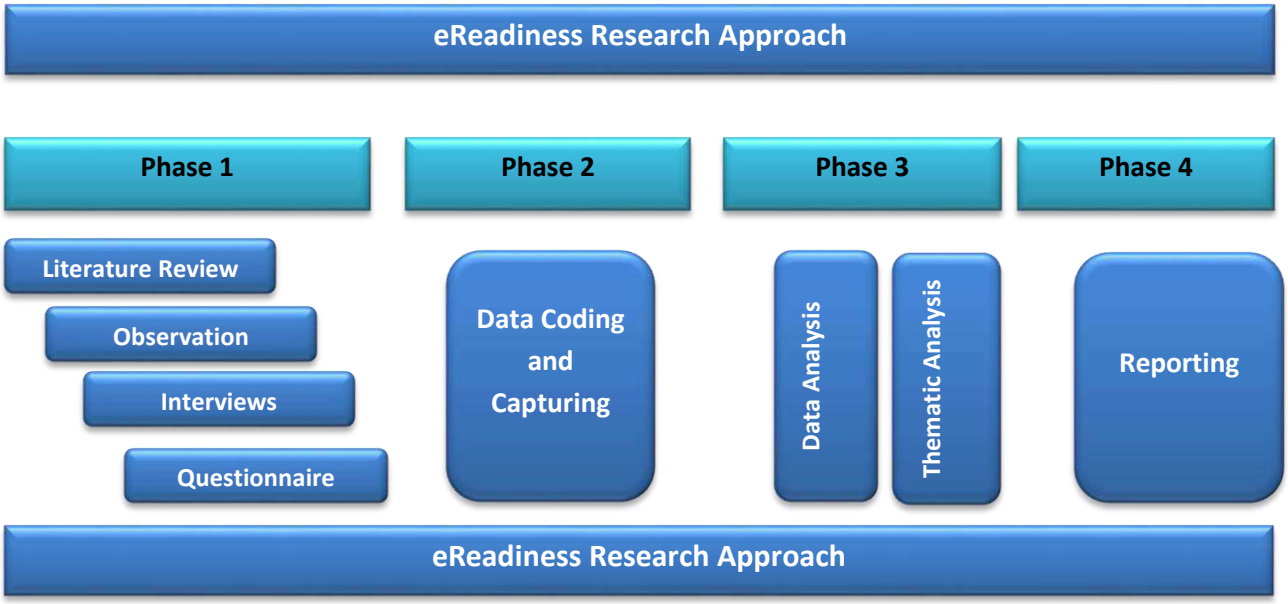

Figure 11 Research Methodological Approach

There were 1330 questionnaires distributed to 133 schools. Only 857 returned their questionnaires, thus the response rate achieved was 64%. It is within these methodological constraints and parameters that the results and related discussion should hence be viewed. All teachers were asked to complete the survey questionnaire. Table 2 provides descriptive information about the sample. As it can be seen in Figure 19, individual characteristics were evenly distributed across the sample for example gender, district, years of teaching experience, ICT training, ICT skills & competencies, ICT professional development needs, and school ICT activities and infrastructure [teacher characteristics, pedagogical practices & ICT use, school factors, and system & other external factors]. For the purposes of analysis, a number of variables were created to describe the teacher and school-level characteristics.

The approach was based on exploratory research with the goal of using multiple sources of data following a qualitative approach supported by a set of focus group interviews, individual interviews as well as literature review, and quantitative approach supported by a questionnaire. The research aim was to help us to better understand the dynamics of the constraints inhibiting ICT diffusion and uptake as well as how and why it followed a particular trajectory.

Observations

We assessed the present state of ICT in each and every school we visited, then conceptualized the need to indicate the existing gap [adequacy of the ICT infrastructure and appropriateness to achieve GDE pillar 6 ICT in Education] and then used the Theories below to point at some of the critical issues. A Class Learning Interactions – Observation[7] tool which enabled the collection of various data regarding the use of ICT tools, organization of learning, and teacher-student interactions in the lesson. The goal was to understand through various lenses if there were any unique pedagogical activities and how teachers mediated learning using a variety of technological tools especially the Interactive White Board (IWB) which was a common tool among schools surveyed.

Interviews [Individual & Focus Groups]

This was an effort to probe teachers so that we have a deeper understanding of what is actually happening on the ground. We were then able to get rich contextual data that helped us develop a deeper understanding of the context of the situation.

Questionnaire

The questionnaire completed by teachers provided general information of how individual-level and school-level characteristics influence teachers' use of ICT. This was built on previous large-scale studies on ICT use in schools, most notably the Second Information Technology in Education Study (SITES) study and the related literature. Whilst the issue of ICT integration is influenced by a range of systemic factors that operate at different levels of the school system, the primary enabler remains the initiative of individual teachers who are expected to appreciate the benefits afforded by ICTs. In Gauteng it was becoming clear that investments in ICT do not guarantee adoption and appropriation by teachers.

[7] Manny-Ikan, E., Tikochinski, T. B., & Bashan, Z. (2013). Does use of ICT-based teaching encourage innovative interactions in the classroom? Presentation of the CLI-O: Class Learning Interactions – Observation Tool. Interdisciplinary Journal of E-Learning and Learning Objects, 9, 219-232.

LITERATURE REVIEWED

Disruptive Technology in Schools

Technology use is one of the innovative forms of strategies that classroom activities are exposed to. Christensen (2008) argues that disruptive technology is an innovation that makes a complicated and expensive product simpler and cheaper and thereby attracts a new set of customers. This translates into disruptive technologies usually having worse product performance initially but have features that (generally new) customers value. They are often cheaper, simpler, smaller or more convenient to use. Christensen (2008) further on says that sustaining technologies generally improve the performance of established products that is valued by mainstream customers in major markets; however, cheaper technologies take a lot of effort because of time that is needed on them.

On the other hand, disruptive technology are concepts, phenomena and discoveries that have the potential to create transformative effects in education and use a network of existing and future technologies to facilitate a transformational learning space that infuses collaborative learning, thinking, teaching or facilitation, learning tools and open educational resources beyond the course paradigm to either students or the faculty (Alsagoff, 2009). According to Siemens (2009), disruptive learning innovation is also defined as what happens when an emerging technology is introduced and embraced by some. The innovation is disruptive because it champions, more than previous technologies, the efficient and agile companies/organizations more than the inefficient/non-agile groups. It then provides new opportunities for competition because it can level the playing field, allowing broader groups of people to do things that only the experts or privileged could do previously (Reynolds, 2003). What it means is that the more technologies come and go, the more complicated they create in a workspace. This means that one cannot be trained for a particular technology once and for all, but there should be constant trainings that ought to take place to keep up with the changing trends.

For example, compact discs that contained music overtook the vinyl phonograph industry; digital cameras eliminated 35 mm film production; and the mobile telephone, a computer and Internet, the most disruptive technologies yet, have yet to see their full innovative potential opines (Christensen, Johnson and Horn, 2008). Finally, Wittmann (2009) believed that by definition a disruptive technology must change the cost of doing business.

Therefore, imagine someone who was trained to operate only on vinyl phonographs, that person would not be coping as we speak because now we are still talking compact discs which might be on their way out since music can now be stored and played in the USB.

According to Horn (2010) personal computer companies like Apple were able to greatly disrupt the minicomputer world in the 1980s. Horn further says that apple "was uniquely innovative in establishing the standard for user-friendly computing". Apple computers were designed for a market that did not exist. Their first computers would have been considered completely worthless to minicomputer users. Slowly, Apple was able to improve their product outside of this existing market until their product was able to fulfill the needs of those customers. Another example of disruption is when Toyota introduced low-priced, fuel-efficient cars into the North American marketplace. The Japanese automakers were able to disrupt the American automakers as they continued to improve their vehicles by developing more sophisticated cars that competed with the American market. Public education enrollments in online classes are exhibiting the classic signs of disruption as they have skyrocketed from 45,000 in 2000 to roughly 1 million today" (Christensen, et al., 2008). According to Christensen, et al. (2008), there will likely be a transition from the traditional teacher-led classroom where instruction is delivered through computer-based learning to a model where software will become the primary mode of delivery. In this model, the teacher will serve as a facilitator who can provide much needed one-on-one instruction for students who may be struggling. It is interesting to note that the system outlined by Christensen, et al. (2008) sounds very similar to the modular system used in technology education during the 1980s and 1990s. According to Christensen, et al. (2008), "the data suggest that by 2019, about 50 percent of high school courses will be delivered online". With this in mind, educators must prepare to meet this challenge with an open mind and look to disruptions that may be taking place in the present for guidance in preparing for the future. This may involve the reinvention of our current educational system and a re-evaluation of the way that teachers develop and deliver instruction.

Education before Technology

Klopfer et al., (2009) says that technology can have a reciprocal relationship with teaching. The emergence of new technologies pushes educators to understanding and leveraging these technologies for classroom use; at the same time, the on-the-ground implementation

of these technologies in the classroom can (and does) directly impact how these technologies continue to take shape. While many new technologies have emerged throughout history, so has the cry for educators to find meaningful ways to incorporate these technologies into the classroom – be it the typewriter, the television, the calculator, or the computer. And while some professional educators may have become numb to this unwavering 'call' – and for good reason – it is crucial to consider that the excitement over games and social networking isn't just business and industry "crying wolf." Indeed, those previous technologies have a powerful place in instruction and the classroom; but without them, strong lessons and learning objectives can still be achieved. With these more recent technologies, we think educators should take the call, even if only on a trial basis.

Undoubtedly, without these recent technologies (i.e. digital games, Web 2.0, etc.) in the classroom, strong lessons can still be achieved, but there's a sharp disconnect between the way students are taught in school and the way the outside world approaches socialization, meaning-making, and accomplishment. It is critical that education not only seek to mitigate this disconnect in order to make these two "worlds" more seamless, but of course also to leverage the power of these emerging technologies for instructional gain. My personal opinion is therefore that, the fact that we should strive to make education responsive, we need to look into who this education is for. By looking at who this education is for, we need to consider facts that our youth are digitally survey and this means that when we draft a curriculum that will not speak what they are exposed to in their communities, we might as well get rid of formal education because nothing binds these youth to the school.

If for example we take digital gaming, simulations, and social networking and analyze them; they afford us the ability to convey concepts in new ways that would otherwise not be possible, efficient, or effective, with other instructional methods. In other words, these technologies don't just help us teach the old stuff in new ways – they can also help us teach new stuff in new ways. Below is a brief description of these technologies; popular educational and non-educational examples of each, and what researchers and practitioners are finding about their potential and impact on teaching and learning.

Digital Gaming

Digital games encompass much more than your computer's Solitaire or Nintendo's Super Mario Bros. Over the last decade, the genre of digital games has exploded to include numerous platforms and designs. Digital games, whether computer- game console, or handheld-based are characterized by rules, goals & objectives, outcomes & feedback, conflict/competition/challenge/opposition, interaction, and representation of story (Prenksy 2001) or more simply, "purposeful, goal-oriented, rule-based activity that the players perceive as fun" (Klopfer, 2008). They are distinguished by two key elements; (1) an interactive virtual playing environment, and (2) the struggle of the player against opposition. Gaming is already a widespread activity in our culture —more than 45 million homes have video-game consoles (Feller, 2006). Over 154 million Americans (that's about half of the country's population) play video games (Emrich, 2005). In a given week, the average eighth-grade boy will play video games for about 23 hours, while the average girl will play about 12 and that is more time than they spend watching TV (Dawley, 2006). Therefore, one of the most obvious benefits to using these technologies for learning is that students are often already familiar with these interfaces and the "language" of interacting with and utilizing them. Both inside and outside the classroom, some strong examples of powerfully engaging gaming models have emerged. Some have been used quite a bit in the educational setting, while others have mainly garnered popularity in pop culture. We outline some examples of both below.

Theoretical Pillars for Digital Education

According to Sheninger (2014), digital education has around 7 pillars that are discussed below:

i. Communication

Leaders can now provide stakeholders with relevant information in real time through a variety of devices. No longer do static, one-way methods such as newsletters and websites suffice. Vital information can be communicated through various free social media tools and simple implementation strategies in order to meet stakeholders in the digital age. Digital leadership is about engaging all stakeholders in two-way communication.

ii. Public Relations

If we do not tell our story, someone else will, and more often than not, another's version will not be the one we want told. Leaders need to become storytellers-in-chief. We can now form the foundation of a positive public relations platform using free social media tools where we control the content. By doing so, we create how we share all of the positives associated with our schools, and create a much-needed level of transparency in an age of negative rhetoric toward education.

iii. Branding

Businesses have long understood the value of branding and its impact on current and potential consumers. Leaders can leverage social media tools to create a positive brand presence that emphasizes the positive aspects of school culture, increases community pride, and helps to attract/retain families when looking for a place to send their children to school.

iv. Student Engagement/Learning

We cannot expect to see increases in achievement if students are not learning. Students that are not engaged are not likely to be learning. Leaders need to understand that schools should reflect real life and allow students to apply what they have learned using the tools they are using outside of school.

v. Professional Growth/Development

With the rise of social media, schools no longer should be silos of information and leaders do not have to feel like they are on isolated islands that lack support and feedback. Leaders can form their own Personal Learning Network (PLN) to meet our diverse learning needs, acquire resources, access knowledge, receive feedback, connect with both experts in the field of education as well as practitioners, and discuss proven strategies to improve teaching, learning, and leadership. There are also new and exciting ways to acknowledge both formal and informal learning using digital badges, as opposed to more antiquated systems that focus on contact hours instead of learning. To remain relevant and on the cutting edge, leaders need to be cognizant of how to harness and leverage a slew of free tools to follow their learning passions.

vi. Re-envisioning Learning Spaces and Environments

Once leaders understand the pillars and how to use them to initiate sustainable change, the next step is to begin to transform learning spaces and environments that support essential skill sets and are aligned with the real world. Leaders must begin to establish a vision and strategic plan to create an entire school building dedicated to learning in a more digital world. In order to do so, leaders must be knowledgeable of the characteristics and dynamics that embody innovative learning spaces and environments such as Bring Your Own Device (BYOD), blended learning, the flipped classroom, gamification, maker spaces, and virtual learning. The only challenge with BYOD is that, when I was collecting data in some rural areas in Mpumalanga province, I came across a school that had adopted the system of BYOD but the challenge was that since devices differ, it was taking a while for technicians to maintain the learners' technological devices because of their varying makes from manufacturers.

vii. Opportunity

It is important for leaders to consistently seek out ways to improve existing programs, resources, and professional development. Digital leaders leverage connections made through technology and increase opportunities to make improvements across multiple areas of school culture.

Key idea: Education Demand for the Information Age or 21st Century or the Contemporary Classroom, Digitally-Enabled Education System, Digital Fluency Learning Opportunities

The 21st century poses a challenge for many educators to rethink what they teach and how they teach (McLoughlin & Lee, 2008; Peters, 2000). There are a range of possible reasons for this and I will mention a few. One reason may be attributed to massive technological innovations and the diffusion of technological tools taking place within contemporary society. The digital age learners termed "net-generation" or "digital natives" are using new digital technologies including mobile phones, digital cameras, tablets, videogames, phone based cameras, GPS, wireless technologies, internet, digital music players, and many more (Prensky, 2001). There is an argument (Peters 2000; McLoughlin 2007; Voogt, Erstad, Dede & Mishra, 2013) that due to extended exposure and use of technology, digital native learners think and learn differently. The following are typical characteristics pertaining to how they think and learn:

they are used to receiving the information very fast, they like to parallel process and multi-task, they prefer graphics before their text rather than the opposite, they prefer random access (hypertext), they function best when they are networked, they thrive on instant gratification and frequent rewards-they prefer games to "serious" work. (Prensky, 2007, p. 40). So, teachers will have to be cognizant of the attributes above if they want to reach their learners' needs and interest.

Another likely reason may be associated with the role of the school in preparing learners future careers. In the 21st century there is a focus on globalization and the internalization of national economies with technology at the forefront (Voogt, Erstad, Dede, & Mishra, 2013). Therefore, to fully live and participate in the complex global economy learners will have to be conversant with the 21st century skills (Prensky 2007). These are collaboration, communication, digital literacy, citizenship, problem solving, critical thinking, creativity and productivity skills (Voogt, Erstad, Dede, & Mishra 2013). Voogt et al (2013) argue that these skills are not well implemented in current pedagogical practices due to lack of competent teachers, failure to include these skills in the school curriculum and assessment, and the general lack of proper strategies to adopt innovative teaching and learning practices. Hence the demand for the schools' systems to change so that learners have the right ingredients to live and succeed in the global economy.

Lastly, new technologies have opened new teaching and learning avenues (McLoughlin & Lee 2008; Prensky 2007; Prensky 2001; Rosenberg 2001). Through internet and networked social platforms learners are now having the information at their fingers (Peters 2000). They can no longer rely on teachers as the information source because they are able to learn what interest them anytime beyond the school walls (Kivunja 2014). In addition, learners no longer prefer passive acquisition of knowledge and information. They can now use social tools to participate in knowledge production, and to share this with a wider networked community of learning (McLoughlin & Lee 2008). Capitalizing on these opportunities may help in making sure learning becomes a participatory and social activity.

Clearly with the emerging digital landscape education systems cannot and will not remain unchanged. As Prensky (2001) noted, "today's students are no longer the people our education system was designed to teach" (p.3). One size-fits all, one- way communication,

and students working alone may have worked in the industrial age, but might not be suitable in the digital age where learners should collaborate, to interconnect and to participate in knowledge creation (Tapscott in Kivunja, 2014). Hence many school systems around the world are making an innovative paradigm shift to turn traditional classroom into digitally-enabled smart classrooms. In Singapore (Tang 2002), South Korea (Kim 2010) and Malaysia (Sultan, Woods & Koo, 2011) for example, schools are using leading edge technologies including internet connectivity, electronic books and smart boards. This is in an effort to link the school to the society, to fuel innovative and creative teaching and learning, and to improve the school management and administration capacity. South Africa is also not exempted as many projects such as Gauteng Paperless Classroom (Motshekga, 2015), ICT for Rural Education Development (ICT4RED) (Botra, Rerselman & Ford, 2014) have been undertaken to promote the dissemination and use of digital technologies in the South African school. It is hoped that teachers will use them to implement the pedagogies that fit with the 21st century.

However, mere access to technology will not translate into fundamental changes in teachers teaching (Cuban 2009). Teachers also need to be equipped with the 21st century skills and be trained for pedagogical approaches that leverage use of digital tools (Voogt, Erstad, Dede & Mishra 2013). Part of the training includes the knowledge on how to use web2.O tools and social software tools such as wikis, blogs, podcasting, and social networking sites to design learning task and to encourage learners' knowledge creation and sharing (McLoughlin 2007). It is argued that use of such tools will also help teachers to meet the needs of their learners and to provide them with best learning experience through customization, personalization, collaboration and networking (Bryant in McLoughlin and Lee 2007).

Research (Prensky 2001) indicates that there is an overwhelming ICT knowledge gap between digital native learners and their immigrant teachers. So Prensky (2007) encourages teachers to work together with their learners. In doing so teachers will learn ICT skills from their learners and at the same time teach learners how to use technology wisely and responsibly. For example, if the teacher does not know how to make a podcast for his learners, he can ask learners to do this as an assignment either in groups or individually.

Then he must make time to listen to each learner's podcast and to provide constructive feedback.

Prensky (2007) also found that many schools ban the use of ICT tools by learners instead of taking the advantages of their affordances. Wikipedia is one of the tools many schools have banned. They claim that it does not provide reliable information. However, as Prensky (2007) argues teachers can use it to encourage learners' creation of local knowledge. Teachers can work with learners to write articles about a local activity, culture, place or tradition and post this on Wikipedia. Teachers can also work with their learners to critically evaluate the information they get from internet.

Another technological tool schools should welcome is the cellphone. Many schools' technologies in America have banned cellphones because they fear that learners will use them irresponsibly. However, cellphones do have great pedagogical potentials as learners can use them for data collection and information searching. He goes further to suggest that teachers should start implementing open cellphone exams similar to open book exams, so that learners can use these tools to search information rather than using them to cheat during exams. These will also give teachers the opportunity to ask higher order thinking skills.

Another digital tool teachers need to know how to use is the Learning Management System (LMS). According to McLoughlin and Lee (2008) LMS are not new in education, and though earlier models were replications of what teachers did in traditional classroom, LMS have great potential to support teaching and learning in the digital age. To this Dawson, Bakharia and Heathcote (2010) add that LMS allow connecting teachers and learners who are geographically dispersed, they provide timely access to teaching and learning materials, and allow learners to discuss issues pertaining to their learning online. Therefore, McLoughlin et al (2008) encourage teachers to implement reformed pedagogical methods that will leverage use of LMS for learners to create their own materials, work independently with the learning materials and contribute to the materials archived on LMS.

Ubiquitous Computing in Education

Evolution of computers has affected the nature of teaching and learning in the education system. The notion of ubiquitous computing was introduced as a result of "enhancing

computer use by making many computers available throughout the physical environment, but making them effectively invisible to the user" (Weiser 1993). Ubiquitous computing brings about an environment where access and interaction with variety of computers is inevitable. However, for Weiser (1993), bringing computers to this level will be important only if there is a synergy between human's problems and computers' abilities to solve the problems. Weiser (1993) insists that most often than not, computers are likely used in isolation from human's situations and it is for this reason that they become a point of focus other than "disappearing from our awareness". This suggests that computers should be used intimately other than being used as human assistant (Kay 1991 & Tesler 1991).

