BUILDING IKHWEZI, A DIGITAL PLATFORM TO CAPTURE EVERYDAY INDIGENOUS KNOWLEDGE FOR IMPROVING EDUCATIONAL OUTCOMES IN MARGINALISED COMMUNITIES

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Declaration

I hereby declare that this thesis is the result of my own research, supported by sources cited in the references. This thesis has not be submitted for a degree at any university. However, part of the work presented in the thesis has already been presented in the following conference papers:

1. A Look into Classification: Towards Building an Indigenous Knowledge Platform for Educational Use [166].

2. Beyond Broadband: Internet Use, Indigenous Knowledge and Development [223].

3. Towards Building an Indigenous Knowledge Platform to Enable Culturally-sensitive Education Underpinned by the Technological Pedagogical and Content Knowledge (TPACK) Framework [224].

Signature:

Supervisor: Alfredo Terzoli

To all my loved ones:

This baby is *"Malala pipe, no more!"* because of your continued love and support. Thank you; kea leboha!

Acknowledgements

"Knowledge is in the end based on acknowledgement."

Ludwig Wittgenstein

First, let me, in a coincidentally Hollyhood fashion, start by thanking the Divine Grace. *Seokamela, Mmoloki, Mmopi oa maholimo le mafats'e, uena Tlhatlha-Macholo, kea leboha!* Everything that I have achieved is, indeed, through your amazing grace.

Secondly, I would like to thank all the people who have rooted and supported me in this (long) journey. I am not going to single anyone by name, suffice to say topping the charts is my family: a very rich family comprising of a number of families with distinct roots from two countries, Botswana and Lesotho. I am blessed to have you all in my life. Your presence has enriched my **'being'** in so many ways that I am unsure where to start. I am, I repeat, *I am* because of all of you: dear members of my 'blended' family. Without each of you, I would have not persevered in this journey. Thank you, and much love to you all: mothers, aunts, sisters, dad, brothers, cousins, uncles, and, off course, grandma, the living matriarch of the family!

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Abstract

Aptly captured in the name, the broad mandate of Information and Communications Technologies for Development (ICT4D) is to facilitate the use of Information and Communication Technologies (ICTs) in society to support development. Education, as often stated, is the cornerstone for development, imparting knowledge for conceiving and realising development.

In this thesis, we explore how everyday Indigenous Knowledge (IK) can be collected digitally, to enhance the educational outcomes of learners from marginalised backgrounds, by stimulating the production of teaching and learning materials that include the local imagery to have resonance with the learners.

As part of the exploration, we reviewed a framework known as Technological Pedagogical Content Knowledge (TPACK), which spells out the different kinds of knowledge needed by teachers to teach effectively with ICTs. In this framework, IK is not present explicitly, but through the concept of context(s). Using Afrocentric and Pan-African scholarship, we argue that this logic is linked to colonialism and a critical decolonising pedagogy necessarily demands explication of IK: to make visible the cultures of the learners in the margins (e.g. Black rural learners). On the strength of this argument, we have proposed that TPACK be augumented to become Indigenous Technological Pedagogical Content Knowledge (I-TPACK). Through this augumentation, I-TPACK becomes an Afrocentric framework for a multicultural education in the digital era.

The design of the digital platform for capturing IK relevant for formal education, was done in the Siyakhula Living Lab (SLL). The core idea of a Living Lab (LL) is that users must be understood in the context of their lived everyday reality. Further, they must be involved as co-creators in the design and innovation processes.

On a methodological level, the LL environment allowed for the fusing together of multiple methods that can help to create a fitting solution. In this thesis, we followed an iterative user-centred methodology rooted in ethnography and phenomenology. Specifically, through long term conversations and interaction with teachers and ethnographic observations, we conceptualized a platform, IKhwezi, that facilitates the collection of context-sensitive content, collaboratively, and with cost and convenience in mind.

We implemented this platform using MediaWiki, based on a number of considerations. From the ICT4D disciplinary point of view, a major consideration was being open to the possibility that other forms of innovation—and, not just 'technovelty' (i.e. technological/-technical innovation)—can provide a breakthrough or ingenious solution to the problem at hand. In a sense, we were reinforcing the growing sentiment within the discipline that technology is not the goal, but the means to foregrounding the commonality of the human experience in working towards development.

Testing confirmed that there is some value in the platform. This is despite the challenges to onboard users, in pursuit of more content that could bolster the value of everyday IK in improving the educational outcomes of all learners.

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[1]This chapter draws extensively from [224], a published conference paper.
[2]This chapter draws extensively from [166], a published conference paper.

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Glossary of Terms

AIK African Indigenous Knowledge

API Application Program Interface

CA Capability Approach

CHAT Cultural-Historical Activity Theory

COFISA Cooperation Framework on Innovation Systems between Finland and South Africa

CAPS Curriculum and Assessment Policy Statement

DDI Digital Divide Institute

ESD Education for Sustainable Development

HCD Human Centred Design

ICT Information and Communication Technology

ICT4D Information and Communications Technologies for Development

IT4G Information Technology for Government

GNP Gross National Product

HDI Human Development Index

IK Indigenous Knowledge

IKS Indigenous Knowledge Systems

IS Information System

I-TPACK Indigenous Technological Pedagogical Content Knowledge

ITU International Telecommunications Union

KM Knowledge Management

KR Knowledge Representation

KRF Knowledge Representation Framework

LL Living Lab

MDG Millennium Development Goal

OSCA Ownership, Social advantage, Confidentiality and Accessibility

PoP Points of Presence

R&D Research and Development

SLL Siyakhula Living Lab

SiLLMU SLL Management Unit

SECI Socialization, Externalization, Combination, and Internalization

SDG Sustainable Development Goal

TPACK Technological Pedagogical Content Knowledge

UCD User Centred Design

UX User Experience

UNDP United Nations Development Programme

WSIS World Summit on the Information Society

Chapter 1

Introduction

Information and Communications Technologies for Development (ICT4D) is a field of study that looks into how Information and Communication Technologies (ICTs) can be used as agents of development [130, 151, 245, 277, 295]. In this field, to both paraphrase and borrow the words of Zembylas [315], the central question is not on the usefulness of ICTs in bringing about development: it is on "what ICT[s] can and cannot do to help create a more socially just and democratic society" (p. 20)?

There are certainly many dimensions to this question. However, we will focus mainly on the cultural dimension; for, in a deep ecological sense, we believe this dimension promotes learning that is attuned to the environment—in the broadest sense of what the 'environment' might mean. Thus, in our opinion, this dimension must be prioritized in ICT4D engagements in order to engender genuine agency, which allows, for example, those living in the margins of society to fully participate in development. Fundamentally, we also believe this to be key to ending the so-called digital divide—a disparity between those who benefit from the broad use of ICTs including the internet and those who do not [60, 80, 290, 314].

Thompson [287] has argued that ICTs not only have the power to create new inequalities through the digital divide, but can also intensify existing ones. Cognisant of this, the Digital Divide Institute (DDI) [80]—one of the many entities that works at closing the digital divide—argues that "the real issue is not so much about access to digital technology but about the benefits *derived* from access" (para. 2). In other words, according to the DDI, efforts at bridging the digital divide must go beyond 'infrastructural' access; that is, if the objective is to link ICTs to developmental goals.

Thinyane, Dalvit and Terzoli [285, p. 1], in agreement, have suggested that initiatives aimed at bridging the digital divide "should include ethnographic considerations and be sensitive to cultural aspects that [...] make the Internet unusable, irrelevant and foreign to many marginalised communities" (p. 1). This, they argue, can be achieved through use of Indigenous Knowledge (IK) and other adaptation mechanisms that provide epistemological access to the internet as a development platform.

IK as a knowledge form and Indigenous Knowledge Systems (IKS) as a worldview are often conflated together, and related almost exclusively to indigenous people—as in the First Nations or the First people of the land. This is a fallacy that has contributed to the difficulty in defining IK.

In this thesis, we are primarily interested in the non-foreign knowledge that resides in the everyday realm; for this reason, we adopt a simple definition of IK as knowledge that is specific to a particular place or locality (i.e. geographic area), and which enables its holders to get the most of their natural environment [73, 226, 118, 306]. This definition is well-accepted, along with a host of other terms that are intended to enhance understanding. For example, in the Encyclopedia of Environment and Society [71], IK is defined as knowledge comprising of "technical and/or environmental component, [...] labeled by the overlapping terms *traditional environmental knowledge, indigenous technical knowledge, ethnoecology, folk science,* and *local knowledge*" (p. 986).

Notwithstanding the varied terms used to describe and/or situate IK, a constant concern about this knowledge, by virtue of existing largely in tacit form, is that it continues to be de-valued and/or regarded as low status knowledge [67, 226, 227]. This is despite IK being linked to development [49, 50, 79, 109, 227]—to be precise, endogenous development, which, for sustainability reasons, is preferable than exogenous development. The difference between 'endogenous' and 'exogenous' is that the former suggests the cause or origin is internal, while the latter suggests the cause or origin is external [172]. This difference in orientation, in fact, is what causes Hountondji [137, 138] to refer to IK as endogenous knowledge: to draw in the importance of the local, internal perspective over the foreign, external perspective in thinking about cultivating agency that potentially can result in concrete (developmental) changes.

From the endogenic perspective, this thesis contributes to efforts aimed at valorising IK beyond ideology to concrete use, specifically in the education context: to help improve educational outcomes of learners, particularly from marginalised backgrounds (e.g. rural areas). There is plenty of research that speaks to the value of IK in teaching and learning;

see, for example, [74, 128, 220, 228, 231, 294, 274]. So, with the presumption of value being accepted, the thesis focuses on how ICTs can be used to allow IK relevant to formal education or schooling to be acquired, stored, preserved and disseminated.

A quick question to ask is: what qualifies as relevant IK? The answer is: any everyday local knowledge that can be harnessed as the familiar in teaching the unfamiliar curricula concepts. This seemingly simple answer in practice is complex. IK—akin to all other knowledges—exists in flux. Therefore, it must be expected that the notion of relevance shifts, and what ultimately matters is the understanding of the environmental context that constitutes the lived experience of the students. With this in mind, we decided that the question of relevance necessarily must be tackled with the assistance of teachers; since they are tasked with the primary responsibility of mediating and helping students to learn and construct meaning of subject matter. In other words, we acknowledged that the teachers are the gatekeepers of knowledge; thus, they can determine what IK can be used in concrete and tangible ways to enhance understanding of the curricula. Underpinning this acknowledgement, was a fundamental understanding that teachers in the 21st century remain key to providing a living and meaningful education, and, in fact, have to become 'digital leaders' [16] and/or 'digital practitioners' [32].

At this point, and for the sake of clarity, it is worth stressing that the emphasis on IK is not intended to be viewed as a rejection of Western knowledge—or any other knowledge for that matter. We, but, frame our arguments around Western knowledge only because foreign knowledge in the African context, historically, and until very recently, had Western origins. Further, being in the ICT4D space, we find this historical fact useful in reminding us, to quote Escobar [92, p. 13] that:

> Development has relied exclusively on one knowledge system, namely the modern Western one. The dominance of this knowledge system has dictated the marginalization and disqualification of non-Western knowledge systems.

But, to be clear, the commitment of the thesis is to advance stronger co-existence of different knowledge systems. In part, to promote the idea of hybridisation of epistemologies in cultivating critical thinking; for, as articulated by Odora Hoppers [226], we believe that:

> The acquisition of Western knowledge has been and still is invaluable to all, but on its own, it has been incapable of responding adequately in the face of massive and intensifying disparities, [...] and rapid depletion of the earth's natural resources (p. 8).

Whence, it is imperative to look into other knowledge systems to encourage an integrated approach to teaching and learning that possibly engenders a new imagination to addressing developmental challenges—endogenously, as advocated, for example, by different scholars in the *'Endogenous Knowledge: Research Trails'* [137] collection. This approach, whatever form it entails, must weave a deep understanding that:

> To integrate Indigenous knowledges into Western academies is to recognize that different knowledges can coexist, that different knowledges can complement each other, and also that knowledges can be in contradiction at the same time [74, p. 120].

To further unpack and bring context to the above, the next section will articulate our interest in education. We hope this will lay the foundation to understanding the goals and objectives of the thesis.

1.1 Education: The Guiding Compass

> *Education will always be a cause for concern, a focus for debate, a problem to be resolved, because it is one of the basic mechanisms through which human life is reproduced.* – John Freeman-Moir and Alan Scott

The epigraph in this section by Freeman-Moir and Scott [102, p. 2] serves as an apt reminder that education is and will remain important for building the society we want. Education is a guiding compass.

In light of the above, a broad question of interest in this thesis is: how do we ensure that education in the ICT age is effective, empowering, foregrounds sustainable development and *bridges* the existing socio-economic inequalities? The development part of the question is implicit to any work linked to ICT4D, especially in instances where it is evident that the digital divide remains a challenge—at the very least, in terms of potentially increasing the social distance between the 'haves' and 'have-nots' in our society. However (or perhaps paradoxically), we will not engage directly with this part, even though we fully acknowledge its importance.

To maintain focus, we will engage, as much as possible, with threads that directly help to demonstrate a link between education and IK. In a way, we hope this will allow us to better navigate the naturally complex space of dealing with ideas that may be perceived as diametrically opposed.

1.1.1   A Critical 'Import': Freire in the Abstraction

From the perspective of ICT4D, the quest to explore how ICTs may facilitate use of IK for empowering education is well aligned with the mandate of promoting use of ICTs as tools for advancing development. We take this exploration by abstracting away the many pertinent development theories. However, this is not to say we ignore them. In a very symbolic manner, we borrow many ideas underpinning these theories from a number of scholars in various disciplines.

In this subsection, we will focus mainly on ideas contributed by Freire [104], from his well known text, *Pedagogy of the Oppressed*. That is, using a language very familiar to programmers, we will 'import' Freire into the current discussion to 'build' a conceptual understanding of the problem central to this thesis.

First, we posit that Freire's *Pedagogy of the Oppressed* supports this thesis in overt and subtle terms, as it provides a language to articulate a key predicament of an educational landscape characterised by dichotomies of the 'haves' vs. 'have nots' and/or domination vs. subordination. This is a predicament that South Africa shares with many nations in Africa due to the dual nature of its economy—an economy, which remains fitting to describe in similar terms as Mbeki [178] by evoking a contradiction laid out in the novel *Sybil, or the Two Nations*.

To this predicament, Mamdani [171] has basically argued that a desirable solution lies in "one word, decolonisation, and the promise of another, deracialisation" (p. 126). This means, as a society, we must commit ourselves to education that emancipates. In Freirean terms, we must work to transform the debilitating 'banking' modelled education into problem-posing education.

According to Freire [104], education modelled on the concept of 'banking' assumes the students are depositories and the teachers are depositors. He explains in great detail why this assumption is problematic and requires a remedy—if, indeed, the goal of education is to bring about authentic liberation. He argues that:

> Those truly committed to the cause of liberation can accept neither the mechanistic concept of consciousness as an empty vessel to be filled, nor the use of banking methods of domination. [...] They must abandon the educational goal of deposit-making and replace it with the posing of the problems of human beings in their relations with the world. "Problem-posing" education,

Banking Education	Problem-posing Education
Treats students as objects of assistance.	Makes students critical thinkers.
Resists dialogue.	Regards dialogue as indispensable to the act of cognition which unveils reality.
Anaesthetises and inhibits creative power by isolating consciousness from the world.	Bases itself on creativity and stimulates true reflection and action upon reality.
Emphasizes permanence and becomes reactionary.	Roots itself in the dynamic present and becomes revolutionary.

Table 1.1 – Freire's Comparison of Banking and Problem-posing Education

responding to the essence of consciousness—*intentionality*—rejects communiqués and embodies communication. It epitomizes the special characteristic of consciousness (pp. 67 - 68).

In this sense, it causes learning to become a (cognitive) bi-directional process, where the teacher and students commune with each other. Essentially, making it more appropriate to use the terms 'teacher-student' and 'students-teachers' to both describe the commune and to underscore the importance of genuine dialogue.

Table 1.1 provides a further contrast between banking and problem-posing education. As the comparison shows, problem-posing education holds much potential for endogenous development—precisely because its core aim is to cultivate a consciousness that allows people to perceive critically in order "to see the world not as a static reality, but as a reality in process, in transformation" [104, p. 83]. We therefore posit that Freire provides a different, but valid, perspective to understanding the importance of IK in offering the kind of education we require for building a just and fair society. A society, which, hopefully, also provides alternatives to the emerging trend of assimilation into a single culture that is "shaped in the image of a consuming West [and yields] a global middle class with similar tastes and style of life" [202, p. 155].

In the next subsection, we discuss the role of IK in education: to cultivate understanding of the ultimate goal of the thesis, which is to contribute a solution that attempts, in concert with other efforts, to ameliorate the education challenges of learners within marginalised communities.

1.1.2 Importance of Indigenous Knowledge in Education

Education in post-colonial Africa has been, and continues to be, highly debated. In part, due to the poor educational outcomes and questions of relevance of the curricula such as: 'how do we minimise alienation of the inculcated world view of learners as they go through formal education?' or 'how do we implement curricula that is sensitive to the global dynamics of our times, on the one hand, and, on the other roots learners to their own realities?'

There are, of course, many other questions that reflect the complexity of the debate. The above two merely represent the strand of the debate that interrogates the culture of schooling and how it alienates and condemns the majority of learners to failure. Under this strand, there are a number of old questions that remain relevant to this thesis. One such question is by Ntuli [219, p. 184], who metaphorically asked: "Are we still chasing Gods that are not ours?". According to Ntuli [219], this question is pertinent because:

> The failure of our education system to acknowledge the received world views of our students has resulted in our students' alienation from both their backgrounds and the new world into which they are socialised (p. 197).

Dalvit, Murray and Terzoli [68] in 'localising Gramsci's views of folklore in an African context' also make a number of salient points that confirm this view. Specifically in highlighting the risk of cultural dependency on the West within our education system, they assert that:

> In post-colonial African education, the nexus between formal education and social context is missing. [...] The culture of African students is not acknowledged. Little or no effort is made to link or compare knowledge and representations mainly produced in the Western [world] with the ones possessed by the students [68, p. 115].

Essentially, this suggests that a disjuncture between school and the everyday life exists for the students. Many examples in literature show—empirically and otherwise—how this disjuncture reinforces existing inequalities; see Bernstein [39], Bourdieu and Passeron [45], as well as Hoadley and Muller [134] for a grounding theoretical perspective, which compels us to thoughtfully engage on how to improve the educational outcomes of learners at the margins of society—through either social class, culture, race, etc.
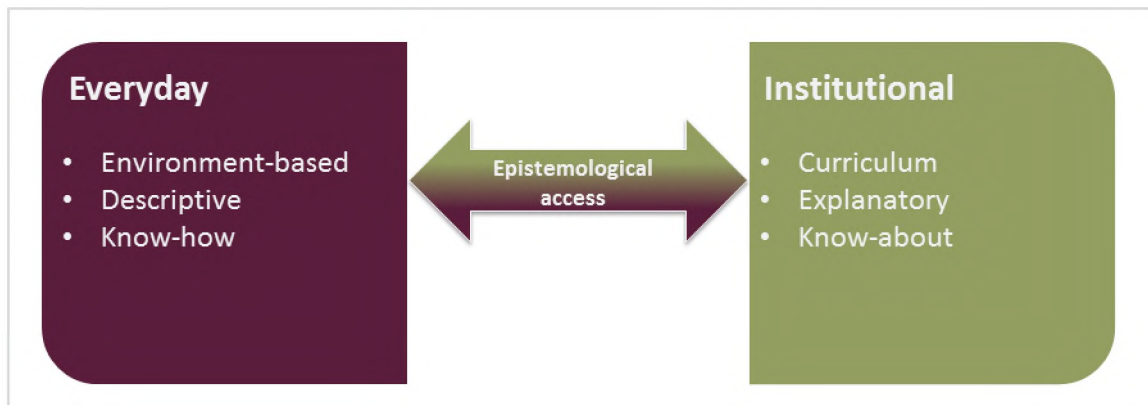
Figure 1.1 – Comparison of Everyday and Institutional Knowledge

Odora Hoppers [226] together with other scholars have argued that conscious and thoughtful integration of IK can meaningfully resolve this disjuncture between the everyday life and school. At the core of their argument is a well established educational principle that learning is most effective when the learning experience is situated in the 'familiar'. IK, as they assert, encompasses the familiar but also provides a lens into how people learn and come to understand the world.

Thus, at the epistemological level (and to a degree ontological level), we can, for example, devise strategies that harmonise the everyday and the institutional (school gained) knowledge such that learning and teaching can be effective. Figure 1.1 provides a summary representation of how the everyday and institutional knowledge compare to each other. These two knowledges are essentially different from each other, based on their focus. And, as the figure suggests, harnessing one knowledge to aid understanding of the other is key to providing epistemological access.

To offer but a small clarifying example, the 'how-to' everyday knowledge of making *amarhewu,* a fermented mealie pap beverage, could be harnessed to explain the scientific process of fermentation and catalysis. Discussing this process firstly from the students' lived experience, a teacher could, for instance, demystify why an old clay pot—used exclusively for the fermentation process—brews faster than a new clay pot. To elaborate, the teacher would essentially explain to the students that the alleged 'memory', which is believed to be held by the old pot is, in fact, the malt or bacterial residue left from the previous brews. In other words, the teacher would make the students understand that the leftover residue helps to catalyse the fermentation process.

Above and beyond unpacking the scientific concepts, the teacher could further use the *amarhewu* example to provide an ecological understanding on the importance of recycling

and/or avoiding waste. This, in and of itself, is key for justifying why ecological thinking is fundamental to survival and sustainability—precisely because by nature this thinking is endogenic.

To sum up, we specifically hope that the above example, brief as it may be, illustrates why we believe the use of everyday IK, to facilitate teaching and learning, wholly supports the metaphor of education—particularly in the formal schooling sense—as a guiding compass in cultivating critical thinking and/or socially engaged thinkers. These thinkers, from the vantage point of this thesis, can bring about endogenous development, and are akin to Gramsci's 'organic' intellectuals [117].

1.2 Problem Statement and Scope

Educational research shows that background/prior knowledge of learners plays an important role in establishing context for moving from the 'known' to the 'unknown'. As specifically argued in works like [67, 274, 294], IK is the background/prior knowledge for learners: it embodies useful examples and metaphors that can be used to support teaching and learning. However, as Dei [74, p. 118] notes:

> A profoundly challenging task in the academy [has been] to facilitate the recognition and validation of the legitimacy of indigenous knowledges as a pedagogic, instructional communicative tool in the processes of delivering education.

This partly puts into perspective why, despite a definite trend of interest by many scholars in post-1994 South Africa, Nyoka [225, p. 5] exasperatedly writes:

> [...] scholars extol the virtues of 'indigenous knowledge systems' but never actually proceed to produce such systems; producing 'IKS' always seems to be some kind of an agenda for the future.

Nyoka is highlighting an old standing problem around access and availability of IK. With this in mind, and mindful of the fact that emerging or new technologies offer an opportunity to recast old problems in search of solutions, a question of interest to us is: can IK suitable for the education context be readily availed in a manner that also recognises the importance
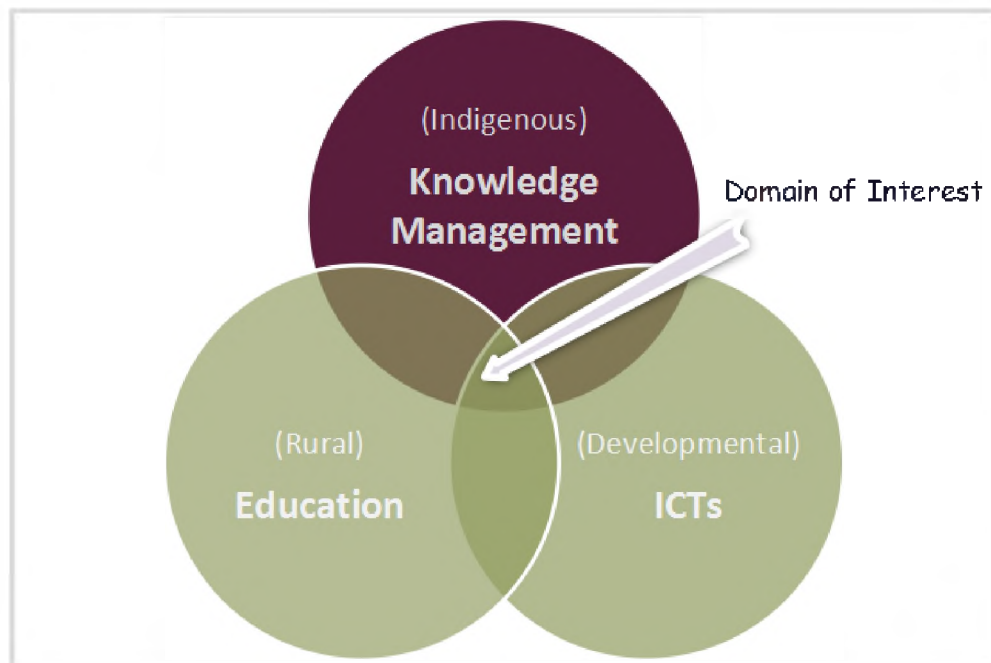
Figure 1.2 – Areas of Research Interest

of not widening the digital divide? This question frames the scope of this thesis, which as depicted in Figure 1.2, lies within the intersection of three domains: education, indigenous knowledge management and ICT4D.

Education is a very large field with many specialities, areas of concern and multiple (often competing) theories and perspectives. In the thesis, we restrict ourselves, as much as possible, to an area that focuses on how ICTs can be used to advance the educational goals of the marginalised communities. And, our core question is as outlined below.

How do we bring in IK and ICT knowledge together to engineer light and viable solutions that that help to solve a core problem in education of improving performance outcomes of the marginalised?

Put differently, our question is: how do we build digital (education) solutions for our context in a manner that combines, to borrow the words of Mazrui [177, p. 63], "indigenous authenticity with universal rationalism"? These words by Mazrui, while written in a broad context of thinking about development in Africa, are pertinent: they invite us to conceptually and methodologically consider how, for example, science and technology can be applied to solve our problems, but without losing touch with our *being* and *reality*. Building on this thinking, there are two sets of questions that are important for shaping and framing our scope.

The first set of questions relate directly to IK and how to make this knowledge accessible in order to demonstrate its value in addressing the specific problem that is of interest to the thesis. These questions are as follows:

➡ how can IK be used within formal education settings to bring about endogenous thinking (i.e. thinking that will inspire an inherently inward oriented approach to development)?

➡ what counts as important IK for use in teaching and learning?

➡ what qualifies as an acceptable informatics system for collecting IK in the rural context?

The second set of questions, which are of equal importance to the first, pertain to the technical aspects of realising a light design for use in resource limited settings. These questions are centred around a pragmatic concern of how to build a user-centred, grounded design at little or no cost to the users. Basically, these questions are about sustainability, and are as follows:

➡ how do we (re)imagine engineering of artefacts in an ICT4D context and in an era of myriad frameworks, architectures, methods and other tools that support abstract thinking of solutions: to focus on a problem as opposed to implementation details?

➡ how do we build light enough solutions to minimise support and maintenance efforts or overheads?

➡ how do we conceptualise a light design in a context where bandwidth is a challenge?

We should emphasise that the above questions are not new. Asking them anew serves as a reminder that the quest of finding solutions to old problems never ends. We purposefully decided to pursue answers to these questions using an iterative and experimental approach based on the Living Lab perspective, as will be discussed briefly in the next section.

1.3 Methodology

The core question in this thesis, together with the secondary questions that emerge from it, suggest a need to understand the specific conditions or constraints in which a solution can be found. We believe this understanding can and could be gained through use of a pragmatic, iterative and experimental approach that has roots in ethnography or an *in situ* oriented methodology formulated using, for example, the LL research concept. Chapter 3 will expound more on the LL, and a project based on this concept called the Siyakhula Living Lab (SLL).

However, to provide a brief context, LLs are premised on the idea that for solutions to be effective and meaningful, they must be co-created with users situated in the context of their everyday life. Inherently, this means a deep understanding of the lived experience of users is required in order to be able to involve them in the co-creation process of a fitting solution. It is for this reason that, in methodologically applying this research concept, we started with a phase of familiarising ourselves with the community of would-be users.

The familiarisation phase consisted of numerous short-stay trips that involved participating mostly in the initiative by SLL to offer ICTs literacy training to interested community members. From the SLL perspective, training is a key and strategic activity to enabling informed participation that can eventually lead to effective use of ICTs in pursuing developmental goals.

Along with the efforts to familiarise and immerse ourselves in the world of our would-be users, we performed a basic review of available ICT4D and relevant literature: primarily to deepen our understanding on key issues of concern in navigating the ICT4D landscape, while searching for fresh questions and meanings that may yield an appropriate and fitting solution to the problem being addressed. Methodologically, to get to this kind of solution, the entire process entailed:

1. Observing, interviewing and interacting with would-be users and other stakeholders to understand the requirements and implementation possibilities of viable solution.
2. Designing and implementing a candidate solution based on the understanding of the requirements and the embedded reality that captures conditions of use.
3. Testing and refining the implemented solution.

At times, some phases were carried out in an overlapping fashion. Overall, while distinct, the above phases were carried out in a manner that keeps with the spirit of iterative methodologies.

1.4 Thesis Structure

This chapter outlined the scope and problem of interest to this thesis, which basically aims to contribute an ICT based solution that can work in concert with existing efforts to achieve effective context sensitive education that embraces multiculturalism. To echo Clark and Gorski [60], this type of education must necessarily:

> be more proactive in addressing, critiquing, and working to eliminate the digital divide as it manifest in both schools and the larger society. It must direct its efforts toward closing the worker–leader divide, in all its manifestations, that Eurocentric education established and perpetuates. It must do this by vehemently and continuously rearticulating that all students can learn and, hence, lead.

The remainder of the thesis is divided into nine chapters. The first four chapters contribute to the context, with each chapter offering a different lens for enhancing understanding on the scope and framing of the thesis. Besides serving as background, these chapters proffer theoretical perspectives to understanding why and/or how ICTs are enablers for tackling new and old societal challenges. These four chapters are followed by ones that primarily focus on the conceptual, methodological and practical concerns in searching for an appropriate and fitting solution—aligned to the goals of this thesis.

Below is a concise breakdown of the remaining chapters.