Within the education circles, the ubiquitous computing brings about many affordances and come in many sizes. Based on Weiser's (1993) explanation, these sizes vary from a 'wall-sized' interactive surface (interactive boards), 'notepad' (personal computers) to 'tiny computers' (tabs and pads). The introduction of the tiny computerized devices in the education system has grown tremendously. The portability of these tiny computerized devices and their prices has made access to these resources to be very easy. However, their display size and power consumption is always a concern especially when they are used to enhance teaching and learning in the classroom (Weiser 1993). Over and above their power consumption, their interaction area is also small and one might struggle when keying information using a keyboard. This has necessitated researchers to enquire about possibilities of having ubiquitous devices that reduce power consumption, have high performance and be cheaper with high mobility (Weiser 1993). Even if there are sceptics around ubiquitous devices, Tinker and Vahey (2002), regard ubiquitous devices as technological devices which will ensure that students have access to "computation and wireless connectivity". Their handheld feature coupled with relevant educational software applications support students' inquiry approach. Ubiquitous computing expands classroom walls and the digital divide is narrowed as students' access to computing becomes ubiquitous (Tinker & Vahey 2002).

Weiser (1993) (cited by Abowd & Mynatt 2000)'s vision of ubiquitous computing was that people and environments should be augmented with "computational resources that provide information and services when and where desired". For Weiser's (1993) vision to be realised, mobile computation should be encouraged and there should be a radical move

from usage of shared 'big-scale computers such as desktops' devices to a personal 'hand held computers such as laptops and personal digital assistants (PDA)' devices (Abowd & Mynatt, 2000). These portable computing devices are of course part of the on-going revolution in the education technology. Moreover, in order to have an effective education system, there should be a "new paradigm of interaction which is inspired by constant access to information and computational capacities" (Abowd & Mynatt 2000). In the past decade researchers have thoroughly researched on the natural interfaces, content-aware applications and automated capture and access in order to explore the interaction model in computing.

From the research conducted in the Tokushima University, Ogata and Yano (2004) argue that social interaction is organized and mediated through context-aware computing. The context-aware computing is improved by "wireless telecommunications capacities, open networks, continuous increase in computing power, improved battery technology and the emergence of flexible software architecture" (Ogata & Yano 2004). For Ogata and Yano (2004), there is permanency in ubiquitous learning; learners don't lose their work because it is recorded daily. Accessibility is evident since every learner has access to their saved documents anywhere. Ubiquitous computing involves Immediacy of information. Information is accessible quickly and problem solving is instant. Learning through ubiquitous computers encourages high interactivity; learners' knowledge becomes elevated as they interact with peers, teachers and experts.

Access and usage of ubiquitous computers in education encourages ubiquitous learning which is best explained as a "computer supported collaboration learning (CSCL) environments that focuses on the socio-cognitive process of social knowledge construction and sharing" (Ogata & Yano 2004). Furthermore, ubiquitous learning enables integrated "high mobility with pervasive learning environment", when a learner has access to "mobile device, the system dynamically supports his/her learning by communicating with embedded computers in the environment" (Ogata & Yano 2004). The importance of embedding computers into the environment is that they should assist in solving human problems and serve human's needs (Abowd & Mynatt 2000).

ICT Trends in Schools

Globalisation and technological change has accelerated the usage of technology in schools around the world. Educational instructions have changed from traditional to technology based instructions (Aktaruzzaman, Shamim & Clement, 2011). The use of Internet and Web based materials has made teaching and learning materials to be accessible anytime and anywhere. Clement et al (2011) regard ICTs as tools that can "enhance the quality of education" through increasing "learner motivation and engagement" (p.117). However, these can only be achieved if ICTs are used appropriately and adequately. Amongst other reasons why ICT initiatives collapse is that the context, barriers of these ICTs and other sustainability factors (economic, social, political and technological) are not properly taken into consideration (Aktaruzzaman, Shamim & Clement 2011). According to Tinio (2003) educational relevance on the use of ICTs is very important since educational benefits of ICTs are not automatic. This is supported by Clement et al (2011) as they suggest that there should be an "understanding of potentials of different ICTs when applied in different context for different purposes and awareness of priority education needs and financial and human resource capacity".

Technology has affected the social, economic and political interaction of the society (Carmona & Marin 2013). The use of ICTs in education has linked and bridged the knowledge gap between schools. According to UNESCO's (2010) report, technology has grown massively and more ICT tools are used in the education system to communicate, collaborate, manage and deliver subject content knowledge fruitfully. Figure 13 presents examples of ICT tools that are trending across the globe.

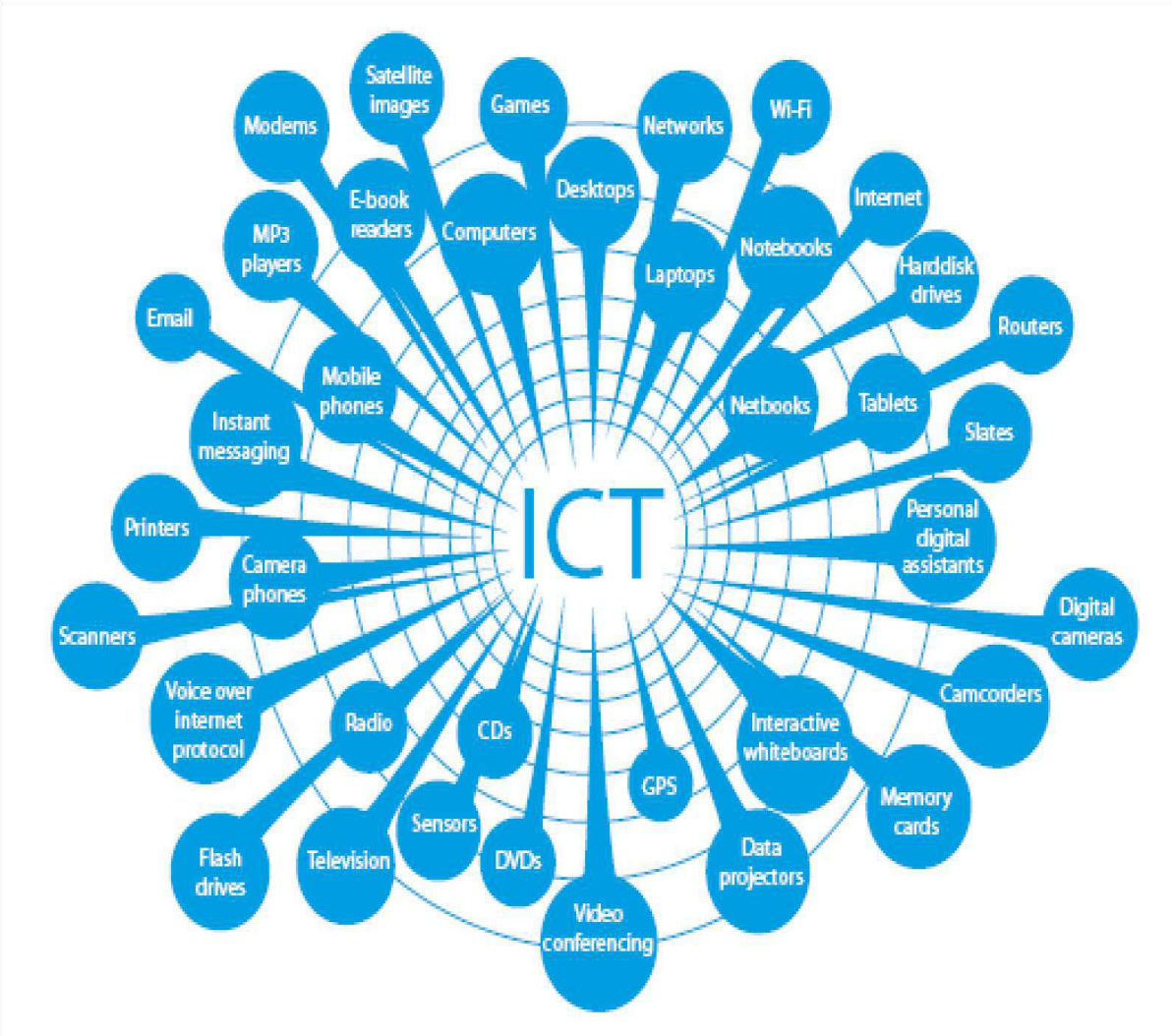

Figure 10 Trending ICTs

When technological trends are incorporated into the educational system, a "higher quality education can be provided at a cheaper cost and spread over a larger segment of the population" (Carmonia & Marin 2013). Textbooks and other printed materials are of course threatened by the ubiquity of these mobile ICT devices. For Graham (2006) (cited by Carmonia & Marin 2013), usage of online resources enables learners to be active participants, learning and teaching is expanded beyond classroom walls. Mobile learning, cloud computing and ubiquitous learning are amongst other ICT platforms that provide learning opportunities to the learners (Carmonia & Marin 2013).

For White (2008) usage of mobile technologies in education can pose lot of challenges since "technologies are very difficult to control" and there are also security features that need to

be dealt with. Even if these technologies are known to be convenient due to their accessibility and usage, lack of connectivity such as adapters and ports limits their productivity (White 2008). Moreover, White (2008) recommends that these devices can best be used for personal organisation and entertainment. Even though the research indicates that mobile phones have been successfully integrated in the language field (for listening of lectures and speeches), White (2008) suggests that more research on how these devices can enhance and modify learning is needed. Otherwise technology will end up driving education instead of education driving technological use (Tinio 2003).

Incorporation of ICTs in teaching and learning has made a massive impact in the education system. Amongst other things that have changed since ICTs were introduced in the education circles are teaching and learning environment, teachers and learners' roles, curricula and delivery and media application (Majumdar, 2015). It is of course impossible to accommodate every learner during lesson delivery. For Majumdar (2015), ICTs (Multimedia materials) give learners "control to review the topics at their own pace and in accordance to their own individual interests, needs and cognitive progresses". The affordances of ICT resources coupled with appropriate pedagogic approach enable teaching and learning to change from a traditional to a modern approach. Table 2 indicates changes of different educational aspects since ICTs were introduced in the classroom.

Table 2 Changes in Teaching-Learning Environment

Changes in Teaching-Learning Environment			
MODEL	**FOCUS**	**ROLE OF LEARNER**	**TECHNOLOGY**
TRADITIONAL	TEACHERS	PASSIVE	CHALK & TALK
INFORMATION	LEARNERS	ACTIVE	PERSONAL COMPUTER
KNOWLEDGE	GROUP	ADAPTIVE	PC+ NETWORK

ICT usage has changed the traditional drill and rigid approach into a more flexible and interactive approach. Learners collaborate and adapt to new learning environment.

Table 3 Changes in Teachers' Roles

Changes in Teachers' Roles	
Transmitter of Knowledge	Guide & Facilitator of Knowledge
Controller of Learning	Creator of Learning Environment
Always Expert	Collaborator & Co-learner
Learning to use ICT	Using ICT to Enhance Learning
Deductive/ Expository	Interactive/Experiential/Exploratory

The teacher is no longer a source of knowledge but a facilitator of knowledge. Teachers have become long life learner; they collaborate and interact with the subject content globally. Table 3 presents the changing role of the teacher in the classroom.

Table 4 Changes in Learners' Roles

Changes in Learners' Roles	
Passive Learner	Active Learner
Reproducer of Knowledge	Producer of Knowledge
Dependent Learner	Autonomous Learner
Solitary Learner	Collaborative Learner
Solely Learning Content	Learning to Learn/Think/Create & Communicate

Learners change from passive to active learning participants and they are capable of producing their own knowledge. Table 4 presents the role of the learner in the contemporary classroom. Through ICT usage learners become less dependent and learning becomes spontaneous. The changes above signify that since ICTs were introduced in education, teaching and learning has never been the same as before (Majumdar 2015). Both

learners and teachers' roles have transformed to suite the 21st century skills. Even if ICTs resources cannot serve as silver bullet for all educational problems but they have availed more opportunities and transformed the education system.

Competencies Supporting Digital Pedagogy

There is disconnection between how today's students learn and how teachers teach, this is as a result of poor communication between today's students (digital natives) and teachers (digital immigrants) (Dosaj 2007). The digital natives live in an immersed technology world while digital immigrants are still rooted within a linear and systematic principles environment. The technological skill gap between these two generations is seriously having a negative impact on the social interaction especially within the education cycles. Information and Communication Technologies are "raising the bar on competency needed to succeed" and learners are challenged to compete in the knowledge economy and collaborate with diverse society (Dosaj, 2007). Teachers are also challenged to apply a teaching approach that matches the modern learning style.

The traditional teaching and learning approaches cannot be applied to address today's educational challenges. Today's education requires learners and teachers who are active knowledge producers and can use digital tools to acquire knowledge and interact with the world (Mcloughlin & Lee 2008). Moreover, Lai (2011) insist that "the potential of digital technology lies in its capacity for supporting a more interactive and communicative process. Given the affordances of ICT resources and their influence on teaching and learning, it is important to adopt technology driven pedagogy that support ICT integration. Otherwise we will find ourselves applying an approach that is passive and more teacher-centred (Mcloughlin & Lee 2008). The best approach that support digital pedagogy seems to be connectivism since it is known to be aligned with digital age and network society.

Digital immigrants trail behind digital natives, the language between these two entities is at different ends. The challenge that digital immigrant teachers have is that they "assume that learners are the same as they have always been and that the same methods that worked for the teachers when they were students will work for the students now" (Prensky, 2001, p4). Digital immigrants lack pedagogic competencies that encourages high access to information, independent, active and ubiquitous learning. Digital natives process information differently

from digital immigrants. They (digital natives) receive information fast and multi-tasking is well executed however, one cannot confirm that high access to information can be good or can increase information overload (Prensky 2001). Learning through simulations is known to increase cognitive thinking because learners are immersed within the learning environment (Mitchell & Savill-Smith, 2004). Many researchers insist that through simulations and gamification, cognitive abilities and skills are developed and high order thinking skills depicted in the Bloom's taxonomy is achieved (Clarke & Clarke, 2009).

Digital Fluency in Schools

Technology has been viewed as changing the way people learn and interact for thousands of years (White 2013). There is little doubt that the Internet, through its networked and mobile functions, has changed the way people live. This includes how they find information and the way they communicate.

Digital fluency can be defined as the ability to reformulate knowledge to express oneself creatively and appropriately in a digital environment, and to produce and generate information rather than simply to comprehend it (Wang, Myers, & Sundaram, 2012). This implies that being digitally fluent not only involves knowing how to engage with technology, but also be able to produce things of significance with the technology (Papert and Resnick, 1995). This goes beyond the notion of digital literacy, which focuses only on teaching learners to make syntactically correct expressions (Wang, Myers & Sundaram, 2012); a digital fluent person can decide when to use specific digital technologies to achieve their desired outcome. They can articulate how the tools they are using will provide their desired outcome.

A *digital fluent* student is one who:

- Knows where and how to find and access information quickly and accurately;
- Can critique the relevance and accuracy of information being accessed;
- Is an adept producer of digital content;
- Can recognize and use the most effective methods of reaching their intended audience; and
- Understands and demonstrate how to use digital technologies responsibly.

Digital fluency refers to the skills necessary for the individual to use the internet to search, retrieve, contextualize, analyze, visualize and synthesize information effectively (Barlet & Miller, 2011). It has three components:

- Net-savviness, a practical understanding of the way the internet works;
- Critical evaluative techniques, the knowledge and use of basic checks, techniques and principles that can be applied to assess the trustworthiness and accuracy of information; and
- Diversity, the extent to which users' online consumption is broad, varied and diverse.

Importance of digital fluency

Digital fluency will become a prerequisite for obtaining jobs, participating meaningfully in a society, and learning throughout a lifetime (White 2013). In the 21st century, digital information is rapidly overtaking print as the principal means of communication. It is essential that digital fluency is fostered within the school curriculum and in the pedagogical practices of schools and teachers so that students can thrive in the digital age (White 2013). This view is alluded to by Miller & Barlet (2012) who recommends that digital fluency should be placed at the heart of learning. Pupils should be capacitated with all the skills and knowledge to evaluate and assess information. Government should include digital fluency as a core competency in the national curriculum.

The digital fluency of Pupils

In 2011, an online survey was conducted with primary and secondary teachers in England and Wales about their views on their pupils' digital fluency, and how it might be taught in school. They received 509 responses. Findings were that, internet teaching and learning is fundamental to pupils' school and personal lives: 88 percent of teachers surveyed consider internet-based research to be important for pupils' schoolwork, 95 percent report that their pupils have brought information into the classroom they have found online. Most respondents reported that their Pupils bring internet- based information into the classroom at least occasionally, 75 percent of respondents reporting internet-based content to be important in the formation and validation of their pupils' beliefs.

Teachers believe overwhelmingly that digital fluency needs to be given more prominence in the classroom. Ninety nine percent viewed digital fluency as an important skill for young people to possess, and 88 percent thought it should be given more prominence in the national curriculum.

Disruptive Innovations and Online Epistemology

Internet is central to forming our world-views, our attitudes, and our beliefs. Browsers like websites, blogs, tweets, YouTube, and Facebook; to name a few, give us volumes and volumes of information (Barrlet & Miller, 2011). As anyone who has spent a small amount of time online will know, the quality of this information can be far from perfect. To separate the wheat from the chaff, one of the philosophical disciplines in the western tradition, that is epistemology, can help to judge the merits of different pieces of information (Miller & Barlet 2012). Epistemology studies the nature of truth, which includes how we acquire and validate knowledge. Online epistemology is the ability to distinguish good from bad information, and that requires the application of both personal techniques and skills that allow one to make a careful, reasoned judgement.

The internet architecture, functionality and usage, presents some difficulties and pitfalls that make judgement even more difficult. These according to Barrlet & Miller (2011), include:

- The absence of gate keepers how to discern the good information from bad usually stems from a system of collectively constructed and supported institutions and norms.

- Anonymity and the pedigree problem, a person cannot claim to know enough about every subject to make direct judgments about the truth or falsehood of every claim made. Much internet discussion occurs in places which are anonymous, or where identity and authority can easily be faked.

- The generational divide, parents and guardians are typically the main guardians of information, to a greater or lesser extent ensuring that the material children consume is age-appropriate, comprehensible, and accurate. This supervision is often absent with the internet, this might be due to the fact that children know more than

their parents about the internet and other browsers as they spend most of their time online and hence the qualitative discontinuity between the 'Digital Natives' and Digital Immigrants' (Prensky 2001).

- The pseudo-sites and propaganda, many websites are not what they seem; some are created for nefarious ends that are specifically designed to appear trustworthy.
- The use of imagery, in social media sites hosting visual content, image manipulation techniques are increasingly allowing misinformation to be powerfully and attractively packaged.
- The echo chamber, the internet can sometimes act against the purveyors of misinformation.

Twenty-First Century Skills

The school curriculum should examine what should be learnt and what should be known to be a participant in 21st century society, that is, a globally connected society (White 2013). In the United States of America (USA) in 2002, was a *Partnership for 21st Century Skills* founded by the US Department of Education with a number of large corporations. The partnership consulted widely and developed a thorough framework of skills needed by learners for the twenty-first century. The framework of 21st century student outcomes can be summarized as including four major areas which are:

Core Subjects and 21st Century Themes

- Learning and Innovation Skills
- Creativity and Innovation
- Critical Thinking and Problem Solving
- Communication and Collaboration

Information, Media and Technology Skills

- Information Literacy
- Media Literacy
- ICT Literacy
- Life and Career Skills

Although the traditional skills remain important in this framework, a range of new skills such as critical thinking, problem solving, communication and collaboration are asserted as important in the digital age. The statement is clear that twenty-first skills need to be explicitly taught, within other disciplines or as a discipline in their own right.

Another international project in the US, the *Assessment and Teaching of 21st Century Skills*, has provided a strong research base in order to identify and define 21st century skills. Their conclusion (Binkly, Erstad, Herman, Raizen, Ripley, Miller-Ricci & Rumble, 2012, p. 18-19) shows the following ten skills in Table 5, organized into four categories, as necessary for 21st century learning.

Table 5 Project Tomorrow at http://www.tomorrow.org/index.html

Ways of Thinking	***Tools for Working***
1. Creativity and innovation	6. Information literacy
2. Critical thinking, problem solving, decision making	7. ICT literacy
3. Learning to learn, Metacognition	*Living in the World*
Ways of Working	8. Citizenship --- local and global
4. Communication	9. Life and career
5. Collaboration (teamwork)	10. Personal and social responsibility - including cultural awareness and competence.

Digital or 21st Century Pedagogy

There is no doubt that digital media and the Internet have changed the way that people access information and communicate with one another (White 2013). The Internet is so prolific that it has become a global phenomenon.

The teaching aspects of the curriculum have been centered on the content to be learnt and the learning process in the context of a learning environment or pedagogy for many years. Teachers are familiar with the finer details of the content that they teach and the learning methods that they employ, and are constantly seeking to improve both content and pedagogy. This was often discussed as pedagogical content knowledge (Shulman 1987). However, according to White (2013), content and pedagogy are no longer sufficient in a

digital world because there is now a technological dimension for accessing information and for communicating.