➡ Chapter 2 deepens the understanding of IK and its link to development. The chapter also provides a summary of the evolution of ICT4D, to situate the work of this thesis within the ICT4D.

➡ Chapter 3 discusses the concept of Living Labs to provide both context and rationale for the approach followed in the thesis.

➡ Chapter 4 provides an insight on the education landscape in South Africa and reviews a framework from the literature for enhancing teaching and learning using ICTs. We further provide a critique that puts forward a proposal for augmenting the framework: to tangibly promote the mainstreaming of IK, as opposed to it implicitly left as part of 'context'.

➡ Chapter 5, drawing on insights from Knowledge Management (KM), reviews categorisation of knowledge—indigenous and scientific. This review constitutes an initial step to understanding some of the practical implications for the design of an ICT based platform that can be used to make IK readily available in the education process.

➡ Chapter 6 provides a bridge to move from the high level to the specific concerns of implementing a fitting solution.

➡ Chapter 7 discusses the process of how users were engaged in order to gain an understanding of their needs and requirements in relation to the possible development of an ICT platform for capturing and sharing IK.

➡ Chapter 8 details the design and implementation process of the ICT solution that meets the priorities of the users, as inferred from the analysis of their interviews.

➡ Chapter 9 tests the implemented solution and discusses the modification of the design through the gleaned feedback to emphasise the importance of iterative design.

➡ Chapter 10 concludes and offers insights on possible future work.

Chapter 2

ICTs for Endogenous Development

Since the second half of the 20th century, efforts have intensified in Africa (and elsewhere) directed at bridging the existing divides as part of a broad inclusion agenda for all people to live a life of dignity and (relative) comfort. The United Nations Millennium Development Goals (MDGs), for example, communicate the quintessence of this agenda, which is important to us for two main reasons.

First, because of the obvious importance of building an inclusive and just society, where people understand, at a bare minimum, that a life of dignity lies in peaceful existence and having food to eat. Second, because the agenda centralises the importance of ICTs: this fact can be gleaned directly from the International Telecommunications Union (ITU) media report [141], which indicates that before the signing of the Millennium Declaration "world leaders reiterated their belief that ICTs would be instrumental to meeting all eight MDGs" (The Digital Divide and the MDGs, para. 1).

Sadly, it has been variously challenging to meet the MDGs [147]—hence their extension and/or reincarnation through the setting of new global goals, otherwise known as Sustainable Development Goals (SDGs). Adaptation to context has been a key challenge. As Fukuda-Parr [106] notes, this is due to a correlative relationship that exists between adaptation and ownership—a relationship whose importance she cleverly amplifies in the question, "How can [national and local] authorities take ownership of an agenda without relating it to the local context?" (p. 4).

This question is very important to us, as it is implicated in the many failed ICT4D projects and/or initiatives [40, 125, 129, 174, 183, 210, 289, 304, 305]. These failures, unlike with, say, 'startups' are significant, as they symbolically represent yet another failure to put

the last in our society first. Chambers [53] in *Rural Development: Putting the Last First* makes some compelling arguments in this regard. He essentially labours, as he hints in the preface, to show how "[e]xtremes of material and social deprivation can narrow awareness and warp, embitter and kill" to warrant us to work hard to avoid failure in projects linked to the 'last' in our society: the marginalised.

It is against the above background that we are particularly interested in the question: how do we gain a deep understanding of the context in which solutions are to be operationalised? Further, with that understanding, how do we ensure that the solutions have resonance with the people, and in fact that their agency is enhanced by these solutions? The answer, as it may be expected, is complex.

IK is deemed a potential resource for unveiling some critical aspects of the context, which have a bearing on how to engage with the developmental agenda. Before we elaborate more on this point, perhaps it is prudent to list some of the distinguishing features of IK. According to Ellen and Harris [88] this knowledge form tends to be:

➡ local in that it is rooted to a particular geographic area and set of experiences of people living in those areas;

➡ tacit in nature, and therefore, not easy to explicate or codify;

➡ transmitted orally or through observation and imitation;

➡ gained through practical day-to-day experience and trial-and-error as opposed from theory—as this knowledge is empirical rather than theoretical;

➡ learnt and reinforced by repetition;

➡ situated within broader cultural traditions of a community;

➡ constantly changing, in part to reflect the dynamism of culture;

➡ organised in categories that reflect function; this is evident in instances where IK is at its densest and is directly applicable;

➡ distributed always in fragments because the knowledge does not exist in its totality in any one place or individual.

The above enumeration points to the embeddedness of IK to everyday life. It communicates the fact that IK embodies the skills, experiences and insights of people, which can be harnessed to maintain or improve their livelihood [118, 307, 311] through formulation of appropriate problem-solving strategies [313]. In other words, the enumeration explains why IK is potentially a powerful resource for development, particularly when it comes to "strengthening sustainable livelihood opportunities within local communities" [109, p. 8].

The enumeration also points to the potential difficulties in digitising IK. In a sense, it brings to the fore the question asked by Winschiers-Theophilus, Jensen and Rodil [310, p. 456], "Can technology preserve the dynamic nature and social-embeddedness of IK?" To an extent, this question remains open; in part, because "current technology design is deeply rooted in a Western epistemology" [310, p. 456], which is different on some level with that underpinning IK. However, this does not, in any way, suggest a dichotomy exists between indigenous and Western knowledge [14, 15, 74]. Agrawal [14], beyond trivially pointing out that the West has its own IK, explains in great detail why to think a dichotomy exists is preposterous.

Agrawal [14] further notes that the recognition of IK and its relevance to development, "heralds a long overdue move" (p. 414). He argues that this knowledge represents a potential shift to successful development, which is rooted in knowledge that emanates directly from the marginalised and/or those within the space under development. This type of development, which Agrawal alludes to, is synonymous to the endogenous development we mentioned in Chapter 1.

Endogenous development is inward oriented; it essentially begins with an audit of what is already available to solve problems. Ndoye [200] in giving emphasis to this orientation and its ties to IK unequivocally reminds us that "[t]here can be no endogenous development founded upon extroverted behaviour patterns, cultures and modes of life" (p. 83). It is from this vantage point that IK can also be seen as central and not peripheral to the task of building a just multicultural society, which we all hopefully want.

In the sections that follow, we will elaborate more on what is meant by development. The core objective is to weave together an understanding of how endogeneity and ICTs can help to advance (local) development. Endogeneity, in this thesis, broadly refers to an endogenous outlook, or as defined by Adesina [12, p. 135], to "an *intellectual* standpoint derived from a rootedness in the African conditions" [emphasis added]. We added the emphasis on 'intellectual' because, as we will later see, one of the scathing indictments of failures in ICT4D pertains to the intellectualisation dimension.

2.1 Development: What does it really mean?

It is implicitly understood that development has to do with progress and/or success. Despite this understanding, the definition of development remains nebulous [26, 187, 305], in part, because at a conceptual level the term is heavily contested [92, 169, 186, 187, 287].

This notwithstanding, there are two dominant development perspectives: one favouring material or economic growth, and the other privileging the self-determination ideal [172, 295]. In many ways, the latter subsumes the former in that it considers both the material and immaterial to be significant.

Now, focusing particularly on the disadvantaged and marginalised, the question is: what outcomes do we want in 'pursuing' development? In this pursuit, can we genuinely afford a narrow definition of development, which is limited to the material or economic gains? In other words, can we afford to pursue what Mansell [172] refers to as 'market-led development' rooted in neoliberal policies?

Chambers [54] has, for example, reminded us that: "What matters most to poor people often differs from what outsiders assume. Income matters, but sometimes less than other aspects of life" (p. 14). Kivunike, Ekenberg and Danielson [149] based on their own work with rural communities, confirm this fact. Further, they proffer an argument that development for all people, extends beyond the economic to include the social and political dimensions. They solidify their argument by using Amartya Sen concept of 'development as freedom' [257], which is influenced and inextricably linked to his Capability Approach (CA) [255, 256]. (Incidentally, Mansell [172] also uses Sen in her work.)

According to Sen [257], development in the holistic sense should be regarded as a process that expands the substantive freedoms that people have. As he elaborates:

> Freedom is central to the process of development for two distinct reasons.
> 1) The *evaluative reason*: assessment of progress has to be done primarily in terms of whether the freedoms that people have are enhanced;
> 2) The *effectiveness reason*: achievement of development is thoroughly dependent on the free agency of people.

Sen [257] , based on these reasons, weaves an argument that points to the connections that exist between various freedoms, which enable people to enact their agency effectively. He writes:

> What people can positively achieve is influenced by economic opportunities, political liberties, social powers, and the enabling conditions of good health, basic education, and the encouragement and cultivation of initiatives (p. 5).

This very idea clarifies, for us, why freedom in broad terms should be regarded as a natural organising principle for promoting a better and more acceptable society. For this reason, Sen's view of development underlies work done in this thesis. His view, in fact, intersects greatly with a developmental discourse that advocates, among other things, for use of Human Development Index (HDI)—instead of Gross National Product (GNP)—as a comprehensive and alternative foundational measure of development; see, in particular, the 1999 United Nations Development Programme (UNDP) *Human Development Report* [292], where Sen also makes a 'Special Contribution'[3] to partially explain his "initial hesitation" (p. 23) to having HDI as crude index for measuring "human development and deprivation" (p. 23). The 2001 UNDP report [293] is another interesting read as it links ICTs to (human) development; Figure 2.1 summarises this link and demonstrates that "human development and technological advance can be mutually reinforcing, creating a virtuous circle" [293, p. 28]. Further, the figure shows how technological innovation can enhance human capabilities, and act as "a means to human development because of its impact on economic growth through the productivity gains it generates" [293, p. 28].

The next section explores the nexus between ICTs and development. A brief historical account of how the conceptualisation of ICT4D has evolved over time is also provided: to show how the thesis fits within the ICT4D research space and the broad developmental landscape.

2.2 ICT4D: Binding ICTs to Development

In the previous section, we briefly explored the meaning of development; for, as Unwin rightly reminds us, "How we define ICT4D depends entirely on the development perspective that we adopt" [295, p. 360]. We, as already stated, adopt a broad view of development that accounts for the many dimensions that enhance the human experience. Based on this view, the "basic objective of development is to create an enabling environment for people to enjoy long, healthy and creative lives" [291, p. 9].

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[3]Sen uses this contribution to pay tribute to Mahbub ul Haq the originator of the HDI idea; he basically attributes his role in helping to devise the index to Mahbub tenacity.

Building human capabilities
- To live a long, healthy life
- To acquire knowledge and be creative
- To enjoy a decent standard of living
- To participate in the social, economic and political life of a community

- Resources for education, health, communication
- Employment

Knowledge Creativity

Advances in medicine, communications, agriculture, energy, manufacturing

Economic growth

Resources for technology development

Productivity gains

Technological change

Figure 2.1 – Links Between Technology and Human Development [293]

How then do we define ICT4D? To be precise, how do we define ICT4D beyond stating that as a term it "denotes a novel interdisciplinary research field, which explores the impact of ICT in various development challenges" [277, p. 222]?

Before we provide an answer, a disclaimer is warranted. For us, the broad view to development lends itself to numerous interpretations of ICT4D—all of which are important, provided we are clear about the context. The context we privilege, as already alluded to, is one that accounts for inequalities and speaks to various divides in our society, mainly from the vantage point of bridging the digital divide.

With the disclaimer in mind, and guided by a number of global level conversations around development—including those that gave way to the hosting of the World Summit on the Information Society (WSIS) [139, 140, 150]—we synthesise a definition of ICT4D appropriate for this thesis, specifically by drawing on Heeks [130] and other international development agencies such as the UNDP [293], and the World Economic Forum [312]. We thus define ICT4D as an enterprise that focuses primarily on how ICTs within *marginal*

contexts can holistically contribute to human development and, in turn, technological innovations, with economic growth as but one dimension of interest.

We stressed 'marginal contexts' in recognition of arguments put forth by Brown and Grant [51] on the need to distinguish between the use of ICTs 'for development' and their use 'in developing' countries. As they argue, the distinction is "more than an exercise in semantics" (p. 96). It is a matter of dealing effectively with epistemic, methodological, and theoretical concerns on the one hand, and on the other, a matter of casting more light on the 'for development' agenda, which has been "overshadowed by works within the 'in developing' stream" [51, p. 105]. Further, in rounding off their argument, Brown and Grant [51] stress how the conflation has, for instance, "masked the surprising dearth of research focused on understanding the impact or effect of ICTs on development-based constructs" (p. 106).

Beyond research, this means there is a need to unmask and make explicit even that which seems obvious. So, for example, by emphasising that we are focusing on the marginalised, we are also acknowledging, albeit indirectly, that development is woven in the very fabric of *being* human: development never ceases to be a concern even among the developed and/or privileged—that we depreciate this fact is a matter of construction, as argued extensively by many developmental theorists, including Escobar [92] and Mkandawire [187].

The above said, it is important to understand that ICT4D frames its mandate within the moral justice domain in order to give priority to finding solutions to the problems faced by the marginalised. Heeks [130], among others, has made this point before, arguing:

> Most informatics professionals spend their lives serving the needs of the world's wealthier corporations and individuals because, to borrow bank robber Willie Sutton's phrase, "that's where the money is." Yet seeking to squeeze a few extra ounces of productivity from firms that already perform relatively well, or save a few minutes in the life of a busy citizen, pales in ethical importance when compared to the potential benefits of applying new technology to our planet's megaproblems. [...] Compare designing a system for an African or Asian community to doing the same for a company in the global North. The former is quite simply more interesting—a richer, more satisfying, more colorful experience (p. 26).

In sum, through this argument, Heeks [130] shows how ICT4D is a deliberate binding of ICTs to development, as it relates to social justice. Thus confirming from a moral

and/or ethical perspective that ICT4D is about finding solutions that will ameliorate the conditions of the marginalised.

The next subsection will chronicle how the ICT4D discourse and practice has been shaped by some of the lessons gleaned from failures. The goal is to create a foundation for understanding how the chosen research approach fits within the current ICT4D and broad developmental landscape.

2.2.1 The Journey Towards Universal Access

The inability to delineate between the 'in developing' and 'for development' use of ICTs, as argued above, has impacted how we (cohesively) understand the mandate of ICT4D. It is perhaps in this context that Heeks [132, p. 4] argues:

> ICT4D policy and practice are fragmented across many thousand of organisations, tens of thousands of projects, hundreds of thousands of communities, and billions of individuals. The closest [semblance to a unifying] node is WSIS: part-structure, part-process that acts as a centripetal force strong enough to draw some ICT4D fragments together.

Best [40] also depicts ICT4D as fragmented. He argues that different disciplines work in silos, despite the multi-, inter-, and transdisciplinary nature of ICT4D. As a consequence, there are knowledge gaps, which reflect the inherent failure to regard learning as an intellectual imperative to developing a full picture understanding of ICT4D. As he puts it:

> The biggest gap-producing problem in the ICT4D program as both an academic and field-focused project is that it has failed profoundly to be a *progressive* intellectual enterprise. This essentially means that it has failed to learn from the past; we [in the field] have collectively failed to stand on the shoulders of those who have gone before us (p. 51).

Best weaved his argument drawing on Heeks' [129] assertion that the majority of ICT4D projects end in some failure, despite all the good intentions behind them. We, too, will draw on Heeks [130, 131] to provide a brief historical account of how the ICT4D in developing countries evolved. Out of his two papers just mentioned, we shall rely heavily on the one
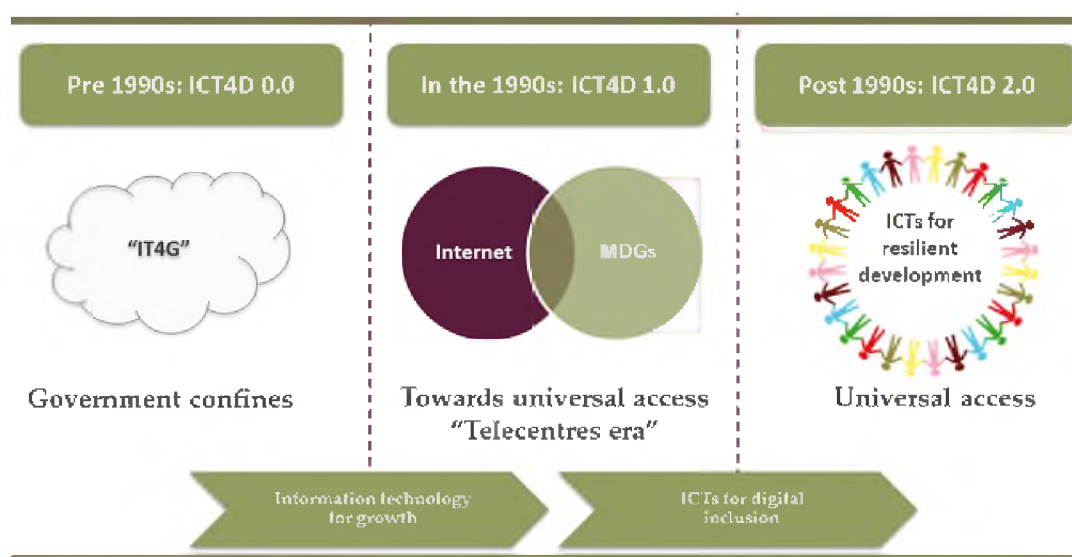
Figure 2.2 – Evolution of ICT4D: Past to Present (inspired by [131])

titled, 'The *ICT4D 2.0 Manifesto: Where Next for ICTs and International Development*' [131].

Figure 2.2 captures a synthesised overview of the evolution. As depicted in the figure, there are three phases to the ICT4D evolution, marked by distinct transitioning themes. The theme from *ICT4D 0.0* to *ICT4D 1.0* was 'information technology for growth', while 'ICTs for digital inclusion' captures one for the shift from *ICT4D 1.0* to *ICT4D 2.0*.

In the first phase, the pre-1990s era, what would have qualified as ICT4D in fact, according to Heeks [131], was Information Technology for Government (IT4G) in developing countries. ICTs were used largely within governmental organisations for data processing and overall management of information resources; their use was essentially at a level that is of no immediate relevance to people at the grassroots level.

In the 1990s, the field entered its second phase, *ICT4D 1.0*. This marked the 'official' beginning of what may be regarded as informatics and community based ICT4D work—radio and television[4] were practically the only forms of ICTs used in the prior phase. With *ICT4D 1.0*, the focus essentially shifted to users at the grassroots level and/or the periphery of society. The potential of the internet together with the articulation of MDGs as global developmental goals contributed to this shift. Largely, in that, many stakeholders came to understand deeply that access to quality information is key to ameliorating some of the world's problems like poverty, poor health and education, and gender inequality.

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[4]For all intents and purposes, televisions were a rarity to most people in developing countries. Thus, their use as source of developmental information was limited.

Telecentres were "the archetype for this period" [130, p. 27], as they were deemed quick to deploy. However, telecentres failed to generally deliver in their promise [26, 130]. Rural South Africa in this regard is not an exception. In the few places where the telecentres were deployed, they didn't work due to a number of reasons that include: lack of computer skills training [61]; lack of support from governmental structures like the Department of Social Development, as was expected in the Mpumalanga case, see [165]; and lack of good business models that, for example, adopt the Google philosophy—that is, in lieu of depending on economic resources of community members for sustainability, they depend on external parties through some value add service[5]. Despite failed deployments, telecentres succeeded at least in one regard: they pushed the developmental dialogue beyond simple access; see, for example, Heeks [131] and Yaw [314].

Post 1990s, with some valuable lessons learnt, ICT4D entered its third phase, dubbed *ICT4D 2.0*. Focus, in this current phase of ICT4D, is on resilient development and achievement of universal access goals through use of appropriate ICTs. The primary question is: how do we grant the largest number of people and/or communities access to different kinds of resources such that they can exercise their agency? Or rather: how do we attain the goals of universal access in a manner that supports meaningful and sustainable development? This question is asked against the background that innovation in this phase must, as a minimum, be collaborative (para-poor) as opposed to laboratory (pro-poor). Pro-poor innovations emanate outside the poor communities, while para-poor innovations are achieved inside, working along with the poor communities—we would argue, more or less, following the Freirean approach. To support this shift, Heeks [131], has proposed good practices to increase success in the implementation of any *ICT4D 2.0* project based on lessons drawn from *ICT4D 1.0*, see Figure 2.3. One key aspect to note from the figure is that in terms of technologies to use, we must strive for an appropriate mix. This means, for example, that the proliferation of mobile phones in this phase of ICT4D should not be an excuse for abandoning other technologies. In short, we must "simultaneously push along both the PC <u>and</u> the mobile route" [131, p. 8].

The next subsection will attempt to present in a different light the significance of shifting into para-poor paradigm. Precisely because learning is critical to the success of the ICT4D field, this subsection will highlight the importance of not being ahistorical in our application of ICTs as tools for development.

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[5]This requires a radical commitment to putting the last first and believing in their humanity: to understand there is value in wanting to reach them, say, via paying for advertising in platforms they use. Put differently, this requires taking seriously notions of social entrepreneurship in ICT4D endeavours.
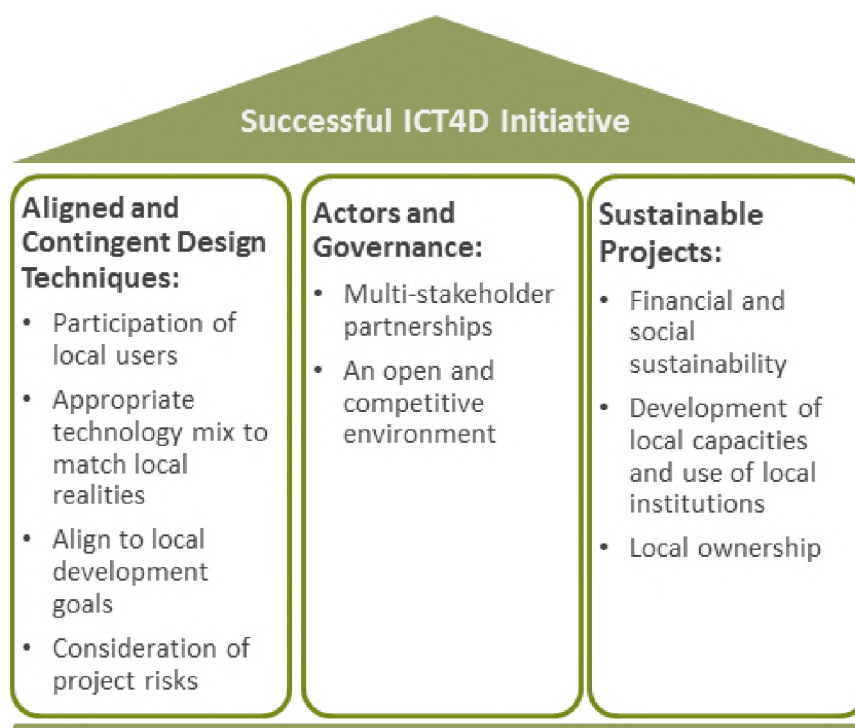
Figure 2.3 – Good Practice for ICT4D 2.0 Implementation [131]

2.2.2 Nexus to Local Development: Endogeneity and ICTs

In this subsection, as our point of departure, we will use Adesina's understanding of endogeneity: to further bring clarity why this thesis holds that the nexus between endogeneity and ICTs is critical to advancing (African) development, particularly at the local level.

Before we proceed, we must stress that the 'local' is not divorced from the 'global' in our argument. The local, in the endogenic sense, provides a particular orientation to development, where growth stems from the grassroots to eventually have international/global impact. In cunning ways, this conception has resonance with the thinking of Mao Tse-Tung on how the local relates to the international/global, when he notes: "if what we say and do has relevance for our humanity, its international relevance is guaranteed" (qtd. in [168]).

Now, to bring focus on Africa and her people, a few questions are worth asking. Why does Africa remain with gross inequalities, despite decades of earnest efforts to address and resolve existing socio-economic challenges? Why, for example, have ICTs failed in their promise to bring about development? Or rather, how do we begin to make sense of Best [40], and his assertion that the failure of ICT4D projects has also been at the intellectual level?

Unpacking Best [40], the failure can be rearticulated as one of failing to de-link the potential of ICTs from Western thought. Mansell [172], in fact, gives credence to this idea in her interrogative exposition of ICTs and development discourses, when she writes:

> [...] claims that the transformative potential of these technologies [ICTs] is *necessarily* consistent with human development aspirations are symptomatic of a Western-centric and universalist model of economic growth and development (p. 109).

The *necessarily* embedded assumptions, together with the already posed questions, bring us to the heart of endogeneity. Like Adesina [12], in his pursuit to understand endogeneity in greater detail, we will draw on the wisdom of Archie Mafeje. To this end, we think it is fitting to start off with a pertinent reminder by Mafeje [168] that "ahistoricity is a greater risk than historicity. [For] to evolve lasting meanings, we must be 'rooted' in something" (p. 106). This is pertinent because we believe a historical lens is important to understanding the factors that have made it challenging to grasp how top-down and/or exogenous approaches to ICT4D—compared to bottom-up and/or endogenous approaches—fail in their intention to activate people into exercising their own agency.

The above said, we will attempt to maintain historical awareness, but without journeying fully into history to establish the nexus between endogeneity, ICTs and (local) development. Our argument will be highly abstracted, even though endogeneity can be understood at a micro, meso and macro levels.

Returning back to Best's [40] assertion about lack of *progressive* intellectualism within ICT4D, one question to ask is: what are the implications of this deprivation to Africa? Here being historical is important. We must ask where Africa was when ICT4D entered its official phase, ICT4D 1.0.

For an answer, yet again, we will call upon Mafeje; however, this is not to say there are no other perspectives. To convey how intellectually vulnerable Africa was to external impositions in the early phases of ICT4D 1.0 (in 1988 to be exact), Mafeje [169, p. 61] writes:

> Africa is the worst victim of intellectual and cultural imperialism and, consequently, is in the grips of the worst development crisis ever. And yet, no clear views have emerged from African intellectuals as to how the situation could be remedied. This could be a measure of the social alienation of most African intellectuals.

The alienation, as a running theme to Mafeje's work, has multiple dimensions to it, centred around the rejection of alterity and acceptance of endogeneity [12]. Endogeneity to Mafeje hinged around the importance of being 'rooted' ontologically in Africa's conditions. Thus, from his vantage point, endogeneity is a tool for thinking about development while rooted in the realities of the immediate, so as to gain a nuanced understanding of context. It is about remembering, for example, that:

> The same class category need not behave the same everywhere in the world. African entrepreneurs might forgo opportunities to maximize value in favour of kinship considerations or leisure. [... This means for] evaluating prospects for development, all these reflexes [based on the given examples] are relevant and valid, which is not to say they are objective [167, p. 9].

Although seemingly dated, this point that Mafeje makes remains valid to contemporary development efforts. The presumption of 'sameness' has to be interrogated at all times. Questions need to be asked to gain insights about how one context may slightly differ with another, such that we are able to address some of the pressing issues in ICT4D projects like sustainability, replicability and adoption.

IK by its very nature encapsulates insights about the immediate and the concrete aspects of reality. Thus, if it is reasonable to assume that the marginalised possess insights about their environment, then, it is equally reasonable to assume that IK can be used to amplify their voice in development [14, 50]. In outlining the numerous uses of IK, Goduka [109] validates this supposition; she provides an apt reminder that:

> IK is also used at a local level by communities as the basis for decision-making pertaining to food security, human and animal health, education, natural resource management and other vital activities. IK is a key element of the social capital of the poor, the means to invest in the struggle for survival and it constitutes the main asset in efforts to gain control of people's lives. For these reasons, the potential contribution of IK to locally managed, sustainable and cost-effective survival strategies should be promoted in the development process (p. 8).

Drawing directly from Goduka and many other authors, the nexus between IK and endogeneity can hopefully be inferred. This nexus explains the importance of valorising use of IK in developmental endeavours. In a pointed way, it reinforces the argument, for example, by Wane [306, p. 33] that:

> Indigenous knowledge holds transformative possibilities because it provides an overt understanding of cultural processes by which information is legitimated and delimited. Learning from indigenous knowledge, by first investigating what local communities know and have, can improve understanding of local conditions and provide a productive context for activities designed to help these communities.

Thus, to conclude, we posit that using IK to promote endogeneity—rootedness to African conditions—offers a greater potential for gaining a deep understanding of the immediate, local context, such that it is possible to achieve the goals of development with the help of ICTs. Of course, this presupposes a firm acceptance of IK as a growing and dynamic system of knowledge [15, 50, 79, 179, 170, 190, 226]. Or, put differently, a living knowledge, which in pursuit of survival, interacts with other knowledges: to contest and/or assimilate ideas of import to development.

2.3 Conclusion

As most authors argue, ICTs can be used as tools for development. However, given the past failures of ICT4D, it is prudent to critically understand the local context and the broad complexity of development. Fundamentally, this requires asking and re-asking questions that may enhance how we think about development, especially with endogeneity in mind. One possible question to ask, based on words borrowed from Adesina [13, p. 1], is: how do we ensure that the digital era "brings new hopes that Africa might be able to secure its development as a continent in a world characterised by accelerating inequalities"?

Indeed, there are no simple answers. In this chapter, from the ICT4D perspective, we presented arguments that make a case for the use of IK in thinking through possible answers for implementing locally appropriate solutions. We aligned ourselves with old arguments that put emphasis on the combined pursuit of freedoms and use of bottom-up approaches to development. We then proceeded to build an argument on how sustainable development ties to endogenous thinking, which, because of its inward orientation, we posit has the potential to cultivate lasting solutions.

With the above in mind, we wish to unconventionally end with an extensive quote that tentatively shows how the threads introduced in this chapter weave into the fabric of the thesis. This quote is from Ndlovu [198, p. 137] and it aptly reminds us that:

> [...] the rethinking [...] of pan-African education in order to resonate with the world views and aspirations of the African peoples, particularly the indigenous peoples, whose knowledge, world views and experiences have, for a long period, been oppressed, subalternised and inferiorised, cannot be a fruitful exercise, unless the exercise also involves rethinking and/or unthinking development as a discourse, a concept, a process and practice on the continent of Africa. This is mainly because the purpose of education, as a means of knowledge production, is to advance development of the people in any particular context across the world. Thus, the process of decolonising education in Africa needs to be accompanied by that of decolonising development, so that there is no mismatch between the education that is imparted to the peoples of Africa and the manner in which they conceive development.

A manner which, as suggested in this chapter, must ideally be endogenic; that is, if we want development efforts to be effective, relevant and meaningful.