The technological aspect was emphasized by Koehler & Mishra (2008) who introduced a way of conceptualizing teaching in the digital age by arguing the need for technological pedagogical content knowledge. Their acronym TPACK, underlines the technological, pedagogical and content knowledge that is fundamental for teachers in the digital age. In fact, TPACK is now argued by Finger (2010) et al in White (2013), as a necessary standard for teacher education. A good starting point for teachers is the technological, pedagogical and content knowledge (TPACK) necessary for teaching in the digital age (White 2013). The question remains about how education can change existing teaching practice to utilize TPACK and the perspectives that should be embraced for teachers and students to become fluent in the use of digital technologies. Resnick (2002), argued that the pervasiveness of digital technology will be necessary for a lifetime.

As the way learners learn is changing, the way teachers teach should change to respond to the needs of the 21st century skills. Student-centered and assessment driven learning is key (Roberts 2011). There should be a shift between traditional educators/teachers' role to that of facilitator, because technology drives self-directed learning.

Learning through Online Pedagogy

Online learning environments permit a range of interactive methodologies (McLaughlin, 2000). Principles of online pedagogy according to Pelz (2016) encourage teachers or educators to let pupils/ students do most of the work, because the more quality time students spend engaged in content, the more of the content they learn. Strategies of putting students in charge of their own learning include:

- Student led discussions; this can be done through icebreaker activities, where a teacher can refer learners to a website which they are to read then discuss among themselves. In another activity introduce the idea of students as discussion facilitators. The teacher can also give detailed instructions to get the student led discussions off on the right foot.

- Learners/students find and discuss web resources; this can be in a recurring assignment where learners can locate a website which deals with relevant content of their discussions. They review the website and facilitate a discussion on it. Learners gain the practice to evaluate authenticity of such sites, and are exposed to new information than that presented in their textbook (Pelz 2016).

Learners are to create knowledge; teachers are to scaffold and support the construction of learner knowledge (Anderson & Hamilton 2016).

PRESENTATION OF RESULTS TO MAP THE RESEARCH TERRAIN

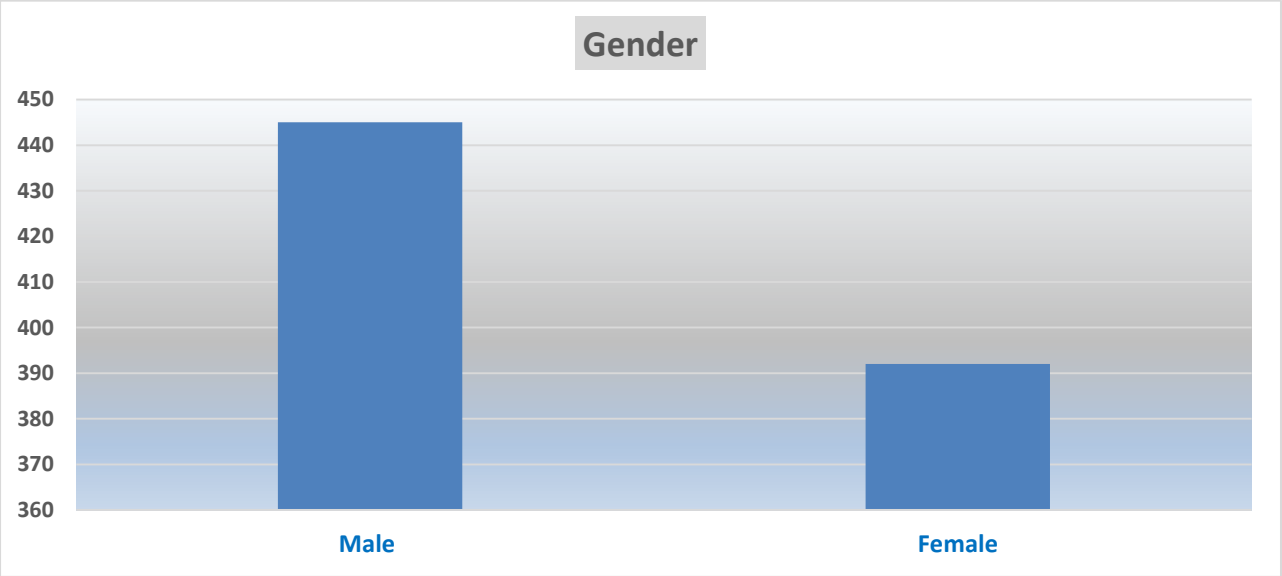

Figure 11: Gender Distribution of Participants

Figure 14 provides clear evidence that there were more males than females who participated in the research.

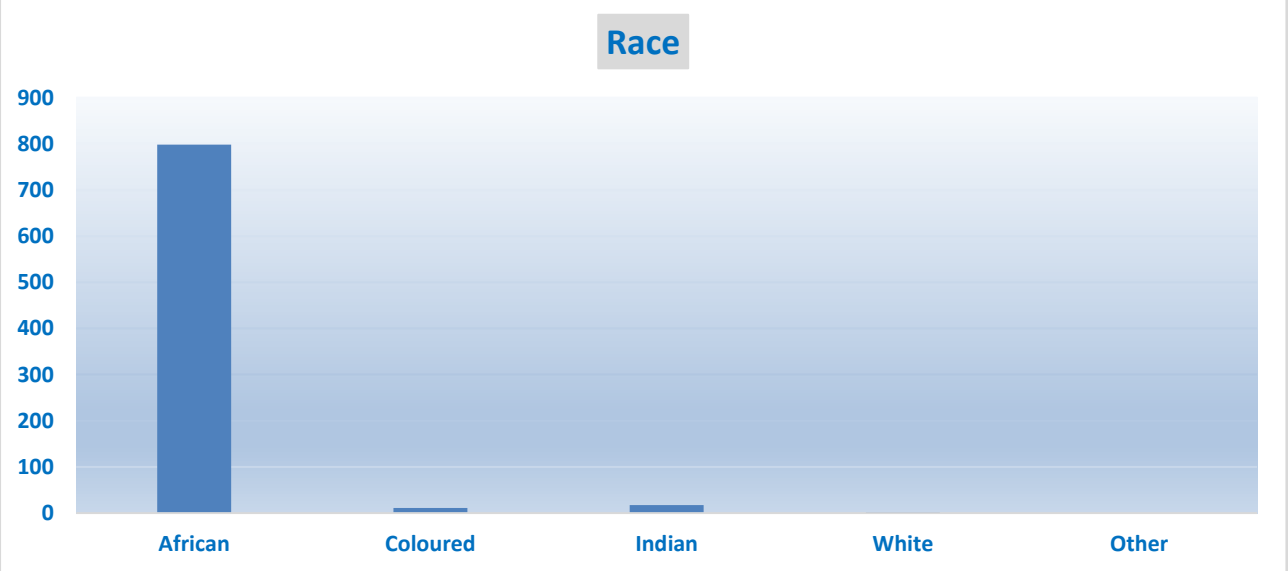

Figure 12: Race Distribution

Figure 15 provides clear evidence that there were more Black Africans who participated in the research.

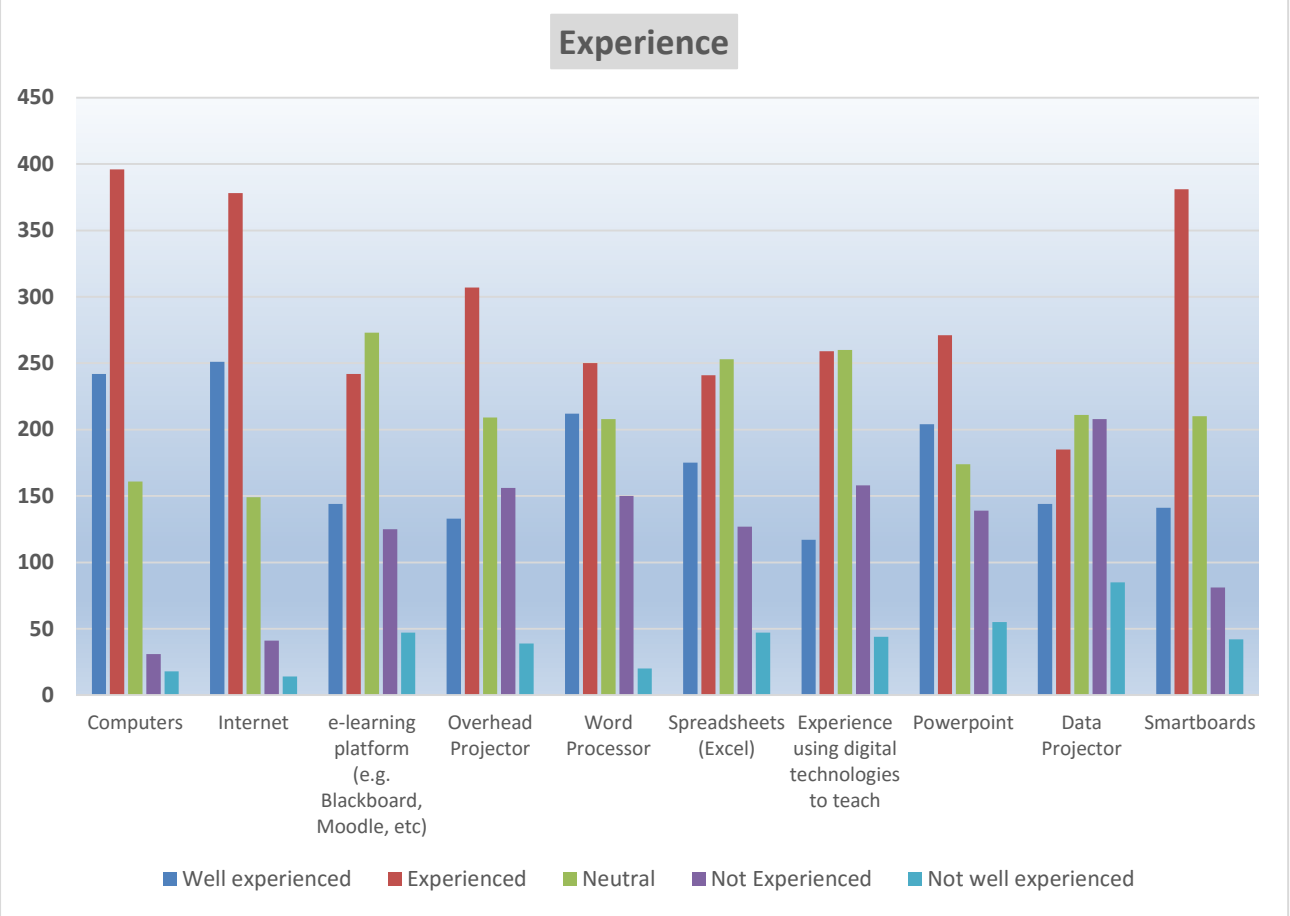

Figure 13: Experience of Teachers with Different Technologies

Figure 16 provides evidence of teachers' skewed distribution of experiences with various technologies. Therefore teachers need meaningful development activities to increase their technological knowledge and in the process develop Technological Pedagogical Knowledge in order to integrate ICT tools in teaching and learning. The experiences are really skewed due to the wide variations in their skills and competencies. There is no doubt about teachers knowing Internet and computers, but how to make use of these to teach is the issue.

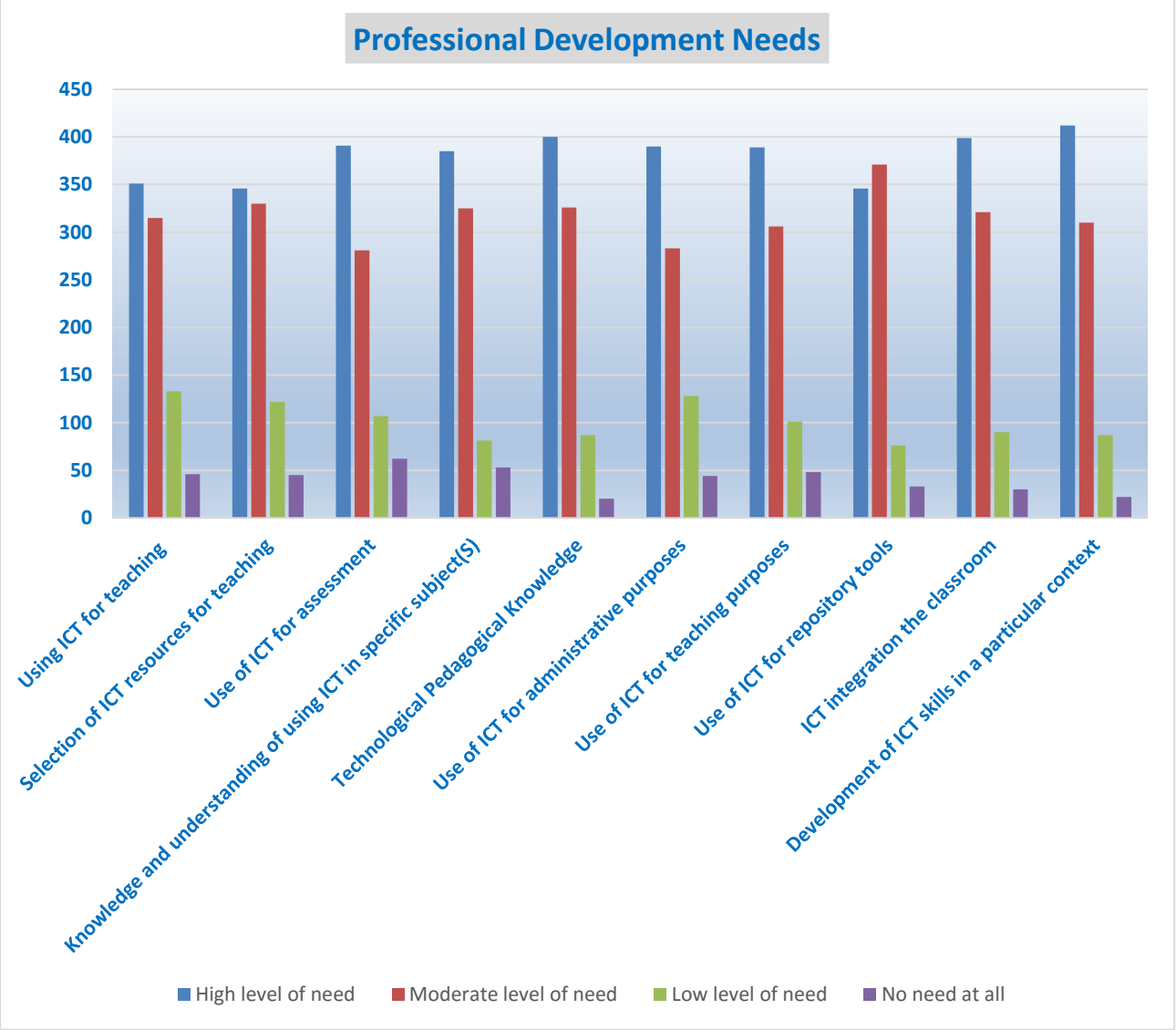

Figure 14: Professional Development Needs in Specific Areas

Figure 17 confirms the level of ICT professional development needs among teachers. This correlates with teachers' various experiences with different technologies as pronounced in Figure 16.

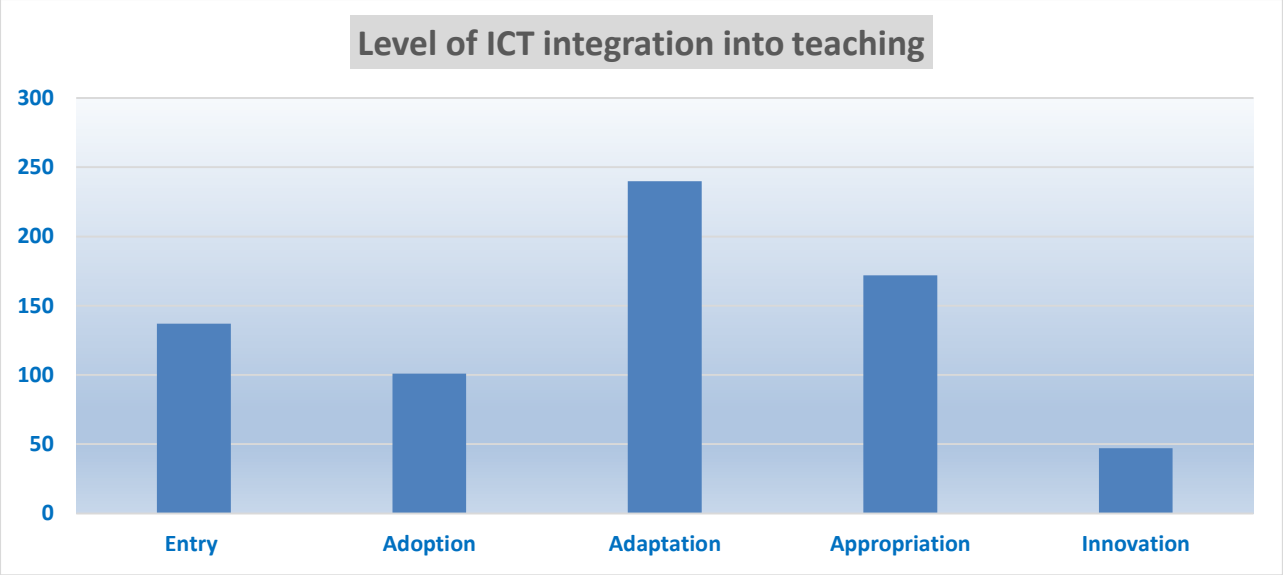

Figure 15: Level of ICT Integration

Figure 18 presents a picture that demonstrates that all is not bad on the ground as teachers are fairly distributed in the different levels. Again this is subject to their interpretation of what they understand by ICT integration.

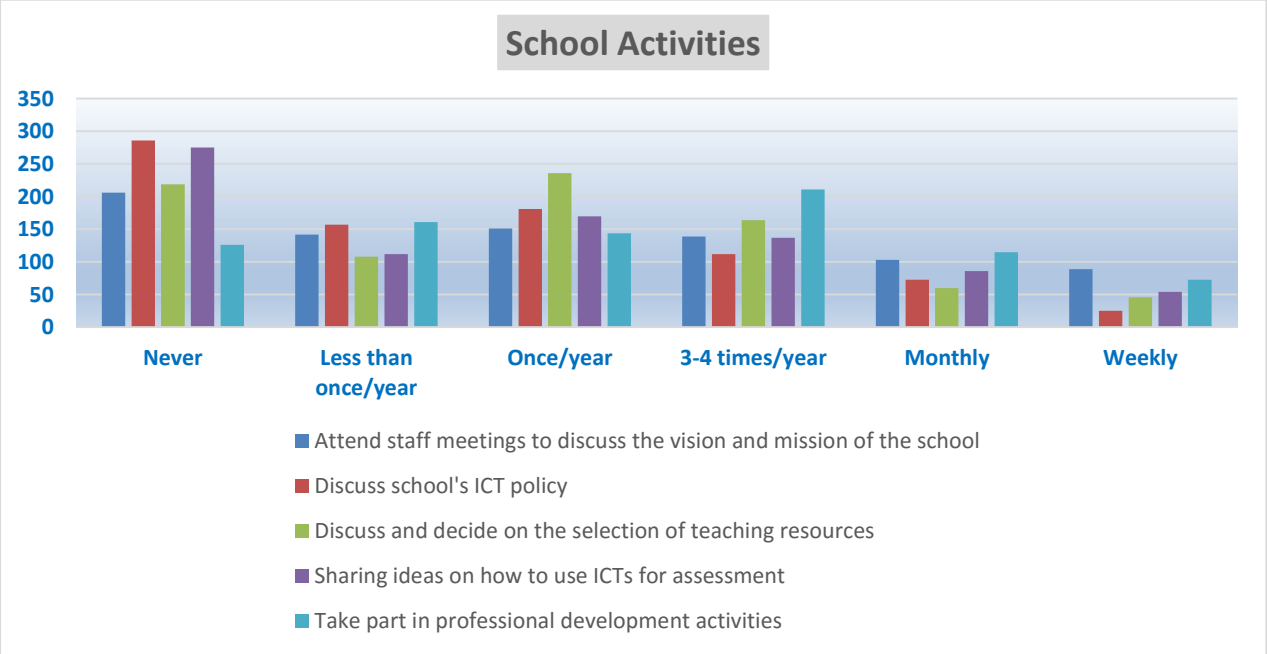

Figure 16: Activities of a Functioning ICT School

In Figure 19 it is clear that there are administrative issues that need to be addressed in order for all schools to be part of the contemporary schools. The fact that 'never' seems to dominate is problematic.