Chapter 3

Understanding the Living Lab and Siyakhula Living Lab Mandate

As stated in the introductory chapter, the work in this thesis is conceptually located in the intersection of three fields: education, ICT4D, and KM. This abstraction pertains to the 'rooting' of the thesis as opposed to its branching.

The thesis branches, as shown into other disciplines or fields of study in the form of various selected intellectuals that help to enrich the conversation. For example, Gramsci nourishes the thesis in a number of ways. His thoughts on creating "organic intellectuals" [117] from the working class fits well with our intended objective of contributing a solution that may (ultimately) help to improve educational outcomes of learners from marginalised backgrounds. Furthermore, his ideas on hegemony are instructive enough to be tied to a fairly recent methodology like the Living Lab, especially his articulation on the value of working in close connection with various stakeholders. This articulation offers an alternate understanding of the African idiom, 'unity is strength'[6]—as it expresses how such working relations can make visible the invisible, such that it is possible to develop authentic and appropriate solutions. To be sure, here we are referring to solutions which are also rooted in the realities and priorities of communities [53, 54, 56, 57].

Figure 3.1, depicts in a simplified manner some key ideas that will be featured in the the thesis from other intellectuals including Gramsci. We will, however, not engage with many of these ideas in this chapter. The figure serves but as a representation of the 'big picture' to the formulation of the thesis.

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[6]This is translated from the Sesotho idiom: kopano ke matla!
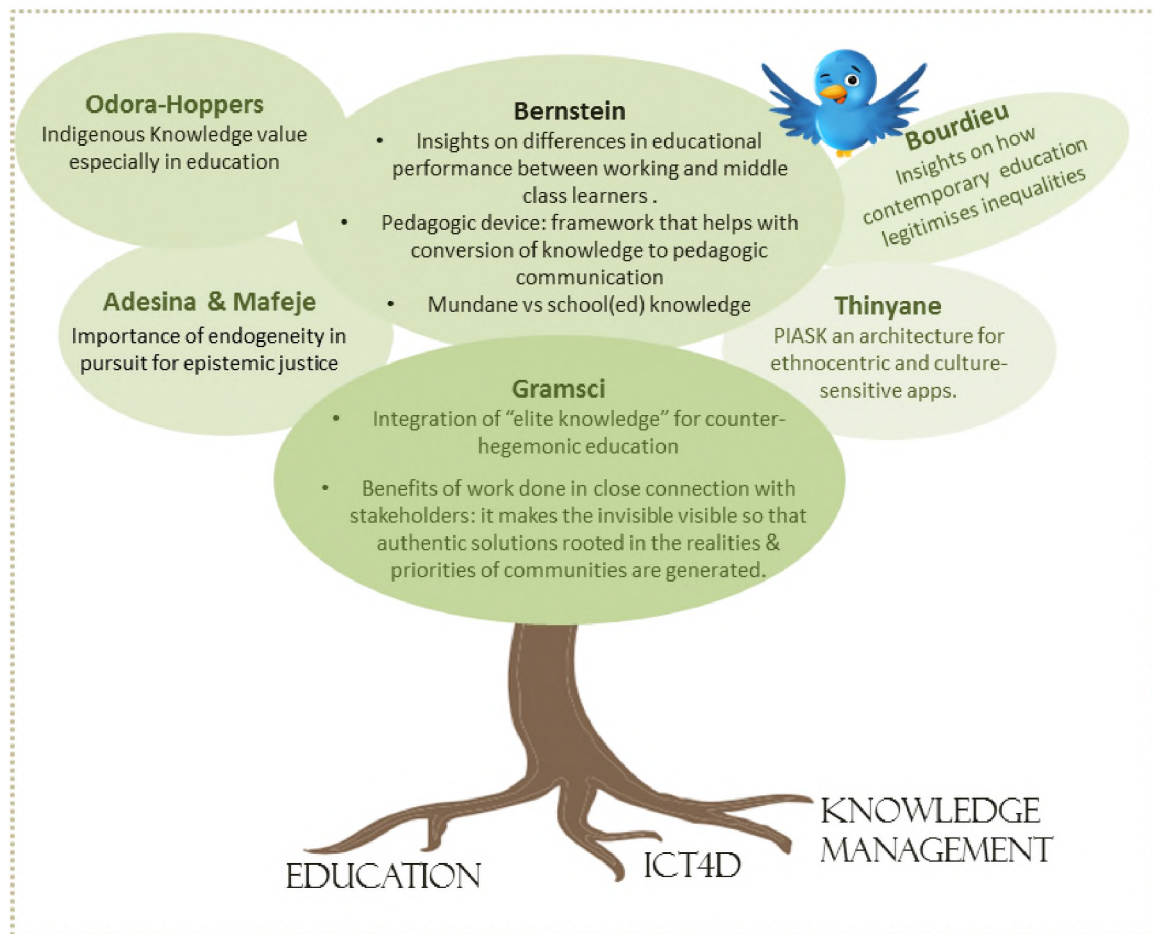
Figure 3.1 – Infographic Tree of a few Savants Grounding this Thesis Work

In this chapter, the primary aim is to give context and a clear rationale for the research approach, with the big picture in mind. To this end, we will start off with a discussion on the Living Lab research methodology, which, as intimated before, encapsulates the approach followed. The goal is to also show why this research concept is appropriate for use within ICT4D projects in general.

The chapter ends with a comprehensive but concise section on the Siyakhula Living Lab (SLL) [6]. Siyakhula in isiXhosa means 'we are growing together'; but the word can also be translated more profoundly to mean 'we expand our being through others' [223]. One of the goals of the SLL section is to show how the Living Lab concept has been appropriated within the scope of ICT4D. But above and beyond this, the goal is to locate how the work carried out in this thesis fits within the broader mandate and/or vision of SLL.

3.1 Living Labs

Although Living Labs were popularised in Europe in the mid 2000s, the concept originates from earlier work by the late Professor William Mitchell from Massachusetts Institute of Technology (MIT) [34]. The popularity stemmed from the need to bridge gaps between open innovation and user innovation [252]. Put differently, Living Lab emerged from Research and Development (R&D) need to address the question of how to innovate for impact and/or the mutual benefit of all stakeholders in the 'demand and supply' chain [18, 19].

Central to this was the question: how do we conduct an alternate form of 'market research' that is sufficiently nuanced and effective enough to close gaps, which left open, may lead to creation of products and/or services that are misaligned to the needs and priorities of would-be users? From a 'market' perspective, Living Labs provide the required answer based on two core functions they perform:

> (1) closing the pre-commercial gap by manifesting initial demand for products and services, as well as (2) orchestrating the actions of disparate actors in order to gain critical mass for the creation of a product or service.
> [19, p. 100]

At the heart of these functions is user involvement. Eric von Hippel has written extensively for more than three decades about the significance of involving users within the innovation process; see [127, 297, 298, 299, 300]. On the strength of his and other like-minded colleagues work, a more generic perspective may be advanced based on user involvement, and how it makes Living Labs versatile for use in different contexts around the world. From this perspective, a Living Lab can be understood as a research methodology that foregrounds users in the processes of innovation.

To be precise, this concept is premised on involving users within a real life context and at every stage of the research, inclusive of the development and innovation processes [18, 27, 81, 90, 208, 250]. The emphasis here is that users must be at the centre as opposed to the periphery of innovation systems, where they might be reduced to guinea pigs [90]. Essentially, this means all work is done collaboratively with the users from inception to the end of a project: the users together with other vested stakeholders are co-creators and co-innovators of services and/or products.

The above said, how then do we define a Living Lab? As might be expected, there are a number of definitions. Bergvall-Kåreborn, Ihlström Eriksson, Ståhlbröst and Svensson [34, p. 3] define a Living Lab as follows:

> A Living Lab is a user-centric innovation milieu built on every-day practice and research, with an approach that facilitates user influence in open and distributed innovation processes engaging all relevant partners in real-life contexts, aiming to create sustainable values.

As we note, the definition is pegged on user-centric innovation; for, as Ballon, Pierson and Delaere [27] remind us, this is one of the novel aspects of Living Labs, which promotes active involvement of users from early on in the innovation phase. This active involvement provides numerous benefits for all stakeholders [27, 81, 90, 250]. In the African context, we posit that this involvement can be interpreted as the invocation of the *Ubuntu* philosophy, if we read the spirit of creating beneficial gains to all stakeholders as an open acknowledgement that each depends on the other—I am because you are. We will elaborate on this in the next section when we discuss SLL's philosophy and operational framework.

3.1.1 Elements of a Living Lab

According to Almirall and Wareham [19, p. 89], "Living Labs are fundamentally infrastructures that surface tacit, experiential and domain-based knowledge such that it can be further codified and communicated". This understanding of Living Labs resonates deeply with the work undertaken in this thesis. First in the very obvious sense of working with IK, which, as we have already suggested, tends to have a strong tacit dimension to it. Second, in explicating the importance of experiential knowledge. This cements, for example, why endogeneity is so important to the thesis—and indeed other endeavours (like feminism and Afrocentrism) devoted to ending epistemic injustice.

Schuurman and colleagues [251] have also found some resonance in the above definition provided by Almirall and Wareham [19]. This can be gleaned directly from the conceptual model they have proposed, depicted in Figure 3.2. This model helps to deepen an understanding of what constitutes a Living Lab. Simplistically, it reflects that a Living Lab consists of material and immaterial infrastructure.

> The material infrastructure consists of the tangible assets that are brought in the Living Lab: physical networks, user devices and research equipment. The
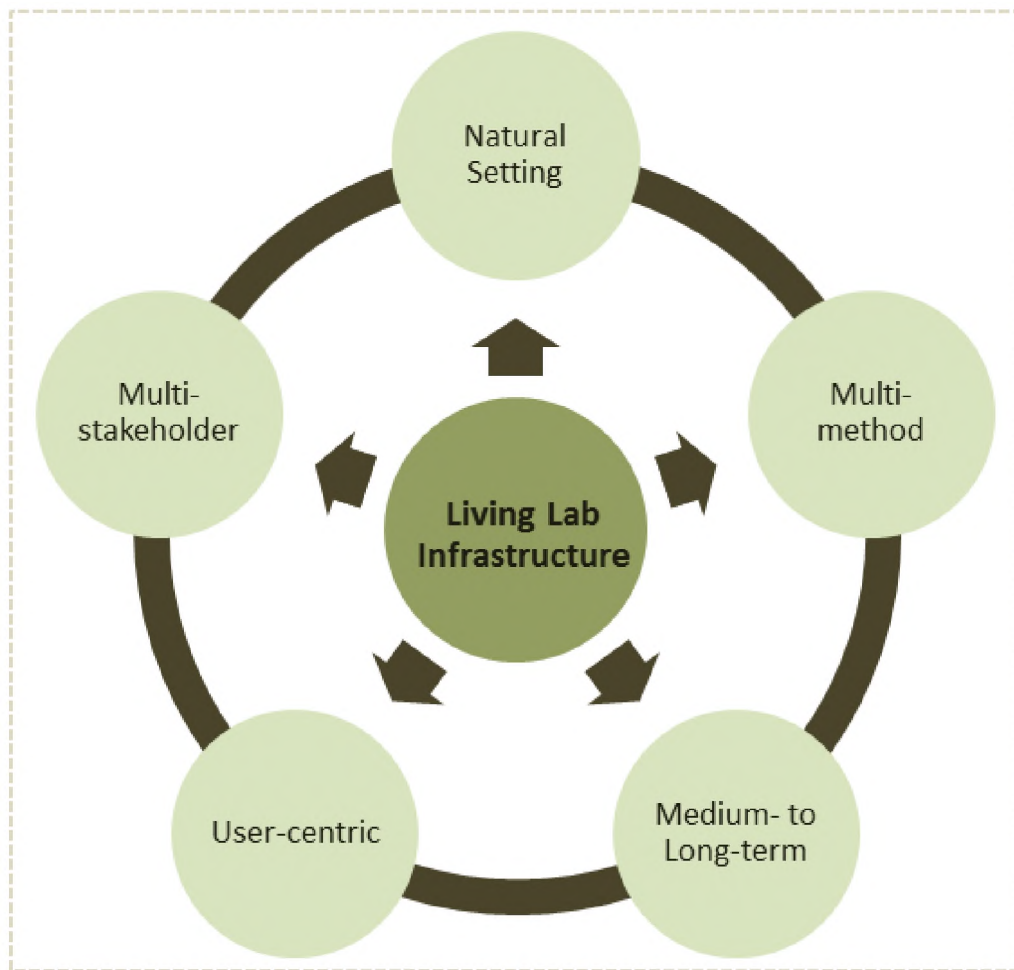
Figure 3.2 – Elements of a Living Lab [251, 252]

immaterial infrastructure consists of the non-tangible assets of the Living Lab: end-users, stakeholders and the environment. [...] The infrastructure as a whole forms the central tenet of the Living Lab constellation [together with] the five general Living Lab characteristics [which make] it clear that Living Labs are to be regarded as innovation systems that incorporate both the individual input from end-users (user-centric) as well as the social environment (natural setting) through their multi-methodical and multi-stakeholder approach that takes place on a medium- to long-term basis [251, pp. 6-7].

As it might be expected, the fusion of these elements varies in different Living Labs. In the next section, we will discuss the Siyakhula Living Lab (SLL): to detail the particularities of our Living Lab, and to provide an understanding of the context for this thesis. Before we delve into this section, however, we shall discuss why, at an approach and paradigm level, Living Labs accommodate use of multiple methods to surface the tacit knowledge.

3.1.2   Living Lab—Approach and Paradigm

As a basis for the formulation of their Living Lab definition, Bergvall-Kåreborn *et al.* [34, p. 3] argue that a "Living Lab is both a milieu (environment, arena) and an approach (methodology, innovation approach)". Given this, if a Living Lab also qualifies as an infrastructure for surfacing the tacit, a fitting question to ask is: how is this task achieved?

This question speaks directly to the approach of Living Labs, which, as alluded to, involves judicious and delicate mixing of different techniques and methods to co-create solution(s) suited to the needs of the users. This is the case because the act of 'surfacing' may in an archaeological sense be likened to excavation: since due diligence is required from gradually scratching the surface to unearth what is deeply buried under.

While this metaphor may be imperfect, it does communicate at least two truths about the Living Lab approach. Firstly, iteration is ingrained to the approach. Thus, akin to the excavation process, it takes repetition to remove layers that may, for example, hinder co-creation of appropriate solutions with users. Secondly, disorder (or mess), not in the disparaging sense, is inevitable. For, as suggested by many authors from different domains, working in real life settings demands dealing with "the messiness of everyday life" [31, 83, 101, 144, 239, 253].

However, as Dourish and Bell [83, p. 205] remind us, "messiness is not a problem to be eliminated; it is [...] what makes things interesting." To be sure, here the allusion is that there is a productive side to openly engaging with the mess of the everyday—with inherent contestations, contradictions, pluralities, and everything else in between that confirms the old adage, 'change is the only constant in life'.

One proviso—aside from naturally expecting to be challenged psychologically, socially, technically and pedagogically—is that the engagements must be underpinned by sound logic and reasoning. Researchers in this regard are guided by the paradigms they subscribe to. "A *paradigm* is a way of looking at the world. It is composed of certain philosophical assumptions that guide and direct thinking and action" [182, p. 8]. Mertens [182] (based on Lather [158] and Lincoln and Guba [162]) has synthesised a useful table reproduced as Table 3.1, that captures the four main paradigms and the various other labels used to describe them.

In practice, the demarcation between the various paradigms is not clear [64, 182]. But this is not a problem. Some paradigms can flow into each other because their underpinning ontological and epistemological assumptions may differ without being contradictory [64, 162,

Postpositivism	Constructivist	Transformative	Pragmatic
Experimental	Naturalistic	Critical Theory	Mixed Methods
Quasi-experimental	Phenomenological	Neo-Marxist	Mixed Models
Correlational	Hermeneutic	Feminist theories	Participatory
Causal comparative	Symbolic interaction	Critical race theory	
Quantitative	Ethnographic	Freirean	
Randomized control trials	Qualitative	Participatory	
	Participatory action research	Emancipatory	
		Postcolonial/Indigenous	
		Queer theory	
		Disability theories	
		Action research	
		Indigenous	
		Human rights/equity focused	

Table 3.1 – Label Commonly Associated with Different Paradigms [182]

182]. The listing of *participatory* under different columns in Table 3.1 immediately confirms this. It says that there are overlaps between transformative and pragmatic paradigms, and possibly with the constructivist paradigm if, say, action research is considered. Or rather, it says that there is a basis for locating Living Labs at the intersection of some or all of the four main paradigms—especially given that Living Labs by design and/or intent are meant to be participatory and multi-methodical, which means we can apply ethnographic methods together with, say, qualitative and quantitative methods.

Due to being embedded in natural settings, it is worth noting that an overall ethnographic approach tends to be used within a Living Lab [18, 27, 237, 241, 250]. According to Palmer [237, p. 31], the biggest "advantage of an ethnographic approach in a Living Lab context is that it is ideally holistic and reflexive." Ideally because the "multi-methodological structure [of a Living Lab] reinforces the triangulation [of methods], which is valuable for an ethnographic approach" [241, p. 123]. Reflexive, and we stress, if the suggested reflexivity rests upon what Freire [103, 104] termed 'critical consciousness'.

To us, critical consciousness is particularly important when a Living Lab is situated in a context marked by great inequalities, where mutuality of co-creation of solutions might require a serious commitment to emancipatory ideals. This becomes evident, for example, when one (superficially) considers how power relations might be structured in a European Living Lab compared to an African Living Lab like SLL, which also happens to be situated in a rural context. Such a comparison from a historical perspective might also point to a need to take seriously the indigenous paradigms within Living Labs to encourage "cultural and social immersion as opposed to scientific distance as the best approach" [185, p. 179]

to collaborative innovation.

In the African context, using Table 3.1 as reference, an indigenous paradigm with a postcolonial slant to it would be preferable. The Afrocentric paradigm is a good example. According to Mkabela [185, p. 181] "the Afrocentric paradigm provides methods African people can use for making sense of their everyday experience. It takes the indigenous African's point-of- view" in order to affirm "Africans as subjects, human agents, rather than as objects in a European frame of reference" [25, p. 2]. But this is not to say that the paradigm is exclusively about Africa; it is about ensuring that all cultural centres are equally respected. Further, the paradigm is about facilitating use of a dynamic, multicultural and multimethod approach to research [185, 232].

To sum up, the Living Lab approach and/or paradigm can potentially be explained or framed within existing research paradigms, but not entirely. The view that users are more than subjects but allies/co-creators, and the focus on integrating research with innovation is an important difference. A difference that opens up, paradoxically, the possibility of *stumbling* upon (or surfacing) useful ideas amid the messiness of the everyday. Here, the word 'stumbling' is used serendipitously or symbolically as a reminder that innovation is sparked by many things including the mundane. For this reason, Living Labs can be regarded as 'serendipitous' spaces for cultivating (innovative) ideas from both the act of doing and being.

3.2 Siyakhula Living Lab (SLL)

The SLL is a product of a multi-component, multi-partner and multi-disciplinary initiative that was started by the universities of Rhodes and Fort Hare in 2002 [282]. The field work component of this initiative started in 2005 [235, 282]. As Terzoli [282, p. 82] explains: "The SLL represents the re-organisation of the field work component of this initiative, along the lines of the emerging R&D methodology commonly known as a 'Living Lab'". This re-organisation, or to be precise, the concretisation of the project into overt use of the Living Lab methodology happened in 2008/9 through the Cooperation Framework on Innovation Systems between Finland and South Africa (COFISA). To be sure, until 2008, the initiative known then as the Dwesa project, was operating for all intents and purposes as a Living Lab—albeit, as Palmer [237] rightfully notes, there was a lack of awareness of this fact.

At this point, it might be worthwhile to take heed of Mafeje [168] and avoid the wrath of ahistoricity. From a historical perspective of Living Labs, it is not at all surprising that we were oblivious of the fact that the Dwesa project qualified as a Living Lab: given, as alluded to before, that the concept of Living Labs originates from the global North. However, once we became aware, it was about recognizing that, in fact, Living Labs operate under the same African idiom of unity that was underpinning our work, especially at a level of leveraging a practice of cooperation among Bantu people called *letsema* in Sesotho and *ilima* in isiXhosa. Ramphele [246, p. 3] describes *letsema/ilima* as a "term for collective action which traditional agrarian communities used to build social capital and tackle common challenges". For us, this description attests to the definite parallels that exist between Living Labs and *ilima*, which at a conceptual level was the foundation for our work. For this reason, we argue that the strategic decision to formalise the Dwesa project into SLL was not merely about adoption for its own sake: it was steeped, among other things, in Afrocentrism/Afrocentricity. (According to Mafeje [168, p. 106], "Afrocentrism can be regarded as methodological requirement for decolonising knowledge in Africa or as an antidote to Eurocentrism through which all knowledge about Africa has been filtered". Asante [25, p. 2] further stresses that "Afrocentricity is not the reverse of Eurocentricity but a particular perspective for analysis which does not seek to occupy all space and time as Eurocentrism has often done.")

To-date, SLL comprises of two main sites in the Eastern Cape Province: one in a rural area and the other in the peri-urban area. There are a few other sprouting sites, also located in the Eastern Cape; Grahamstown is one such site.

The conceptual work of this thesis is linked mostly to the rural site, which also happens to be the inception site of SLL. The latter point is significant in that it captures why this site serves as a template or reference point for the other sites, particularly when it comes to framing the SLL mandate and outlook.

To contextualise the framing, our starting point will also bring the spotlight to the rural site. This site comprises of a number of communities that are geographically located in proximity of each other in the Wild Coast area of the Eastern Cape Province. To be exact, the communities are located in the Mbashe local municipality, not far from the Dwesa-Cwebe Nature reserve (marked on the map in Figure 3.3). As Dalvit, Siebörger and Thinyane [70] note:

> The natural environment, consisting of the nature reserve and the adjacent coastline are assets for the communities. The unspoiled natural beauty and

Figure 3.3 – Map Depicting Location of the Dwesa-Cwebe Nature Reserve

wild beaches have the potential to significantly promote eco-tourism in the region (p. 228).

Unfortunately, in the narrow sense of development, the communities live under severe socio-economic hardships in relative comparison to the other sites that are not rurally located. This is despite the fact that the communities experience high rainfall levels and have fertile soil which can enable intensified agricultural production and commercial forestry [238]. Among a myriad of factors hindering development, physical access, for example, is a concern. The heavy rains tend to affect the conditions of the roads: all roads leading to these communities are gravel, except the bridge segments over the Mbashe and Nqabara rivers, which typically flood and cause some communities to be inaccessible.

Other infrastructural challenges are gradually being addressed. Gumbo and colleagues [124, p. 2], lest we forget, remind us that "[u]ntil late 2009, the majority of the households [unlike today] did not have direct access to electricity or running water". Telecommunication is also improving, partly through SLL's efforts on setting up infrastructure for internet access: achieved by connecting the communities via participating schools into a single network entity.

The schools are what we call Points of Presences (PoPs) [69, 70, 124, 278]. From a technical perspective, the schools are points of connectivity in the wireless broadband island; that is, the schools via a delicate mix of (fixed and mobile) WiMAX and WiFi connect to each other to form a single network with internet access [124, 264, 266, 265]. From a lay perspective, the schools are simply the go-to places for internet access, where one can gain access using either a school's lab machine or personal WiFi-enabled device within a radius of a school.

Of course, aside from internet access, community members can use the lab machines for other tasks. This is highly encouraged; as one of the key aims of SLL is to move beyond a narrow vision of adoption and diffusion of ICTs that focuses on handheld devices (e.g. mobile phones) instead of engineering a reality in which handhelds can seamlessly be used in conjunction with other devices—as it happens in the 'haves' side of the divide.

To be sure, SLL aims to cultivate ICT use in a manner that does not make handhelds a panacea for innovation within marginalised spaces. Similar to other developing context, use of mobile phones in particular, is huge within SLL communities. In spite of this, the view in SLL is that exclusive focus on these devices may contribute to the widening digital divide—unless, of course, deliberate effort is taken to cultivate nuanced use of multiple ICT devices such that an individual inherently appreciates that production of 'involved' content, like a lengthy email, may be better achieved on, say, a netbook, rather than on a phone. The rationale here is to ensure that we can, eventually, have users that become more than consumers of ICT services. That is, we have users that become producers and embark on tasks like video editing and creation of content in various forms. In the Gramscian sense, this is a vision about imagining organic growth of ICT skills and knowledge: a vision where driven by passion, users begin to use resources available to them (like the internet) to learn.

Given the low digital literacy among many community members within SLL, training, for example, is an absolute imperative to realising this vision. In the next subsection, we expound on SLL's philosophical and operational approach to facilitating meaningful use of ICTs, which, as we will see, foregrounds training.

3.2.1   SLL Philosophy and Operational Framework

As previously stated, Living Labs operate on a philosophy that demands key stakeholders to be collaboratively involved in all processes leading to creation of innovative solutions. In SLL, this philosophy, based on conceptualising this working together of stakeholders as *ilima*, is akin to *ubuntu*—a philosophical concept that is difficult to fully describe [168, 242].

According to Mafeje [168, p. 107] *ubuntu* "is not translatable in English (carelessly translated, it comes out as 'humanity' which is a generic term with no social-cultural connotations)". This is valid and perhaps the reason the proverb *'umuntu ngumuntu ngabantu'* is normally evoked to amplify the significance of *ubuntu* in affirming individuals to *be*, but without forgetting their relational existence to others. The proverb is very simple in its translation, 'a person is a person through others'. Yet complex in communicating the *ubuntu* values it encapsulates—values, for example, of deep respect, equality and justice.

Chambers [54, 55, 56] series of engagements on 'whose reality counts?' reverberates a deep understanding of *ubuntu*. This comes out, for example, in his argument that development professionals must be reflexive and realise their own need to change: to become humanising in order "to be able to reverse the normal view, to see another reality, to soften and flatten hierarchy and to embrace a new professionalism" [54, p. 15]. This, as he urges on, is necessary for:

> What is right depends on who we are, where we are and what we can do. What we perceive as right depends on the traditions we work in and what we see as the ethical basis for action. It is a strength that we are all different. The question is whether we can converge and share, learn from each other, and together do better [56, pp. 282-283].

In SLL, ultimately this is a question about *ubuntu*, which in binding it to Living Labs becomes: how do we cultivate the spirit of *ubuntu* to co-create and co-innovate (naturally also taking into account that setbacks will occur)? Another way to ask the question is: how do we cultivate 'give and take' relationships, which enable various stakeholders to engage jointly in the innovation and creation processes of products and services?

First, we must remember that in any Living Lab, "the aim is to accomplish quattro helix by harmonizing the innovation process among four main stakeholders: companies, users, public organisations and researchers" [275, p. 6]. With this in mind, to give structure
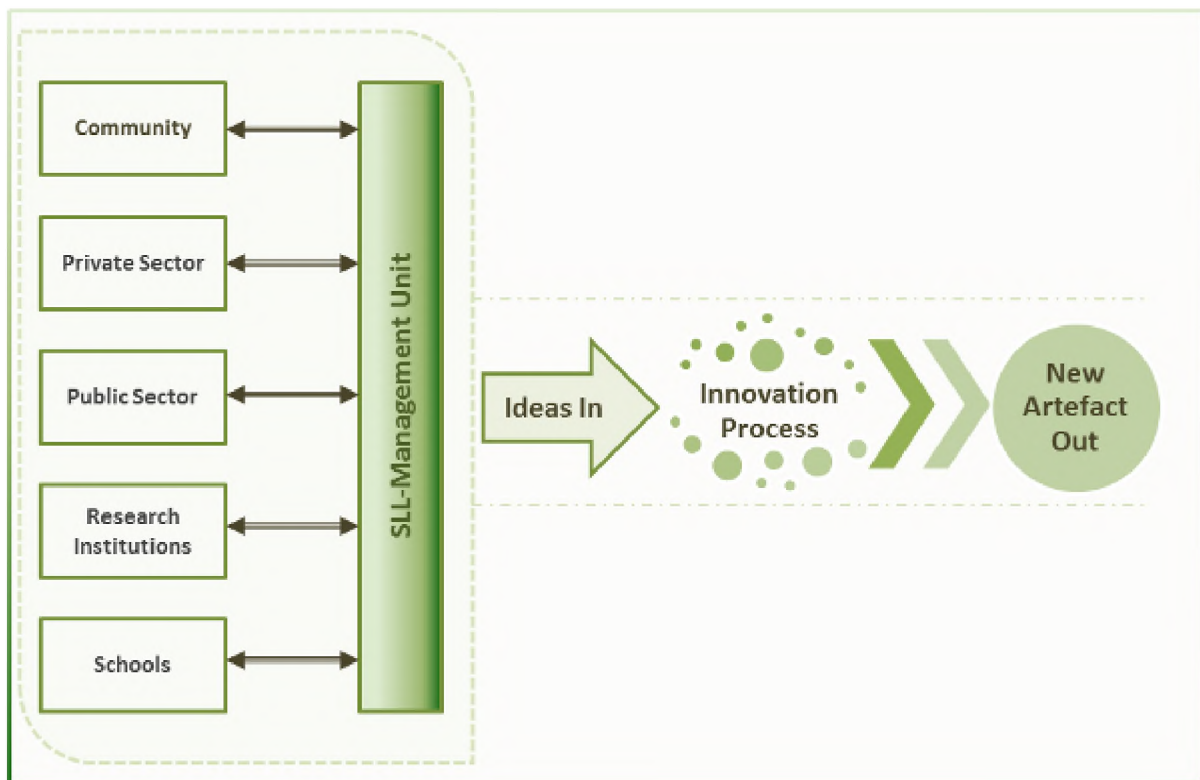
Figure 3.4 – SLL Operational Framework

to communication that happens within SLL, an entity known as the SLL Management Unit (SiLLMU) manages and facilitates communication between various stakeholders, which, as illustrated in Figure 3.4, indeed confirms a quattro helix partnership. As the figure would suggest, the communication contributes to the innovation pipeline: in the very sense of helping to generate ideas, which can be channelled into the innovation process for creating new artefacts i.e. new services and/or products.

Second, as part of the operational strategy, SLL offers ICT skills training to community members [122, 123, 237]. Logistics for these trainings are managed by SiLLMU with the help of the community (through an elected representative executive committee) and ICT champions in schools. These trainings form part of a core strategy for enhancing ICT diffusion as well as creating an honest channel for an open dialogue with community members.

Researchers conduct most of the trainings. It is part of their giving or ploughing back to the project, but also a strategic means of getting to know and be known by the community [222]. Basically, training is constructed as a gateway to getting researchers identifiable to the community so that it can be easy for them to 'blend in': to hopefully identify problems that may, on the one hand, align to their specific skill-sets and/or research interests, and,

on the other, be useful in growing SLL for impact and sustainability [222].

This construction of training and who conducts training in SLL is underpinned by a nuanced understanding of the nexus between the Living Lab approach and the *Pedagogy of the Oppressed.* The reciprocity inherent to the use of the Living Lab translates into an understanding of how the researchers in their roles as trainers are fundamentally what Freire [104] in the *Pedagogy of the Oppressed*, calls 'teacher-students', while the trainees are the 'students-teachers'. In other words, in teaching, the researchers are learners themselves learning from the trainees who in their own right are teachers. Again, with this understanding comes the awareness of the problematic nature of using words like training, which may imply what Ntuli [219, 220] refers to as a 'tabula rasa' transfer of knowledge. As such, without any disregard for the need to grapple with the language, the objective is to help researchers come into a deep realisation that co-creation and co-innovation of solutions—implied and embedded in the use of the Living Labs—demands genuine solidarity, which in the words of Freire [104, p. 49], " is a radical posture".

3.2.2 SLL Research Activities

Research activities carried under the SLL umbrella can be divided along two main dimensions, as captured in Figure 3.5. The first dimension, perhaps predictably so, pertains to work around connectivity from the perspective of guaranteeing access to network and internet resources. The second dimension, which is central to the work undertaken in this thesis, relates to all work done in pursuit of realising the goal behind the use of Living Labs as a methodology; for simplicity, we refer to this dimension as the 'methodological and/or philosophical' dimension.

The methodological dimension as shown in Figure 3.5 is largely focused on management and service engineering research work. Under the management branch, research focuses on impact and outcomes; this being the case, sustainability is one of the key areas of research. Service engineering deals with work that results in co-innovation and co-creation of artefacts or services that stand to benefit the community both directly and indirectly. The direct and indirect distinction is about acknowledging a category of artefacts or services that enable and/or support the ones which community users will interface with.

There are a number of other activities that have been represented as distinct in Figure 3.5. However, strictly speaking, research activities within SLL are connected to each other, in more ways than one. In the figure, only two categories (user requirements and IK) are
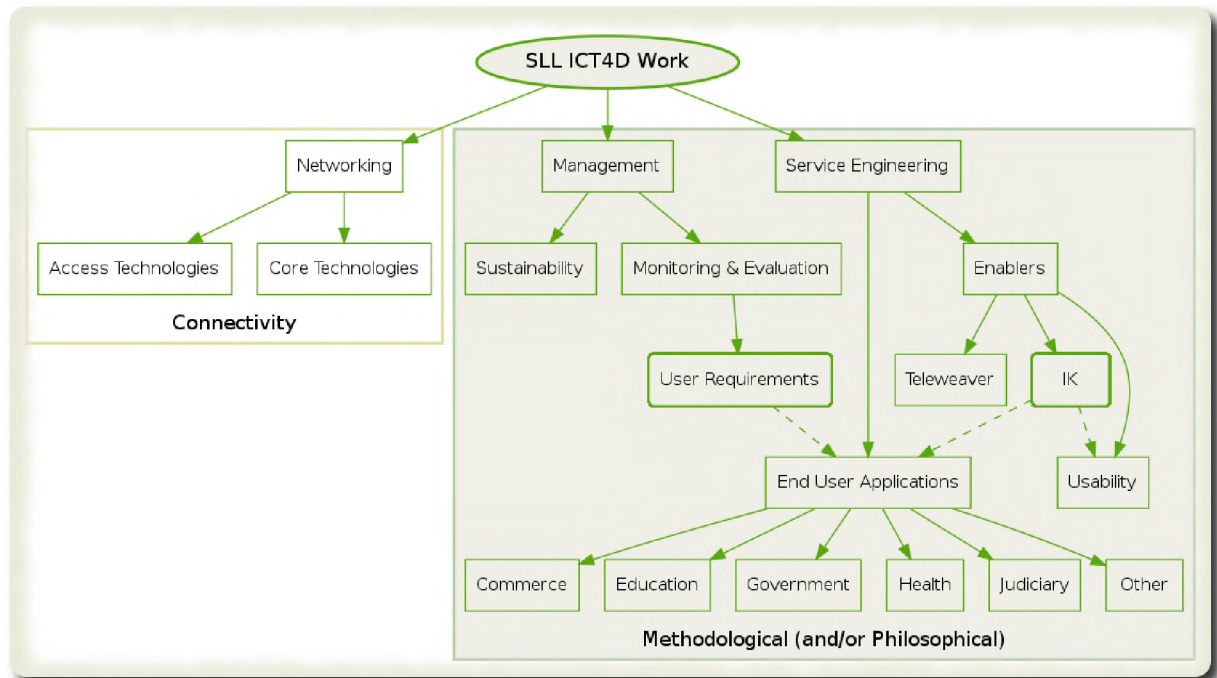
Figure 3.5 – Taxonomy of Research Work in Siyakhula Living Lab (adapted from [124])

shown to have such a connection. Basically, based on how we relate these two categories to those connected to them using dashed arrows, we can deduce one of two things: 1) the possibility of the taxonomy collapsing, at least in the Aristotle's sense of achieving categorisation [10], or 2) the possibility of having multiple hierarchies to represent the work undertaken in SLL. To us, the latter holds: precisely because "from our modern (Aristotelian) perspective, we no longer view the world as having *only* one reality" [157, p. 27]. Hence, we appreciate that user requirements, for example, can be related to both the management and the service engineering categories, without there being a contradiction.

The next subsection will look at IK separately as a category of special interest to the thesis. The objective is to briefly explain how IK fits in the broad research landscape of SLL; in part, to make visible why IK links to usability concerns and development of end user applications, as shown in Figure 3.5.

3.2.3 Indigenous Knowledge: ICT Diffusing 'Medium' in SLL

As suggested before, in the context of ICT4D and/or the quest to bridge the digital divide, diffusion of ICTs is important, but, with a critical proviso: users must derive benefits from having access to ICTs [80]. This proviso raises multiple questions on how to gain a deep understanding of the targeted community of users and their context: to adequately address and resolve, for example, the 'adapt/adopt' tensions in the promotion of use of ICTs.

We will not explicate these questions in this subsection. Suffice to say, SLL recognises their importance; hence why a Baseline Study report [233] was commissioned, through the support of COFISA, as part of the process that catalysed or formalised operations of the initial initiative into SLL. (As a small digression, the Baseline Study has resulted in the following [234, 235, 236] spin-off publications that are also worth reading.)

The main objective of the Baseline Study was to bring some holistic understanding of the reality on the ground. A very basic thematic analysis of the Baseline Study report is suggestive of the importance of the 'local' to the task of diffusing ICTs successfully. By implication, this connects IK to diffusion, but also to the methodological paradigm of Living Labs. The connection lies in understanding that the local focus has everything to do with surfacing insights that can be used to think through appropriate solutions. For, these insights qualify, in part, as IK and/or knowledge that can be harnessed in various ways to enhance usability.

Usability is a layered concept centred on quality of use [41]. Within the broader context of acceptability, usability addresses questions around usefulness, based on five key attributes: learnability, efficiency, memorability, errors and satisfaction [204]. Interpreted in a context like SLL, these questions amplify the need for localisation and design of culturally sensitive interfaces [85, 108, 154].

All in all, stitched to the SLL's mandate, the connection between IK, diffusion and Living Labs reveals why innovation driven by a methodological approach that valorises learning, experimentation, and mixing of local knowledge (IK) with theory is important. Fundamentally, it shows why beyond physical access, diffusion must facilitate co-creation of solutions that are well aligned with the natural environment and 'being' of communities in their particular localities [223].

3.3 Conclusion

This chapter sought to explain the Living Lab research concept, in part, to frame understanding of the SLL mandate. A mandate that, for all intents and purposes, aims to find tangible answers to Njabulo Ndebele's question, "what kind of means need to be devised to facilitate the rapid yet creative improvement of life in rural areas?" [197, p. 112]. A question that essentially reminds us that through rural development we can effectively begin to 'put the last first' [53, 55].

The chapter also sought to highlight the various elements that are ingrained to the Living Labs, which combined create an enabling space for collaborative innovation that foregrounds and valorises users at all times. One key point mader is that, as infrastructures for surfacing insights, Living Labs inherently use multiple methods to ensure that different dynamics which shape reality within a particular context are deeply understood. Ultimately with or without use of Living Labs, this is significant; largely because there is a correlation between the levels in which we understand reality and the quality of solutions that are proposed and implemented within that reality. Indeed, this also explains why explorations within Living Labs are done under 'natural setting': to ensure that appropriate solutions are co-created based on understood, and not assumed, reality.

Chapter 4

Technology and Culturally Framed Education: An Overview [7]

We now accept that ICTs are an integral part of the everyday life. A question that is perhaps open for debate is whether the use of ICTs can be optimised to engender authentic solutions, which are aligned to the natural environment of the people. As suggested before, in this thesis, we narrow and re-frame the question by asking: can ICTs facilitate education grounded in *people's own realities*, especially those of the marginalised rural poor?

We ask this question motivated by a well established link between education and development. A link typically articulated through a reminder that good quality education can act as the cornerstone of development. According to Spaull [273, p. 34], "Quality education can be defined as the acquisition of the knowledge, skills and values that society deems valuable". To be sure, these dimensions to quality are deemed essential for enabling people to use their agency to participate proactively in development.

Above we placed emphasis on *people's own realities* because we believe, like many other scholars, that all education, especially Education for Sustainable Development (ESD), is intrinsically linked to the valorisation of IK. Owuor [231] makes a number of salient points about the shift towards ESD in Sub-Saharan Africa. She argues that this form of education has foregrounded the importance of alternative approaches to school curricula, which demand an in-depth understanding of the dynamics of the local context of learners. Furthermore, she argues that a meaningful strategy to achieving the goals of ESD lies in following "an endogenous approach [...] that involves the contextualization of the school

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[7]This chapter draws extensively from [224], a published conference paper.

curriculum by integrating indigenous knowledge with other relevant and useful knowledges into formal education" [231, p. 21].

This thesis is a partial response to addressing how the integration can be achieved. Specifically, the thesis looks into how both IK and technology can be integrated into formal education. In other words, the thesis explores how ESD can be achieved effectively with the support of technology—or more accurately ICTs.

In terms of teaching effectively with technology, a framework known as TPACK is increasingly regarded as ideal. We also believe that this framework fits our context and broad vision of SLL in that it cultivates teachers understanding of the various pieces of knowledge and their interactions with each other in facilitating a holistic and efficient approach to learning. However, there is a caveat.

TPACK partly embeds IK within pedagogical knowledge, framed by the idea of 'contexts'—more or less, in the postmodernism or radical contextuality sense of "everything is context dependent" [91, p. 130]. For purposes of epistemic justice or decolonisation of knowledge, we argue for explicit inclusion of IK in general and African Indigenous Knowledge (AIK) in particular within the framework. We believe the continued rendering of this knowledge as implicit perpetuates the Western hegemony. We arrive at this conclusion through a reading of various sources (e.g. [11, 24, 59, 63, 74, 75, 186, 220, 219]). Not mincing his words, Adesina [11], for instance, states that such an epistemic intervention can be regarded as a simple matter of recognising that "[w]e must move beyond making aliens of our students" (p. 243): their inculcated world view must be used to connect them to their being and critical learning. A number of authors (e.g. Escobar [91], Grosfoguel [119] and Ndlovu[199]), from slightly different perspectives, assert that this would effectively lead to a decolonial turn. According to Escobar [91, p. 132], in particular, a "decolonial turn is also an epistemic turn, a turn toward different configurations of knowledge, ones that would be linked, and contribute to, worlds and knowledges otherwise".

In the next section, we will provide context for our argument through a brief discussion on the education landscape in South Africa. Bourdieu's [44] critical analysis on the role of education in contemporary society will be used to provide a broad sociological understanding of the landscape. Following this, we will provide more details of the TPACK framework. This framework is central to our proposal on how to move towards a technology and culturally framed education that can potentially bring about sustainable endogenic development.

Figure 4.1 – High-level Snapshot of the Education Landscape

4.1 Education Landscape

A disciplinary field like *Sociology of Education* details the complexity of issues that colour the educational landscape. Figure 4.1 provides a glimpse of some of these issues. The figure shows that culture, language, learners' background, curriculum theory, etc. interact with each other in various ways. These interactions—which embody environmental, social, economic, cultural and political dynamics—actually have an impact on the educational outcomes, as they influence overtly and covertly how knowledge is constructed and transferred.

In this thesis, precisely because the issues within the educational landscape are many, we navigate the space sensitively without delving too much into the intricacies. The next subsection describes the education system in South Africa briefly, but with some sociological perspective. This is followed by a subsection that argues the importance of AIK in education. This argument, to borrow the words of Dyson [86, p. 177], is:

> [...] driven by the unease at the attainment gap between 'disadvantaged' students and their favoured peers, and by a worry that this group of young people might be left behind even as the system improved overall.
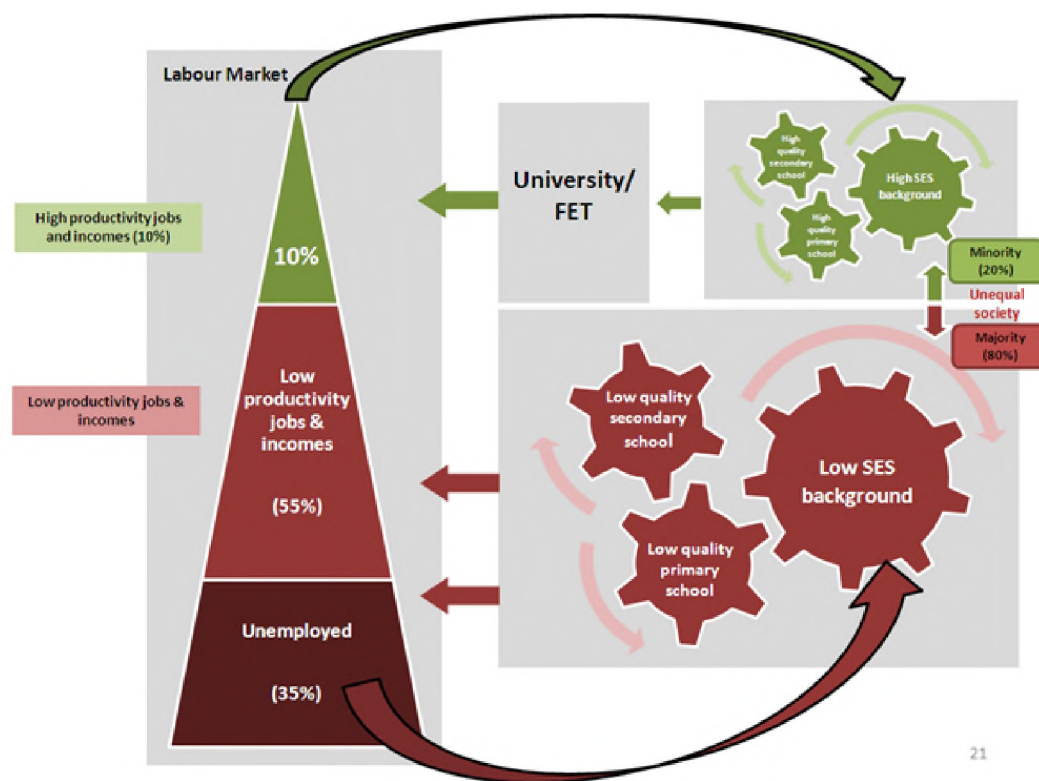
Figure 4.2 – Framework for Understanding South African Education by Spaull [270]

4.1.1 South African Education: A Tale of Two Nations

Over the last decade or so—notwithstanding the historical legacies—the South African education system has been qualified, for example, as "very inefficient" [279, p. 5] or a "national disaster" [42, p. 58]. Whatever description may be used, the education system in South Africa is in deep crisis.

The above has been attributed to the fact that the educational system is generally divided by privilege into two [42, 270, 271]. Spaull [270] provides us with a framework, depicted in Figure 4.2 that explains this phenomenon and how it reinforces existing inequalities in society. (Because the "digital divide" mimics structural inequalities, this framework is also conceptually useful for understanding this divide in the South African context.)

As shown in the figure, schooling is closely tied to the labour market: low quality schooling often leads to no jobs or low paying and low productivity jobs; while high quality schooling often leads to high paying and high productivity jobs. This 'picture' represents what is well known and documented in South Africa and other parts of the world. In the case of South Africa, Marais [173], further reinforces this 'picture' of a "two-tier school system" as follows:

One part of the system is comparatively multiracial and dispenses an education of reasonable quality that can serve as a launch pad for successful tertiary education. A small minority of learners benefit from it. The other part provides substandard education and, especially in the case of many rural and township schools, does little more than [produce] 'warehouse' learners. African schools in townships and rural areas tend to be worst performing ones; those that excel tend to be in (formerly white) affluent neighbourhoods (p. 324).

Bourdieu [44] provides an understanding of the structural mechanisms at play, which sustain and reproduce the above reality. Fundamentally, this understanding lies in accepting that the education system preserves and legitimises existing inequalities. As Bourdieu [44, p. 35] puts it, "faith in the school as an institution of liberty and equality obstructs the school as conservative and actually unjust despite—and even—because of its formal equality".

In a practical sense, the formal equality is theoretical: for, it reinforces the alienation of learners from 'disfavoured' backgrounds, since the values and culture transmitted in schools is essentially foreign to them, whilst it can be regarded as native to those it favours. In other words, in their essence, schools:

[...] contribute to favouring the most favoured and disfavouring the most favoured. As a result the equity that governs the entire system is actually unjust, and, in any society that proclaims democratic ideals, it protects all the better than would be their open and obvious transmission [44, p. 36].

If we refer back to Marais and Spaull analysis, the majority of learners in (democratic) South Africa fall under the 'disfavoured' category and the minority count as 'favoured'. With this in mind, a pertinent question to ask is: how do we make the education system just to favour the disfavoured?

According to Bourdieu [44], the answer lies in giving "the disinherited the real means for acquiring what others have inherited" (p. 36). Necessarily, this means demystifying and accepting at least two facts about the role of education in contemporary society.

First, that education "plays a critical role in the reproduction of the distribution of cultural capital and thus in the reproduction of structure of social space" [44, p. 33]. Aronowitz and Giroux [22, p. 80], in their analysis of Bourdieu's work, describe cultural capital as "different sets of linguistic and cultural competencies that individuals inherit by way of class-located boundaries of their family". They go on to assert that:

A child inherits from his or her family those sets of meanings, qualities of style, modes of thinking, and types of dispositions that are assigned a certain social value and status in accordance with what dominant class(es) label as the most valued cultural capital. [...] Certain linguistic styles, along with the body postures and the social relations they reinforce (lowered voice, disinterested tone, non-tactile interaction), act as identifiable forms of cultural capital that either reveal or betray a student's background. In effect, certain linguistic practices and modes of discourse become privileged by being treated as natural to the gifted, when in fact they are the speech habits of dominant classes and thus serve to perpetuate cultural privileges (pp. 80, 83).

Second, and linked to the first point, understanding that education through schooling "transforms inequalities of fact into inequalities of merit" [44, p. 38] by using an ideology of 'gifts'. The favoured qualify as gifted based on competences they have gained socially. However, this is not meaningfully acknowledged because the effects of the environment are discounted through the assumption that schools are neutral spaces. As a consequence, teachers become ineffective in helping the disfavoured to acquire the competences necessary for their success, and as such, "those who 'inherit' become those who 'merit'" [44, p. 33].

In the next subsection, with Bourdieu in mind, we argue that IK can be a useful resource in giving the disinherited a chance to possibly escape their social destiny. This is not to say that we deem IK as the silver bullet for fixing our education system: we do recognise that there are many other factors to be considered—social, economic and political. We, in fact, agree with Aronowitz and Giroux [22, p. 87] that:

The internalization of dominant ideology is not the only force that motivates working class students or secures their failure. Their behaviours, failures and choices are also grounded in material conditions.

The above withstanding, we but reason that IK as a base for cultural capital can contribute to having the disfavoured favoured within an education system that currently "makes a very major contribution to the rigidity of social structure" [44, p. 39], which as shown in Figure 4.2 predetermines the destiny of most people in society.

4.1.2 African Indigenous Knowledge in Education

The introductory chapter has broadly discussed the value of IK in education as a base and resource for grounding the learning experience in the familiar before moving into the unfamiliar. Or, to quote bell hooks[8] [136] from a different context, it acts as a means that enables learners to "feel the fun and excitement of learning in relation to living regular life, of using everything [they] already know to know more" (p. 2).

IK, in short, qualifies as background knowledge for learners; yet, as noted by Dalvit, Murray and Terzoli [67, p. 293]:

> [...] in the post-colonial African context, local indigenous knowledge is attributed low status and excluded from formal education, disempowering African students educationally and ideologically, by devaluing their knowledge and entrenching Western epistemological hegemony.

Discussed briefly in the previous subsection, Bourdieu's theory of cultural reproduction provides a lens to understanding why the above is the case. Moreover, the theory, if extrapolated to the contemporary African context, explains why the culture of school is alienating to the majority of learners. Further, it explains why we have a growing crisis in our classrooms [11, 42, 49, 219, 279]. According to Adesina [11], this crisis compels us to take seriously the:

> [...] need to move beyond making aliens of our students — who sit through [lessons] with teachers whose epistemic gazes are firmly planted in the global North, and do little to acknowledge the collective memories and sense of our wards [or 'locality'] (p. 243).

To change this reality, we need "an education process [...] which is deeply rooted in the epistemological reality of the local people" [49, p. 142]. Basically, as Hountondji [138, p. 36] suggests:

> [...] to help the people and their elite to capitalise and master existing knowledge, whether indigenous or not, and develop new knowledge in a continual process of uninterrupted creativity, while applying findings in a systematic and responsible way to improve their own quality of life.

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[8]Name deliberately written in lower case by preference of author.
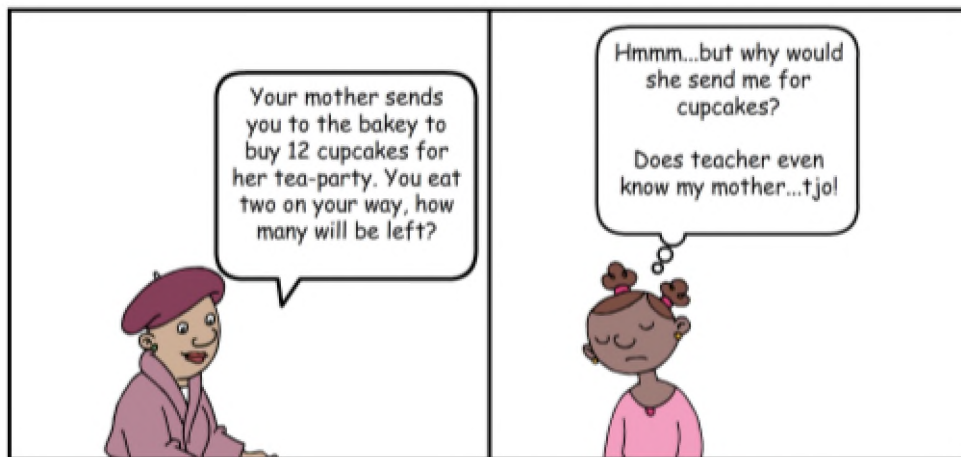
Figure 4.3 – Example of 'Marie-Antoinette' in the Classroom

For this to happen, we need to urgently incorporate IK into the classrooms to address the educational crisis and to achieve sustainable development—rooted, as previously argued, on critical and endogenous thought. According to Hays [128, p. 203]:

> One argument in favour of incorporating indigenous knowledge into education systems is pedagogical: children 'learn better' if information is presented to them in a language and context that they can relate to and if their areas of competence are valued rather than denigrated.

Reinforced by the above, we specifically argue for the incorporation of AIK, which according to Owusu-Ansah [232, p. 1], refers to "experiential knowledge based on a worldview and a culture that is basically relational". A worldview and culture that we believe can help us to avoid relating with our learners in ways that rival in frivolity the infamous Marie-Antoinette (mis)quotation, 'let them eat cake'.

Figure 4.3 provides a contrived example of what we regard as exogenous or Marie-Antoinette outlook in education. To fully understand, let us imagine that a learner from the SLL community is grappling with subtraction. The teacher, as possibly suggested in the teacher's guide, asks the question depicted in the figure—relating to the number of cupcakes that will be left should the learner help herself, without permission, to two in a dozen. Before we proceed, let us further imagine that the learner in this scenario is one of the many that derives a benefit from the school's feeding programme. Now, minus the fact that there is no bakery in this community and tea parties are an alien concept, how perplexing is the teacher's question? Would it come as a surprise that instinctually the correct answer for the learner remains 12? Instictually, this is so because the cultural

and social background of the learner rewards acquiescence to age. In practical terms, this means being sent on an errand by an elder carries a meaning that makes eating the two cupcakes sacrilegious to the learner.

Of course, pedagogically speaking, the expectation is that the above example would not be used by a teacher—at least, at a level of conceptually helping the learner to understand what it means to subtract. But the reality is much complex. Shakespeare awaits the learner. This, the teacher knows; just as they know that the learner must grapple in their immediate future with entrepreneurial lessons based on notions of 'bake sales'—or, to draw on existing material produced for classrooms, 'party planning businesses', as represented in Figure B.1 on page 189.

To extrapolate from the above, teachers in a context like the SLL function with an understanding that a gap exists between the reality of their learners and the material produced to facilitate learning. That is, they understand on some level that the existing learning materials have not been designed to resonate with the lived experiences of their learners: the 'cupcakes' are a norm. Does this contribute to the negation of IK or any other knowledge that can connect learners to new knowledge? The simple answer is, yes.

However, it would be disingenuous to argue, for example, that "teachers simply find indigenous knowledge unimportant" [254, p. 306], despite clear stipulations in the existing policies to integrate this knowledge into formal education [77, 79, 109, 143, 310]. Teachers, in fact, find their cues daily in the learning materials, which—deliberate of otherwise—serve to normalise cultural assimilation. For this reason, it is prudent to accept the inherent challenges and complexities to closing the existing gap(s).

In advocating for an inclusive solution that strives to bring balance or complementarity to different knowledge forms, we must retain a consciousness that ultimately moves us "to transform society in ways that enhance the collective good" [136, p. 294]. This is to say, our efforts to valorise AIK must be read in context of building a truly multicultural knowledge society, "where all knowledges play an equal role in determining the direction and future of the world" [199, p. 96].

In the next section, we will discuss a framework that interrogates teachers' knowledge. Or rather, the categories of knowledge that a teacher must ideally possess to be effective in the classroom of the 21st century, where the assumption is that technology is indispensable to teaching and learning.

4.2 Technological Pedagogical Content Knowledge

TPACK (sometimes written as TPCK) is an augmentation of the pedagogical content knowledge (PCK) framework proposed by Shulman [263] to facilitate knowledge growth in teaching. As Mishra and Koehler [184, p. 1017] put it, TPACK "is a conceptual framework for educational technology [built] on Shulman's formulation of 'pedagogical content knowledge' and extend[ed] to the phenomenon of teachers integrating technology into their pedagogy."

According to Shulman [263, p. 9] PCK extends "beyond knowledge of subject matter [... in order to capture a ...] particular form of content knowledge that embodies aspects of content most germane to its teachability". He adds that for the subject matter to be truly understandable to others, PCK necessarily has to include "the most useful forms of representation of [core ideas within taught topics], the most powerful analogies, illustrations, examples, explanations, and demonstrations " [263, p. 9].

In sum, from Shulman's work, we can conceptualise PCK as an intersection of pedagogical knowledge (PK) and content knowledge (CK) such that we have a form of knowledge that is mostly "strategic" in nature. A knowledge form that blends together:

➡ subject matter content knowledge;
➡ knowledge of students' background—with particular emphasis on conceptions and misconceptions that may cause learning to be easy or difficult;
➡ curricula knowledge—with scope extending beyond what may be covered outside a specific subject area including knowledge of alternative curriculum materials; and
➡ general pedagogical knowledge.

Shulman provided his framework at a time when only a few individuals—like Seymour Papert[9]—had asserted their optimism about the potential of ICTs (or more accurately computers) in learning. Thus, it is unsurprising that his work is missing the technology dimension. This dimension is incorporated into the TPACK framework, as depicted in Figure 4.4.

As seen from this figure, technological knowledge (TK) intersects with PCK to create TPACK. Akin to PCK, TPACK is a strategic knowledge form. The key difference is that

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[9]He is a man that was presumably "laughed at [...] in the sixties when he talked about children using computers as instruments for learning and for enhancing creativity"[260]. Today, his work has shaped and influenced our views on the use of computers (or ICTs in general) in learning.
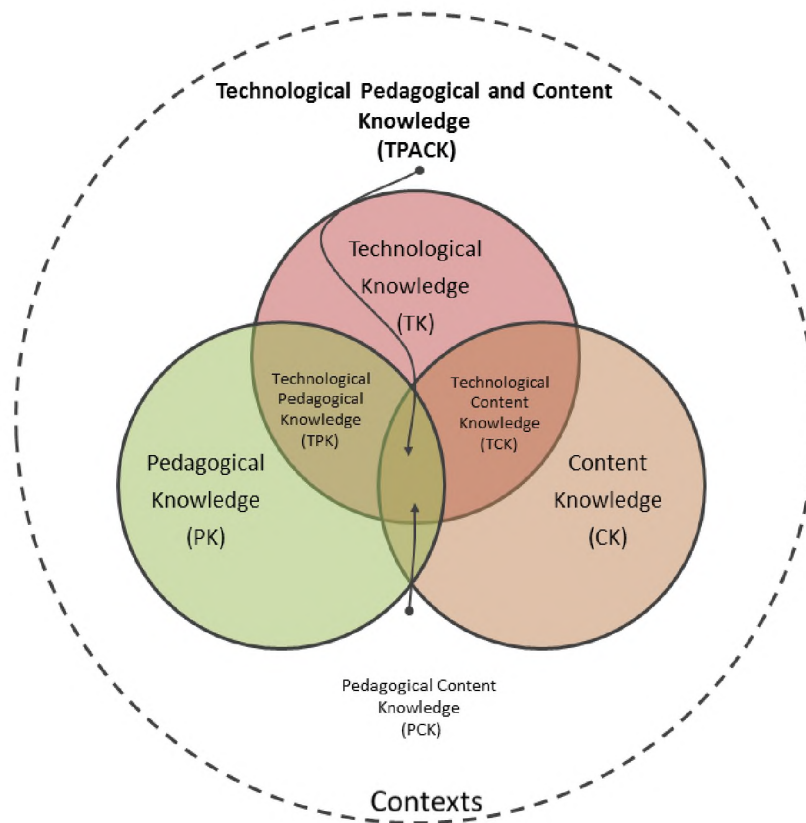
Figure 4.4 – TPACK Framework [153]

TPACK accentuates the importance of technology in teaching and learning. Hence the description of TPACK as a framework that:

> [...] encompasses understanding [of varied] representations of concepts using technologies; pedagogical techniques that apply technologies in constructive ways to teach content in differentiated ways according to students' learning needs; knowledge of what makes concepts difficult or easy to learn and how technology can help redress conceptual challenges; knowledge of students' prior content-related understanding and epistemological assumptions; and knowledge of how technologies can be used to build on existing understanding to develop new epistemologies or strengthen old ones. [152, p. 3]

There are many other views that challenge to some degree the above description; see [301] literature review on TPACK for a detailed discussion. Angeli and Valanides [21] contest, for example, the use of the term 'technology' as a synonym for ICT. For them, the lack of precision in some instances removes the "theoretical clarity", which is essential for using the TPACK framework effectively. In providing this clarity, they introduce a strand of TPACK, which they call ICT-TPCK.