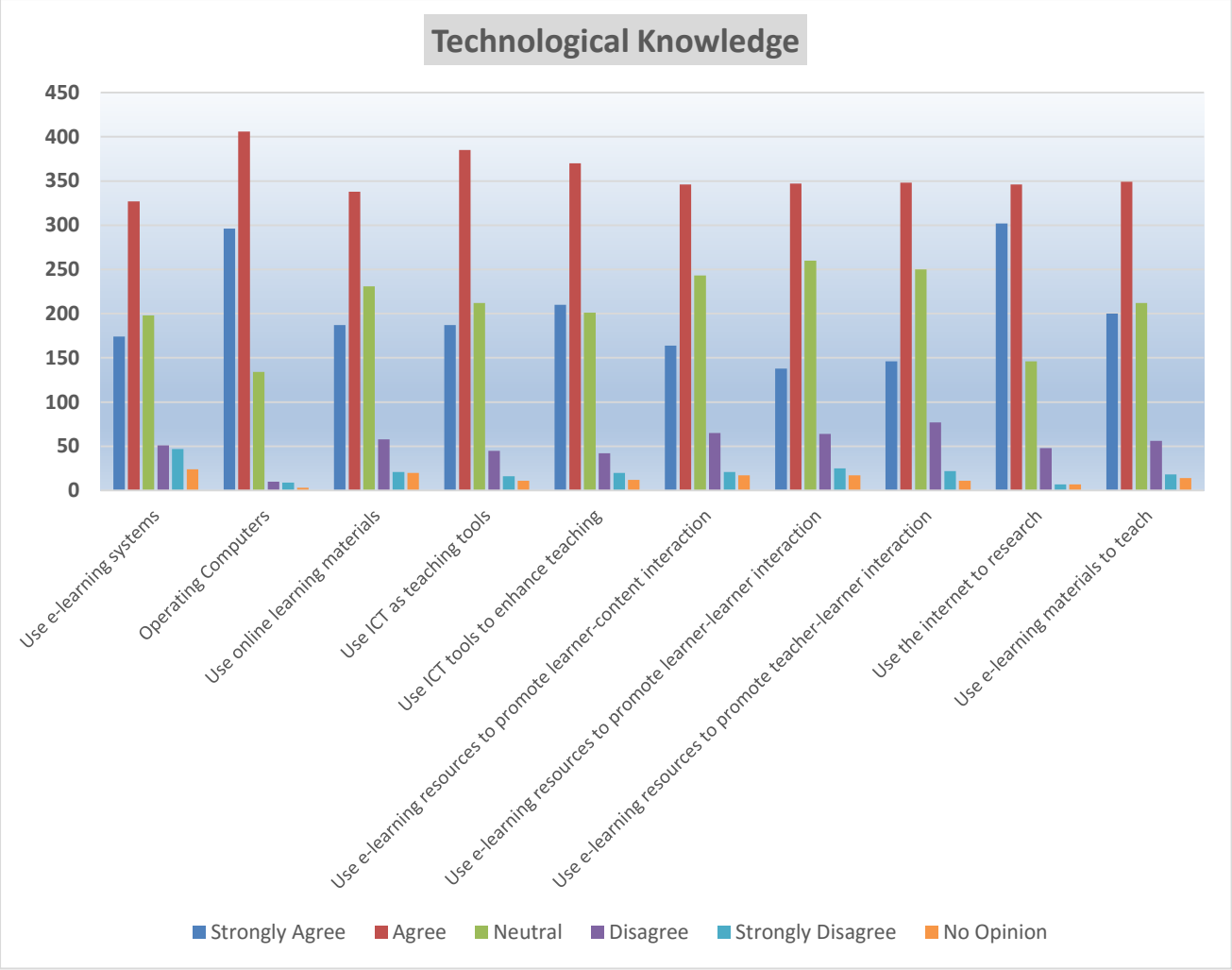

Figure 17: Teachers Technological Knowledge

Figure 20 provides evidence that teachers do not receive adequate ICT training prior to becoming teachers. Teachers have access to their own computing devices but technological knowledge is a challenge.

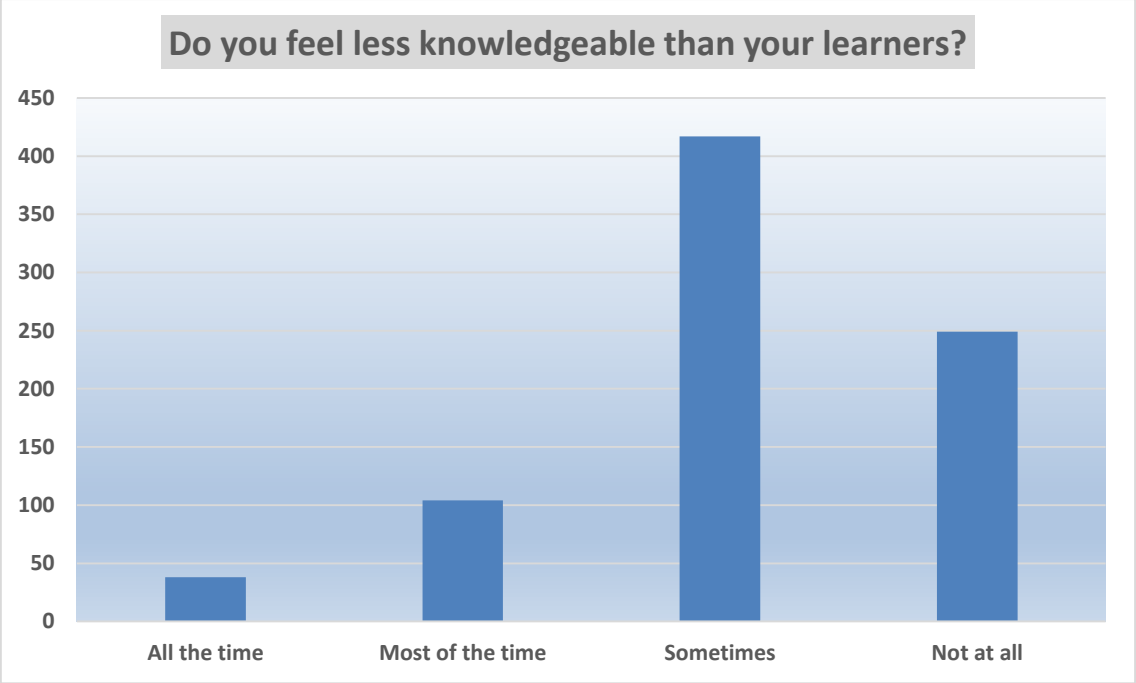

Figure 18: Teachers Feeling

Clearly, there are teachers who feel digitally 'bankrupt' as some feel not up to par with learners. There is a need to move teachers to an acceptable level of their ICT skills and conceptual understanding of digital tools in their profession. Bringing teachers to the adoption level will be a good start and acceptable level to help them develop deeper understanding of the contribution of ICT to learning and transformational pedagogies.

Table 6 Descriptive Statistics [Comparing Means & Standard Deviation]

Descriptive Statistics

	Mean	Std. Deviation	N
Race	1.19	.859	849
Skills	1.33	.574	856
Confidence	1.47	.651	849
Attitude	1.48	.768	849
Training	1.30	.562	857
Support	1.46	.655	856
Use of ICT to Teach	1.96	2.363	849
Use of ICT for Administrative Purposes	1.80	.896	847
Use of ICT as a Repository	1.78	.840	834
Technological Pedagogical Knowledge	1.70	.820	841
ICT Integration in the Classroom	1.73	.856	848
Use of eLearning Systems	2.60	1.458	850
Use of ICT for Teaching	2.25	1.021	858
Use of ICT to Enhance Teaching	2.23	1.058	857
Use of ICT for Assessment	1.81	.923	841
Use of eLearning to Support Learner-Content Interaction	2.41	1.099	858
Use of eLearning to Support Learner-Learner Interaction	2.49	1.130	857
Use of eLearning to Support Teacher-Learner Interaction	2.44	1.060	856
Use of Internet to Research	2.00	1.005	858
Use of eLearning to Teach	2.31	1.130	855
eLearning Platforms	2.69	1.188	847
Technology to Teach	1.77	.870	844
Smartboards	2.43	1.042	857
Teachers Feel Less Knowledgeable on ICT than Learners	3.17	.865	846

In this case we look at the variability of the mean and the standard deviation (see Table 6) to determine the distribution of the data. Standard deviation is basically the summary measure of the differences of each observation from the mean. Figure 22 gives us a good measure of variability to understand the distribution. In this case we can conclude that the data is very spread out even the distance between the mean and the standard deviation is large. The use of ICT is widely spread out which tells us that there is a lot of work to achieve a normal distribution in the use of ICT in the classroom.

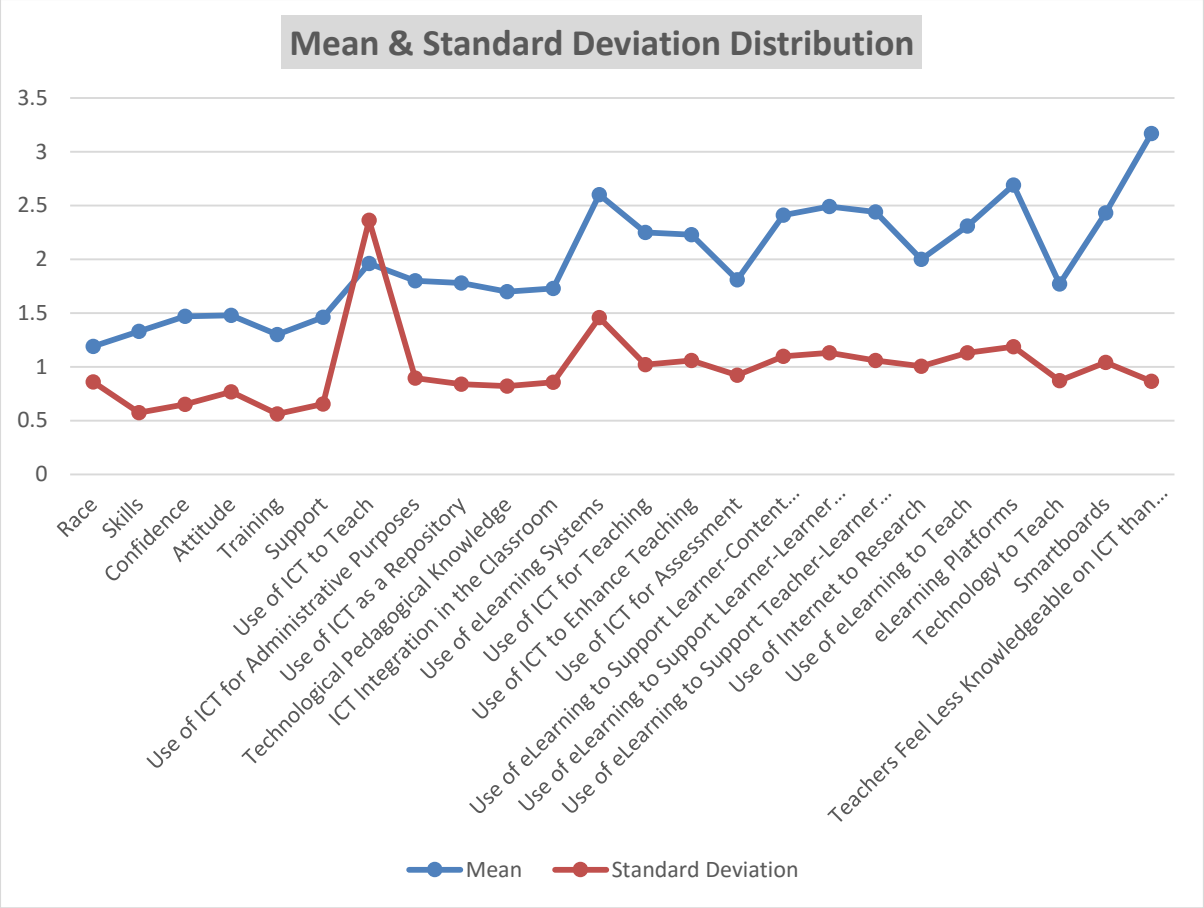

Figure 19: Mean & Standard Deviation Distribution

Pearson Correlation Analysis

The Pearson correlation analysis was performed to understand the relationship between variables. The sign of the correlation coefficient determines the relationship of the correlation as it can be positive, negative, and no correlation. The value of Pearson correlation coefficient *r* does not depend on which of the two variables is considered x or y. According to Peck, Olsen, & Devore (2015) the Pearson correlation coefficient "only measures the inherent strength of the linear relationship between two numerical values" (p. 228). In this case we use Evans (1996) guide on strength of correlation whereby an absolute value or *r* is suggested:

- .00 - .19 "very weak"
- .20 - .39 "weak"
- .40 - .59 "moderate"
- .60 - .79 "strong"
- .80 - 1.0 "very strong"

In the Pearson correlation tables we highlight variables as follows:

- Red – Strong & Very Strong Correlation
- Yellow - Moderate Correlation

The rationale to identify moderate to very strong correlation is because more work needs to be done to bridge the gaps and inequalities that exist.

Table 7 Pearson Correlation I

Pearson Correlations							
	1	2	3	4	5	6	7
1. Use of Computers	1	.079*	-.112**	-.107**	-.002	.010	.014
2. Skills		1	.499**	.386**	.125**	.054	.027
3. Confidence			1	.618**	.172**	.134**	.066
4. Attitude				1	.086*	.079*	-.007
5. Use of Internet to Research					1	.630**	-.106**
6. Use of eLearning to Teach						1	-.216**
7. Teachers Feel Less Knowledgeable of ICT than Learners							1

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

- Confidence plays an important role in ICT integration and had strong correlation with attitude. In order for teachers to develop confidence in the use of ICT in their profession they must have access to development opportunities. It is clear that if confidence is low they easily develop attitude towards ICT tools.

- Internet access to research plays an important role in ICT integration and had strong correlation with the use of eLearning to teach. There must be creative ways to make digital materials readily available beyond the Internet connection. As connectivity continues to be an issue then it should not contribute to teachers' determination to using ICT in their classroom. The need to research digital materials must be minimized.

Table 8 Pearson Correlation II

Pearson Correlations						
	1	2	3	4	5	6
1. Technological Pedagogical Knowledge	1	.020	.028	.033	.117**	-.098**
2. Use of Computers		1	.079*	-.112**	-.107**	.010
3. Skills			1	.499**	.386**	.054
4. Confidence				1	.618**	.134**
5. Attitude					1	.079*
6. Use eLearning to Teach						1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

- There is a moderate correlation between ICT skills and confidence, so it is important to boost teachers' confidence through continuous training.

- There is a strong correlation between confidence and attitude. Therefore, there is a need to provide upfront training before teachers develop attitude towards ICT tools or digital devices.

Table 9 Pearson Correlation III

	Pearson Correlations								
	1	2	3	4	5	6	7	8	9
1. Race	1	.071*	.274**	.269**	.112**	.029	.017	.052	.014
2. Years of Working Experience		1	.229**	.233**	.081*	.082*	.088*	.003	-.117**
3. Years of Teaching Experience			1	.093**	.049	-.049	-.067	-.046	-.114**
4. Use of Computers				1	.079*	-.112**	-.107**	-.047	-.083*
5. Skills					1	.499**	.386**	.503**	.406**
6. Confidence						1	.618**	.548**	.482**
7. Attitude							1	.413**	.327**
8. Training								1	.691**
9. Support									1

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

- There is a strong moderate correlation between ICT skills and confidence so it is important to boost teachers' confidence through continuous training and support.

- Training has strong correlation with support signifying the importance of continuous access to support and boost teachers' confidence.

Table 10 Pearson Correlation IV

	Pearson Correlations								
	1	2	3	4	5	6	7	8	9
1. Race	1	.112**	.029	.017	-.009	.079*	-.017	.080*	.074*
2. Skills		1	.499**	.386**	-.016	.069*	-.012	.028	.027
3. Confidence			1	.618**	-.056	.035	.026	.033	.066
4. Attitude				1	-.032	.102**	.061	.117**	-.007
5. Use of ICT to Teach					1	.286**	.262**	.200**	.096**
6. Use of ICT for Administrative Purposes						1	.500**	.519**	.185**
7. Use of ICT as a Repository Tools							1	.666**	.157**
8. Technological Pedagogical Knowledge								1	.156**
9. Teachers Feel Less Knowledgeable of ICT than Learners									1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

- The use of ICT for administrative purposes has moderate correlation with 'Use of ICT as a Repository Tool' and 'Technological Pedagogical Knowledge.'

- Technological Pedagogical Knowledge is important and can only be developed through continuous training and support, which in the long-run will boost teachers' confidence in the use of ICT in the classroom.

Table 11 Pearson Correlation V

	Pearson Correlations										
	1	2	3	4	5	6	7	8	9	10	11
1. Skills	1	.499**	.386**	.081*	.071*	.046	.077*	.059	.106**	.125**	.054
2. Confidence		1	.618**	.082*	.091**	.051	.121**	.106**	.141**	.172**	.134**
3. Attitude			1	.088*	.251**	.028	.038	.033	.035	.086*	.079*
4. Years of Working Experience				1	-.239**	.117**	.190**	.196**	.169**	.111**	.196**
5. ICT Integration in the Classroom					1	-.030	-.155**	-.176**	-.175**	-.096**	-.163**
6. Use of eLearning Systems						1	.514**	.429**	.426**	.422**	.399**
7. Use of eLearning to Support Learner-Content Interaction							1	.819**	.811**	.562**	.744**
8. Use of eLearning to Support Learner-Learner Interaction								1	.843**	.528**	.823**
9. Use of eLearning to Support Teacher-Learner Interaction									1	.607**	.784**
10. Use of Internet to Research										1	.630**
11. Use of eLearning to Teach											1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

- Use of eLearning Systems has moderate correlation with 'Use of eLearning to Support Learner-Content Interaction', 'Use of eLearning to Support Learner-Learner Interaction', 'Use of eLearning to Support Teacher-Learner Interaction' and the 'Use of Internet to Research.' This is significant given that those three types of interactions take place in an eLearning platform through the Internet.

- There is a strong correlation between 'Use of eLearning to Support Learner-Content Interaction' and ['Use of eLearning to Support Learner-Learner Interaction', 'Use of eLearning to Support Teacher-Learner Interaction' and 'Use of eLearning to Teach].'

- There is moderate correlation 'Use of eLearning to Support Learner-Content Interaction' with 'Use of Internet to Research.' Though there is correlation however creative is needed here to ensure that learners are re-directed to digital education resources in an offline environment. The issue here is sustainability in making digital education resources available only in an online platform.

- There is a strong correlation between 'Use of eLearning to Support Teacher-Learner Interaction' and ['Use of Internet to Research' and 'Use of eLearning to Teach']. Interactivity has to take place beyond the walls of the classrooms. This correlation provides evidence that interactivity beyond the walls of the classroom can only take place through Internet which demands reliable Internet connection. However this again raises the issue of sustainability thus lesson capture could prove the solution so that learners continuously download lessons in their tablets or any other digital devices when on-campus.

Table 12 Test of Homogeneity of Variances

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Skills	11.181[a]	3	839	.000
Confidence	2.480[b]	3	832	.060
Attitude	4.273[c]	3	832	.005
Training	2.697[d]	3	840	.045
Use of Computers	10.720[e]	3	801	.000
Smartboards	13.407[f]	3	840	.000
TPK	2.671[g]	3	827	.046

a. Groups with only one case are ignored in computing the test of homogeneity of variance for Skills.

b. Groups with only one case are ignored in computing the test of homogeneity of variance for Confidence.

c. Groups with only one case are ignored in computing the test of homogeneity of variance for Attitude.

d. Groups with only one case are ignored in computing the test of homogeneity of variance for Training.

e. Groups with only one case are ignored in computing the test of homogeneity of variance for 'Use of Computers.'

f. Groups with only one case are ignored in computing the test of homogeneity of variance for Smartboards.

g. Groups with only one case are ignored in computing the test of homogeneity of variance for TPK.

The Test of Homogeneity of Variances through Levene Statistic helps us understand the sample variance. In cases where there is equal variances then we can say there was homogeneity of variance. In our case our null hypothesis is that all variances are equal. In this case the significance values for items in Table 12 are less than p-value 0.05 signifying that variances are not equal therefore pursuing other test such as ANOVA is not necessary. Though we went on to do ANOVA in Table 13 it is clear that the distribution is skewed. Figure 22 confirms that the distribution is not normal.

Table 13 ANOVA

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Skills	Between Groups	7.363	4	1.841	5.732	.000
	Within Groups	269.409	839	.321		
	Total	276.771	843			
Confidence	Between Groups	1.301	4	.325	.767	.547
	Within Groups	352.909	832	.424		
	Total	354.210	836			
Attitude	Between Groups	2.345	4	.586	.990	.412
	Within Groups	492.618	832	.592		
	Total	494.963	836			
Training	Between Groups	.639	4	.160	.504	.733
	Within Groups	266.209	840	.317		
	Total	266.847	844			
Use of Computers	Between Groups	129.569	4	32.392	37.235	.000
	Within Groups	696.829	801	.870		
	Total	826.398	805			
Smartboards	Between Groups	62.004	4	15.501	15.321	.000
	Within Groups	849.854	840	1.012		
	Total	911.858	844			
TPK	Between Groups	12.753	4	3.188	4.824	.001
	Within Groups	546.512	827	.661		
	Total	559.264	831			

E-READINESS OBSERVATION FINDINGS

The Educational Information & Engineering Technology (EDIET) researchers conducted observation sessions in 35 schools to establish teachers' preparedness to integrate ICT tools into teaching and learning and to document teachers' ICT practices in the classroom. There were 90 lessons attended in total, however only 57 lessons used some form of technology shown in Figure 23. In an effort to respond to the most fundamental obligations of schools to prepare learners for the contemporary [21st century] society 63% of the lessons attended integrated technology. 37% [33 lessons] of the lessons did not use technology at all and most of those schools did not have access to ICT infrastructure, while in some classes teachers were not confident to use the technology in those classrooms.