Our work is rooted in this strand of TPACK. However, to reduce memory overload, we will not qualify 'technology' as proposed by Angeli and Valanides [21]. For us, this is a consideration only because we are proposing for another dimension be added to the TPACK framework to explicitly recognise the value of IK. The next section provides more details on our proposal.

4.3 I-TPACK: For Enriched Multicultural Education

As suggested in the previous section, PCK constitutes the heart of TPACK. One key point that Shulman[263] makes about PCK is that it:

> [...] also includes an understanding of what makes the learning of specific topics easy or difficult: the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons (p. 9).

Embedded in this statement is the role played by IK as background knowledge. The TPACK framework also embeds IK within PCK, and further emphasises its inclusion under 'contexts' of teaching and learning. These 'contexts', as shown in Figure 4.4, act as a demarcation of all knowledges contained within TPACK.

Despite IK being included in some form in TPACK, we believe its framing, particularly within 'contexts', has the danger of rendering this knowledge invisible. This is an issue, for as Shiva [261, p. 2] reminds us, IK can be "made to disappear by simply not seeing it, by negating its very existence". Based on this, we therefore believe it is crucial to explicate, in some contexts, the role IK plays in minimising the disconnect between the 'lived' knowledge and one embedded within the schooling curricula—assuming, of course, we accept that multicultural education has to necessarily value the learner's inculcated world.

We posit that the African rural space is one apt example of a context where the role of IK has to be stressed in both teaching and learning. Accordingly, we argue for TPACK to be augmented for such a context: by making visible the contribution of IK in bridging a divide that potentially serves to devalue a learner's own sense of being or culture. We believe this will discourage (unnecessary) rote learning that stems from using an alien frame of reference in teaching—which in paraphrasing Marais [173], produces 'warehouse'

learners instead of critical learners that will eventually contribute (in a significant way) to endogenous development.

Before getting too much further into the details, we must clarify that we are indeed aware that the explicit inclusion of IK in TPACK adds to the existing complexity of the framework—discussed, for example, by Graham [115] and Niess [207]. To be sure, we are aware that the complexity, at least, arises from two fronts: 1) from the increase in the number of knowledges that the teachers must cope with, and 2) from the fact that IK as a knowledge form is classified as hard to source, due to its tacitness and/or embeddedness in the lived life.

With the above in mind, we argue that uprooting IK from the various contexts of learning is an important step towards a deliberate and conscious move from the ideological to the pedagogical integration of this knowledge in schools. As it might be known, the discussions on IK and its value in formal education have been ongoing for more than a decade in South Africa, driven, in part, by questions such as: 'how do we successfully educate our learners who predominately come from a cultural context based on indigenous epistemology?' [49] and 'how do we transcend the two-tiered racialised institutional structure of education in post-apartheid South Africa?' [171].

At an ideological level, there is a general consensus that the answers lie partly in incorporating indigenous capital content into the curricula—see, for example [170, 199, 220, 226]. This consensus is grounded in two key assumptions. First, we all want an education system that fosters critical thinking and minimises rote learning and regurgitation of facts. Second, and related to the preceding point, we want a transformed education system i.e. one that successfully serves to counter the logic that creates hierarchies of knowledges and relegates other knowledges to the margins.

Figure 4.5 captures the augmented TPACK framework, which we call I-TPACK (pronounced as ee-TPACK). Introducing IK to TPACK, as shown in the figure, brings to the fore the following additional knowledge forms:

- ➡ Indigenous pedagogical knowledge (IPK)
- ➡ Indigenous content knowledge (ICK)
- ➡ Technological and indigenous pedagogical knowledge (TAIPK)
- ➡ Indigenous pedagogical and content knowledge (IPACK)
- ➡ Technological and indigenous content knowledge (TAICK)
- ➡ Indigenous technological pedagogical and content knowledge (ITPACK)

Figure 4.5 – I-TPACK Framework

These additional knowledge forms need to be well understood in order to make I-TPACK functional. To bring this clarity, further research is required to understand how I-TPACK may be cultivated from its constituting knowledge forms. It is, however, important to stress that the ultimate goal of I-TPACK is to promote transformative teaching supported by ICTs; basically, to:

➡ minimise potential 'cultural disconnect' brought by the devaluing of IK.

➡ encourage learning that emphasises inward (i.e. endogenous) thinking.

➡ create positive synergies between IK and western knowledge systems.

To briefly explain the rationale behind the name I-TPACK. We decided to mimic isiXhosa, a language which characteristically uses 'i' (pronounced as ee) to prefix nouns imported from other languages—by way of example, parliament becomes 'ipalamente'[10]. In taking this decision, we were symbolically attempting to convey the importance of language in valorising IK. As Ntuli [220, p. 54] reminds us, "A language represents a specific

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[10]The formal equivalent is *kwiNdlu yoWiso-mthetho.*

world-view and ontology". This inherently means that language provides the grammar
to understanding IK. For, "In IKS communities, language contains movement, process
and transformation" [227, p. 6]: to primarily express the flux in which all things exist
in relation to each other, and in the context of their environment (both physical and
metaphysical).

Of course, even without the naming, the overall importance of language in any endeavour
that relates to teaching and learning is something that has been commented about by
numerous scholars, especially in expressing the interplay between language, culture and
education; see [24, 45, 181, 195, 201, 219, 229, 248]. These works, and similar ones, also
provide a basis to understanding the breadth and depth of the I-TPACK framework.

For example, I-TPACK can be well understood within the bold logic of Afrocentricity in
education, particularly as advanced by Asante [24, 25]. Hence, we are suggesting that
I-TPACK is an Afrocentric framework for a multicultural education in the digital era.

Why use the centric qualifier, specifically with the 'afro' suffix? We believe the lengthy
quote below provides an apt response to this question. As Asante [24, p. 171] notes:

> [...] in education, *centricity* refers to a perspective that involves locating
> students within the context of their own cultural references so that they can
> relate socially and psychologically to other cultural perspectives. Centricity
> is a concept that can be applied to any culture. [...] A person educated
> truly in a centric fashion comes to view all groups' contributions as significant
> and useful. Even a White person educated in such a system does not assume
> superiority based upon racist notions.
>
> [...] The Afrocentric approach seeks in every situation the centrality of the
> African person [...]. In education this means that teachers provide students
> the opportunity to study the world and its people, concepts, and history from
> an African world view.
>
> It must be emphasized that Afrocentricity is *not* a Black version of Euro-
> centricity [...]. Eurocentricity is based on White supremacist notions whose
> purposes are to protect White privilege and advantage. [...] Unlike Euro-
> centricity, Afrocentricity does not condone ethnocentric valorization at the
> expense of degrading other groups' perspectives.

In a country like South Africa, this makes Afrocentricity in education all the more
important. And, explains why from the very dawn of democracy scholars like Ndebele
[197] argued that sincere efforts will have to be made to remould:

> [...] the education system toward one that will inculcate [the] emergent values [of *ubuntu/botho*] and speed up, at the same time, the production of skilled and educated Africans at all levels of social and economic activity (p. 111).

We believe that I-TPACK can contribute towards this vision of education. Firstly because the framework also bodes well with the aims and principles of the recently introduced curriculum, better known as Curriculum and Assessment Policy Statement (CAPS). For example, like CAPS, the framework principally holds that IK must be valued in the education process; as such, it can similarly be argued that it "promotes [use of] knowledge in local contexts, while being sensitive to global imperatives" [77, p. 4]. Secondly, the framework is, in principle, aligned and/or complementary to existing sociocultural and cultural-historical frameworks in education such as Cultural-Historical Activity Theory (CHAT)—stemming originally from the work of Vygotsky [302].

CHAT offers a counter hegemonic perspective for understanding teaching or learning as socially, culturally and historically situated. However, this is not the only reason for singling out this framework. We have singled out CHAT because of its emerging links to TPACK. Terpstra [281], for example, demonstrates how CHAT can be usefully harnessed to develop TPACK as a knowledge form. In a way, this supports the argument for I-TPACK and the "claim that using CHAT leads to changes in the location of representing what is educationally relevant" [248, p. 189].

On the whole, even though much work is still required to realise I-TPACK, this framework—used, possibly, with theories rooted in praxis—holds a potential to ameliorate some of the challenges in education; in part, because of its basic commitment to connect the use of everyday knowledge to teaching and learning in a digital age.

4.4 Conclusion

This chapter reinforced the importance of IK in education, largely through valorising existing works and knowledge of a few select scholars. As we reasoned in the chapter, use of IK can potentially help create a consciousness that will make visible the fact that the success of the privileged within the education system stems from harnessing their background knowledge. This means, to borrow bell hooks [136] words, IK can be used to unlock doors for:

> [...] students to enter passionately [into] a pedagogical process firmly rooted in education for critical consciousness, a place where they [can feel] recognized and included, where they [can] unite knowledge learned in classrooms with life outside (p. 3).

With the above in mind, we specifically advocated for making visible the role played by IK within the TPACK framework; we proposed for the framework to augmented to become I-TPACK. At its core, I-TPACK aims to improve the educational outcomes for all learners. We do acknowledge that it will take years for I-TPACK to take root within our education system. Still, we believe with sustained efforts and commitment to endogenous development, we can reap rewards from adopting I-TPACK as a framework for promoting effective learning and teaching within a 'radically transforming' space of ICTs, while also promoting mutual understanding for a symbiotic multicultural society.

Chapter 5

Knowledge Management Insights for Cultivating IK [11]

Knowledge in today's society is a critical resource. Or, to quote Odora Hoppers [226, p. 8],"Knowledge is a universal heritage and a universal resource. It is diverse and varied". As such, there is a dire need to safeguard and manage this resource as part of ensuring meaningful access and use.

Knowledge Management (KM) as a disciplinary field—albeit difficult to define [105, 164]—focuses on the depth and breadth of what this entails, whilst also striving to ensure that a distinction is made between 'knowledge management' and 'management of knowledge' [110]. Although, this distinction is material and not just a matter of semantics, we eschew it. Instead, and without engaging with the myriad of definitions in existence, we take the broad view of KM as a field that embodies insights, principles, theories and methods that contribute to management of knowledge—as an involved process that includes knowledge capture, creation, representation, sharing and transfer [145, 217].

One insight we glean from KM is that categorisation is essential for understanding and developing appropriate strategies for managing knowledge. In this chapter, we look into categorisation, mainly as a starting point to grappling with the question of how to cultivate and harvest IK suitable for the education process. Given the 'diversity and variedness' of knowledge, we are particularly interested in an understanding that provides a synergistic and harmonised view to categorisation.

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[11]This chapter draws extensively from [166], a published conference paper.
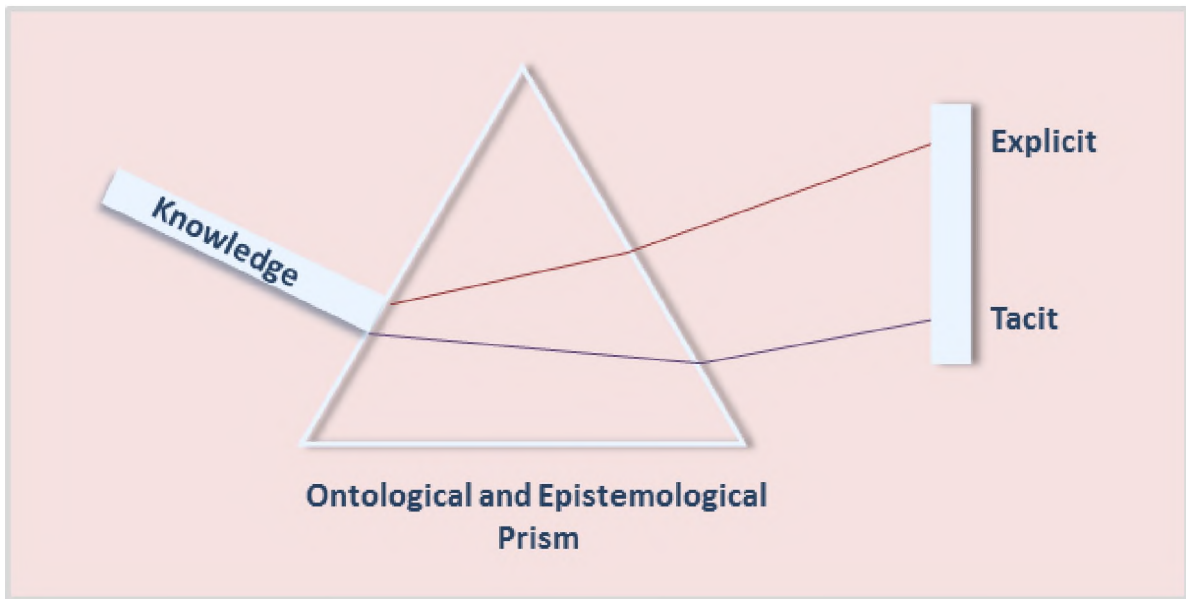
Figure 5.1 – Metaphor for Categorisation: Light Dispersion through a Prism

To us, a harmonised view of categorisation is one which invokes, as a metaphor, the 'dispersion of light through a prism' experiment. Using Figure 5.1 to explain, knowledge is cast onto an ontological and epistemological prism to be separated into a spectrum that ranges from what can be clearly explicated to what cannot. And, between these two ends, the knowledge exists as a continuum that can be expressed in varying levels that capture the abstract/concrete, the historical/ahistorical, the common/esoteric, the local/global, etc. Simply put, the prism acts as a critical filter to processing knowledge.

In direct relation to the position of this thesis—that IK can enhance Black/African education—Dei [76] makes a salient argument that potentially strengthens our prism metaphor, particularly when he writes:

> [...] it [is] imperative to reiterate that in the current epoch of globalization and advance capitalism, schooling and education have become discursively configured to meet the needs of modernization from the context of Euromodernity. For African learners we need to develop theoretical prisms or perspectives that are able to account for our lived experiences and our relationality with other learners. Such prisms will be rooted in our cultures, histories and heritage and be presented as frames of reference for the intellectual and political projects of designing positive (i.e., solution-oriented) educational goals for learners (p. 103).

With the above in mind, the next section will provide a review of how knowledge is
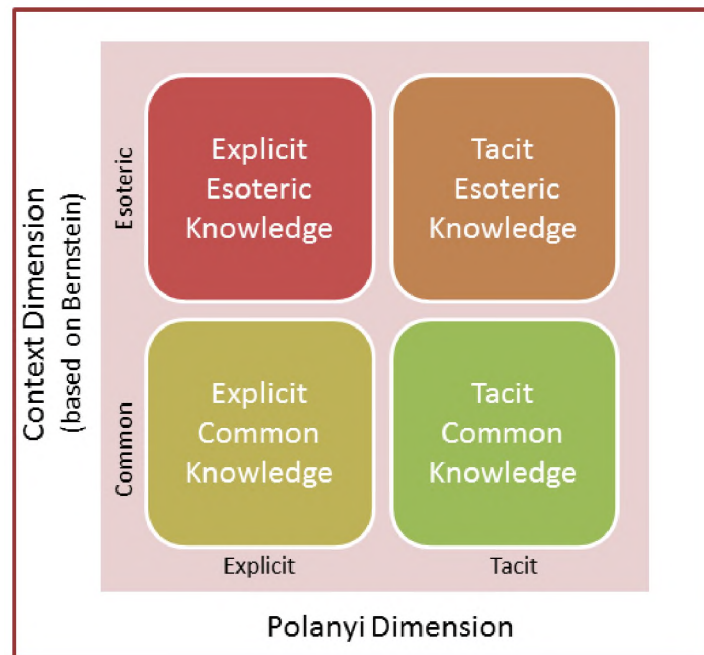
Figure 5.2 – Example of a Basic Two-dimensional Knowledge Categorisation

categorised at a very basic and broad level. This section will be followed by one that discusses categorisation of IK. The logic to the sections does not imply that a dichotomy exists between IK and western knowledge—for, as we previously pointed out, Agrawal [14, 15] and Dei [74], for example, warn against this type of thinking.

5.1 Basic Knowledge Categorisation

Categorisation—often, but mistakenly treated, as a synonym for classification—refers to a "process of dividing the world into groups of entities whose members are in some way similar to each other" [142, p. 518]. Inherently, this makes any task related to categorisation non-trivial. This is because the task can be achieved in various ways depending on how the domain of discourse is conceptualised, and/or based on the criteria that is used to render the resulting categories beneficial. However, once the work is done, Kwanisk [157, p. 24] rightly reminds us that the output "can be used as a rich representation of what is known and useful in communication and in generating a fresh cycle of exploration, comparison, and theorizing".

Available literature suggests that categorisation, at its most basic level, can be achieved along two dimensions [17, 212, 244]. We respectively refer to these as the *Polanyi Dimension* and the *Context Dimension*. The former, common for most categorisations, is based largely

on Michael Polanyi's philosophical inquiries on knowledge, while the latter draws from works of other scholars relevant to the context or domain of discourse for which the categorisation based on.

Figure 5.2 provides an exemplification of a categorisation that embodies context suited specifically to our work. As shown in the figure, this context is shaped by Basil Bernstein. In the next subsections, we will discuss briefly the salient points that make Polanyi and Bernstein categorisations relevant to this thesis.

5.1.1 Polanyi – Explicit/Tacit Categorisation of Knowledge

A long and deeply embedded belief is that all knowledge can be categorised as either explicit or tacit. Explicit knowledge refers to knowledge that can be codified and articulated in some language or format, while tacit knowledge refers to knowledge that cannot be easily articulated in any coded format [96, 203, 212].

Polanyi cautiously accepted this categorisation. His main caveat was that explicit knowledge cannot be seen as distinctively separate from tacit knowledge because "we can know more than we can tell" [244, p. 4]. As he clarified in one of his publications:

> [...tacit and explicit knowledge] are not sharply divided. While tacit knowledge can be possessed by itself, explicit knowledge must rely on being tacitly understood and applied. Hence all knowledge is either tacit or rooted in tacit knowledge. A wholly explicit knowledge is unthinkable [243, p. 7].

This astute assertion by Polanyi is very pertinent to this thesis. Firstly, it explains why knowledge cannot be explicated completely from the minds of the people that hold it. Secondly, it reinforces, for example, the need to be selective in representing knowledge: given the impossibility of representing explicitly all that is tacitly known and understood by a person or community.

Both reasons (which are interrelated), highlight an inherent problem with any endeavour that aims to cultivate and codify knowledge. But more specifically, they point to a key limitation of the work in this thesis.

5.1.2 Bernstein's Categorisation

Categorisation, as already alluded to, can be carried out in many ways; fundamentally, this makes the task vantage point dependent. To establish Bernstein's vantage point and/or categorisation, we start off with a brief context to his work (which, as a disclaimer, does intersect with Bourdieu's work, discussed in the previous chapter).

For about four decades, Bernstein devoted himself to finding answers that may explain how social inequalities may be perpetuated/engendered through schooling. Bernstein's work, through continuous revision and augmentation, demonstrated how language (codes), social class and knowledge structure interact with each other to influence schooling outcomes—see, Hoadley and Muller [134] or Maton and Muller [176] for a concise but detailed review of Bernstein's work. In this subsection we are interested in aspects of his work that have evolved from the paper titled, "*On the classification and framing of educational knowledge*" [36].

As his 'criteria' for categorising knowledge, Bernstein used complementary discourses—that he termed horizontal and vertical discourses—to argue the existence of two basic types of knowledge. The first is *common, everyday or mundane knowledge*, which is derived from the horizontal discourse, and the second is *esoteric or theoretical knowledge*, which emanates from the vertical discourse.

Both discourses are important to this thesis, albeit one more than the other. The discourses lay the foundation to understanding the differences between mundane knowledge and esoteric (or school oriented) knowledge. They explain how, for example, meaning (or knowledge) is formulated in the material (everyday mundane) world and the immaterial (transcendental) world. In a horizontal discourse, meanings never transcend their immediate context: they are restricted to everyday or mundane contexts [38, 134]. On the contrary, meanings in a vertical discourse transcend the immediate context: there is a coherent, explicit structure that exacts a systematic and/or hierarchical ordering of principles, which facilitates meaning to be generated—independent of (the immediate) context—as "an on going process in extended time" [38, p. 161].

Between these two discourses, the horizontal discourse has a higher appeal to us—since the knowledge it sanctions strongly correlates to IK. According to Bernstein [38, p. 159], the knowledge under this discourse "is likely to be oral, local, context dependent and specific, tacit, multi-layered, and contradictory across but not within contexts". Based on this description, it is our opinion that the horizontal discourse offers a useful frame for understanding how IK may be freed from the local context to circulate in other contexts.

As a prerequisite to gaining this understanding, the next section explores how IK is categorised. The actual unpacking of how knowledge flows and circulates is done in the penultimate section: through a generic discussion on knowledge creation and transfer on the one hand, and, on the other, through a restricted elaboration of how knowledge is pedagogised. The latter draws on Bernstein; we hope, therefore, that the discussion will serve to further cast light on our vantage point to categorisation.

5.2 Indigenous Knowledge Categorisation

As we have already suggested, any task related to categorisation is non-trivial; primarily because of how the domain of discourse is conceptualised, and the criteria that is used to render the resulting categories beneficial. In this section, we will further illustrate this point by looking into two IK categorisations, which are relevant to our work.

The first categorisation is one-dimensional in that categories are simply teased out from how IK is defined. That is, there is no specific criteria other than what is believed to constitute IK. Specifically, as stated by Dalvit, Murray and Terzoli [67], three categories of knowledge comprise IK: *traditional, common* and *specialised* knowledge.

The second categorisation, depicted in Figure 5.3, is multi-dimensional, and was proposed by Thinyane [284]. According to this categorisation, there are four categories of knowledge comprising IK: *common, culturally shared, specific group* and *specialist* knowledge. To discern potential use and availability, each category is mapped along dimensions four dimensions: Ownership, Social advantage, Confidentiality and Accessibility (OSCA) [284].

The above two categorisations are not at odds with each other, even though the basis of their formulation is different. Figure 5.4 provides a mapping between these two categorisations to show how, for example, the second categorisation can be reproduced from the first. Solid lines suggest mapped categories are strongly correlated to each other—there is a high probability of locating the same piece of knowledge using either of the two categorisations. On the contrary, the dashed lines represent a weak correlation; these lines specifically compel one to view 'specific group knowledge' from different dimensions—as perhaps recommended by Thinyane [284].
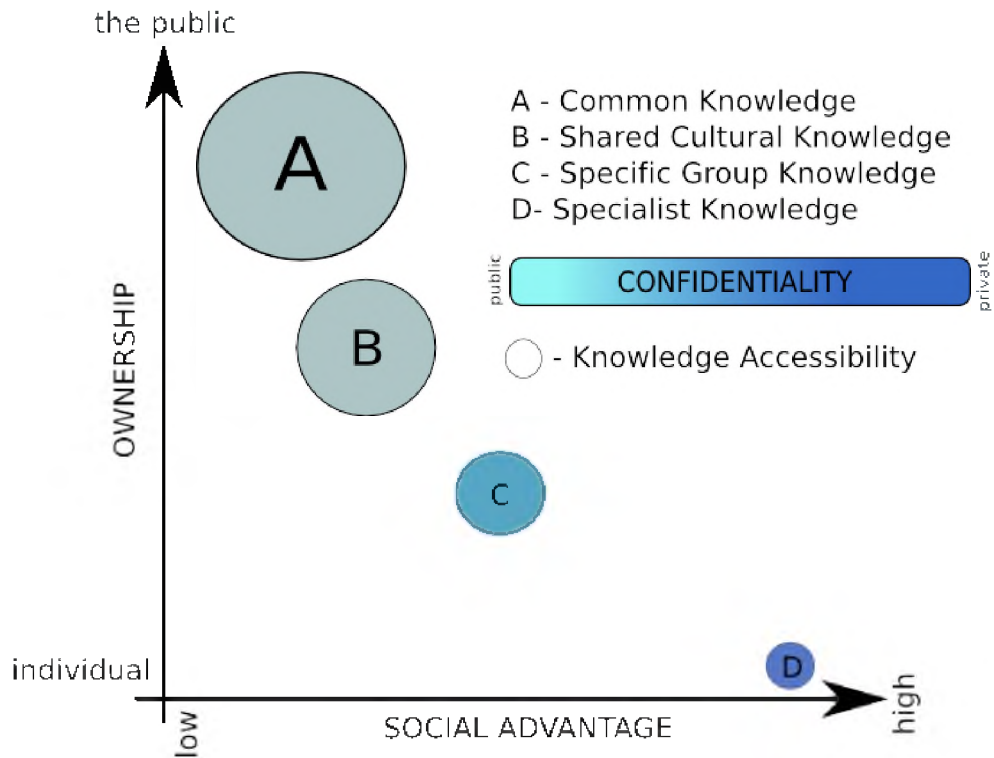
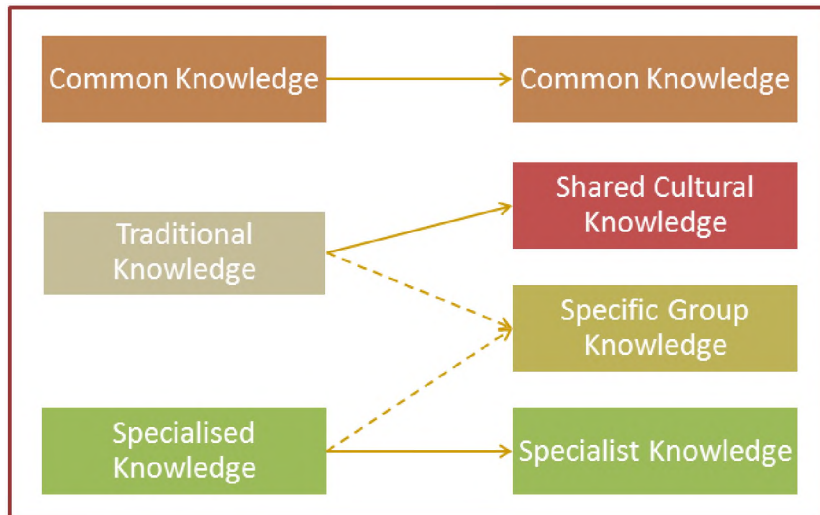**Figure 5.3** – The OSCA Knowledge Matrix [284]

Figure 5.4 – A Mapping between Two IK Categorisations

5.2.1 Key IK Categories

In this subsection, we shall provide a brief description for each category that features in the two categorisations mentioned above. Hopefully, this will help to clarify the mapping between the categorisations, as depicted in Figure 5.4.

1. **Common Knowledge**

   This refers to knowledge which we can claim is known by everybody and concerns every aspect of daily life [67]. On the one hand, the universality attributed to this knowledge makes it easier to access, as it is open and readily available to the public. On the other hand, it poses a challenge in validating it as truly universal. This means care must be taken in codifying this type of knowledge for use in a (formal) educational context: to minimise poor conceptualisation of curricula knowledge. Otherwise, the sterile dichotomy between indigenous and western (scientific) knowledge will persist to the detriment of empowering the disadvantaged [14].

2. **Traditional Knowledge**

   There is no clear-cut definition for traditional knowledge. Yet, in terms of what is recognised as IK, this category eclipses all others (hence a common tendency to treat it as a synonym for IK). Dalvit *et al.* [67], for example, provide a description that centres on what associates this knowledge to its recognition. As they state, this knowledge "is often associated with the religious, spiritual or occult sphere, and is validated by having been part of a specific culture for a long time" [67, p. 288]. By angling towards how this knowledge is validated, Thinyane [284] through use of OSCA parameters, divides it into *shared cultural* and *specific group* knowledge (in lieu of defining it as one monolithic entity).

   (a) **Shared Cultural Knowledge**

      This refers to knowledge specific to a particular cultural group. This knowledge embodies cultural practices, values and beliefs of that particular group. It also includes knowledge that provides skills for survival. For the most part, this knowledge is openly accessible to its group and the public in general—since it is non-confidential and non-proprietary. In recent years, this has spurred a number of debates concerning the possible exploitation of the 'indigenous people'. Hence, it is crucial to exercise diligence in cultivating this knowledge, despite it being open.

(b) **Specific Group Knowledge**

This knowledge is held by particular groups that may share specific interests, values, heritage, skills, tastes, etc. In some ways this knowledge can also be regarded as clique owned knowledge. For this reason, this knowledge tends to be private and confidential to those who own it. Still, because of the dynamic nature of IK, aspects of this knowledge may become common knowledge in time, space or perspective.

3. **Specialist Knowledge**

This knowledge is confidential and similar to specific group knowledge, except it is intrinsically tied to specific fields of (a)vocation. Further, it is often held exclusively by "experts" in those fields, who usually pass it on in an apprenticeship style to 'designated' protégés or heirs. Inherently this makes access to this knowledge rather stringent, in that privilege is attached to its communication.

As the above descriptions possibly reveal, the boundaries between the categories are weak or non-restrictive. Further, the boundaries are not absolute: time and space can have a blurring effect. Essentially, this means we cannot expect to locate various kinds of knowledge exclusively within particular categories.

Figure 5.5, for example, shows a categorisation based on the use of the OSCA framework for various pieces of knowledge that reside among community members within a context like the SLL. In the figure, confidentiality and access have been combined into one parameter, represented by the size of the bubble. What this figure confirms is that some knowledge will reside on the boundaries; based, of course, on the criteria used for the categorisation.

The criteria itself depends on factors that include how the knowledge is understood and/or conceptualised. To clarify, let us consider, for example, how initiation knowledge could have been placed in Figure 5.5. As common knowledge, initiation is understood as a rite of passage to adulthood that allows, among other things, for individuals to acquire specialised knowledge about their cultural and group belonging. With this in mind, was it possible to legitimately position knowledge about initiation at the intersection of all categories, without losing qualities of exclusivity? Or, given that we are using a two-dimensional representation, was it justifiable to opt for a positioning that puts emphasis on the sacredness of this knowledge—to highlight the importance of dimensions of access, confidentiality and ownership, as proposed by Thinyane [284]? Using a *siNtu* cultural lense, both these questions could, in fact, be answered in the affirmative, and without contradiction—for, akin to postmodernism, understanding is contextually negotiated.
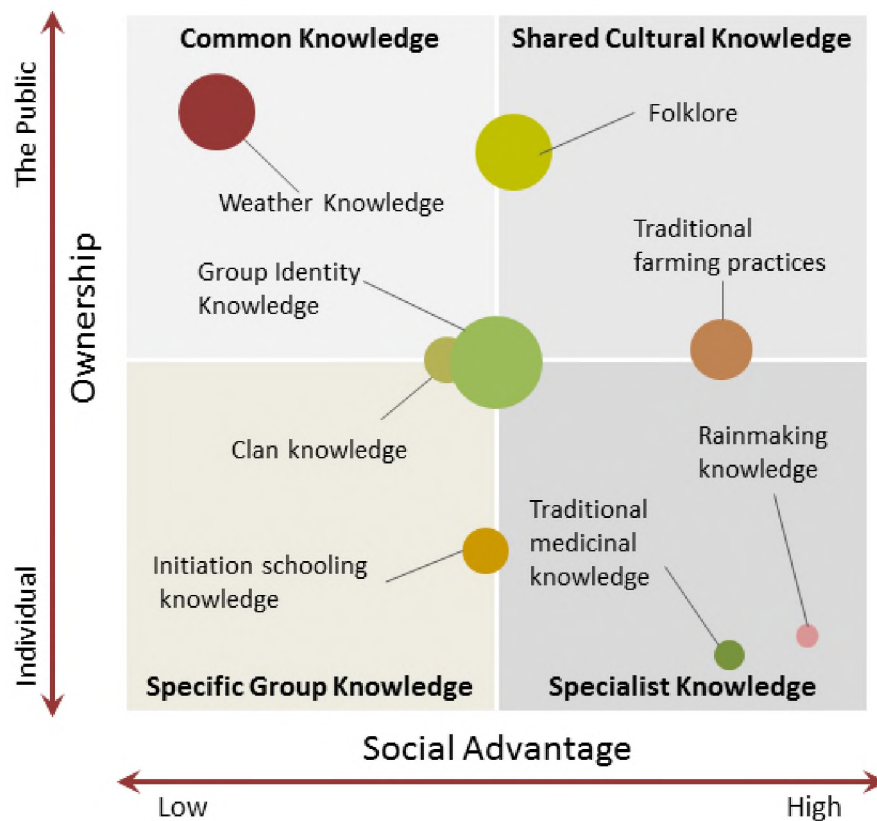
Figure 5.5 – Possible positioning of different instances of IK using the OSCA

So, what intrinsically makes these questions pertinent is how they provide yet another reminder that positioning of any knowledge, and not just IK, lies in the ideas of utility and representation. And through these ideas, why it might be important to think broadly about questions such as:

➡ How can boundaries that mimic access and confidentiality restrictions within a community or locality be maintained in cultivating and harvesting IK?

➡ How do we ensure that these boundaries can shift to reflect the dynamic nature of IK, yet remain protective enough to limit 'intellectual piracy'? .

As it might be evident, these questions have implications for building or selecting an appropriate (digital) IK platform for the intended use. The next subsection explores some of these implications.

Figure 5.6 – IK Life Cycle (adapted from [313])

5.2.2 Implications for the IK Platform Design

As already alluded to, there are a number of implications that need to be considered carefully in order to build or select an effective and usable digital IK platform that, for example, strives to maintain context in tact to ensure proper understanding of the content it will store and disseminate. These implications stem from questions pertaining to identification and/or categorisation of what qualifies as IK, in broad and specific terms.

One key implication for the platform is that it needs to allow multiple views of reality to be represented, as well as permit—to some degree—for contestation/debate to happen around the represented knowledge. This is important for capturing the pluralistic nature of IK, and for enabling validation to occur through collective consensus of the community, which holds the knowledge sought after.

Hence, the platform must support the manner in which IK is exchanged and adapted within the community. Figure 5.6, a representation of the life cycle of IK adapted from [313], captures the steps needed for 'architecting' this support. As the figure shows, the life cycle begins with recognition and identification of IK, moves to capturing, then to the processing stages where, among other things, the knowledge is validated before it is stored and availed for usage.

As it might be expected, the task of recognition and identification is not trivial. The teasing out of various pieces of knowledge, which comprise IK requires sensitivity to context, sometimes in a very nuanced manner: typically influenced and rooted in epistemological and ontological considerations, which intrinsically dispel the idea of packaging knowledge into (neat) categories.

A second key implication, stemming and entwined from the first, is that experts (or expertise) may be required to disambiguate meaning from multiple interpretations, particularly between the discovery and the validation phases of IK. Hence, mechanisms or processes for establishing the 'authenticity' of IK (to be stored in our platform) must be carefully designed to ensure participation by all relevant stakeholders.

Implications	
Access	• Simple interfaces needed to minimise distractions in carrying out a task, but also to achieve inclusive access • Language restrictions should be avoided • Different end-user devices should be supported

Representation	• The domain of discourse should be modelled with fidelity and clarity; as such, expressive knowledge representation formalisms or technologies are needed for purposes of:
	  – Preserving, as much as possible, context of use
	  – Enabling intelligent reasoning
	  – Facilitating discovery of new knowledge
	• Decisions in the overall implementation of the platform must be representative of the cost realities; this is also a matter of access

Sustainability	• Overall decisions for design and implementation must foreground sustainability at the level of:
	  – Making maintenance easy
	  – Enhancing use through sensitive application of usability theories, principles, and guidelines.
	  – Factoring in broad environmental issues
	• Leveraging of tools (e.g. audio-visual support tools for users) should be done in strategic and futuristic manner that aligns with trends

Table 5.1 – Technology implications for building an IK Platform

Further, effort must be made to ensure that different modalities are supported, together with varied perspectives that may allow different levels of participation. This idea links issues of access to Knowledge Representation (KR)—to be discussed in the next section—and by extension, those that relate to sustainability. This linking comes with hidden implications. Table 5.1 provides a summary of these implications from the vantage point of building or selecting an appropriate ICT based IK platform for a context like the SLL. As it might be concluded, most of these tabled implications point to the importance of understanding the sway of human and social dynamics in enabling use of the platform. Or, to put it differently, they advance a deep understanding of why users must be at the centre of the design process. An understanding such as one advanced by Heeks [131] that technical/technological implications for a design, although important, should, if needs be, be subordinated to the overall needs and realities of the users.

5.3   Knowledge Representation

Knowledge Representation is important to any work related to KM. According to Davis, Shrobe and Szolovits [72], the best way to understand KR is through the five key roles that it plays. These roles (to varying degrees) simultaneously position KR as a:

1. *surrogate*—a substitute or stand-in for things that naturally exist in the world under discussion, which enable reasoning about that world to happen. In principle, there can never be a perfect representation/surrogate. However, it is possible to have one that closely resembles the 'intended referent' in the world. Thus, with an understanding that "any imperfection can be a source of error" [72, p. 19], care needs to be taken in the selection of a representation.

2. *set of ontological commitments*—a sum total of decisions that reflect what is made (in)visible in a representation. A question of import for making these decisions is: which parts of the world need to be brought in 'sharp focus' and which parts require 'blurring'? Or rather, which aspects of the world being represented are most relevant? The latter framing, in serendipitous manner, connects to philosopher Herman Dooyeweerd's theory of modal aspects. In a very simplistic manner, this theory explains how our everyday experience is distilled from different but mutually dependent spheres (i.e. aspects) of meaning [29, 30]. As a consequence, the theory makes it possible to see why some aspects of knowledge cannot be represented. But most importantly, the theory makes it possible to reconcile the idea that KR can be seen under multiple lenses—as, for example, this section posits.

3. *fragmentary theory of intelligent reasoning*—a basis for assessing a representation by looking into what it fundamentally qualifies as an intelligent inference, on the one hand, and, on the other, as valid set of inferences to sanction and recommend. Basically, this assessment focuses on answering the following three questions: '(i) What does it mean to reason intelligently?, (ii) What can we infer from what we know?, and (iii) What ought we to infer from what we know?'

4. *medium for efficient computation*—a means to yielding recommended inferences without wasting resources. The central question here is: how do we compute with a representation to yield results in a timely and efficient manner?

5. *medium of human expression*—a means by which people articulate what is in the world. Or rather, a language that captures how well and perhaps, how easy it is to communicate what is represented.

As Davis *et al.* [72] further note, the above roles have important implications for both research and practice. Specifically for practice, they provide a framework that helps "to characterize and make explicit the 'spirit' of a representation" [72, p. 28]. That is to say, the roles provide a logic that can be used to select an appropriate representation for any given task. This is because understanding the connectedness of the roles makes visible the paradoxes and competing demands inherent in a representation. And this, in turn enables selection to become a product of intelligent trade-offs among various desired characteristics.

It is against this backdrop that Davis *et al.* [72] make a point to remind us that:

> Although the representation we select will have inevitable consequences for how we see and reason about the world, we can at least select it consciously and carefully trying to find a pair of glasses appropriate for the task at hand (p. 28).

Reverting back to the initiation knowledge example in the previous section. Because we were using a two dimensional matrix, we had a limitation in terms of placing this knowledge at the boundaries of three categories. This is a particular consequence to the selection made and does not negate the fact that a Venn diagram could have been used—perhaps, had the discussion at hand not been around the OSCA framework.

Bottom-line, in order to make an appropriate selection, it is imperative that representations are "understood on their own terms and used in ways that rely on the insights that were their original inspiration and source of power" [72, p. 32]. This understanding translates to better management of knowledge.

5.4 Knowledge Creation and Transfer

As alluded to before, our contemporary society—aptly called the knowledge society—is in constant pursuit of new knowledge. Knowledge creation and transfer are thus paramount for survival.

This section reviews a fairly popular model, called the Socialization, Externalization, Combination, and Internalization (SECI) model, which explains how knowledge is shared and created. This model (to be discussed shortly) originates from Nonaka's [212] inquiry on what qualifies as a 'knowledge creating' company, and has evolved through input of his colleagues [215, 216, 217] to become the cornerstone of knowledge creation and transfer.
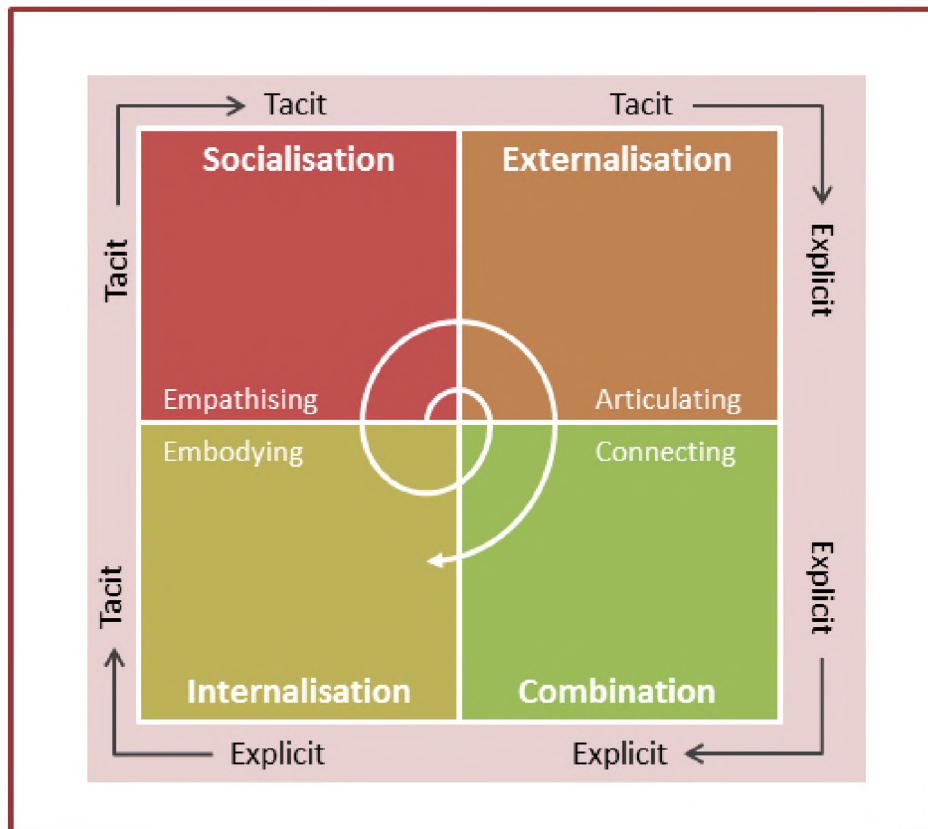
Figure 5.7 – The SECI Model by Nonaka and Takeuchi [215]

5.4.1 The SECI Model and Knowledge Conversion

The SECI model, as shown in Figure 5.7, is attributed to Nonaka and Takeuchi [215]. This model presupposes, like Polanyi [244], that all knowledge can conditionally be categorised as either tacit or explicit. Based on these two knowledge categories, the model expounds on how their interaction facilitates knowledge creation and sharing.

Mathematically, there are four permutations or ways in which these interactions can happen between the tacit and explicit. These are named and explained as follows:

1. ***S**ocialisation*—from tacit to tacit. Akin to how indigenous specialist knowledge is exchanged, knowledge transfer is based largely on the apprenticeship of teaching and learning. That is, knowledge is gained through guidance, practice, imitation and observation. Nonaka [212, p. 99] argues that this "is a rather limited form of knowledge creation. [... As] neither the apprentice nor the master gain any systematic insight into their craft knowledge".

2. ***E**xternalisation*—from tacit to explicit. This conversion process focuses on how to articulate or explicate tacit knowledge. The articulation demands good communica-

tions skills. This one of the reasons the process can be deemed difficult. To ease the process, Nonaka [212, 213] proposes use of metaphors. Further, he argues that any contradictions resulting from use of metaphors should possibly be harmonised through use of analogies.

3. *Combination*—from explicit to explicit. This is regarded as the simplest form of conversion: as the process entails combining already explicated knowledge to create new knowledge.

4. *Internalisation*—from explicit to tacit. This form of conversion, as Nonaka [213, p. 19] argues, "bears some similarity to the traditional notion of 'learning'". Explicated knowledge is used as the foundation for knowledge acquisition and transfer. Also, through the process of assimilation or internalisation new knowledge is created, at least in the sense of tacitly held knowledge being modified and/or augmented.

According to Nonaka [212, 213], these four knowledge conversion processes reinforce each other to enable knowledge growth. The spiral shown in Figure 5.7 serves to communicate this fact. Basically, as Nonaka [213, p. 15] puts it, the "spiral illustrates the creation of a new concept in terms of a continual dialogue between tacit and explicit knowledge."

Overall, this broad conceptual illustration has lead to the wide acceptance of the SECI model [113, 276]. However, this is not to say the model has no flaws. Gourlay [113], for example, has written about the empirical shortcomings of the model—a critique, among several, based on general concerns that the model might be too rooted in the Japanese cultural context to be usable in other contexts.

Nonaka and his colleagues have responded to some of the criticism, and in so doing have not only brought clarity to the model, but have also augmented it; see [214, 216]. The augmentation includes the addition of the Japanese concept of *ba*, "which can be thought of as a shared space for emerging relationships" [214, p. 40]. *Ba* expands understanding of the SECI model by making explicit the importance of context, both in the broad and lived sense, to knowledge creation. Arguably, this explication ties knowledge creation in profound ways to IK. That is, provided we grasp that "*ba* is a context which harbors meaning" [214, p. 40], and as such, without knowledge of the local (IK), we lose some perspective and/or the potential to transcend between the knowledge boundaries.

There are four types of *ba* that correspond to each of the four knowledge conversion modes described in the SECI model. We will not discuss these here, but we must emphasise that each type of *ba* contributes to "the dynamism to continually create new knowledge through a cycle of converting tacit knowledge into explicit knowledge and then reconverting it into tacit knowledge" [214, p. 47].

5.4.2 Knowledge Conversion—Educational Context

It is worth reiterating that one of the objectives of this thesis is to explore how IK—suitable for acquisition of school knowledge through the process of recontextualisation—can be availed via a digital platform. We believe explicating this knowledge can facilitate increased (re)production of educational content suited to the needs of the African child.

The next chapter will offer a glimpse of the content we have in mind. For now, the objective is to demonstrate that the SECI model can be used in the educational context. Specifically, the model can be used to complement Bernstein's analysis. Part of this analysis is crystallised through a complex framework known as the 'pedagogic device', which explains how knowledge is converted (or translated) into pedagogic communication.

Before we proceed, it is worth mentioning that the pedagogic device encapsulates part of the answer to Bernstein's enduring sociological question: "How does the outside become the inside, and how does the inside reveal itself and shape the outside?" [37, p. 94]. It is in relation to this question that one, for example, understands Hoadley and Muller [134, p. 74] point that Bernstein's publication on the pedagogic device was "a terse and somewhat enigmatic statement of his theory. [... It] was an ambitious attempt to capture the role of education in the sociological big picture, reaching from social structure to individual consciousness".

While the sociological analysis is important to this thesis, we will abstract away from it: to but focus on the essence of what constitutes the pedagogic device. As better summarised by Hoadley and Muller [134, p. 74]:

> The pedagogic device consists of a hierarchical relation between three sets of rules—distributive, recontextualizing and evaluative—that together describe the process of the transformation of knowledge from the field of production of knowledge, to the field of recontextualization, to the field of reproduction in the classroom.

As noted by Singh [267, p. 574], the fields are also "hierarchically related, in that, recontextualization of knowledge cannot take place without the original production of knowledge, and reproduction cannot take place without recontextualization".

The above withstanding, an argument can be advanced that recontextualisation has a symmetric relationship with both production and reproduction fields. The premise for
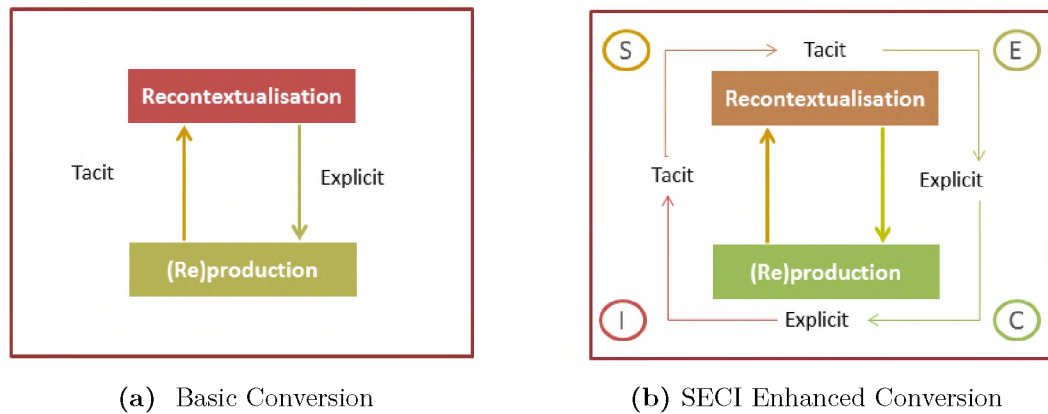
(a) Basic Conversion

(b) SECI Enhanced Conversion

Figure 5.8 – Conversion of Educational Knowledge

this argument lies in Polanyi's view, discussed in section 5.1, that "all knowledge is either tacit or rooted in tacit knowledge" [243, p. 7]. Based on this assertion, we can collapse, without contradiction, production and reproduction into one: to represent, as depicted in subfigure 5.8a, recontextualisation as a process that makes the tacit explicit. In so doing, we confirm not only the symmetric relation, but the very idea that knowledge creation is a dynamic and spiralling process rooted in the tacit—given, as Polanyi explained, that we cannot expect produced or reproduced knowledge to ever be fully explicated.

As previously stated, the SECI model also describes knowledge creation as a spiralling process. This suggests, indeed, that the SECI model can be used to understand, in broad strokes, how knowledge, outlined in the pedagogic device, circulates. Subfigure 5.8b speaks to the complementary role of the SECI model to the abstract comprehension of Bernstein's theory as encapsulated by the pedagogic device.

In sum, without depicting the rules that regulate pedagogic communication—as outlined in the description of the device—the subfigures in Figure 5.8 paint a clear picture that the SECI model can be used to understand how knowledge in the educational context circulates.

5.5 Conclusion

The undertaking of this thesis is to contribute a solution towards the cultivation, harvesting, preservation and use of IK in formal education. KM provides many insights and perspectives pertinent to each activity just mentioned. However, for pragmatic reasons, in this chapter we used an eclectic approach to specifically gain insights relevant to cultivation and harvesting. To this end, we looked at categorisation, which as explained, provides a broad understanding of how knowledge in any given domain can be differentiated (into categories). Further, to grapple with how to represent our category of interest, the chapter explored the fundamental roles played by KR. These roles, in concert, provide a frame for selecting a suitable representation—aligned to the goals of use and preservation.

The actual use and preservation of knowledge can be activated through an understanding of knowledge creation and transfer processes. Based on this, we introduced the SECI model, which arguably "has become the cornerstone of knowledge creation and transfer theory" [276, p. 544].

As a footnote, this model amplifies the importance of IK. The use of *ba* to bring clarity to the model makes this link clear. Firstly, it inadvertently illustrates Mafeje's point on endogeneity and its imperative to suffice internally held knowledge for developing theories and paradigms that are rooted in the local, 'the ultimate firma terra'. Secondly, it reinforces Ntuli's [219, 221, 220] argument on why the Japanese offer a good template to follow in terms of using IK in developmental and educational efforts. As Ntuli writes: "[the Japanese] harnessed their indigenous knowledge systems to develop themselves and to do this they shaped their education to suit Japanese conditions" [221, p. 174]. By way of conclusion, this implicitly suggests there is hope in following strategies and implementation approaches that adopt and adapt the Japanese motto: 'Japanese spirit, Western technology'. The next chapter contemplates how this is achievable in the context of developing an apt solution for this thesis.

Chapter 6

Praxis: For Implementing Digital Everyday IK for Educational Use

The previous chapters collectively served to provide the context, rationale and a theoretical framework for exploring how IK can be injected to the formal education process: to ultimately help reduce the alienation brought by the current banking education system. The even numbered chapters, in particular, were the loom on which the fabric of the argument was woven on. Chapter 2 cultivated the thesis perspective on the (known) link between development and education. Chapter 4, building on this perspective, attempted to show how education rooted in IK may translate to endogenous development. Further, in tying formal education to schooling, the chapter laid the foundation to understanding that schools, as structures of social reproduction:

> can also marshal, or be marshalled into, potentially powerful strategies for tackling (at the local level, at least) some of the structural underpinnings of social and educational disadvantage. They can, moreover, do so without necessarily falling into the trap of casting children, families and communities as the dependent clients of school professionals who claim to 'know best' [86, p. 189].

This thesis holds that IK qualifies, at some level, as a strategy for marshalling social change. Mainly in that the indigenous epistemologies support a pluralistic approach to education that can potentially help to think, unthink and/or rethink both development and education [11, 198].

Nyoka [225], as quoted in the first chapter, expressed how seemingly easy it has been to "extol the virtues of 'indigenous knowledge systems' [than to] actually produce [these] systems". Indirectly, this inspired us to ask: aside from the insinuated lack of willingness by scholars and other stakeholders to forge ahead with the task of availing IK(S) [225], what other factors have acted as a barrier? In other words, what will it take to produce or document IK, given that this knowledge typically exists in tacit form?

To be concrete and realistic, we decided from the outset that our imperative was to produce IK that could be used to solve an actual problem. This imperative merited a textured and theoretically rich review as provided in the previous chapters in order to curve out a fitting strategy of implementation based on pragmatism and praxis.

As part of formulating this strategy, this chapter will look into the practical questions for availing IK from a digital or ICT based platform. In 'pursuit of endogeneity'—as Adesina [12] puts it—the questions will stem from an inward perspective of finding fitting solution(s) to outlined needs, and not the outward perspective of attempting to prioritise use of new technologies. This perspective is also informed by the view that 'technovelty' (i.e. technological/technical innovation) may not be as important as social or other forms of innovation.

Heeks in a number of his works speaks to this view; in fact, this is part of the reason we specifically mapped the journey of ICT4D in Chapter 2 based on his paper, titled: 'The *ICT4D 2.0 Manifesto: Where Next for ICTs and International Development'* [131]. In this paper, he argues that ICT4D, to avoid more failures, must strive to bring balance between the technical and the social: instead of privileging the technical over the social. To bring this balance, Heeks [131, p. 5] recommends, to quote him verbatim:

⟹ Less emphasis on what might be used (the Internet and PCs), and more emphasis on what is actually used (mobiles, radio, television).

⟹ Less emphasis on fundamental technical innovation; and more emphasis on application and business model innovation.

⟹ Less emphasis on piloting and sustaining new applications, and more emphasis on assessing and scaling existing applications.

These recommendations in a sense are orientating us towards the concept of 'light design' in searching for a solution that may be deemed appropriate.With the various points of emphasis in mind, the next section will attempt to map out the content that the IK platform should ideally store.

6.1 Mapping Platform Content: Guiding Questions

As we have already alluded to before, there are numerous questions that we should ask in pursuing the goal of having an ICT based IK platform suited for the formal educational context. Some of these questions include long-posed questions with which it is critical for us to (re)engage.

Es'kia Mphahlele an educationalist and a writer of note, asked a range of questions that remain important to the topic of how to provide education that does not alienate the vast majority of learners that reside in the margins of our society. Selecting only a few of these questions, Mphahlele [193, pp. 41, 42], quoted verbatim, asks:

⇝ Can primary and secondary school teachers be inspired to rewrite folktales, myths, praise and heroic songs, proverbs, lyrics or work songs past and present in various languages, inexpensively reproduced, for use at all levels from Grade 1?

⇝ Are we willing to find common ground for a drastic overhaul of the examination system to accommodate the process of liberalizing the curriculum?

⇝ Are we willing to confront and resolve the dramatic transformation of the culture of literacy and independent enquiry to a consumerist culture that rides on the wings of the media, especially television and print?

The first question in particular resonates more with this thesis in how it advocates for teachers to take charge in creating content that students may identify with. Language, indeed, is key to this goal. However, it is not the only dimension of import; the cultural dimension also matters. This means, beyond just literally translating stories such as 'Goldilocks and the three bears' into mother tongue language —as done in transformative learning programs like *Takalani Sesame*, an adaptation of an "internationally acclaimed children's educational media program, Sesame Street" [258]—we need to infuse other culturally relevant aspects that students will identify with. Why? So as to not assume that it is non-alienating to ask a black Xhosa child, whose idea of locks is represented by dreadlocks, and gold might not even be associated to hair, a question such as: '*kutheni igama lakhe nele Goldilocks?*' ('why is her name Goldilocks?').

Mphahlele essentially understood the problems inherent to translations; hence his proposal for folktales to be rewritten. For him, we argue, all tales carry their symbolism. For example, Goldilocks' golden hair could be understood as a symbol of joyful innocence. Hence, why it may be deemed legitimate to ask the question: 'why is her name Goldilocks?'.

As we have just argued, this question has the potential to be alienating; unless, in rewriting the tale of Goldilocks, the young joyful girl, who makes herself feel at home in the bears' cottage, is given a name along the lines of Rasta-girl (in isiXhosa, of course).

Aside from the importance of rewriting folktales, one other thing that actually makes Mphahlele's first question interesting is the mentioning of 'work songs'. This is interesting from the perspective of being possibly reminded that the routines of the students may not be well represented to allow their lived experiences—of, say, helping in making *amarhewu*—to be harnessed in a manner that aligns with the conceptualisation of a worker in their community. A conceptualisation, perhaps, best described by Teffo [280, pp. 161,162] that in many African communities:

> workers are not exclusively those people who are formally engaged or contracted to an employer in return for payment. A worker is rather any able-bodied and mentally sane person who contributes to the welfare and advancement of the family, community, and nation.

Returning back to the questions by Mphahlele, while they were specific to the literary curricula, they act as an apt reminder that all curriculum at some level is deeply linked to storytelling—a mode typically used in the transmission of IK. Grumet (cited in [111]) captures this link in defining curriculum as "the collective story we tell our children about our past, our present and our future". Mphahlele's body of work speaks to this definition; particularly in its insistence on the value of telling stories that are oriented to the needs of the audience, based on the argument that education is "an *agent* of culture [and] at the same time it is culture itself" [194, p. 47] [12].

All in all, appreciating the general power of stories to the curricula compels us to ask: what stories must we tell (and/or collect) to aid the process of teaching and learning? To ask, specifically: can we tell a story, as depicted in Figure 6.1, to communicate scientific knowledge? But most importantly, to ask: what kind of engagement would be required with teachers to get the stories we want? In other words, what would be required to capture IK that can be used in the classrooms either directly as is or indirectly having influenced production of suitable learning materials in various formats?