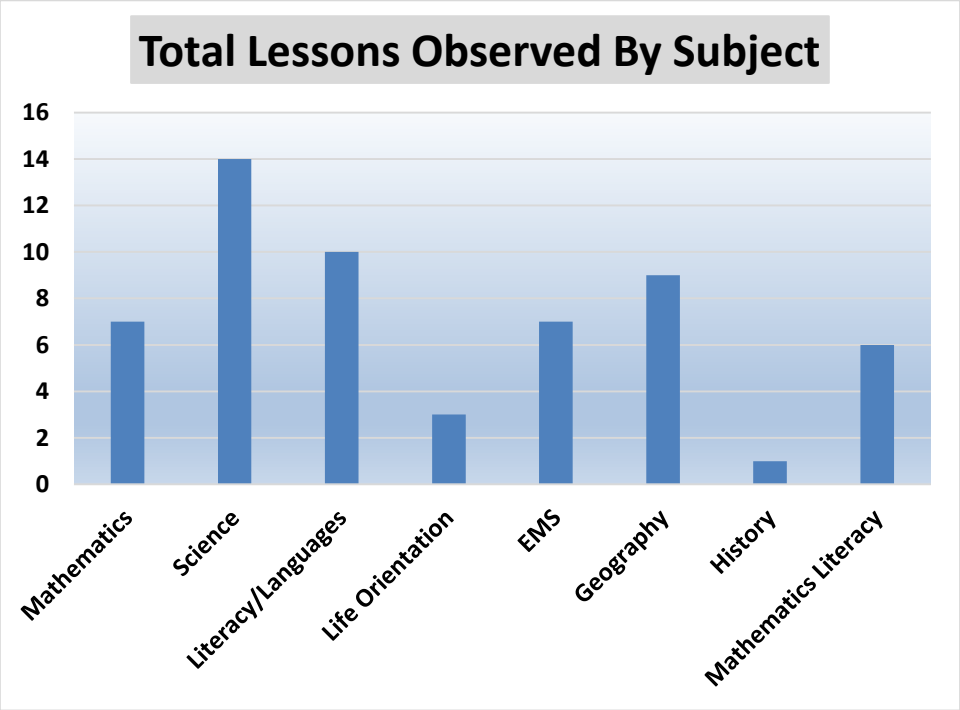

Figure 20 Lessons Observed

If ICT is to meet the needs of teachers and learners, it must also take into account the complexities of real classrooms, the way children and teachers learn. Teacher learning and professional development activities are a key factor in the success of ICT in the classroom (Thompson, 1994). In this respect, successful implementation of ICT requires a rich understanding of all participants, the way they interact, the context in which they interact, and any limitations including the curriculum, and in what ways all these interactions might be improved. Thus the rich data gathering and analysis underpin the analysis which is

complex and multi-layered. This research brought the three different types of interactions to understand how technologies enable the environment. The three different types of interactions are: Learner-Content, Learner-Teacher, and Learner-Learner. This was an effort to establish the role of technology in the process of teaching and learning as ICT implementation is complex as shown in Figure 24.

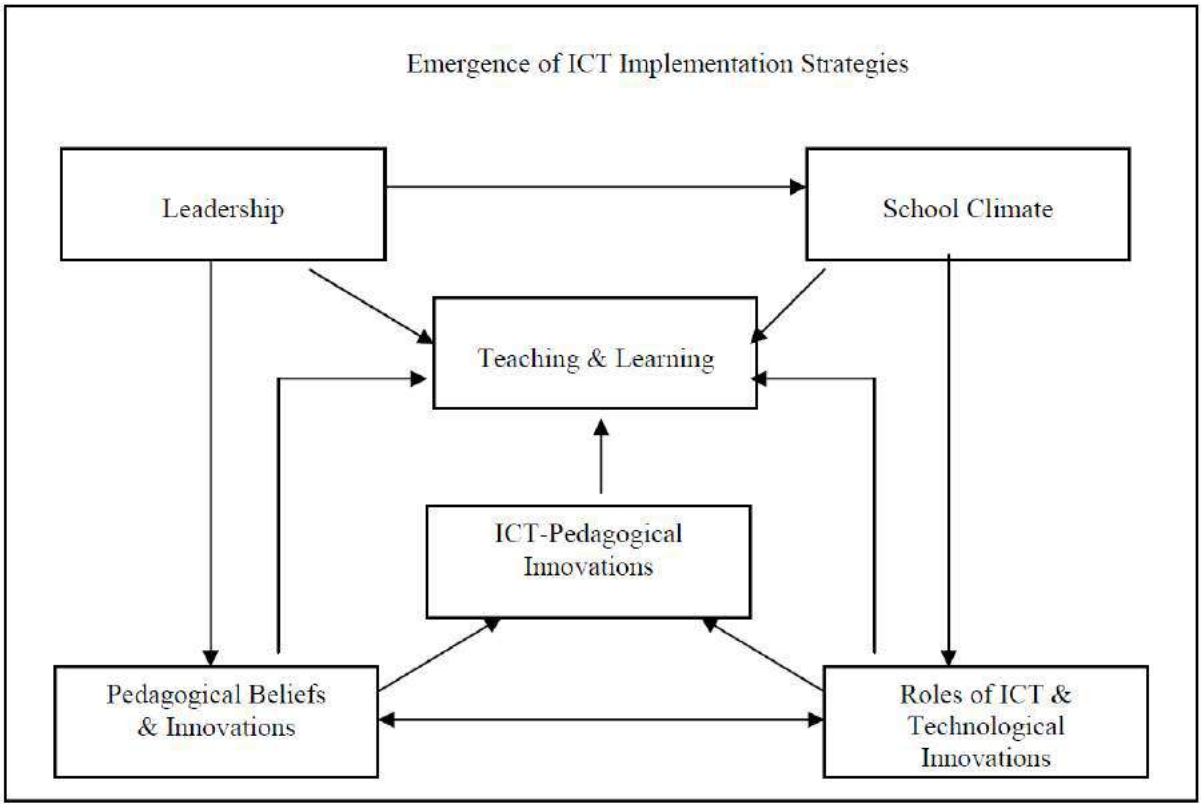

Figure 21: ICT Implementation Strategies at School and Classroom Levels (Wong, Li, Choi, & Lee, 2008)

The conclusion for the observation activities are as follows:

- Teachers use a purposeful selection of technologies for personal, administrative, teaching and learning purposes.
- Teachers' practices were found to be incremental and progressive, and aligned to their comfort zones [Skill Levels].
- Teachers adopted and used technologies on account of the value propositions afforded to them.
- The aggregated patterns of use, practice and adoption are located on continuums.

The observation of lessons made us conclude that the International Society for Technology in Education (ISTE) for Teachers is important in the development of teachers. Though smartboards [Interactive Whiteboards] were popular in grades 11 and 12, teachers were underprepared in the use of ICT in their teaching to the point that the Interactive Whiteboards (IWB) became whiteboards for them to write on and in most cases took the place of data projectors. Figure 25 confirms that in the lessons observed smartboards were popular. In the next section we will have an understanding of how teachers were using different technologies in the classroom.

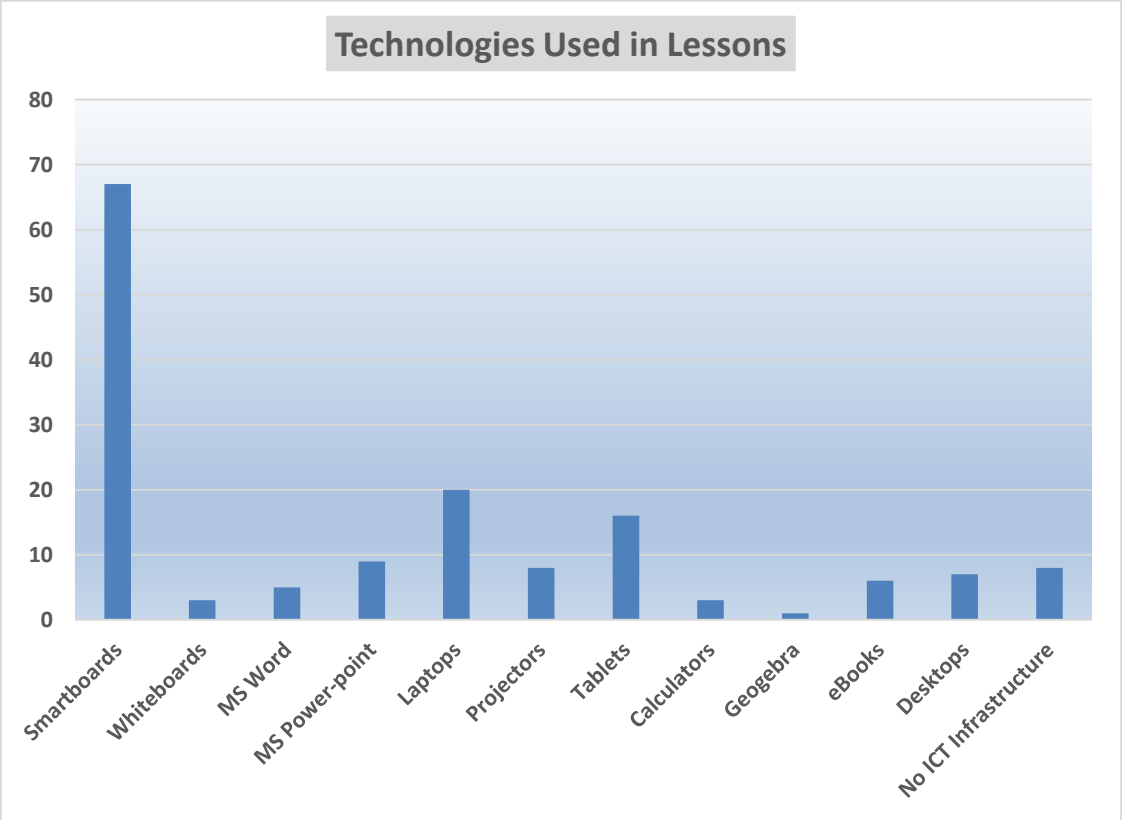

Figure 22: Technologies in the Lessons

The usage of various technologies was minimal given that we visited 133 schools and attended 90 lessons and only 57 met our standards of technology adoption and integration. Most of the 33 schools did have access to some desktop computers however they were used for administrative purposes. In some cases the schools did not have any access to ICT infrastructure for administrative or educational purposes. In many instances the technology was there but teachers still resorted to using IWB like whiteboards and data projectors because of their ICT skills and competencies. Therefore the ISTE standards published in the

National Educational Technology Standards (NETS) for Students[8] should serve as the foundation for any teacher development programme before moving to the National Educational Technology Standards (NETS) for teachers[9]. NETS for Students provide six areas of technology competencies:

- Basic operations and concepts
- Social, ethical, and human issues
- Technology productivity tools
- Technology communication tools
- Technology research tools
- Technology problem-solving and decision-making tools

Teachers should in the first instance demonstrate basic technology operations and concepts and this is basic understanding of technology, such as computers, IWB, tablets, and the Internet. The intervention programmes must have performance indicators at various levels to ensure that teachers develop confidence in the use of ICT in their work environment. As teachers develop proficiency they will be demonstrating their ability to navigate the popular technology such as Interactive Whiteboards with ease and make responsible choices as to when to use what technology for what purpose. Once they have conceptualized technology in their teaching environment then teachers will begin to use technology productivity tools whether creating podcasts or any other media. Videos were popular in the different lessons observed however most of the content was not informed by the South African context.

Furthermore teachers need to develop understanding of how to use technology communication tools to create interactive environment and allow peer to peer interaction so that learning happens beyond the walls of the classroom. The results showed that the only interaction that was happened the most was the learner to content and others are left behind in the process. The interaction between learner and content is important however 'learner-teacher' and 'learner-learner' is very important as well. Learners should be able to develop a culture of collaboration and be able to effectively interact with a wide range of audiences. Given that connectivity was a problem it is important that digital learning resources are made available right away and this will allow teachers to make decisions on

[8] https://www.iste.org/docs/pdfs/20-14_ISTE_Standards-S_PDF.pdf
[9] https://www.iste.org/docs/pdfs/20-14_ISTE_Standards-T_PDF.pdf

the relevancy and appropriateness of technology or media in a lesson. Lastly teachers are to model to learners on how technology can be used to develop critical thinking skills and problem solving by using the appropriate technology tools. Figure 26 presents the number of lessons per grade. Grade 11 was more popular in the classroom observed.

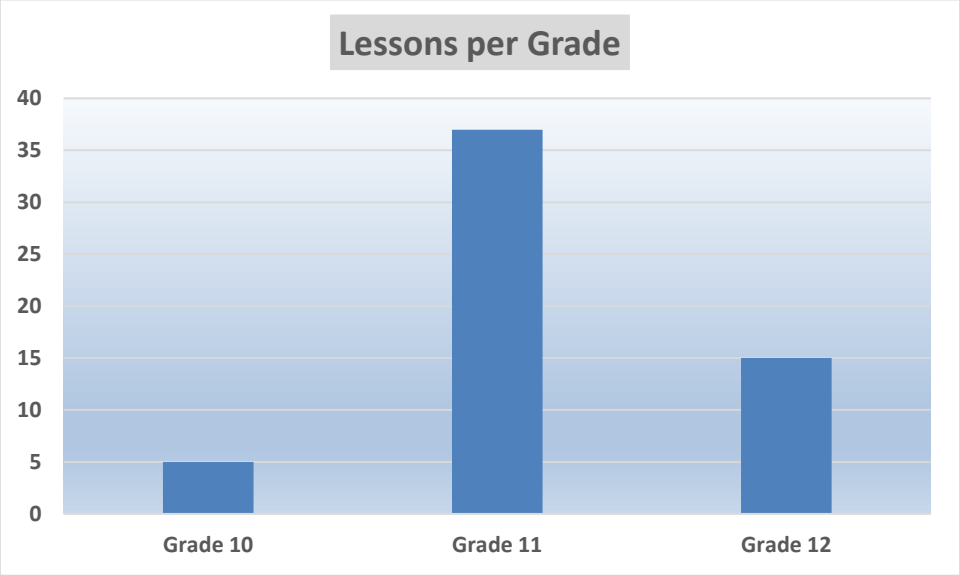

Figure 23: Grades Popular with Technology

THE USE OF ICT IN SCIENCE LESSONS

Lesson Observation 1

The teacher started the lesson without use of any form of technology. After introducing the lesson, he displayed some specimens and posters of mammals e.g. sheep, goat and human beings. Although the smartboard was functional, the teacher did not use it to illustrate the lesson. The smartboard lacks internet connectivity and cannot interact with the learners' tablets. Most of the activities centered on identification of the mammals and their dental formulas. The teacher instructed learners to describe the dentation of human being, sheep and goat. Learners were also required to draw and label parts of the digestive system of a sheep from posters placed on the board. The teacher engaged in explaining the dentation and the digestive tract of each of the animal on the poster. The teacher outlined the differences in all the three mammals. Learners asked questions and responded to questions from the teacher.

Lesson Observation 2

The teacher was using Power Point presentation for her lesson this allows her to also insert pictures or videos. The lesson was about human evolution and the theories around it. There was a video about human evolution which captured the learner's attention. Being able to download video helped for clarification. At the end of the lesson there was an activity that they did in pairs. The smart boards were easy to operate since they came with all the material. Teachers still need help finding e-Learning material that is there on the smart boards. While I was observing I found out that some teachers still prefer writing on the board. Some are very confident when it comes to use of ICT in their classroom. Interactive board provides flexibility, allows all different kinds of media including photos, videos to be displayed. It does not limit the content of their lesson if anything it improves the lesson and makes it more interesting. However it was clear that teachers are still familiarizing themselves with the ICT tools and they don't trust technology as they are still not confident when it comes to integrating ICT in their classroom.

Lesson Observation 3

Calculating the velocity of a free fall object and labeling all the forces that are there on a free fall object. Lastly was calculating the weight of the free falling object. The first teacher I observed was a grade 11 Physical Science teacher. Since the interactive white board comes with e-Learning textbook at the end of that textbook there is a formula. I observed that he was using Smart Notebook which allowed the teacher to draw and do some calculations at the same time. At the beginning of the lesson the teacher was uncomfortable having me there but as the time went by he seemed more and more relaxed. Having e-Learning material on the interactive white board helps because it has all past exam papers prescribed textbook for all the subject activities that are very interesting. The school also has three ICT interns at their disposal to support teachers with ICT related matters especially technical issues. Though there was IWB some teachers still believe in using the chalkboard and in some instances the IWB becomes a whiteboard to write on. The Physical Science teacher was using Smart Notebook which is on the interactive white board. Sometimes learners jump-in when the teacher is experiencing problems operating the interactive white board. Using ICT tools helps save time and allows use of additional learning material obtained from other resources.

Lesson Observation 4

This was a revision session, the teacher started off with showing the learners a PowerPoint Presentation that had all the content and he was reading through the content on the slides. Then the teacher used the smart-board to explain the processes of meiosis and mitosis, he was drawing illustrations and labeling them but the learners still did not understand. So he transitioned and used a video that explained the processes. The learners were very passive during the lesson they hardly interacted with the teacher.

Lesson Observation 5

The teacher taught Physics where he explained objects in motion. His lesson was interesting and what I picked up is that he was teaching from a loaded syllabus which was projected to the smart board. The fact that there were pictures projected, learners seemed interested. The interaction from the learners' perspective was energetic. The projection of images was

clear and visible. The teacher also looked more confident in the content and also in the use of the smart board. His knowledge on the tool was just excellent. Whenever he was confronted with going back to a concept, he would do so with ease and with the usage of varying colours to enforce understanding. His assessment task too was on a soft copy and classroom management was good.

Lesson Observation 6

The technologies used were smartboards and they didn't use any tablets, the activities were about discussing Newton Laws**.** The Interactive Whiteboard presented a platform for the teacher to display his power-point presentation and also played videos to show more examples.

Lesson Observation 7

The teacher used a simulated video to explain the physiology of the heart. She started by giving learners an activity to test their prior-knowledge on the physiology of the heart. The technology that was used included the ***projector*** and the teacher's laptop. There was ***no smartboard*** in the classroom. Learners did not have IPads or tablets. The teacher projected on a white sheet as she did not have the screen in the classroom. The lesson was taking place in a mobile classroom (the container).

Lesson Observation 8

The teacher uses smartboard pen to describe concepts of motions and velocity, he then opened a textbook that had the same topic and was explaining by annotating on the PDF to note all the important concepts and terminology.

Lesson Observation 9

The teacher started by asking questions about the stages required for photosynthesis to take place. The learners explained according to their understanding and gave general feedback. He then played a video that had animation and simulations of photosynthesis taking place. The teacher paused the video and explained what was happening in the video by annotating using a smartboard pen.

Lesson Observation 10

In this school all grade 12s have tablets and teachers have laptops. Grade 11 and 12 classrooms have smartboards. The teacher started her lesson by saying, “having knowledge of your heart structure and its function will help you appreciate how this important organ works to pump blood to the whole body. Although it is barely the size of a human fist, the heart is a powerful muscle inside the chest, with a cone shape and a pointed end facing the left”. She opened a Life Science E-book on the smartboard and asked learners to open their text books. She knew where to find an e-book on the smartboard as she was talking she used a smart pen to highlight the important lines. She then talked about The Heart Wall:

The epicardium, or the outermost layer of the heart, is a thin layer of membrane that lubricates and protects the outside portion of the heart.

The myocardium, or the muscular layer of the heart wall, consists of the muscle tissue. It consists of the majority of the thickness of the heart and is responsible for the pumping action of the heart.

The endocardium, or the innermost layer that lines the inside of your heart, is a smooth lining that keeps blood from sticking to the heart and prevents the formation of potentially harmful blood clots.

Lesson Observation 11

This lesson used an Interactive Whiteboard as a medium to present a lesson on electric power. Demonstration of how electrical energy is converted in an electric circuit was done through drawing circuit diagrams. Learners were answering questions from the textbook. The teacher did not access eBooks from the IWB.

Lesson Observation 12

This lesson used an Interactive Whiteboard as a medium to present a lesson on electric power. Demonstration of how electrical energy is converted in an electric circuit was done through drawing circuit diagrams and videos were used as part of the lesson.

Lesson Observation 13

Explanation of Ohms Law by the teacher: The teacher used an IWB as a whiteboard. The presence of the IWB gave the teacher a space to write and explain different formulas. In some instances the teacher will switch to PowerPoint presentation, thus making the IWB a multi-display platform.

Lesson Observation 14

Explanation of electric circuits by the teacher: The teacher was using the IWB as a whiteboard instead of maybe animating circuits and demonstrating how they function live. Instead the teacher was writing on the IWB.

Conceptual Framework Analysis

Through the Interaction Equivalency Theorem (Anderson, 2003a) lens, which consists of the three interaction elements found in formal education courses among teacher, learner, and content we explain the observations. This lens helped us to gain insights into the dimensions of the classroom to understand how ICTs [technologies] contribute to teaching and learning as a relational property of a three-way interaction posited by Anderson (2003a) consisting of learners, content, and teachers to enable greater engagement and enhance the classroom experience.

Learner-Content Interaction

- I have observed that learners were adequately engaged with the lesson content in the classroom. Although the teacher did not use the smartboard to teach, but learners used their tablets to refer to life science content in the tablets. Learners also wrote the dental formulas of animals and drew the digestive system of a sheep in their textbooks.
- Learners used their tablets in the classroom to refer to the content in their tablets. However, few learners are not able to use their tablets because the tablets are damaged or stolen.