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[12]The Es'kia Institute [283] also provides a condensed understanding of Mphahlele as a critical thinker—or "someone who challenges us to: 'know our Afrika intimately, even while we tune into the world at large'".
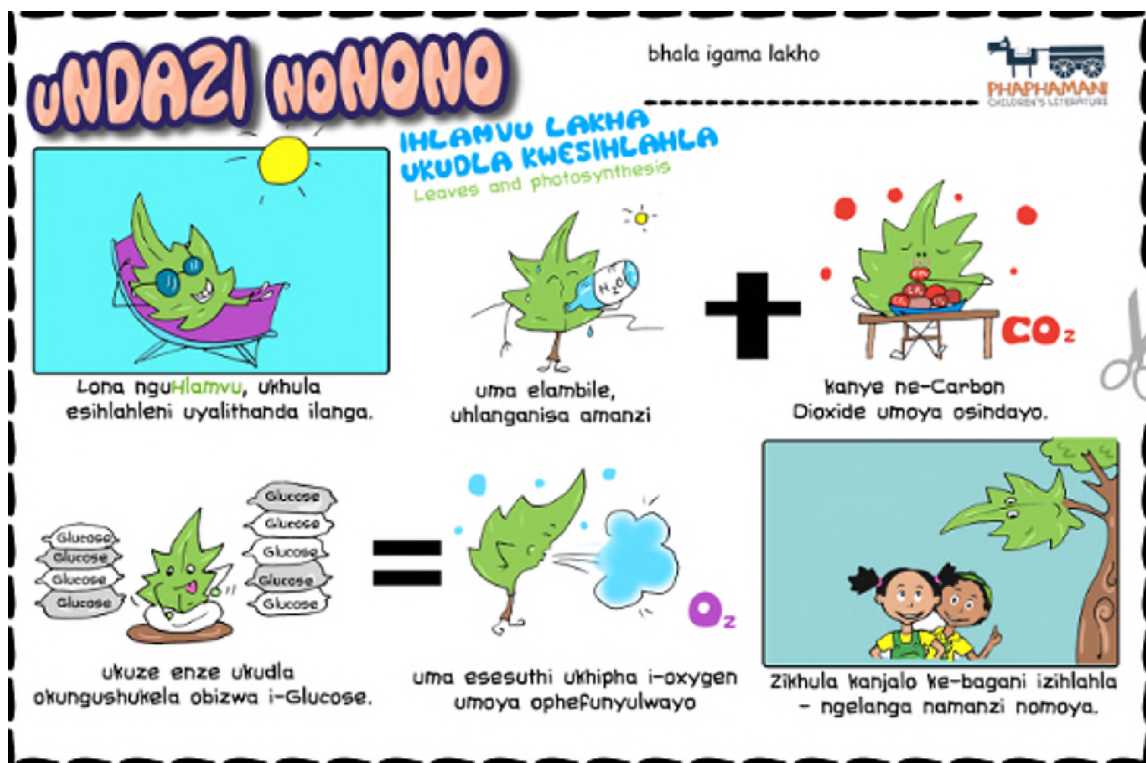
Figure 6.1 – Photosynthesis Illustration
©Used with permission, copyright Phaphamani Children's Literature 2014

As the previous chapters suggest, we are able to assume, based on literature and advocated for pedagogical practices, that contextualised education is important. Further, that availing everyday IK, as the background knowledge of students, is instrumental to bringing in the contextualisation.

The above questions, therefore, lay the foundation to thinking about the praxis for implementing a platform sharing and storing the everyday IK that can be injected into the education process. The next section details the strategy that informs the praxis for implementation.

6.2 Implementation Strategy and Praxis

When it comes to praxis, the imperative, for us, is to always strive to produce something that can be used in concrete and tangible ways. In a sense, this is a basic demand for using a pragmatic, research approach such as the Living Lab that centres and prioritises the involvement of users from the very early stages of any process of design: to ensure that the resulting artefact can be beneficial to the users.

This means, in thinking of praxis as a strategy when using a research approach like the Living Lab, the first step is to make an effort to understand the users. The second step is to allow a whole methodology to emerge, grounded in the knowledge and understanding of the users; but, at the same time, still underpinned by sound theoretical frameworks and reasoning.

In the case of implementing an IK platform, the SECI model of knowledge creation, as discussed in the previous chapter, is one of the key frameworks to consider. This framework includes the Japanese concept of *ba*, which provides an understanding—profoundly aligned to the philosophy of *ubuntu*—of how relationally knowledge can be acquired in shared spaces. This particular understanding emerges from the argument that:

> *Ba* may also be thought of as the recognition of the self in all. According to the theory of existentialism *ba* is a context which harbors meaning. Thus, we [can] consider *ba* to be a shared space that serves as a foundation for knowledge creation [214, p. 40].

From the above, we can glean that being part of a shared space is essential to the knowledge creation and sharing process. This, in and of itself—aside from the commitment to use the Living Lab research concept—hinted that social immersion was instrumental to achieving the goals of this thesis. Therefore, there was strategic value in conducting fieldwork. According to Kreesing and Strathern (cited in [189]), fieldwork may be defined as "intimate participation in a community and observation of modes of behaviour and the organization of social life". Fieldwork was necessary since, to quote Thinyane [284, p. 108], the:

> intrinsically relational and social aspect of knowledge exchange processes [within SECI] is a crucial consideration that must inform the development of [a] knowledge platform. It is an aspect that differentiates one deployment from another due to the differences in the underlying social dynamics within communities.

Inherently this means the task of building and/or selecting an appropriate IK platform does not primarily lie in the depth and breadth of academic analysis; rather, it lies in the deep understanding of the target community, and how it exchanges and adapts its knowledge. In fact, based on the life cycle of IK, shown in Figure 5.6 on page 74, this is a fundamental requirement: given that the first step of the life cycle practically involves identifying and recognising the knowledge sources available within a community. It is from

this step that it is possible to move to the capturing, or as it may be called within the SECI framework, the externalisation process of making the tacit explicit. To be sure, this is the process that maps to the ability to add new content, which can (later) be validated, stored, shared and used as intended.

Ultimately, to get to the stage of usage, the overall strategy to developing a fitting IK platform hinges on understanding the community. For, to a large extent, the success of the platform will depend on finding people who are keenly interested in contributing and validating its content.

6.3 Conclusion

As a key consideration to building and/or selecting an appropriate ICT platform for availing IK suitable for use in the educational schooling realm, this chapter explored, in practical terms, the question of how to move out of the 'rhetoric trap' that Nyoka [225] bemoans. A trap of extolling the virtues of IK(S) as opposed to actually producing it, so as to gain benefits from its use.

To meaningfully move out of this trap, a practical dialogical strategy is needed to engage what is available with the eye to suit context. Inherently this means deep insights about the users would be needed to produce a fitting IK platform. The next chapter will discuss insights cultivated ethnographically that have a bearing on user requirements and engagement. These insights are key in facilitating a design that is rooted in the needs, priorities and realities of its users.

Chapter 7

Engaging Users: The Methodological Journey and Insights

Chapter 3 provided a big picture understanding of the Living Lab approach. As explained, this approach is not restricted to any specific research method, i.e. any method can be used, provided it is appropriate for a real life context; serves the intended goal(s); and most importantly, enables users to be involved in an empowered manner that allows for co-creation and/or co-design of solution(s).

The real life context precondition bodes well with ethnography and ethnographic qualitative research. We used this knowledge to decide on how best to engage users. In line with ethnographic practice, the initial phase was focused on gaining insights about the SLL community, largely through fieldwork observations and informal interactions.

This phase was carried out through a number of week-long stays in the community that fell within the school calendar from 2012 to 2014. During these stays, we were primarily involved in the activities that capture the mandate of the SLL: we were carrying out ICT training and helping out with the maintenance work of the computer lab and internet infrastructure. Chapter 3 detailed why participating in these activities had strategic value, particularly in ensuring that the SLL community members have access and means to negotiate their citizenship in the digital world.

The initial (familiarisation) phase was supplemented and followed by in-depth, semi-structured, exploratory interviews with members of the SLL community—who, as previously stated, happened to be teachers. The key objective was to attempt to learn more about their pedagogic practice. We specifically opted for in-depth, semi-structured

interviews because "they provide much more detailed information than what is available through other data collection methods, such as surveys. They also [potentially] provide a more relaxed atmosphere in which to collect information" [47, p. 3]. In other words, interviews engender flexibility or room to spontaneously change direction [249]: to, perhaps, explore specific issues in depth.

However, it is vital to understand that interviewing requires craftsmanship [156]: "to ensure consistency between interviews, and [. . . to] increase the reliability of the findings" [47, p. 5]. Understanding this is crucial; given that interviews, as their major pitfall, can be prone to bias depending on the skills of the interviewer and/or motivation of the interviewees [47, 64, 156, 249].

In our assessment, the benefits for use outweighed the possible pitfalls. Perhaps because through the early stages of our fieldwork observations, we grew particularly doubtful of the efficacy of questionnaires: based largely on the fact that they were often used as survey tools in the SLL communities. Our sense was that their continued use—especially in the refinement of the hypothesis or problem understanding phase—routinise research in a manner that potentially makes it difficult to surface the issues and priorities of people living in the SLL communities. Anecdotes that led us to this belief include the various questions and statements that suggested, crudely or otherwise, that research was primarily about getting people to fill questionnaires; and, by implication, secondarily about driving innovation to improve people's quality of life.

Disrupting and/or interrupting this conceptualisation of research, particularly when employing the LL approach was/is an issue of import. Precisely because this conceptualisation leans towards essentialising research as a data extraction exercise, with participants cast as a means to an end. Of course, this can be contested. The bigger point here is that we sought to use a method that valorises spontaneity to enable participants to freely disrupt the flow of information sharing. From this vantage point, interviews seemed more suited to the task of supplementing the ethnographic fieldwork observations. Supplementing, for, to borrow the words of Walford [303, p. 147], "interviews alone are an insufficient form of data to study social life".

Before detailing how we conducted the interviews, the next section will expand a bit more on the familiarisation phase. We hope this will paint a clearer picture of the SLL context: to provide an enriched understanding of the choices or trade-offs in selecting and/or building an appropriate platform.
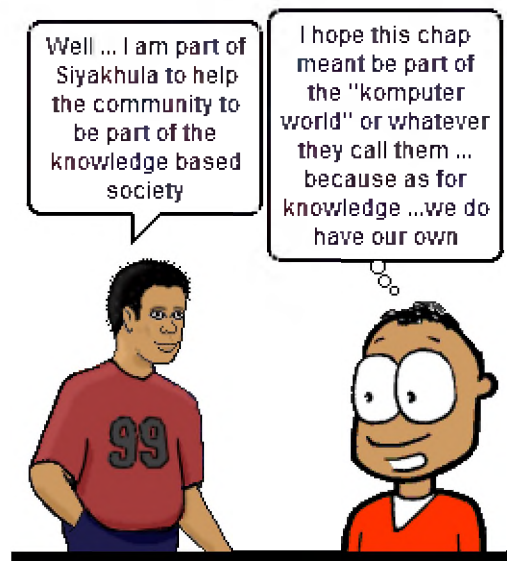
Figure 7.1 – A Fictitious Enactment of Exchanges in the SLL Community

7.1 Familiarisation Phase

Trust within Living Lab is an important virtue for building rapport and relationships that get users' to participate as co-creators and co-innovators. Basically, trust enables the users and other stakeholders to have frank engagements that allow ideas to be openly shared, tried and tested in the collaborative process of creating appropriate solutions.

In addition to their function to build skills, we deemed ICT trainings as helpful conduits for developing trust and/or giving gradual visibility to the researcher-trainers within the SLL communities. Thus, through training sessions, it was possible to create windows of opportunity for open dialogues to happen—naturally, at varying levels of frankness. These dialogues allowed questions such as 'why do you attend training?' or 'why, as an outsider, are you invested in our community as a trainer?' to be asked. Figure 7.1 is a fictitious enactment resulting from the latter question being asked. The point we wish to make with this figure, which depicts a man with his hands in his pockets, and another with exaggerated eyes that are almost popping out of their sockets, is that non-verbal aspects of communication cannot be discounted. Yet, we do concede that dealing with such communication can be difficult.

Hence, we will mainly share anecdotes gleaned from the fieldwork that are centred around vocalised communication. We hope the anecdotes, fused with our reflected thoughts (and/or in between the lines readings), will provide some insights on how to potentially bridge differences that may stem from people or different stakeholders working together.

7.1.1 Learning Sensitivity: Lesson(s) in Self-awareness

SLL Management Unit (SiLLMU) makes an effort to ensure that researchers and/or partners who work with the SLL communities ideologically believe in doing social good. However, this does not erase the fact that people can cause harm while trying to do good. To minimise causing harm, as we have already alluded to, one requirement, at least, for researchers, is to serve as ICT skills trainers in order to eventually gain some 'insider' status. In a sense, training can be regarded as the medium for learning sensitivity.

Sensitivity is a basic cornerstone for building solid relationships as required by the use of the LL research concept. However, learning sensitivity is not as easy as it sounds, particularly in the marginalised contexts such as those represented by the SLL communities. Privilege, for instance, can be an obstacle to actually doing research and gaining insights about the users. This means, to sensitively navigate the landscape in these contexts, requires more than just decency or etiquette. It requires consciousness around matters of ethics and privilege. This idea was crystallised during the frequent week-long stays of training and 'social immersion': it was crystallised by the cynicism that one had to 'field'.

The cynicism found its way in the informal conversations through questions and statements at unveiling agendas. An example of such a question from a community member is: 'so, I see you came in the Fort Hare car... you are a researcher ... here for your degree, right?!' This particular rhetorical question was commonly asked, and this begs the question: why?

In our reflections, this question was intended to bring self-awareness to us, as researchers. Subversively, we were made to appreciate why a supposedly innocent act of researchers driving in the community in an university car, bearing a logo that reads 'in lumine tuo videbimus lumen' (in thy light shall we see light), speaks to some kind of privilege—or advantages that the researchers have over the vast majority of community members. It is important to emphasise that these advantages extend beyond race and/or gender—for a black female researcher may, for example, be seen as having the advantage of speaking the white man's language, which means she holds the latent ability to 'speak to power' and/or, if needs be, to act an intermediary despite being female. The advantages lie at the perceived class position of the researchers. But there could well be other factors of consideration. "Age, religion, and nationality also impact how people in the field respond to researchers" [230, p. 289].

But at a practical level what does it all mean? What does it mean to be subtly reminded that in a week you will be driving out of a community? What does it mean to be reminded

of your "position in the social world" [112, p.489]—to be reminded that self-awareness and reflexivity are key to the fieldwork interactions? These are not easy questions to answer, for privilege is intrinsically invisible to those who have it. Further, because privilege is constituted by many factors that include social class, economic class, race, religion and sex [180]. Still—having learnt the importance of humility in assuring the community members that we understand the reciprocity of *ubuntu,* the breaking bread and cooking together as we did in 2013, for example, in an event to bring all stakeholders together—we learnt a few other lessons of appreciating that our 'being' is implicated in doing research in a context like the SLL. We learnt to muddle along in the field, we must:

➡ *listen, listen, and listen to read between the lines* – this is the most obvious yet not necessarily the easiest of tasks in particular environments, where silence itself may be constructed as a form of dissent. Or if not that, the culture is such that the formally educated individual is positioned as the natural voice of those who are but informally educated.

➡ *learn the community culture to understand what it means to negotiate in it* – again, this is obvious, and indeed speaks to the reason we use ethnographic methods and/or methodologies as a sector; however, our point here is that it is important to understand what might count as transgressive behaviour to be able to negotiate without causing offense. Change as far as we are concerned comes through a process of negotiation.

➡ *Aim for the 'Halo effect' to work in our favour* – this requires some unpacking, but fundamentally the idea here is to consider the question: if your presence has a rippling effect that correlates directly to the success/failure of a project, what 'energies' should ripple? The halo effect is an old phenomenon that explains how an evaluation of one attribute of a person (or entity) engenders bias in evaluating other attributes. Basically, as explained by Nisbett and Wilson [209], the halo effect implicitly makes us understand why we have sayings such as 'love is blind'. All in all, what we are suggesting is that we should acknowledge the value of community members we work with: this will help to rejuvenate them in all initiatives intended for their upliftment. To quote Freire [103], we should remember that we "do not come to teach or to transmit or to give anything, but rather [we are there] to learn with the people, about the people's world".

7.1.2 Encounters with the Teachers

In being researcher-trainers, it became easier to move around not as complete 'outsiders' within the schools (as PoPs) and other community spaces. This enabled us to gradually cultivate relationships with the teachers through casual and informal conversations, centred on the mundane. Over time these conversations gave us proximity to understand the teachers at a social human level. That is, beyond knowing what subjects and classes the teachers teach, we got to appreciate that, for the most part, they are an aspirational middle class: they, for example, teach in public schools, but send their own children to private schools for reasons attached to class mobility. An attempt to converse and unpack these reasons was fruitful in terms of also understanding the macro and micro level issues in education.

The key issues, at a macro level, pertained to administration, leadership and availability of resources. These issues, while important, fall outside the immediate scope of this thesis; thus, we will not go into any further details.

Under micro level issues, it was common for the teachers to outline generally well known social challenges as impediments to the education system. For example, teachers—without fail—mentioned the lack of parental involvement as a major concern. Probed further, they explained that this was due to:

➡ Parents being forced by financial reasons to be away from the home to be able to help in cultivating the reading culture by, for example, encouraging their children to go to public libraries (if any).

➡ Grandparents[13] being illiterate—mainly in the sense of being unable to read or write English.

Other micro level issues that surfaced included:

➡ High absenteeism rate attributed directly to adverse weather conditions, particularly rain and windy conditions.

➡ High student-to-teacher ratios as a result of the failure for many rural schools to attract as many teachers as urban schools. This translates to the inability for teachers to make meaningful contact with all students, given as well the fact that the current CAPS curricula is perceived as both content and assessment heavy.

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[13]Most learners according to the teachers stayed with their grandparents.

➡ Lack of discipline contributed, in part, by student (mis)behaviour and other systemic failures.

➡ Difficulty in completing the year syllabus, despite the curricula having a set schedule to help with the pacing of content delivery. According to the teachers, this happens, in part, because a teacher is often compelled to first unpack the language and/or vocabulary of what is assumed as known knowledge before moving forward with the curriculum lessons.

These issues—however differently articulated—helped us to understand the organic, psychological social and situational reality of teachers. Further, and most importantly, these issues provided us with a base to think through some of the key questions to ask in structuring our interviews, as it will be discussed in the next section.

7.2 Interview Phase

As already stated, the interview process was preambled by a passive phase of building rapport to be able to later identify teachers who might be interested in contributing to our research. Aside from concerns around consent, we wanted teachers who, ideally, had a basic understanding that the alienation of most students in the classrooms is a problem both in the short and long term. To put it differently, we were interested in teachers who embodied an understanding that the "world view of [their] students reflects social and cultural relations which are different from and antagonistic to those which are represented in the school" [68, p. 114]. Teachers who, through practice, were probably using IK or everyday knowledge to find culturally appropriate examples in their teaching.

To think through selection, we relied on the 'impressions' notes we made following the various conversations we had with the teachers. In the technical sense of thinking about research methods, our selection strategy can be understood from the phenomenological perspective. According to Kvale and Brinkmann [156, p. 26]:

> [...] in qualitative inquiry, *phenomenology* is a term that points to an interest in understanding a social phenomenon from the actors' own perspectives and describing the world as experienced by the subjects, with the assumption that the important reality is what people perceive it to be.

In phenomenology, the goal of selection is not to focus on representativity, rather it is:

> [...] to find and select participants who report having had a specific experience(s) of the phenomenon. This means that there is some, at least vague, idea from the researcher beforehand what the phenomenon is all about and this is legitimate. In other words, the researcher has a general sense of the expected parameters of the phenomenon, and an interest in the phenomenon. However the data may transcend what the researcher thinks he/she knows about the phenomenon, and in fact the researcher wants to suspend pre-understandings in order to discover the meaning of the phenomenon [89, p. 19].

Intrinsically tied to selection is the question of how many participants must ideally be involved in the interviews. Englander [89] argues that this question "is irrelevant due to the fact that the research [based on phenomenology] is qualitative and not quantitative" (p. 20). He does, however, note that by convention, at least, three participants must be interviewed. And, without proposing a definite maximum cautions to not be excessive; for, in citing Giorgi, "Research based upon depth strategies should not be confused with research based upon sampling strategies" (p. 21).

Taking heed of Englander [89], but also partly due to the difficulty in finding many participants (as a direct result of the generally high teacher-to-students ratio), we identified and successfully petitioned six potential teachers for the interviews. Then, we duly prepared for the interviews following expert advise from literature—see, for example, [20, 33, 64, 160, 316]. For example, we prepared a list of possible questions to ask: for, in conducting semi-structured interviews, while the interviewer has the flexibility to ask any question and in the order dictated by the flow of the interchange, it remains important to create a guide to frame the interview.

We further considered the question of how to initiate and conduct the interviews in a manner that eases the formality of the endeavour, but also commits to maintaining the "the interviewee's motivation by keeping boredom at bay" [33, p. 210]. To address this particular question, we decided to use a fictional story[14] that qualified on some level as a use case story for the IK platform. We used this story as a prop or device for initiating the interview questions. (Naturally, this was following the usual and expected formalities of outlining the interview purpose, spelling out how the collected data will be used, and the measures that will be taken to protect confidentiality and anonymity [33, 316].)

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[14] The story was inspired by a current affairs incident involving a reference made by one public figure to another. Partly because of the figures involved, this placed the incident in the common knowledge realm of the SLL community.
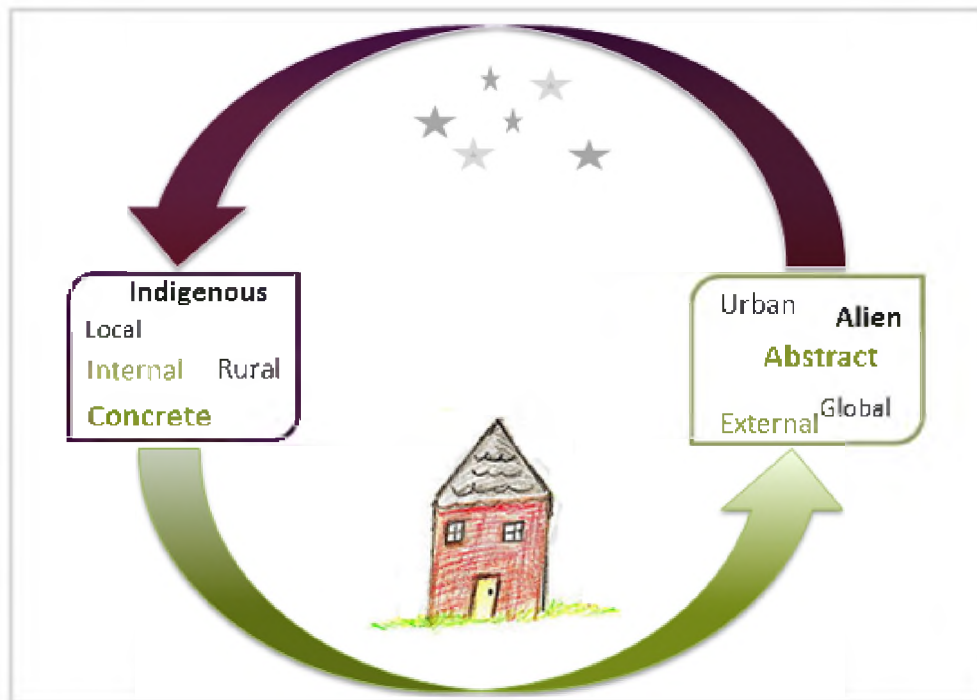
Figure 7.2 – Dialogically Based Education–Conceptual View

As it might be expected, there were reasons for a story as prop. Firstly, through the familiarisation phase, we came to appreciate that an indirect approach, which speaks in the idiom of the teachers and the community, had the potential to relax the interviewees and open up a space for dialogue. Stories were a culturally accepted way of communication. Thus, our logic was their use could help in settling down and assuring the interviewees that we were willing to negotiate a space for dialogue, but without necessarily being disregardful of time. This itself was rooted in the general understanding that and "interview is [but] an *inter view*, an inter-change of views between two persons conversing about a theme of mutual interest" [156, p. 2].

Secondly, we believed a story could, symbolically, illustrate how using IK as a point of departure is helpful in moving from the known to the unknown, and as such, it is useful in promoting dialogical teaching. We believe that this kind of teaching is critical to building a unified education system that, for example, sustains itself by a memory that most children, at some point and irrespective of their background, have a similar abstract idea of a house—to, indeed, draw[15] it as depicted in Figure 7.2. This essentially suggests that we

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[15]Children's drawings are often used by educators and psychologists for assessment and diagnostic purposes. For example, in making our assertion, we were thinking of a fairly well-known test in psychology called the House-Tree-Person test. This test was developed by Buck [52] to assess intellectual and personality functioning. In this test, a child is asked to draw (1) a house, (2) a tree, and (3) a person; the

can " move beyond a notion of difference structured in polarizing binarisms" [104, p. 18] through a concerted effort to end dualisms and a commitment to creating an education system that is radically different from the current one, which practically tells a tale of two nations, as discussed in Chapter 4.

7.2.1 Conducting the Interviews

"Interviewing is one of the most common data collection methods that are employed in qualitative research" [135, p. 64]. However, this is not to say it is easy to conduct interviews, for this requires craftsmanship [156]. Craftsmanship that is steeped in the understanding that "[t]he interviewer is cast in a power position and sets the stage by determining the topic of the interchange" [156, p. 4].

With the above in mind, to conduct the interviews with the teachers, we attempted to observe all the necessary rituals for successful interviews. We briefly communicated the purpose of the interview, which was to learn how the teachers intervened and/or acted as mediators of knowledge in the classroom. The ultimate goal for this was two-fold: a) to find how IK was probably used, and b) to gain insights on how, in practice, TPACK was understood and/or applied by the teachers.

After explaining the purpose, per our preparation, we actively sought consent to proceed with the interview with(out) use of audio recording, stressing that confidentiality and anonymity will be maintained. Following this, to kick-start the interview, we shared a fictitious story of a young teacher-student, called Becky, who comes to teach at foundation level. This story was inspired by a current affairs story where a (controversial) politician known to the community likened another politician to a cockroach. This reference sparked a lot of debate, and it is on the basis of this debate that we created the fictional story; the gist of this story is captured below.

> Becky in anxious excitement remarks: *'I cannot wait to meet my little cockroaches'*! Some colleagues realising how enthusiastic and well-meaning Becky is, decide it might be prudent to share with her an understanding of the community: to flag how use of cockroaches can elicit both a positive and a negative response depending on whether it is associated, for example, with resilience or filth.

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drawing is then used for assessment.

Following the sharing of the above fictional story, the first question was posed along the lines: assuming you were one of the concerned colleagues, what would you say to Becky based on your experience teaching students at your school? We deliberately presumed that the teachers would, in the name of *ubuntu*, be made comfortable by the idea that they would naturally want to be helpful to Becky.

Based on the responses, we asked probing or clarifying questions in an effort to 'seek the particular' [20]. To explore a different area of interest, we relied on the 'scripted' questions to guide us. These questions were generally designed to seek concrete examples to help us understand the pedagogic practice of teachers. These questions included:

1. What strategies do you use in your teaching to make it easier for students to understand? Please provide specific examples from your classroom teaching.
2. If there is a gap between the student's understanding and the curriculum how do you narrow this gap? Please provide specific examples to clarify.
3. What particular support networks have you tapped into—if at all—to assist you in your teaching? In what way have you utilised these networks and why?
4. Do you have any thoughts on how computers or ICTs can be used to support teaching and learning? If you can, please refer to your experience and other anecdotal cases you may be aware of.
5. Do you have any specific comments you wish to make in relation to your experiences as a teacher and/or on how we can improve learning outcomes?

As already suggested, these scripted questions were prepared in accordance with expert advise in literature for conducting effective interviews. The questions constituted but a template for the interview. In asking these questions, again, there were a number of clarifying questions asked, which, we believe—due to having an ethnographic footing—helped to transform the question/answer format of an interview into a 'discussion'. Thus, similar to Schostak [249, p. 50], we can attest that the use of "the 'discussion' strategy [...] created a sense of interchange where ideas amongst co-equals could be tested". However, we must stress that having a vague sense of who the participating teachers were, what and who they taught helped significantly.

As part of analysis, the next subsection will represent *some* of the views expressed—some because what will be presented or interpreted speaks, in part, to the subject and complexity of knowledge representation. To be sure, it speaks to the role of knowledge representation as a set of ontological commitments, as discussed briefly in Chapter 5.
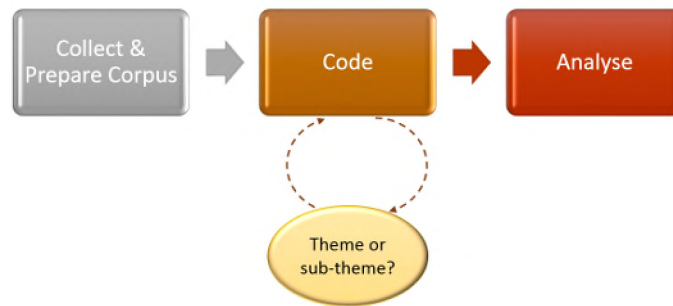
Figure 7.3 – Thematics Analysis Process

7.2.2 Interview Insights and Findings

The various methods used to engage users yielded many useful insights. In this subsection, we will share some of these insights, which, we believe, inform the decisions of design, as will be discussed in the next chapter.

To harness these insights, we used thematic analysis. According to Braun and Clarke [48, p. 79], "Thematic analysis is a method for identifying, analysing and reporting patterns (themes) within data". Rice and Ezzy (cited in [97]) further add that this method necessarily relies on "careful reading and re-reading of the data" (p. 258) to successfully identify themes. Boyatzis [46], however, has warned against qualifying thematic analysis as a method, stating: "It is not another qualitative method but a process that can be used with most, if not all, qualitative methods" (p. 4). Based particularly on Table 3.1 on page 36, this view has resonance with us.

As a process, thematic analysis can be implemented in many different ways. Our implementation, depicted in Figure 7.3, follows a simple, pragmatic approach advocated by Aronson [23]. We collated the transcribed responses from the interviews together with some of our own impression notes taken in all phases of user engagement. From the collated material (corpus), we went through an iterative coding process to discover patterns or (sub)themes in the data for further analysis.