- After her explanation she projected non-labeled picture of the heart, then asked learners to name each part represented and to explain its function. Learners wrote answers in their workbooks. The teacher marked them as soon as they finished.
- Learners seemed to be interested in today lesson everyone is curious about human evolution and the theories around it. Before they watched the video they were interested but not as much after they have watched it. The video brought some clarity confirming any suspicion they had.

- During this section she opened a picture that depicts a structure of a heart. The picture is one of the materials that come with the smartboard. She could have used a video to illustrate this section. This presentation was limited to packages that come with smartboard. Learner participation was very limited and during the lesson the smart board will freeze and the teacher started to panic because she is at the very beginning with the use of a smartboard. ***She relies on her HOD to assist her with technical issues, so she sent one learner to call her HOD to come and assist.***
- Overall the smartboard is loaded with a lot of materials that a teacher can take advantage of however; this lesson the teacher was only focusing on two materials. The teacher explained that they just received training about the smartboard hence she had confidence issues.
- In this case I believe ICT tools really help facilitating the lesson. The additional material that the teacher downloaded was of good help. After the lesson he had prepared an activity on word and displayed for the class to complete.
- The simulation allowed learners to have an experience of how the heart pumps the blood into the body. All learners seemed interested in the lesson; they even asked the teacher to share the simulation with them.

- The lesson had the learner's attention, they showed great interest in watching the video and some of them were making jokes about Angels opening a tap in heaven, learners were willing to learn.

Learner-Teacher interaction

- There was effective interaction between the learners and the teachers in the classroom. The teacher posed questions to the class and learners responded. The teacher provided additional explanation with examples and illustrations. Similarly, learners asked question and requested for more clarifications on some aspects of the lesson, the teacher explained further.
- Using a video to explain using ICT to teach makes a lesson very interesting. Learners seem to be paying more attention when the video is being played.
- Only four learners got three out of five in the activity. I was later informed that these were repeating the grade; therefore they had an added advantage. The teacher then invited learners to watch the video that showed how the heart functions. She stopped the video here and there to name the parts of the heart and to explain their functions. She wrote her explanations on the chalkboard using different colours to highlight important concepts learners needed to know.
- After the explanation he asked the learners questions. The teacher referred the learners to a page number that had an activity for them to complete.
- Interpretation of power formula was done by the teacher.

Learner-Learner interaction

- I observed that there was minimal learner to learner interaction during the lesson in the classroom. Most of the learners did their work independently without consulting one another for assistance. Perhaps this is because the teacher did not give leaners any joint task to perform in the classroom.
- There was no collaboration between the learners during that lesson.
- Learners were quiet taking notes, and they answered questions asked, there was not much engagement taking place.
- Learners were highly engaged with the topic; however the teacher could not use IWB multimedia.
- Learners were discussing about the lesson's topic.
- Learners were given a chance to discuss the relationship between power and potential difference.

- Learners were asked to discuss the relationship between resistors and current

Summary of Good Practice

- ***There was a push towards socio-constructivist [active learning] pedagogies through the use of Interactive Whiteboards (IWB).***
- The use of videos dominated activities in the science classroom.
- The use of IWB - move text and pictures around for demonstration purposes [pressing of buttons and dragging objects across the screen].
- Use of IWB to store, retrieve, and amend ideas or the way demonstration happens, this fosters communal work and continuous learning and adjust if there are mistakes or new approach was to be applied.
- Multimodal input or representation.
- Animating objects.

THE USE OF ICTS IN PURE MATHEMATICS LESSONS

Lesson Observation 1

Learners were given a diagram and they had to prove that a certain side was equal to a certain side where calculations were involved. Since the teacher was teaching geometry the smartboard works to his advantage since he could draw and do some calculations at the same time. However teachers were still experiencing some trouble when operating the smart boards. It was evident that training and continuous support was necessary. ***The teacher believes with enough training there won't be any need for the school to have ICT interns.***

Lesson Observation 2

This was a revision session so basically the teacher used the smart-board to model equations on the board for the learners and then wrote down equations that they needed to solve as a class and then individually.

Lesson Observation 3

This was another class where the teacher was confident in using a smart board. His lesson was Geometry and the teacher used various colors with ease showing the knowledge in using a smart board. Code switching was used to enforce understanding. There were incidents where ***learners wanted to take over the lesson to assist fellow struggling classmates.*** This to me proved that not only the teacher knew how to use the smart board, but learners too were positive and upbeat in using it.

Lesson Observation 4

Observed Mathematics Grade 11 Class, the technology being used was the smartboard only and the class was revising for their upcoming test.

Lesson Observation 5

They were using the smartboards for classwork and for the lesson of the day. There was not much collaboration beside when marking of the classwork was done. The school has a good ICT infrastructure with a downfall of unavailability of internet connection .They have a

computer lab and working electricity in the computer lab. Technical support is limited to the ICT coordinator. Most teachers are young and own a laptop and use them effectively to enhance their teaching and use their own broadband connection to do research and new teachers which make the interaction between learners and educators easier. They have smartboards but mainly used in Grade 12, they received training but on a basic level, ***educators are able to use smart boards but because the school is quite new at using technology to teach. Their level of teaching is just basic.***

Lesson Observation 6

The teacher wrote equations on the smartboard and picked learners to come and solve the equation on the smartboard. The teacher asked learners to use the white board for additional space as the smartboard was not big enough for all the calculations. The technology that was used included the smartboard and learners' tablets.

Lesson Observation 7

The teacher available for observation was free and decided to ask for a class that was not attending any lessons and invited the learners to his class. The lesson started with verbal introduction as he explained to learners about the research and addressed to them that they have already done the topic, it is only for revision.

The teacher switched on the smartboard, navigated on the controls to find the e-Textbook, he searched for the page number of the relevant topic and could not find the page. He then jumped to the white board and started teaching there in which the entire lesson took place there. When done with the lesson he then proceeded to the smartboard and he was able to find what he was looking for and then explained to the learners revising what he just taught on the white board.

Learner-Content Interaction

- Used the smart-board to model equations.
- Learners took notes of the formula(s) to be used to solve in class activities.
- The learners' engagement with the content was great the learners knew a lot, the technology stimulation was okay because the use of technology was just basic. The

lesson was good although there was noise during the lesson when the learners didn't understand some of the content.

- They had classwork and the learners engagement with the content was average, the technology stimulated the teacher's level of teaching greatly because it made her work a whole lot easier which helped her to be able to engage more with the learners.
- Learners took notes sitting quietly listening to the teacher teach.
- Learners wrote answers in the workbook. ***Learners who were lazy to write used their tablets to take pictures of notes that were written on the smartboard.***

Learner-Teacher Interaction

- The interaction between learner and teacher was great and there was no collaboration between learners. The experience was okay although the learners didn't interact much during the Mathematics lesson however after the lesson; there was collaboration within the learners.

Learner-Learner Interaction

- The collaboration between learners was average; there was interaction amongst the learners.
- Learners who were lazy to write used their tablets to take pictures of notes that were written on the smartboard and shared with friends.

Summary of Good Practice

- More communication and constructivist models of task.
- There was a push towards socio-constructivist [active learning] pedagogies through the use of Interactive Whiteboards (IWB).
- The use of videos in mathematics classroom to illustrate mathematics concepts. These videos were downloaded from YouTube due to connectivity issues.
- Use of IWB move text and pictures around for demonstration purposes [pressing of buttons and dragging objects across the screen].

- Use of IWB to store, retrieve, and amend ideas or way demonstration happens, this fosters communal work and continuous learning and adjust if there are mistakes or new approach was to be applied.
- Multimodal input or representation.
    - Animating objects.

THE USE OF ICTS IN LANGUAGE LESSONS

Lesson Observation 1

The lesson was about writing a dialog between two people and being able to use the correct punctuation marks where necessary. Learners had to first sort the paragraph given to them by inserting punctuation marks and then after punctuation they had to make a dialog between two people. After creating a dialog they had to present that dialog in pairs with marks allocated at the end of the oral presentation. There were interns to support teachers when they operated the smartboards. Microsoft Word was used to present the lesson.

Lesson Observation 2

The teacher started off by reading the novel and had a discussion with the learners, she wrote notes for the learners on smart notebook. After that she showed a video of the book they were reading, she occasionally paused the video at certain points to place emphasis on themes and motifs. The learners were engaged, they were collaboratively working with the teacher with the smart-board, and they got the opportunity to work on the smart-board. The teacher called the learners up so they could work on the smart-board.

Lesson Observation 3

The lesson was revision session for the learners and the teacher displayed the poem on the smart-board on a word document they had copies of it on a worksheet, and made notes of important language devices on smart note, on the smart-board, using key words and annotations for the learners and they were just copying these notes into their books, there was very little interaction between the learners and the teacher. The teacher was basically the one who was doing all the talking during the lesson and the learners just sat there passively writing notes into their notebooks.

Lesson Observation 4

The teacher did not really use the smart-board during the lesson she stuck to using the textbook, the learners were doing corrections, the teacher asked the learners for the answers that they had written and she corrected them and they wrote the answers in their books.

Lesson Observation 5

The teacher was using the textbook with the smart-board during the lesson, he used the smart-board to write notes based on what he was teaching and the learners were taking down notes. As the lesson progressed he started a classroom discussion, which was also a classroom activity with the learners, the learners were very engaged in during the lesson they were sitting in little groups and asking and helping each other to contribute to the classroom discussion. The teacher used the smart-board to jot down the learners responses.

Lesson Observation 6

The lesson was revision session for the learners and the teacher displayed the poem on the smart-board, and made notes of important languages devices on smart note, using key words and annotations for the learners and they were just copying these notes into their books, there was very little interaction between the learners and the teacher, the teacher was basically the one who was doing all the talking during the lesson and the learners just sat there passively writing notes.

Lesson Observation 7

The technology was not used much, the only thing that was used was the smartboards and they just used it for notes. The lesson was full of basic stuff that didn't need much of the smartboard; they had classwork and marking of home works. The school has a computer lab with no internet connection, which is locked most of the time.

Lesson Observation 8

The English lesson was so interactive and engaging they had groups in class named from their favorite Television Programme. What I have observed is that the school have good ICT

infrastructure and they have two ICT coordinators from the department who assist the school.

Lesson Observation 9

There were about 35 learners in the classroom on the lesson Life on the trenches. The technology that was available was the smartboard. The lesson started by the teacher displaying a picture on the smartboard, the picture depicted life in a trench. The video was the popular technology which was followed by discussion.

Lesson Observation 10

In this school only grade 12 learners have tablets and teachers have laptops. This school is situated in a Ndebele area and as such most learners speak isiNdebele as home language however at school they do isiZulu as home language. So the teacher had to find ways to enhance teaching and learning of isiZulu in the classroom. In this lesson he did use a variety of ICT tools (videos, pictures and music) to enhance the lesson. This lesson required learners to bring newspaper articles and magazines because they were doing indatshana yephephabhuku/yephephandaba. The teacher downloaded these articles from the internet and printed them for learners before the lesson. He started his lesson and distributed articles and asked learners to ukubuyekeza, ukulungisa amaphutha kanye nokwethula as asked to highlight as they read.

The teacher used PowerPoint presentation smartboards for this lesson. The PowerPoint was very well prepared and integrated very well with lesson. His hyperlinked videos and pictures of the animals the newspapers were talking about. He did this purposefully because his learners do not know other animals in Zulu but in IsiNdebele. So when he projects the video on the screen learners started to say oh! This was the sign that learners understood these animals. As they were doing imibhalo edlulisa imiyalezo, the teacher also played an English video clip that shows how people present messages in an article and he asked learners to extract imiyalezo from the newspaper article and magazines. The way he integrated digital tools in his lesson helped learners to connect dots and start to engage with text. Learner engagement during this lesson was very interesting. The teacher probes questions that foster critical thinking and high levels of understanding of ukulalela

nokuqondisisa. After the lesson the teacher gave learners homework based on their text books, to do Ukukhethwa kwamagama.

Learner-Content Engagement

- Video of the book learners were reading was played and the teacher occasionally paused the video at certain points to place emphasis on themes and motifs.
- Towards the end of the lesson the learners had to take down notes and answer questions about the novel they were reading.
- The engagement with the content was great because they were marking and making corrections.
- The engagement from learner to teacher was great. The teacher was a young teacher which made learning fun and relatable, the collaboration between learners was good. The interaction in class was so interesting because the learners were able to relate with their level of teaching.
- Before playing the video the teacher called learners' attention to finding in the video evidence that corroborated or contradicted the presentation of trench life in the picture she started with. She also asked learners to make notes of those similarities and/or differences in their workbook. After the video was played she asked learners to describe things they found in the video that corroborated or contradicted the picture she started with.
- The video enhanced discourse on life in a trench. Many learners asked questions during the lesson. The video also brought an emotional aspect into the lesson; some learners looked frightened after watching it. The video also served as a motivational tool to some learners who expressed their desire to become soldiers.
- ***The teacher explained to me that he cannot go to class without technology because learners have challenges with IsiZulu given that at home they are speaking isiNdebele.***

Learner-Teacher Interaction

- Video of the book learners were reading was played and the teacher occasionally paused the video at certain points to place emphasis on themes and motifs.

- The teacher was engaging with her learners the teacher was a young teacher which made it easier for learners to engage with her.
- All those questions helped the teacher to describe soldiers' life in the trench. After explaining from the picture the teacher played a clip of the First World War. . After the video the teacher asked learners to form small groups of four to discuss how they fill about life in a trench. The lesson ended with homework. The teacher asked learners to imagine they are soldiers in the trenches during World War I and to write one page letters to their loved ones describing what life is like at the Western Front. The letter ought to look very old, they were told to dip them in tea or to burn them at the edges in order to look old.

Learner-Learner Interaction

- The collaboration from learner to learner was great because there was so much interaction during corrections.
- The video enhanced discourse on life in a trench. Many learners asked questions during the lesson. The video also brought an emotional aspect into the lesson; some learners looked frightened after watching it. The video also served as a motivational tool to some learners who expressed their desire to become soldiers.

Summary of Good Practice

- More communication and constructivist models of task.
- There was a push towards socio-constructivist [active learning] pedagogies through the use of Interactive Whiteboards (IWB).
- Use of video technology which seemed to engage and motivate learners to participate.
- Use of IWB move text and pictures around for demonstration purposes [pressing of buttons and dragging objects across the screen].
- Use of IWB to store, retrieve, and amend ideas or way demonstration happens, this fosters communal work and continuous learning and adjust if there are mistakes or new approach was to be applied.
- Multimodal input or representation.

THE USE OF ICTS IN EMS LESSONS

Lesson Observation 1 & 2

The teacher was using Smart Notebook which is on the interactive white board (IWB) to draw a ledger. Since there are also some calculations involved it's easy to do those calculations at the same time. The interactive white board comes with activities that are in a form of games which are interesting to learners and makes them want to be part of those activities. Everyone wanted to participate. During my visit I observed that even though the school has interactive white boards some teachers did not feel comfortable when using them they still prefer using a chalkboard.

Lesson Observation 3

The teacher used the smart-board to display a PowerPoint presentation, and then he also shared a past paper with the learners on a word document. With that he also showed the learners a very detailed video on the landmarks in South Africa, this video was transmitted to the smart-board via the teacher's laptop using a HDIM cable.

Lesson Observation 4

The teacher was just giving the learners content in the form of a classroom discussion but he was the main speaker, learners asked questions every now and again, and then he simply wrote notes on the smart- board and the learners copied those into their workbooks. After that he gave the learners reading that they needed to do, with a classroom activity.

Lesson Observation 5

The teacher used the smart-board to help and explain the process of what actually happens during the bank reconciliation process, he wrote steps for the learners on the smart-boards and he paused at certain part to get learners input so he could keep them engaged and then showed them a short video that showed the learners how the bank recon process occurs. When that was completed he gave the learners an opportunity to ask questions and he answered those questions and gave the learners an activity to gauge their understanding and also to get the learners to interact with content on a personal level. The activity was an

individual activity that the learners had to complete in their books based on the content covered on the process of bank reconciliation.

Lesson Observation 6

The teacher used the smart-board to help and explain the process of what actually happens during the bank reconciliation process, he wrote steps for the learners on the smart-boards and he paused at certain parts to get learners input just he could keep them engaged and then showed them a short video that showed the learners how the bank recon process occurs. When that was completed he gave the learners an opportunity to ask questions and he answered those questions and gave the learners an activity to gauge their understanding and also to get the learners to interact with content on a personal level. The activity was an individual activity that the learners had to complete in their books based on the content covered on the process of bank reconciliation.

Lesson Observation 7

The teacher was able to navigate the smartboard by searching and opening the relevant files to open the Accounting e-Textbook, she's was able to scroll and open the relevant pages, she opened revenue and expenditure topic, where she was able to use the pen to write over the PDF file and use of the highlighter to outline important concepts. She showed confidence in the ICT usage as where she made a mistake she would select the eraser to erase what was not applicable. She had prepared a video, to explain further to learners, before viewing I realized that she can drag drop a video to the codec to play.

Lesson Observation 8

The teacher taught the lesson without the assumption that learners know what marketing is. The teacher was able to navigate the smartboard with confidence, the lesson was delivered on PowerPoint slides and the teacher made hyperlinks that would take the learners to different sources on the internet to give relevant examples she was able to use the search engine Google, she searched with the class watching if they were not sure about certain things in the topic. She also played a video on YouTube to explain the concepts in a more modern way of functions of marketing.

Lesson Observation 9

The teacher demonstrated how to calculate percentages and the textbooks were used as teaching and learning materials. Individual learners were working on the class exercises. The teacher was dominating the lesson; learners were not given a change to bring their ideas forth. The teacher was drawing tables with a free hand on the Interactive White Board (IWB). Learners used calculators to calculate percentages and income tax.

Figures or numbers were written using free hand and that brought confusion since the teacher's hand writing was not good. The teacher could not use the eBooks installed on the IWB.

Learner-Content Interaction

- Learners seemed to be glued on today activity of filling a general ledger the reason being if a learner was to get the calculation correct it allows them to move to the next stage no one wants to loose. Most learners were taking part makes the whole lesson interesting. The content was easy to follow as presented in both the chalkboard and the IWB.

- This lesson was a revision lesson, so the learners were very involved they were asking a lot of questions on concepts, giving each other responses on topics they did not understand and taking down notes from the smart-board, which were written on the smart-board.

- Learner and content interaction was limited. The prominent interaction was between the learner and their textbooks (grade 11 learners did not have access to tablets they still use hard copy textbooks).
- Learners were taking notes most of the time, the only time there was a buzz is when the teacher asked learners about different marketing tools and they gave example about most digital platforms like social media.
- Learners were able to engage in the topic, there was maximum participation on the expenditure topic and most learners had little prior knowledge on revenue, but participation increased when the topic was explained to them.

- Lesson steps presented on the smartboard though lacking interactivity as it was merely used as a projection tool.

- Learners were answering questions from the textbook and were highly interactive with the content outside of the technology.

Learner-Teacher Interaction

- The ICT enhances the teaching process. Interactive white boards allows teachers to time their lesson allows for specific time allocation. I believe ICT was an enabler when it comes to teaching Accounting using Smart Notebook. Teachers now can download videos for more clarity. When using the IWB lesson looks more presentable to learners. Though teachers are not 100% confident using ICT they struggle through the lesson.

- The teacher was still the expert in this lesson as the teacher used the smartboard to present her notes with learners taking notes not even asking questions as witnessed in other lessons.

- There was less interaction between the teacher and learners.
- The teacher was dominating the lesson, thus learner interaction was very low.

Learner-Learner Interaction

- The objects presented through the IWB seem to spark interactivity among learners regarding the lesson being presented.
- This lesson was a revision lesson, so the learners were very involved they were asking a lot of questions on concepts, giving each other responses on topics they did not understand and taking down notes from the smart-board, which were written on the smart-board.
- There was minimal interaction among the learners as everything was targeted to individual learners.

Summary of Good Practice

- More communication and constructivist models of task.
- There was a push towards socio-constructivist [active learning] pedagogies through the use of Interactive Whiteboards (IWB).
- The use of smart notebook during lessons was an enabler.
- Use of IWB move text and pictures around for demonstration purposes [pressing of buttons and dragging objects across the screen].
- Use of IWB to store, retrieve, and amend ideas fostered communal work and continuous learning and adjust if there are mistakes or new approach was to be applied.
- Multimodal input or representation.

THE USE OF ICTS IN GEOGRAPHY LESSONS

Lesson Observation 1

This lesson was aimed at preparing leaners for the Matric examination. The lesson focused on how to answer matric questions on economic geography. Although the teacher tried to engage learners in some activities, there were minimal activities in the classroom because the smartboard is not connected to the internet and the learner's tablets have no internet access too. Nevertheless, the teacher illustrated and provided several examples to explain the topic on the smartboard [Interactive Whiteboard] in the classroom. There was no interactivity between the smartboard and the learners' tablets; hence both teacher and learners are not able to carry out some of the activities designed in the lesson plan. However, the teacher displayed some images, graphics on the smartboard for the learners to see and draw as illustration of concepts.

Lesson Observation 2

Lesson was about climate change and factors that contribute to climate change. A slide show video of factors contributing to climate change was played and learners were able to come up with factors that can be used on our daily basis and still be ozone friendly. Learners were to collect ozone friendly product for their global warming project and come up with ideas to reduce pollution and reuse product. It was clear here that teachers were interested in integrating ICT into their classroom and the videos seemed to play an important role in their lesson delivery especially given the nature of the lesson climate change.

Lesson Observation 3

The teacher used the smart-board to write calculations for the learners based on what they were learning about, he even went to the extent of drawing illustrations to show the learners how to use the calculations The learners were writing notes whilst the teacher was explaining, he also showed the learners a video from the mindset learning channel based on what he had taught the learners.

Lesson Observation 4

They used the smart board in the Geography lesson but the smartboard kept on freezing and the class would get out of hand. Tablets are only available for grade 12 learners and they don't have internet access in the classroom and they have new smart board that needs smartboards pens because using hands is a challenge because at times the smart board freeze. The smartboard stimulated the lesson however it was challenging when the smartboard froze because the teacher had to pause his teaching and try to fix the problem. The school have ICT infrastructure however they freeze from time to time during lessons which serves as a barrier because teachers don't have any back up they just load lessons on the smart board.

Lesson Observation 5

The technology that was used in the classroom included the smartboard and the teacher's laptop. Learners did not have iPads or tablets. Some were using their cell phones to look for information on the internet. The lesson started with a revision on the previous topic. The teacher projected questions on the smart board. The questions focused on the layers of the earth, the theory of plate tectonics and the types of plate boundaries. These questions were answered orally; the teacher read the questions and asked learners to respond. The revision took about seven minutes. The teacher then introduced the topic on Volcano; she told learners that the lesson will focus on the structure of the volcano and its impact on people and environment.

Lesson Observation 6

The technology used was PPT slides for additional notes that the teacher had and activities arise from the there too. The content used was from the GDE contents platform which contains of different textbooks for different grades. Learners engaged really well with the contents since they were using smartboards than on a white board, although sometimes lessons are delayed because the teacher pressed a wrong button on the board and doesn't know how to get back from where she was before. The teacher had access to online resources which makes learners even more interested in the subject at hand.

Lesson Observation 7

Demonstration of how mining contributes to the South African wealth was demonstrated through graphs and cards. Projection of electronic media through a laptop and IWB was done at the beginning of the lesson. The IWB was used to project eBooks. Pictures from the eBooks were projected on the IWB through the laptop. The teacher used a laptop to access eBooks.

Learner-Content interaction

- Learners interacted with the content in the classroom. From time to time during the course of the lesson, the teacher referred to learners to their notes to confirm certain facts and information during explanation. Learners also wrote down some important points from the lesson in their notebooks. Learner's engagement with the content prompted them to ask questions in the classroom. This has led to more interaction between the learners and the teacher.
- Briefly the video was used to bring a real life situation in the classroom. Learners were able to see the structure of the volcano, how the magma is formed and how the volcano erupts. Learners were also able to see the impact of the volcano eruptions on the environment (pollution and earthquakes) and the destruction it causes to the habitat that surrounds it. The teacher then handed out the worksheets for learners to complete while watching the video. She played the video twice.
- Learners have access to videos which help them to develop their understanding of factors that contribute to global warming. Learners were glued on the screens. Some even started asking questions.
- The learners' engagement was great; they were participating during the lesson.
- Learners were asked to answer questions from the eBooks.
- Learners were analyzing diagrams from the IWB and also showing how minerals affect the country's wealth through drawing graphs and diagrams.

Learner-Teacher interaction

- There was a progressive interaction between leaners and the teacher in the classroom. The teacher prompted some discussions by presenting some issues related to food security in South Africa and learners responded by making

contributions to the discussion. In the same vein learners asked relevant question about various aspects of the topic and the teacher responded by providing answers and prompting further discussion.

- Learners were glued on the screens and some even started asking questions.
- The collaboration with learners was good because they had two different classes in one.
- Evidence of their engagement included various questions they asked the teacher after the video was played. In some cases the teacher asked them to search on internet for answers on the questions they asked.
- Learner-learner and learner-teacher interaction was very high.
- Learners were given a chance to draw diagrams on the IWB.
- Learners were highly participating during the lesson.

Learner-Learner interaction

- Learners interacted among themselves in the classroom. The teacher promoted learner's interaction by giving tasks that require collaboration to solve. For instance the teacher asked leaners to think and come up with some advantages and disadvantages of globalization. The teacher gave leaners five minutes of the lesson time to collaborate together through discussions and come up with answers. There was further collaboration among leaners in solving some practical task (e.g. drawing) that require completion in the classroom.
- The Learners were very much interested and engaged in the lesson. After the video was played, she asked learners to exchange their papers so that they can mark each other's work. She played the video for the third time pausing here and there to ask learners questions, to name parts of the volcano, to emphasize or to explain the concepts. Whilst doing so she was highlighting and annotating her explanations on the video.
- Learners were highly discussing how minerals are useful for the country's economy.

Summary of Good Practice

- There was a push towards socio-constructivist [active learning] pedagogies through the use of Interactive Whiteboards (IWB).
- The use of IWB to project eBooks and various teaching objects.
- Use of IWB move text and pictures around for demonstration purposes [pressing of buttons and dragging objects across the screen].
- Use of IWB to store and retrieve materials.
- Multimodal input or representation and projection of multimedia objects.

THE USE OF ICTS IN MATHEMATICS LITERACY LESSONS

Lesson Observation 1

The teacher used smart notebook (an app in the smart-board) to write formulas for the learners and also to draw illustrations for the learners.

Lesson Observation 2

The teacher was using the textbook during the lesson, just to help the learners understand the formulas. Then she modeled the calculations for the learners using the smart-board so they could see how to use the formula to do the calculations. The learners were taking down the calculations as the teacher was modeling them so they could have it in their books. There was a classroom discussion during the lesson, it was more like a question and answer session, where the learners were asking questions and the teacher and the other learners in the class would respond to the questions.

Lesson Observation 3

They used the smartboard for the classwork and the correction of home works although the smartboard would freeze from time to time. The school has good ICT infrastructure ,it is one of the schools that is well equipped with 16 smart boards, 175 Tablets and 25 laptops and teachers are well trained on how to use smartboards beyond projection, there was no teacher who had challenges using a smart board however they have a computer lab that does not function yet and they don't have classroom internet connectivity ,the only connectivity available is in admin and educators have laptops but they usually use their own personal data for research and downloading resources which is expensive for them.

Lesson Observation 4

The teacher played a video where a dice was rolled, and a coin was tossed practically to show what the possible outcomes are when a coin is tossed or a dice is rolled. The teacher explained the possible outcome using PowerPoint slides from the smartboard to display the probability of different events. When done with the lesson the teacher gave learners an activity that was displayed on a smartboard using Microsoft Word.

Lesson Observation 5

The teacher drew a 2 dimension shape using software called Geogebra on the smartboard which is a square, he wrote the dimensions, and explained what the length, the breadth in centimeters is, and after the drawing and explanation he showed them how to calculate the area of the 2 dimension square. He then drew a triangle and asked the learners to point out the length and breadth and also to calculate the area of the triangle.

Learner-Content interaction

- The learners were very active during the lesson; they were engaged in a classroom discussion. In addition to that they actually assisted the educator during the lesson because she was struggling to use the smart-board. They often went up to the board to write on the board. The smart-board froze during the lesson so the teacher would teach using a textbook when that happened.
- The teacher explained the possible outcome using PowerPoint slides from the smartboard to display the probability of different events.
- The learners were very active in the lesson. The learners were working on calculations, after the teacher modeled they did a few as a class, without the assistance of the teacher and she would just write on the smart-board as the learners gave the steps that needed to be followed to complete the calculation. She did not really allow the learners to interact with the smart-board; she was the only one who used it.
- The teacher was so engaging he was so passionate, his lesson was fun and vibrant.
- The learners answered on what they saw in the video and on the coin, they were amused as every learner in the class could relate, most of them play games that include playing of a dice.

Learner-Teacher interaction

- Used the smartboard to engage learners while she wrote on the smartboard learners would engage with the lessons and begin to ask questions.
- The teacher ask the learners what did they observe when the dice was rolled.

- The learners were asked by the teacher to go point out what is a length and breadth in different types of 2 dimensional shape, after that task he pointed out 3 learners to calculate the area if 3 different types of 2 dimensional shapes.

Learner-Learner interaction

- Learners were very active in the lesson and continuously communicated with each other as the teacher wrote on the smartboard. Learners were giving steps on how to solve or complete calculation.
- There was no collaboration between the learners.
- The learners engaged in the lesson and discussions, most of the learners participated in the discussions and showed excitement.

Summary of Good Practice

- Use of smart notebook app in the IWB to write formulas and draw objects for illustration purposes.
- There was a push towards socio-constructivist [active learning] pedagogies through the use of Interactive Whiteboards (IWB).
- Use of IWB move text and pictures around for demonstration purposes [pressing of buttons and dragging objects across the screen].
- Use of IWB to store, retrieve, and demonstrate which fostered communal work.
- Multimodal input or representation through the use of Geogebra on the smartboard.
- Drawing and animating objects.

THE USE OF ICTS IN HISTORY LESSONS

The teacher was just giving the learners content in the form of a classroom discussion but he was the main speaker, learners asked questions every now and again, and then he simply wrote notes on the smart- board and the learners copied those into their workbooks. But he also added a PowerPoint presentation that had a graphic organizer (which he displayed on the smart-board) that had the important dates of historical events, placed in chronological order. After that he gave the learners reading that they needed to do, with a classroom activity.

Learner-Content interaction

- Learner-content interaction was limited.

Learner-Teacher interaction

- Learner- teacher interaction was limited.

Learner-Learner interaction

- Learners spent time taking notes.

Summary of Good Practice

- There was a push towards socio-constructivist [active learning] pedagogies through the use of Interactive Whiteboards (IWB).
- Use of IWB to write notes and explain through power-point presentation.
- Use of IWB to store and retrieve.

THE USE OF ICTS IN LIFE ORIENTATION LESSONS

Lesson Observation 1

The teacher began by asking learners what study method they are implementing; he explained that there are different study methods for different people, using PowerPoint slides, the teachers lesson delivery showed that she is confident in computer literacy. The teacher was able to navigate through the smartboard without a problem; she had control of the smartboard and captured the learner's attention. She showed them a cut and paste technique of selecting key points of a topic and creating a summary. She also used tables to create a study time table and she was also able to show case her formatting skills. When done with the lesson the teacher gave learners an activity that was displayed on a smartboard using Microsoft Word.

Lesson Observation 2

She greeted the learners and asked them to open LO e-books on their tablets. Learners took out their tablets and did as the teacher asked them. The teacher then started to present her lesson using PowerPoint Presentation. It is important to note that here presentation was very basic. When she was talking about positive role models she used two pictures (Former SA president Nelson Mandela) and Natal Detoit. I noticed a number of opportunities that she could have used different ICT tools to enhance learners learning other than using those two pictures. The teacher went on and talked about the factors that influence life style choices, things like parents and peers, personal values, belief systems, religion, media and social and cultural influence.

In terms of handling PowerPoint in the classroom she was good because she knew where to press to move from one slide to another and when to press. I did not notice technical problems when she was doing her presentation. She still needs to acquaint herself with the digital technologies and to take advantage of them to enhance her lesson.

Lesson Observation 3

This lesson included the discussion of different media and advantage and disadvantages of electronic and print media were also discussed. There was a brainstorming session of how media is playing a role in South African democracy. The teacher was writing notes on the

Interactive White Board (IWB). The teacher kept on deleting information on the slide so that there will be a space to write again. Most features of IWB were not used i.e. (Interactivity, Audio, etc.)

Learner-Content interaction

- The learners took part in discussions, explaining what works for them and what do not work, also briefly explaining what to do before you study judging from their experience, all learners were involved and had something to say, while disagreeing on some points.
- Video was appropriate to the topic of Study Skills, where different study methods were taught; while the video was playing she paused and explained further by annotation by giving further examples.
- Given that her slides were too basic, she supported her presentation with lot of discussions with learners. Discussions brought life in her lesson however; she could have downloaded digital material to enhance her lesson.
- Learners were highly engaged especially when the teacher was asking them about Facebook, Twitter and Blogs
- Learners were asked to discuss how social media is contributing to the democratic society.
- Learners and teachers were highly engaged with the content.

Learner-Teacher interaction

- The teachers ask the learners what did they observe, and in response they were able to interpret the video applying it in their own context.

Learner-Learner interaction

- Learners spent time working individually.
- Learners were asked discuss about their rights and responsibilities
- Informal classroom discussions were taking place

Summary of Good Practice

- There was a push towards socio-constructivist [active learning] pedagogies through the use of Interactive Whiteboards (IWB).
- Use of IWB to move text and pictures around for demonstration purposes [pressing of buttons and dragging objects across the screen].
- Use of IWB to store, retrieve, and demonstrate which fostered communal work.
- Multimodal input or representation on the smartboard.
- Use of eBooks and power-point presentations on the smartboard.

ACCESSING SCHOOLS AND CHALLENGES

- I was given access to the school without restriction. The teacher also willingly allowed me to observe his lesson.
- The school principal and the teachers all cooperated with me to have access to the lesson. I had no restriction in the school, which enabled me to observe other ICT facilities and infrastructure in the school.
- As much as the school is situated in suburbs the level of crime is very high therefore computing infrastructure is stolen.
- Learners use smart boards to upload music or movies resulting in content being deleted, and teachers using smartboard was used as a whiteboard.
- Learners tablets are being stolen so they are very skeptical about bringing their tablets to school and it became a problem since most of their school work is being email to them.
- Teachers are still struggling balance the use of technology in their teaching resulting using IWBs for presentation and in some cases as whiteboards to write on with dry markers.
- There is infrastructure for Wi-Fi that was installed however there is no connectivity.
- The school has not been given smart boards for security reasons because there is no secure infrastructure and there have been previous break-ins.
- There is a computer lab that has no computers at all because the donated computers they were given were all stolen.
- There is strong wife connection however it can only handle 32 devices at a time.
- There is no connectivity available and the administrative staff use 3G/4G data that the school buys.
- When there is shortage of power smart classroom don't function which becomes a challenge since its grade 11/12 classes that are affected.
- The school has experienced a number of attempted break-ins.
- The school has a computer laboratory however it is not functioning because they need to install electricity, the school have few young teachers who gel well with the leaners but they haven't received any ICT training because they are still new and

training is limited, not all educators have been trained, the advantage with the young teachers is that they are clued up with technology and it wasn't that challenging for them to operate the smart boards.

- Teachers having difficulty navigating interactive whiteboards.
- When the smart boards are malfunctioning while they are presenting their lesson this makes them look bad as if they are incompetent.
- The school has no ICT Integration policy. The smartboards are only available for the Grade 11 and 12s and only a few Grade 12s have tablets with no internet connectivity. The school has no electricity problems and teachers need further training.
- The school has a fairly good infrastructure but their computer lab is not functional, the school has no internet connectivity. The only internet connectivity available is in the admin block and that limits most teachers in terms of getting material for their lessons because some buy their own data in order to search and retrieve materials related to their lessons which is so expensive for them.
- In this school every learner has a tablet from grade 8-12 and teachers all of them they have laptops however, there is no smartboards in this school they are still awaiting for the department of education to supply the school. So in this lesson the teacher was using her laptop and the projector to present the lesson. I was told that there are only 3 projectors in the whole school; teachers take turns in using them.
- They don't have adequate training on how to use smart board.
- The computers are not taken care of in terms of upgrading the software.
- Smart boards are updated once in a while.
- Learners can easily access the smart boards they ended up deleting e-Learning content they was installed.
- During lunch break they use smart boards to watch videos and play music and they end up not allowing teachers to use smart boards.
- Out of 14 smart boards that were installed four are no longer function at all one is for grade 12 and the other three is for grade 11.
- All the flash drive ports are damaged so no input devices can be used.
- The school still lacks a reliable internet connection.

- They don’t feel restricted they can use the internet to get videos to clarify to learners.
- When smart boards are giving them trouble the service provider takes time to come look into it.
- Some teachers use ICT only for Administrative school tasks like preparing lessons, recording marks and marking term reports.
- They believe ICT helps saves time allows them to use additional resources
- Firstly there were notes on global warming and all the factors that damage the Ozone layer which leads to global warming.
- Notes were in a form of PowerPoint presentation which had videos and pictures.
- With ICT tools lesson becomes more understandable and being able to use additional resources.
- Teachers are experiencing problems when want to do dual display on the smart boards.
- They have about 2 smartboards, most were stolen. Security of the ICT infrastructure is a serious concern. The school has a poor and incomplete infrastructure due to theft. The only form of support they have is the ICT coordinator whose skills are limited to smart board use only. They have an electricity problem at the school. I realized they don’t have much digital infrastructure, they only have about two classes with smartboards and some classes are not familiar with the smartboards Grade 10 to be precise, Grade 10 doesn’t even have access to the computers and I also noticed they only have one smart board in Grade 12 so that means digital infrastructure is limited and only benefits a few.
- The lesson observed was Grade 10 Language class it was just basic stuff that didn’t need much of the smartboard, they had classwork and marking of home works
- The school has the same problems when it comes to learners using smart boards.
- The school has been losing C3’s.
- They had experienced some break in luckily nothing was stolen.
- When there is power problem grade 11/12 learners have to be moved to other classes which causes chaos at times.

- Learners don’t feel safe anymore they are afraid of being mugged since they carry tablets to school every day.
- When the smart boards are malfunctioning teachers became very frustrated since this makes them look like they don’t know what they doing.
- Service provider takes time to come look if there is a problem with smart boards.
- Even though they have a computer lab it’s no longer functional.
- Due to shortage of tablets since some are being stolen or are still being fixed.
- Laptops that were given to teachers some are now broken.
- During lunch break the learners use smart boards to watch movies or listen to music they end up not allowing the teachers to use smart boards.
- The computer lab is not well secured anyone can have access to it.
- Not having a reliable internet connection the learners now have to go use a multi-purpose center nearby.
- Learners whose tablets are being stolen they are given DVDs which have all the study material they need.
- Not enough security guards for gadgets.
- Whenever there is a problem with the smart boards the service provider takes time to come look into it.
- Knowledge that the learners have about internet is very limited.
- The learners tablet being stolen by other learners.
- When those tablets are broken they can only be taken to one service provider which ends up taking time to be fixed.
- Some learners lost their tablet and some are not working.
- Grade 11 learners use smart boards to upload their music and videos.
- It proves difficult to convince teachers to come for after school training that is provided by the interns.
- One of the smart boards came with no learning material the interns had to upload that material.
- Learners are afraid to bring their tablets to school since they are afraid of being mugged since it has been happening very often.

- They have been having troubles with electricity tripping which becomes a problem for grade 11/12 learners since they only have smart boards.
- All the USB ports had to be closed since learners were uploading their music on the.
- Teachers are struggling to save their lesson on the smart board.
- Three C3's trackers were stolen.
- Laptops that are provide by the GDE for teachers some are not functioning very well and the service provider has not had time to fix those laptops.

SCHOOLS WITHOUT ICT INFRASTRUCTURE

School 1

The school is situated in the suburbs and has 1200 learners and one would assume to be given first preference when it comes to technology in this case its different. The school was built 34 years ago with no functional computer lab or internet connection for that matter. The school does have 3 desktop computers which are used mainly for the school administrative work on daily basis. The principal mentioned that they have been part of ICT training before and they have been waiting for the smartboards to be installed from the beginning of this year.

School 2

The school has plus or minus 900 learners and is located in a very rural part of Johannesburg. The school is still using chalkboards' for writing notes. It was brought to my attention that educators have never been any participated in any ICT trainings. They have no clue about ICT and what it entails. The school still uses mobile classes for teaching purposes. Although it doesn't have normal classroom they do have electricity. They are aware of ICT. They only have one desktop which is used for all schools administrative work. Since the school only has one computer it proves difficult for educators to use it for administrative work since they have to take turns when using it. Matric students are provided with tablet which they only use it for school related work. Nearby the school there is a multi-purpose centre which is at their disposal if they need go online. This centre is opened until late even on weekends which is very convenient for learners especially matric learners.

School 3

This is a suburban school with plus or minus 1200 learners. There is no functional computer lab or internet connection for that matter. The school does have 3 desktop computers which are used mainly for the school administrative e work on daily basis. The principal mention that they have been part of ICT training before and have been waiting for the smart boards to be installed since the beginning of the year.

School 4

The teacher used the chalkboard to write steps for the learners on how to go about writing a summary of a text. The learners gave her their input on the thoughts and she wrote them down into the board and compared those to her notes. The teacher read the learners a short text and they helped to summarize it as a class just so they could practice before they did their own summaries individually.

School 5

The teacher used the chalkboard to write steps for the learners on how to go about writing a summary of a text. The learners gave her their input on the thoughts and she wrote them down into the board and compared those to her notes. The teacher read the learners a short text and they helped to summarize it as a class just so they could practice before they did their own summaries individually.

School 6

The learners got to vote on topics that they did not fully understand and the teacher chose one to go through for the day. Before the teacher went into the content, she asked the learners to give her questions that they would like her to address, and she wrote the questions on the board and answered. She also wrote notes for the learners on the chalkboard and they copied them into their books. When the learners were done with that she gave the learners a past paper exam they had to complete in preparation for their exams.

School 7

The teacher started off by asking the learners to recap on what they had learnt about in the previous lesson and both the teacher and learners engaged in a classroom discussion, then she wrote up a short quiz on the board based on their responses and what they had learned in the previous lesson and learners had to complete that quiz in their workbooks and the teacher just monitored the learners as they were writing the quiz.

CONCLUSION

The findings of this study reveal that teachers' attitudes towards the use of ICT are predominantly positive and this correlate with Figure 18 whereby teachers level of ICT integration is fairly distributed. The distribution based on the 'Guidelines for Teacher Training and Professional Development in ICT 2007'[10] correlates with Haldane & Somekh (2005) five levels of Interactive Whiteboards progression. The interactive whiteboards dominated the classrooms researchers observed. This technology was used as a conduit to present slides, videos, and in some cases used as a whiteboard. Teachers used the technology tools to present and project power-points, videos, and as a writing board.

Foundation (Level 1)

At this level teachers are using the interactive whiteboard primarily as a presentation/projection tool for PowerPoints, videos, and to write as a whiteboard. 16% of teachers who participated fall in this category which entry level according to the 2007 guidelines for ICT teacher development.

Formative (Level 2)

This level coincides with the adoption level in the 2007 guidelines for ICT teacher development. 12% Teachers are able to use various ICT tools, but during observations teachers opted for PowerPoint presentation. Teachers were working mostly on the IWB and operating the computer functions via the IWB and using the pen feature of the IWB. At this level teachers demonstrated confidence with various technologies and interacting with learners while operating the smartboards.

[10] http://www.schoolnet.org.za/sharing/guidelines_teacher_training.pdf

Facility (Level 3)

28% of teachers who participated belonged to this level and were demonstrating exceptional skills in the use of various technologies especially PowerPoint presentations and displaying with Interactive Whiteboards. More features of the IWB were being used to create an interactive classroom environment. Teachers were even creating their own videos beyond downloading YouTube or playing from YouTube. The IWB dominated the classrooms and were being used regularly to advance learning beyond the initial 'attraction' of the technology. This level is in line with the adaptation level in the 2007 guideline for ICT teacher development.

Fluency (Level 4)

This level coincides with the appropriation level in the 2007 guidelines for ICT teacher development. 20% of teachers who participated in the study were using various technologies such as videos, PowerPoint presentations, and more features of the Interactive Whiteboards. Teachers demonstrated willingness to explore new technologies especially web-based systems such as learning management systems which broaden their repertoire of tools and techniques to advance learning. Teacher understanding of technology was beyond the technical know-how and engage learners by encouraging them to come and present using the IWBs. This was an indication of embracing their changing role as teachers in the 21st century. Central to the 21st century classroom is the development of an autonomous learner. Teachers were beginning to save files and access learning materials they saved in the IWB. Teachers were experimenting with various features in the IWB for pedagogic potential to unlock and advance learning.

Flying (Level 5)

This coincides with the innovation level in the 2007 guideline for ICT teacher development. 5% of the teachers who participated fell on this level and went all out to develop entirely new learning environment integrating all digital devices and ICT infrastructure at their disposal. Teachers leverage the power of digital devices to enhance learners' classroom experience. They ensure that learners in their classrooms were developing their digital skills by encouraging them to create their own presentations and present using IWBs. Teachers at this level created databases of learning materials and store them in the IWB or the computer but access through the IWB. This was an effort to create continuity in the

innovative methods of learning in the 21st century. The lessons were well planned using various technologies such as videos and power-point presentation to enhance learners' classroom experience.

The difference between teachers' responses versus what was observed on the ground demonstrates willingness to participate in the pedagogical integration of ICT into teaching and learning. 19% of the teachers who participated were not using technology in the classroom at all and some were even reluctant to participate in the research as they have already participated in similar projects. Given the picture in Figure 18 whereby the integration of ICT was fairly distributed indicates the desire among teachers to use technology in their classrooms. There were instances whereby teachers didn't believe in using ICT to enhance their teaching. They felt that they needed to focus more on learners' performances in the exams. This sent mixed signals on whether the demands ensuring learners were passing made them not to use ICT. Some teachers had negative attitude towards ICT and the state of their electricity infrastructure did not help as it didn't support the Interactive Whiteboards.

The core issue to emerge from the review is that teachers must not be side-lined, but be at the centre of their own learning [development] if they are to change their deep-seated beliefs and habits regarding the use of technology. In order for teachers to develop digital pedagogies we need to move them away from their current position which is low level as shown in Figure 27. Though the distribution in Figure 18 shows otherwise teachers still lack the creativity and innovation needed at the level of pedagogical integration of ICT in their teaching. Teachers were not creating their own learning materials, which are in line with the context or environment they work in. The materials used were mostly from YouTube and the language of the presenters was problematic at times. Therefore, technical competencies must be achieved in order for teachers to adopt and appropriate technology in their classroom. Some of the contributing factors to the slow uptake are:

- ICT Infrastructure Profile in Schools & Competencies
- Contextual factors in the integration of ICT [increased workloads, disruptive learners, limited, technical knowledge in the school]

- ICT integration constraints at the school level [lack of training opportunities, continuous support and resources to experiment with ICT tools]
- ICT integration constraints at the individual level [limited understanding of how to use technology in teaching]

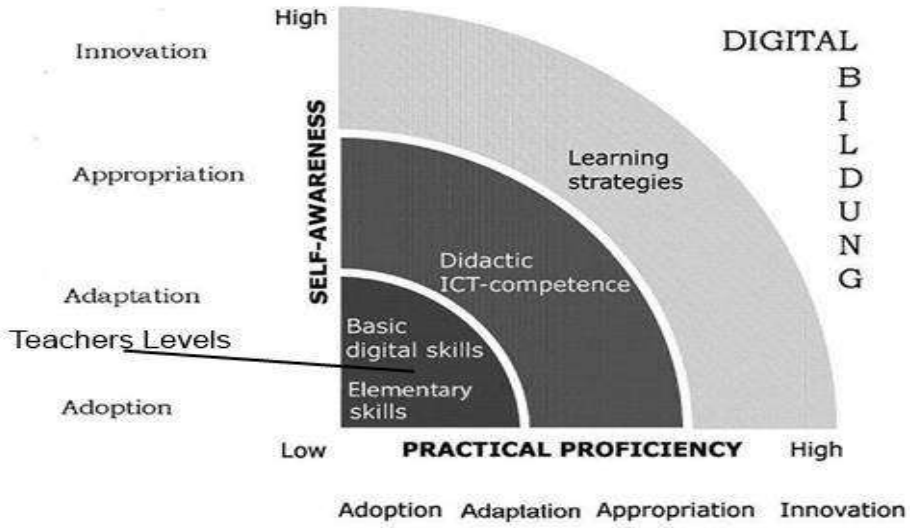

Figure 24: Teacher educators' digital competence (Krumsvik, 2014)

- ICT Integration Constraints at the Professional Learning Community Level

  Teachers have been "blamed for the failure of technology to fulfil its promise" (Convery 2009, p. 25) yet they have been side-lined throughout the ICT integration process.

Our suggestion is the use of Welliver's Instructional Transformation Model (Welliver 1990) to document and present teachers' progression in the five hierarchical states as presented in Table 14. The Welliver model presumes that integration of ICT proceeds in a linear manner from the initial familiarization with the technology to the utilization of technology, then moves towards the beginnings of manipulation and eventually to more innovative ICT usage. In this case it is becoming clear that the teacher as the 'pedagogical craftsmanship' is side-lined. One thing that was obvious across teachers is that they are aware of the emerging technologies especially the computing devices. However they bring different perspectives in the ICT integration discourse they tend to focus on how they will affect their workload and classroom activities, yet they have a syllabus to cover. From the observations it became clear that,

- Teachers use a purposeful selection of technologies for personal, administrative, teaching and learning purposes.
- Teachers' practices were found to be incremental and progressive, and aligned to their comfort zones [Skill Levels].
- Teachers adopted and used technologies on account of the value propositions afforded to them.
- The aggregated patterns of use, practice and adoption are located on continuums.

Table 14 Welliver's Instructional Transformation Model (Welliver, 1990)

1. Familiarisation	Teachers become aware of technology and its potential uses.
2. Utilization	Teachers use technology, but minor problems will cause teachers to discontinue its use.
3. Integration	Technology becomes essential for the educational process and teachers are constantly thinking of ways to use technology in their classrooms
4. Reorientation	Teachers begin to re-think the educational goals of the classroom with the use of technology
5. Revolution	The evolving classroom becomes completely integrated with technology in all subject areas. Technology becomes an invisible tool that is seamlessly woven into the teaching and learning process.

Teachers are demanding continuous support; however the way it has been presented to them is problematic as digital devices are presented to them without proper training and development on their pedagogical use. Thus this report concludes that through effective leadership, training and continuous support teachers' mind-set could be changed so that they adopt and appropriate ICT in the classroom to enhance teaching and learning. Shelley (2004, p. 6.10-6.11) argues that with proper training in using technology teachers:

- Create relationships between active learning and active teaching [Interactivity between Learner-Content, Learner-Learner, Teacher-Learner]
- Develop an appreciation and an understanding of the potential of technology [Shifting mindset – Theory of Change]
- Learn to be authors of multimedia software [Creators of digital education materials]

- Develop leadership skills and become role models for successful integration [Leadership is key and must be at the forefront in terms of support and modelling to teachers and learners as we move to paperless schools]
- Understand the power of technology integration [Map affordances to teaching and learning].
- Design integrated curriculum activities [Pedagogically integrated in the classroom]
- Learn the benefits of technology in the classroom [Map ICT affordances to learning]
- Develop ownership of the technology through authentic experiences [Teachers valuable partners in the pedagogical ICT integration in the classroom]
- Learn to motivate students with technology [Engagement of students with content through edutainment]
- Achieve success by becoming informed and reflective decision makers [Continuous support and teachers input valued at all-time]
- Become advocates for technology integration [Recognize teachers leading the pedagogical ICT integration movement]

In this report it is clear that there are complex multiple interactions among teachers, learners, content, and technology. It is very clear that teachers need to develop their Technological Knowledge and then Technological Pedagogical Knowledge. In the correlation tables it is clear that teachers' confidence and attitude is dependent on their ICT competencies. The need for best practices on the integration of ICT in various subjects would be a plus so that teachers have access models of doing it. Those at the forefront could model to other teachers on creative ways to create an interactive classroom environment supported by technology. The presence of champions among teachers modelling how ICT could be woven into the teaching and learning process is needed together with social structures to collectively support teachers at different stages of the ICT integration continuum.

Recommendations

- The presence of ICT resources within ordinary teaching spaces is key but there must be buy-in from all critical stakeholders especially teachers instead of imposing digital tools on them.
- The provision of high-quality, powerful, and convincing examples of ICT use in subject teaching which go beyond ICT skills and link to the development of wider pedagogical knowledge.
- Differentiation of the training sessions required within a particular cohort of teachers based on the 'Principles for ICT in Teacher Development and Developmental Levels'[11].
- A digital framework must be developed to position ICT in the teaching profession as enabling, instead of being viewed as contributing to cultural erosion and disruptive in the classroom. Educators come from lower socio-economic background have limited access to technology compared to teachers from affluent backgrounds so a level playing field have a bigger role to play in creating and supporting ICT professional learning communities. Government organize ICT professional development opportunities should provide teachers with spaces to build social capital.
- More organised, active and directed support within social structures linked to professional learning communities on how to integrate ICT in their subject.

[11] http://www.schoolnet.org.za/sharing/guidelines_teacher_training.pdf

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APPENDIX A

Observation Instrument

The adoption of the Class Learning Interactions – Observation tool (Manny-Ikan, Tikochinski, & Bashan, 2013) was done to enable systematic observation of the components of ICT-based lessons in different dimensions:

- The structure of the lesson (i.e., the organization of learning in the lesson)
- The nature of interactions taking place between learners and their teachers in an interactive ICT environment.

Researchers examined the approach to integrating ICT trying to understand the pedagogical value of ICT tools.

- Technological Pedagogical Content Knowledge (TPACK) – This is about the different types of knowledge at play in the process of integrating ICT. The most important focus is on Pedagogical Content Knowledge investigating how teachers are using ICT to enhance their pedagogical activities. We are observing if there is any shift in their approach on delivering content materials.
- Interactive Equivalency Theory – The use of this theorem is to explore how ICT facilitate learning through the three common types of interaction: learner-learner, learner-teacher or learner-content interaction. The goal is to see how ICT enables learner interaction with the content [subject] knowledge in order to develop and improve cognitively.

Also at the center of our observation was to see if there is any correlation with what is happening in the Gauteng province and the research work done by Betcher and Lee (2009) and Burden (2002):

- Burden (2002) this model presents a three-stage typology for using the interactive whiteboard:
    - In the first stage, “infusion”, the ICT tools reinforce the existing pedagogy, and the students are mainly passive.
    - In the second stage, “integration”, there is the beginning of a change in the existing pedagogy and an attempt is made to turn the students into active learners.
    - In the third stage, “transformation”, ICT is used in order to afford an added value to the learning process.

- Betcher and Lee (2009) call the process of the implementation of the interactive whiteboard “a quiet revolution” and divide it into three stages:
    - In the first stage, “doing old things in old ways”, teachers teach the same contents using traditional methods.

- In the second stage, “doing old things but in new ways”, teachers introduce some changes, but the teaching methods do not undergo a significant change.
- In the third change, “doing new things in new ways”, innovative pedagogies are implemented.

We view ICT as a cognitive and epistemic tool

- Knowledge acquisition
- Productivity and knowledge creation purposes
- Creating meaningful digital artifacts
- Processing of data and problem solving

Observational researchers spent a relatively long time at a school, as they were trying to obtain a fair sample of typical life within a school. Since they were part of the school and classroom environment while in the school, they had a role that is part “insider” and part “outsider.” Their focus was on the individual school or classroom. It was assumed that the researcher will win the trust of the school staff, or at least spend sufficient time at the school so that the novelty of his/her presence has worn off, ensuring that typical life within the school will be accurately documented. Thus, school personnel will act normally and respond honestly, so that their “story will be told.”

1. What kind of ICT infrastructure is available in the school?
2. In what ways are teachers using ICT tools in the classroom? What are the practices you observed throughout your time at the school?
3. What are the challenges you think teachers are facing in integrating ICT in the school?
4. Is the technology creating new and different learning experiences for learners? If so, in what ways?
5. In your observation are teachers using any eLearning Platforms or Learning Management Systems?
6. What are the activities teachers are embarking on in their use of ICT?
7. Are teachers using ICT to support learners in the creation or development of Content [subject] Knowledge?
8. In your observation how do you describe the level of using ICT in the school?

   Very Low 1 2 3 4 5 Very High

APPENDIX B

Interview Instrument

- What kind of training is available to you as teachers to develop your ICT pedagogical integration in the classroom?
- Is there an ICT integration policy in the school?
- What is your understanding of ICT pedagogical integration in the classroom?
- In your teaching profession tell me about a colleague that inspires you on integrating ICT into teaching? How are they using ICT in their teaching?
- When you use ICT in teaching, in what ways does this affect you as a teacher? Does it enhance your role as a teacher?
- How often do you use ICT at school to complete various administrative tasks? What are those tasks?
- What kind of internet connection is available? How reliable is it?
- What are the challenges you are facing in integrating ICT in the classroom?
- Suppose you were a fruit, which fruit would you be and why?
- To what extent do you agree or disagree with the following statements:
    - ICT is very helpful in my teaching profession
    - I know how to use ICT but I am not interested in using it in my classroom
    - ICT improves the presentation of materials in my lessons
    - ICT limits the content of my lessons
    - ICT makes preparing lessons more difficult
- How would you rate your confidence level with your computer skills or applications?
    - Very Unconfident
    - Not Confident
    - Unsure
    - Confident
    - Very Confident
- How do you describe your level in using ICT in comparison with your learners at school?

  Very Low 1 2 3 4 5 Very High

APPENDIX C

Questionnaire Instrument
INFORMATION SHEET (INCLUDING CONSENT)

Dear Educators:

The Wits School of Education understands the importance of Information & Communication Technology (ICT) tools in the classroom. To counter the confusion caused by the public and private agencies equating the provisioning of ICT infrastructure [hardware] to pedagogical ICT integration in schools, the absence of research informing ICT integration in South Africa, and understanding the inconsistencies in the social, cultural and economic status of the communities the Wits School of Education decided to profile teachers and schools using research. The research has the following objectives:

- To build the Gauteng province picture of how technologies are used in the classrooms.
- To understand variations in practice and access in the province.
- To find case studies of how digital learning is successfully practised.
- To investigate educators' perspectives, attitudes towards ICT integration, experience of ICT usage, intentions to use ICT in teaching & learning, self-efficacy as well as their ICT competencies.
- To understand if schools and teachers are ready for eLearning.

Please note the following with regard to participating in the survey

- Participation is entirely voluntary. However, given the importance of your response, you are encouraged to participate.
- It is anticipated that the survey will take no more than 10 minutes of your time. You are therefore encouraged to complete it.
- The results of the survey will be mainly used to develop meaningful intervention programmes driven by your needs and the schooling environment contextual needs.
- A concise report will also be made available to Wits School of Education for circulation to all members.

CONSENT TO PARTICIPATE

Before commencing with the survey, it is important that you indicate your consent to participate by ticking on the appropriate response box below:

Consent to participate in this survey	√
I am interested in participating in this survey	
I have no interest in participating in this survey	

SURVEY QUESTIONNAIRE

DEMOGRAPHICS

1. Please indicate your gender

   [ ] Male [ ] Female

2. Please indicate the district you work in

   EN [ ] ES [ ] GE [ ] GN [ ] GW [ ] JC [ ] JE [ ] JN [ ] JS [ ] JW [ ] SE [ ]

   SW [ ] TN [ ] TS [ ] TW [ ]

3. Please indicate your race

   [ ] African [ ] Coloured [ ] Indian [ ] White [ ] Other

4. How long have you been working as a teacher?

   1st yr [ ] 1 – 2 yrs [ ] 3 – 5 yrs [ ] 6 – 10 yrs [ ] 11 – 15 yrs [ ] 16 – 20 yrs [ ] 20+ yrs [ ]

5. Did you have any ICT training before starting to teach?

   [ ] Yes [ ] No

6. How long has your school been using computers for teaching?

   [ ] 1 – 3 Years [ ] 3 – 5 Years [ ] 6 – 10 Years [ ] 10 Years +

7. Which of the following technological tools do you have access to, for professional use? ***Select all applicable***

Access to technology	√
Laptop	
Desktop Computer	
Reliable internet connection (WiFi)	
Reliable internet connection (3G/4G+)	
Reliable internet connection (Local Area Network or Wire Connection)	
Mobile device (smartphone or cell phone) with internet access and email functionality	
Mobile device (tablet) with internet access and email functionality	
Mobile device without internet access	
Smartboards	

8. What characteristics do you think are important for educators to successfully integrate ICT in teaching? Please rank the following according to how you see them:

Characteristics for succeeding in ICT integration	Most Important	Important	Neutral	Least Important	Not Important
Skills					
Confidence					
Attitude					
Training					
Support					
Policy					
Curriculum					

9. Please indicate your experience with the following:

Please indicate your experience with:	Well Experienced	Experienced	Neutral	Not Experienced	Not Well Experienced
Computers					
Internet					
e-learning platform (e.g. Blackboard, Moodle,etc)					
Overhead Projector					
Word processor					
Spreadsheets [Excel]					
Experience using digital technologies to teach					
PowerPoint					
Data Projector					
Smartboards					

10. Think of your own professional development needs. Please indicate the extent to which you have such needs in each of the areas listed below:
[4] No need at all [3] Low level of need [2] Moderate level of need [1] High level of need

Professional Development Needs	**Ranking**
Using ICT for teaching	
Selection of ICT resources appropriate for teaching	
Use of ICT for assessment	
Knowledge and understanding of using ICT in your specific subject(s)	
Technological Pedagogical Knowledge	
Use of ICT for administrative purposes	
Use of ICT for teaching purposes	
Use of ICT as a repository tools	
ICT integration the classroom	
Development of ICT skills in a particular context	

11. What is your level of integration of ICT into your teaching?

[ ] Entry [ ] Adoption [ ] adaptation [ ] Appropriation [ ] Innovation

12. How often do you do the following in your school:
[1] Never [2] less than once/yr [3] Once/yr [4] 3-4 times/yr [5] Monthly [6] Weekly

School Activities	**Assign**
Attend staff meetings to discuss the vision and mission of the school	
Discuss school's ICT policy	
Discuss and decide on the selection of teaching resources	
Sharing ideas on how to use ICTs for assessment	
Take part in professional development activities	

If never please explain why?

13. Think of your own technological knowledge. Please indicate your level of confidence:

	Strong Agree	Agree	Neutral	Disagree	Strongly Disagree	No Opinion
I feel confident using e-learning systems (e.g. Blackboard, Moodle, etc)						
I feel confident operating computers						
I feel confident using online learning materials to teach						
I feel confident using ICTs as teaching tools						
I feel confident using ICT tools to enhance my teaching						
I feel confident using e-learning resources to promote learner-content interaction						
I feel confident using e-learning resources to promote learner-learner interaction						
I feel confident using e-learning resources to promote teacher-learner interaction						
I feel confident using the internet to research						
I feel confident using e-learning materials to teach						

14. Do you feel less knowledgeable using ICT than your learners?
    [ ] All the time [ ] Most of the time [ ] Sometimes [ ] Not at all

15. Give a brief summary of the status of your computing and digital infrastructure at your school school (in terms of SMART Boards, Tablets, Software, Connectivity, Computers):