It is worth clarifying that coding, in this context, refers to "breaking up data in analytically relevant ways" [146, p. 143]. But, this perhaps begs the question of what 'relevance' might mean. This is a complex question to answer. In part, because, as Braun and Clarke [48, p. 84] assert, "researchers cannot free themselves of their theoretical and epistemological commitments, and data are not coded in an epistemological vacuum". Essentially, this means that coding cannot be regarded as a value-free exercise. It is an exercise of representation and, as such, it also functions as a set of ontological commitments.
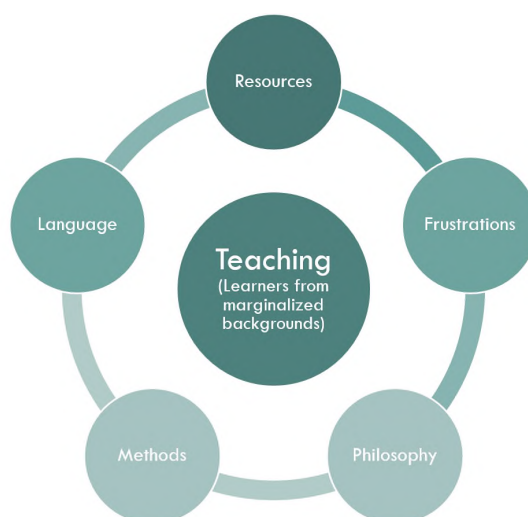
Figure 7.4 – Main Themes from Teachers Interviews

As previously suggested, the ontological commitments result from the many decisions that must be taken in the process of determining what should be represented (or coded in this instance). One decision we had to make, for example, related to whether to follow an inductive or deductive approach to coding. The former is data-driven, themes emerge in an organic fashion through analysis (i.e. reading and re-reading of data); while the latter is theory-driven in that the corpus is analysed through the lens of relevant theories and discourses [48].

After due consideration, we opted to use the inductive approach. Firstly because of our theoretical leaning towards phenomenology—or rather, towards understanding the experience of teaching students from marginalised backgrounds, as part of grappling with the question of how teachers use their everyday knowledge in the classrooms. Secondly because as Thomas [286, p. 238] aptly puts it:

> The primary purpose of the inductive approach is to allow research findings to emerge from the frequent, dominant, or significant themes inherent in raw data, without the restraints imposed by structured methodologies [or theoretical frameworks].

Based on our choice, we effectively performed what may be regarded as inductive thematic analysis to generate themes from the collated data. As already alluded to, the theme generation process was iterative: it involved identifying initial themes and refining them through reading and reading of data. Figure 7.4 maps out the resulting themes. As the figure suggests, teaching as a phenomenon in SLL affiliated (or similar background schools)

is shaped by: methods used in teaching; teaching philosophy; language; resources and broad frustrations.

The themes qualify as distinct "categories for analysis" [97, p. 82]. As such, each theme will be discussed independently as a distinct finding .

7.2.2.1 Methods of Teaching

Boyatzis [46] argues that themes can be identified at a semantic (explicit) level, or at a latent (interpretative) level. All teachers could express explicitly the varied methods they use to teach or facilitate learning. This meant at a semantic level it was possible (and easy) to pick up this theme from the corpus.

To perhaps make a problematic binary distinction, the teachers for the interviews were divided equally into two. We had three language teachers and three teachers in the Mathematics and Science subjects category. This distinction matters only because teaching methods for Mathematics and Science as one participant pointed out "are quite different from the other subjects".

Table 7.1 provides some of the direct snippets from the teachers that speak to how they teach and/or facilitate learning. As the table shows, while there are differences, there are also commonalities. Teachers, irrespective of the subject they teach, rely on use of concrete examples and code switching. On the one hand, this reliance confirms—as discussed in Chapter 4—the importance of rooting learners in the known to move them to the unknown. On the other hand, the reliance points to a deeper problem of communication and ability to make meaning through language of instruction.

The next subsection will further bring clarity to the above-mentioned problem related to language of instruction. It will achieve this, in part, by revealing how language was cast as a challenge to learning and teaching.

Language	Mathematics & Science

Language

➡ "I always teach in groups whenever I introduce something new in the reading corner".

➡ "I always teach them in sentence form from a story. ... Children like stories. I pick up all the words I want to introduce from the story."

➡ "I let them [learners] to dramatise the story. It enhances oral communication skills".

➡ "They sing...recite the lesson. An example on family: this is my father...short and stout. This is my mother with children...my brother, sister..."

➡ "I go around the classroom assisting individual learners with written language, for example, vocabulary, spelling and grammar problems".

➡ I use concrete examples, pictures with words, work cards,...syllable, sound, letter cards...sentence strips.

➡ "One other approach...is to do drilling skills and let them [learners] to write continuously to ensure better understanding and meaning of words."

Mathematics & Science

➡ "I use 30% teacher centred and 70% learner centred approaches. I define concepts and give my students exercises ranging from easy to challenging so that they discover intermediate methods".

➡ "[After introducing lesson] I give students worksheets to work on or conduct an experiment depending on the nature of the day's needs from breakdown of the topic/subtopics into units".

➡ "I only use team teaching if I find that some learners are still not getting the concept".

➡ "Discussion group with question and answer, if lucky works and leads to debate".

➡ "To ensure learners understand a certain concept, I work with concrete examples...use their language and pictures to simplify concepts. "

➡ "I use code switching method where necessary."

Table 7.1 – Perspectives from the Interviews: Language vs. Mathematics & Science Teaching

7.2.2.2 Language of Learning and Teaching

Language, similar to the teaching methods theme, was fairly ease to identify as a theme that cannot possibly be subsumed by others. Language—English, to be specific—is a challenge. One teacher expresses this as follows:

> Teaching content subjects in intermediate and senior phase using English is a challenge. ... Our learners are commonly exposed to English at school. ...The content subjects are based or ...using concepts that are strange to learners. They are strange in that they carry different meaning to ordinary English language. ...The learners get confused when you explain the scientific meaning of the word MATTER.

Save for the example used, the latent sentiment expressed was shared by all teachers—alas, in varying degrees. Still, we speculate that all teachers would agree that their code switching rate in the classrooms might be higher than, say, in private schools. We base this on the explained use of code switching as a method for helping to clarify concepts for the students. For the context, this use is not an anomaly; according to Chen and Rubinstein-Avila [58, pp. 6-7]:

> It is a common problem that students fail to understand their teachers or the content of the materials being taught to them in that language due to their limited resources in that language. In order to solve this problem, teachers code-switch to the native language to explain, annotate or comment on the concepts and the materials where the comprehension problems may arise. This is [useful...] as teachers know that the students do not have enough English competence to make sense of the instruction in English and they cater to students by switching into the shared native language to scaffold understanding.

Gleaning directly from one of the responses, the very lack of language competency is a major problem in teaching lower grades.

> To be specific, grade four as they [students] are introduced to many subjects...they struggle to put meaning and understand words they are assumed to be within their vocabulary.

The struggle for meaning, by all accounts, explains the use of code switching as a method or strategy for negotiating understanding. Further, it offers a glimpse into understanding the plight of teachers working in schools, where English, as a language of learning and teaching, can "more accurately [be] described as a *foreign language* than as an additional language, because exposure to the language is almost entirely limited to the school context" [259, p. 73]. On the flip side, this directly confirms that "African languages are alive and relevant for people today, even though English is the dominant language" [175, p. 87].

7.2.2.3   Teaching Philosophy

The teaching philosophy bleeds out from the teaching methods theme. The theme also fuses with some of the frustrations that teachers experience, as will shortly be discussed.

In instances where we could, in a latent fashion, pick up the theme, the philosophy converged into the value of investing time and energy on ensuring that foundational concepts are understood. To convey this idea, one teacher stressed the importance of clarifying concepts early on, stating:

> If the concepts are defined very well from the beginning then learners don't find any difficulties and very few misconceptions will be dealt with.

Others reinforced this point variously in explaining why they have taken a position to basically cover as much content as time allows, without worrying too much about completing the syllabus for the year. In reality, as one of the participants asserted, because:

> Circumstances force educators to spend much time on redressing the difficulties of the previous grades, instead of focusing on moving forward with the curriculum.

Even though the sample size was small, a brief observation can be made about the effect of the circumstances. It would seem that teachers in contexts such as the SLL have pedagogical beliefs that converge towards particular ways of teaching. This is an interesting observation particularly when it comes to the question of ICT integration or use in the classrooms. Liu [163], for example, arguing from a dissimilar context, suggests "teacher pedagogical beliefs about technology integration can influence teaching methods when using technology" (p. 1013). Given differing contexts, perhaps more research is warranted.

7.2.2.4 Resources for Teaching or Improving Learning Outcomes

The theme relating to resources for teaching has a number of dimensions to it. There is a dimension where it interconnects to the other themes and a speculative dimension for understanding how educational outcomes might be improved.

Resources, and especially their availability or lack thereof, affect teaching. The lack, in particular, exacerbates already existing educational inequalities and effectively takes us back to Bourdieu's theory of cultural reproduction, as briefly discussed in Chapter 4. We arrived at this interpretation through a demonstrated link between class size and teaching methods employed; the snippet below, for example, captures this link:

> Classroom sizes and infrastructure in the school in most instances dictate the method that I use to facilitate learning. For large groups it would be mostly teaching and group experiments...very little interaction between students. For small groups ... there is always a mix...there are a lot of discussions, debate, individual experiments...interaction levels between me and learners and between learners themselves increased.

Not only are the interactions vital, but they also reveal how language qualifies as a resource. The discussion on code switching in Subsection 7.2.2.2 indirectly affirms this. That is, it creates a basis for understanding that "Code-switching [. . . facilitates] the harnessing of learners' main languages as resources [and] becomes a means for exploratory talk in multilingual classroom" [259, p.78]. Use of analogies, stories and concrete examples can be understood in this context, as part of a multi-idiom strategy deployed by teachers in teaching.

A mathematics teacher relating their experience of being in a "cluster", crystallised the potential value of building a community of practice among teachers teaching the same subject. The cluster in this case was a formation of mathematics teachers in neighbouring schools. These teachers use each other as resources. They meet weekly to do their lesson planning and reflect on their experiences. Outside the weekly face-to-face meeting, these teachers remain in communication via a WhatsApp group.

Moving firmly on a speculative level, teachers confirmed the potential of ICTs in education, even though their exact use was not always clear. However, it was implicitly clear that ICTs can enhance the status of a school—in symbolically ushering the school into what

may be regarded as 'modernity'. Speaking directly to this, one teacher made mention of the Comfimvaba schools district technology project—for more on this project, see [100, 240]. For this teacher, the existence of this project validated the importance of ICTs, and more specifically highlighted the need for 'iPads'. This teacher, however, could not explain any further how the 'iPads' can be useful to teaching and learning. One other teacher suggested that ICTs could be used as 'question banks'. The rest of the responses converged around the function of searching for information—one teacher, for example, stating:

> Computers are very relevant even more than the cellular phone. They may be used as a teaching mechanism to extract data and present it.... It is very useful to surf and navigate communicate information at an instant from anywhere.

In addition to the above potential uses of digital ICTs, one teacher talked about the importance of (re)valorisation traditional radio (and perhaps television) in education. The teacher made this point in a roundabout way in explaining why they sometimes turn a blind eye to learners who live in the school neighbourhood, yet arrive late on the mornings MamGcina[16] is on radio and/or television. Basically, even when MamGcina tells a story in English, she uses localised inflections, and this helps to strengthen oral communication skills for the learners.

To conclude, a take home message from the teacher is that progress can be achieved through both the traditional and new media. That is, if we take the context seriously to understand, for example, the power of *ibali* (i.e. stories) in building the language infrastructure of learners.

7.2.2.5 Frustrations in Teaching

There are a range of issues that are frustrating to teachers. The predictable issues relate to resources. To be sure, the challenges inherent to teaching within resource-limited settings. In articulating these challenges, one teacher, in fact, went on to argue for differentiated incentives, saying:

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[16]Dr. Gcina Mhlophe is a renowned South African storyteller.

> As a maths and science teacher, I always feel that we need more salary/incentives than other teachers as our subjects need a lot and serious preparation for the learners to understand the concepts.

The parents, for some of the already discussed reasons, featured prominently in the frustrations of teachers. There is a sense in which teachers believe that better resourced schools also have parents who can help their children cope with the pace of the set curricula. To put it crudely and differently, the teachers believe resourced schools have parents who can teach their children if content not covered in class is set as homework.

Underlying the argument of parents capabilities, is the possible idea that the syllabus is content heavy. Teachers were not explicit about this idea. However, they did register how unsettling the changes in the curriculum have been over the years.

This unsettling sentiment created a frame to perceive some of the brewing frustrations. Frustrations that warranted, to quote Motsemme [192] in another context, "nuanced interpretations of silence" (p. 910): to grapple with the unspeakable. The response below encapsulates this point.

> There are so many things you can't understand... there are things I don't understand... some things are done by the educators and are acceptable... what frustrates me is what is acceptable to the educators... those things which are said 'it's okay'.

There was despondence in the response. The teacher could not really put into words the frustration of her context. Unfortunately this teacher was not alone. There were at least two other teachers who—in responding particularly to the question(s) speaking to their experience—provided answers that demonstrate "ways in which silence can also be viewed as 'present' and 'speaking', rather than 'absent' and 'voiceless'" [192, p. 926]. The snippets for these teachers are shown below.

> I don't know how to answer... it's frustrating ... it can be very frustrating... but then there's always one student... one student who says '[Mx], you know... I want to be like you', and then I go: *'Thixo Bawo*, at least there's something I am doing'.

> The problem is TIME as I've mentioned earlier. Anyway, I am trying my best by making sure what I've taught... they master it. It's not easy because it's not only English that I must teach, there are other learning areas.

A carefully look at the above responses should, hopefully, reveal some connections to the themes already discussed and the embedded silences. The latter, of course, is dependent on accepting Motsemme's notion of speaking silences. The silences, in this instance, we believe speak to how the teachers are, on some level, grappling with the Du Boisian [84] question of how it feels to be a problem. To be precise, how it feels to be a problem (i.e. under the gaze) in a structurally dysfunctional system, where "the quality of education for most black children is poor" [196, p. 38]. And, in reality, where only a few of their learners will qualify, for example, for university [271]. It could, indeed, be considered a stretch to explain the silences by nudging the argument close to Du Bois's [84] concept of 'double consciousness', where one feels under the gaze and therefore divided in their identity. However, there is a precarity for these teachers that must be acknowledged. A precarity that potentially speaks to their festering frustrations—or broad frustrations in teaching, particularly in marginal or impoverished contexts.

7.3 Conclusion

In this chapter, we explored the methodological dimension of engaging our users in the process(es) aimed at formulating a solution to thesis problem. These users, as indicated, are teachers from SLL affiliate schools. The visits to the schools—carried either to conduct training or to help resolve issues related to ICT infrastructure—were used to gain a firm ethnographic footing and to build a rapport with the teachers. Based on this rapport, teachers were recruited for in-depth exploratory interviews.

Inductive thematic analysis was used to harvest insights from the interviews. These insights are essential for driving the User Centred Design (UCD) process, discussed in the previous chapter. The next chapter will detail the realisation of this process; specifically, it will shed light on how we decided on a design that might qualify as fitting.

Chapter 8

Formalising and Realising the Solution Design

Design, as popularly accepted, is an exercise of trade-offs. Inherently this means that the process of design requires careful thinking about the priorities of the resulting artefact and those of the stakeholders. The last chapter presented some key insights gleaned from ethnographic fieldwork observations and interviews to assist in the design process. To be clear, these insights were key in understanding the teaching context and how to possibly co-design an everyday IK platform that can help in facilitating learning that is congruent to the context of learners.

As alluded to already, the design of this platform would need to be solution focused, participatory and user centred. In design, there is a subtle and nuanced difference between these terms (i.e. solution focused, participatory and user centred). Practically, however, we can treat the third term as an umbrella term for the other two. For this reason and without dwelling on the difference, in the next section we will briefly detail how the UCD approach can be used as a practical, down-to-earth approach for yielding designs or solutions that are appropriate for users. After this section, we will go straight into the heart of how we followed the UCD approach: to get the priorities and ideas that eventually yield a suitable IK platform to use.
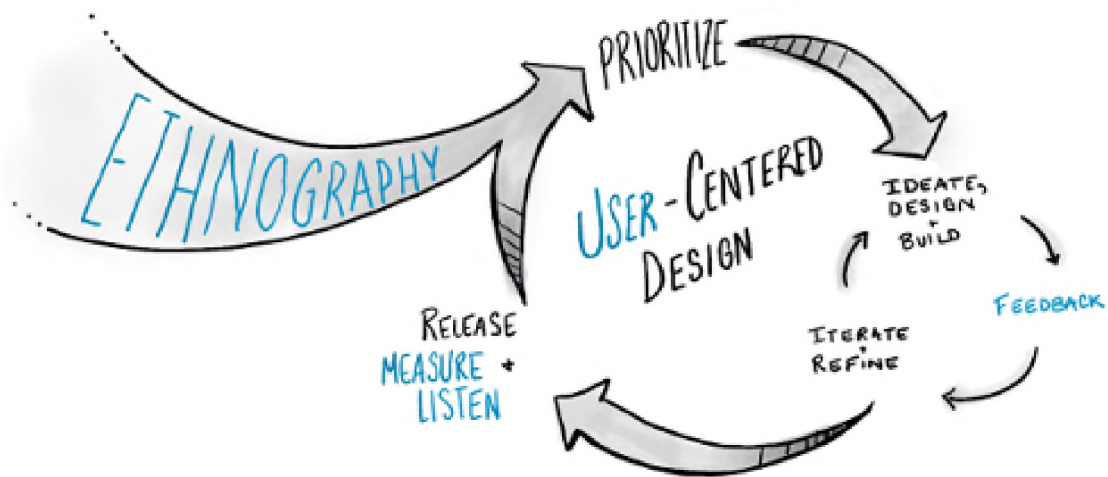
Figure 8.1 – User-Centred Design Cycle by Bradee Evans [94]

8.1 User Centred Design and the 'Masked Power'

In Chapter 3, we indicated that Living Labs (LLs), by nature, lean towards participatory and multi-methodical approaches to co-create and co-innovate solutions that have high resonance with users. The UCD approach fits well with the overall LLs approach, particularly when it infuses the ethnographic method.

In literature, there are varied understandings of UCD; and, for that matter, Human Centred Design (HCD) which is closely related to UCD. For example, Willis [309, p. 1] suggests in her dated (but still relevant) editorial that "a broad spectrum of understandings and dispositions towards user-centred design and its perceived problems" exists. This is the case because design can be understood using different lenses: e.g. as an artefact/product, as a concept, as a process, and/or as a practice [148].

Notwithstanding the multiple perspectives to design (or design thinking), it is commonly accepted that UCD is initiated and sustained by efforts to understand and take into account the needs of the users or stakeholders [9, 218, 309]. Ethnography has proven itself useful in this regard, and indeed has been linked to design—see, for example, [43, 121, 218].

Figure 8.1 represents a UCD cycle that shows how insights gained through ethnography can inform priorities for design. These priorities form the basis for delineating ideas or criteria for selecting and/or building an appropriate design based on user feedback, iteration and refinement process. Following this process, the design may be released for use; however, if it fails to meet the expectations of the users, the cycle may be repeated until a acceptable design is obtained.

Methodologically, while UCD seems simple and practical, the question(s) of how to involve users are, as expected, riddled with complexity. This is even more so when working in a context like the SLL, where perceptions alone of power imbalance may dissuade potential users from participating (fully or not at all) in the design process.

To grapple with some of the complexity that is inbuilt to the UCD approach (or any participatory approach for that matter), it is important to promote a sociological understanding of power. An understanding that:

> Whatever degree of autonomy [is] granted to participants [...] the organisers of the design activities and events in which people are involved, have the final authority (even if it is based on scholarly justifications) to shape and determine the roles of participants and the nature of participation [159, p. 5].

This pointedly suggests that power is masked into the design process. Or rather, there is a need to be "conscious of designer's influence and possible dominance on the design outcome" [310, p. 458]. For this reason, we posit that power (covert or otherwise) has to be both acknowledged and accepted. For those of us who come into spaces like the SLL, the starting point is to accept being identified with power based on the fact that we can leave the space at will, presumably to return to our lives of advantage. To be sure, while the presumption may not always hold, the point is to accept—precisely because we live in a society of 'haves' and 'have-nots'—that some individuals carry with them, to borrow the words of McIntosh [180, p. 9], "an invisible weightless knapsack of special provisions [...that bestows on them] unearned advantage" that simultaneously serves to confer (unsought) dominance over others.

Freire [104] provides deep insights on how the power that leads to domination can be ameliorated through critical consciousness. This is crucial to mention; for, as previously indicated, the consciousness can lead to a radical posture of true solidarity. To both paraphrase and quote Freire [104], a solidarity where the oppressor is freed from seeing and perceiving the world in a manner that only recognises "the oppressed as an abstract category [rather than] as persons who have been unjustly dealt with, deprived of their voice, [and] cheated in the sale of their labor" (p. 50).

In narrating his journey of doing ICT4D work in rural South Africa—a context akin to SLL—Krauss [155] comes to a conclusion that mirrors Freire. He concludes that emancipation of researchers—and, by implication, all those that may be constructed as advantaged outsiders—is crucial for genuine understanding of local concerns, needs,

expectations and realities. It must be stressed that, according to Freire [104], this is valid if, and only if, emancipation is accompanied by humility that engenders trust and enables genuine dialogue.

For Freire [104, p. 90], "Men and women who lack humility (or have lost it) cannot come to the people, cannot be their partners in naming the world". This is the crux to the UCD approach. The 'naming of the world' to be served by the actual design is paramount and essential to making sense of the entire design process. To be sure, because it enables priorities for the design to be set on the one hand, and on the other, it brings appreciation of the value of the ethnographic method in facilitating design.

It is from this vantage point that humility (in service of emancipation and/or critical consciousness) is key to cultivating the sensitivity required for partnering with users in the design process, and for ensuring that their interests are at the centre not the periphery of the process. In a nutshell, the demand for humility makes UCD a practical, down-to-earth approach to follow.

8.2 Casting a Light on the Users

As it should be expected, decisions in UCD are made by taking to heart the needs of the users. Hence, one of the imperatives for using this approach is to strive to know and understand the users well. We used ethnographic methods and interviews for this purpose. Based on the insights gained from using these methods of data collection, this section aims to cast more light on the users: "to evoke empathy and identification" [206] with them during the design process.

Personas are deemed useful for achieving this goal; since by definition they provide descriptions for understanding would-be users of a system to be designed [62, 82, 206]. "Personas are not real people, but they represent them throughout the design process" [62, p. 85]. Similar to Nielsen [206], we believe personas are particularly helpful if they are founded on data and written, say, from an engaging perspective that uses a story to provide readers with 'a vivid description of a user' to identify with.

Below are two personas that we have generated from the engaging perspective. These persona descriptions are generated mainly from the ethnographic portion of our research. To be specific, from the casual and informal everyday conversations with the teachers.

Buhle is a woman in her early 40s. Growing up she wanted to be an accountant. However, because of her class background, she wasn't able to pursue this career path. Buhle teaches mathematics in a school akin in conditions to one she attended as a young woman. Often this realisation causes her to despair about the odds of the majority of her students getting into university to pursue degrees outside the framework set historically by Bantu education. Still, she makes an effort to teach as best as she can, but without raising the hopes of her students with suggestions such as they can grow up to become actuarialists, charted accountants, computer scientists, etc.

For her teaching, she relies on the teachers' guides provided by the department of education. She also relies on the support of other mathematics and science teachers in neighbouring schools. She actually regards this network of support very helpful and cathartic: given the pressure that exists around improving mathematics and science scores in international studies that compare South Africa's performance with other countries. For her, without this network she would have long lost hope. But because of having allies to ventilate to and prepare lesson plans with, all is bearable. There is a glimmer of hope that one day they will turn the tide of poor performance.

(a) Buhle's Persona

Themba is a man in his 50s. He is an English teacher and a unionist. He believes it is important for students to 'learn to read' in order to 'read to learn'. He, however, has problems with the reading material provided by the government. For him, the material fails to reinforce the Black child's identity. He can't say how, but his intuition says it is in the eagerness to ultimately prepare the students for an encounter with Shakespeare and how grammar is taught these days. He feels as a young man he was taught how to treat English as a foreign language. As a result, he can read the dictionary and do a bit of phonetics to pronounce words correctly—even if, by his own words, he lacks the accent of model Cs.

As a teacher, Themba thinks he can qualify himself a success if his students can read and write English properly. Because of time and other factors, he practically thinks the concern about how the students speak English is secondary, even though it seems—to his dismay—that people think to know English is to speak it. This is partly the reason why Themba believes libraries are more important in his community than actually having computer labs with internet access for things like YouTube. For Themba, many of the problems in education can, in fact, be attributed to the lack of libraries and other infrastructure in impoverished areas.

(b) Themba's Persona

Figure 8.2 – Engaging User Personas

8.3 Design Elaboration

Agrawal [14] reminds us that there are political implications in how IK is collected, stored and preserved. This is consistent with Foucauldian thought [28] that, in fact, all knowledge is political. So, before we can begin the elaboration of what might be deemed an appropriate design for the collection of everyday IK suited for educational use, it is perhaps prudent to stress the politics surrounding this knowledge.

The 'everyday' qualifier we use, for example, only allows us to shift marginally out of the intellectual piracy discourse, as it stands around the traditional or specialised forms of IK. Marginally because, aside from rejecting notions that a dichotomy exists between IK and Western scientific knowledge, we recognise the need and importance of taking seriously concerns around the protection of any knowledge—even within the broad context of standing for open internet and access philosophies.

In discussing the modality of preservation (an endeavour that also involves collection and storage), Agrawal [14] argues for an *in situ* oriented approach, as a means of also preserving the agency of local communities in bringing about (endogenous) development. He offers the following two reasons against *ex situ* :

> 1) Ex situ preservation of indigenous knowledge is likely to fail–succeeding only in creating a mausoleum for knowledge. 2) Ex situ conservation, even if it is successful in unearthing useful information, is likely to benefit the richer, more powerful constituencies [. . . instead of. . .] the poor, the oppressed and the disadvantaged (p. 30).

Agrawal [14, p. 30] further notes that

> The mechanics of *in situ* conservation for indigenous knowledges are little understood, and possibly will pose significant political and ethical dilemmas. Such an objection cannot, however, be an excuse for bracketing what seems more desirable.

When Agrawal made his argument, we were yet to firmly enter the internet age. Now, with the many changes that have since happened, the question is: is *in situ* preservation of IK still preferable to *ex situ*? Also, given the agility of technology, to what extent should, we—at least in this thesis—bind ourselves to these two binary choices?

We believe that this question is important for the platform design and the decisions that shape its realisation. It specifically drives us to remember, for example, that while a networked based design may be deemed fitting, a great sensitivity to bandwidth and associated costs is required, based on where our context is located in the geography of the digital divide. To be certain, our context is located where a cloud based (internet) solution may not be ideal. The social and material conditions require, at best, a hybrid solution that provides both cloud and offline options. Or, at worst, an offline only (intranet) based solution.

Aside from the question related to the 'geography of preservation', we needed to further consider whether or not the platform we sought needed to also model its content using IK methods or epistemology. In thinking about praxis, we resolved that the most ideal solution would be one that could be used to collect, store and disseminate everyday IK without much ado. The next subsections explore the details of a solution that might fit this bill, bearing in mind that our users are teachers burdened with heavy loads in resource limited settings.

8.3.1 First Phase: Generating Design Ideas

A design is deemed appropriate if, among other things, it meets requirements. Necessarily, this means requirements are needed to drive the actual process of design. The requirements may be linked to, or dictated by the issues of cost and convenience, which have an unshakeable bearing to the context and the actual design, as it is exemplified in this thesis.

A core requirement, in our case, is that the actual design must support collaborative production of content suitable for educational use. To be precise, the content must be useful in facilitating learning that is aligned to the lived experience of the learners: to improve the performance outcomes of the learners, and to get the teachers truly operating on "Freirean aphorisms such as 'teaching within students' reality' or teaching students to read 'the word and the world'" [28, p. 356].

Concretely, what does the above mean for actualising a fitting design for the users in our context, as represented by the created personas? Through this pointed question, we began the ideation process i.e. the process of developing ideas for the design.

As our point of departure, we considered the kind of content that we hoped to capture. We used the logic that, if we were clear on the actual content, then we could better

apply Knowledge Management (KM) theories as discussed in Chapter 5 to activate the knowledge creation process, which in a sense (and as it relates specifically to this thesis) binds the idea of capturing IK to content production. To offer a brief reminder, knowledge creation can, for example, be understood through the concept of knowledge conversion. This concept, according to Nonaka and Von Krogh [217, p. 635], "explains how tacit and explicit knowledge interact along a continuum". Our particular interest in this interaction is borne out of the desire to capture some of the tacit knowledge that teachers use to (re)contextualise concepts in teaching. A desire ingrained in understanding that "[w]hile tacit knowledge held by individuals may lie at the heart of the knowledge creating process, realizing the practical benefits of that knowledge centers on its externalization and amplification" [213, p. 20].

Now, returning back to the question of the actual content, what was it that we were after? In other words, and in concrete terms, what did we hope to get—beyond the abstract notions of having content that is both relevant to the curricula and reflects the local imagery?

To answer this question, it was imperative to bring into focus the human context: given that teachers—aside from being the target users—are gatekeepers of knowledge as well as the broad emotional experience of the students in and out of the classroom [100, 288]. In their capacity as gatekeepers, it is worth stressing that the teachers are critical to the task of bringing in the integration of technology to the classroom [65, 66]. Thus, how they are engaged, particularly within a project that has an ICT dimension, has overreaching implications. It is in thinking of these implications that the importance of centring the teacher/user was reinforced, particularly in answering the dual question of: what content was ideal and what design might fit its collection?

From the interviews and the conversations, we learnt that the teachers in our context already had deep concerns about the lack of time in pursuing the mandate to educate well. Based on this, we needed to assume that the teachers, at best, had a few minutes to explicate the knowledge they held and to engage within the platform under design. Thus, we needed to think through how best to streamline the capturing process: to activate the sharing of the everyday IK relevant for teaching and learning.

After weighing a few options, we decided it might be worthwhile to get teachers to volunteer substitute examples to those in textbooks, which they had used to clarify concepts to their students. At the core of this idea was the question of how to create synergies with initiatives by companies such as Siyavula Education [268] that produce open textbooks

and learning materials aligned to the curriculum—albeit, in our opinion, not in a manner that is effective for teaching in resource limited settings (and/or, as partially discussed in Chapter 4, teaching the 'disfavoured' [44]). To bolster or perhaps contextualise our point, we turn to one of the many examples from a Siyavula produced textbook. The example, depicted in Figure 8.3, is a preamble activity for learning about animal body coverings. Gleaning from this figure, as a basis to understanding that animals have body coverings suited for their environment, the learners are expected to, for example, already possess knowledge about a costume and—although not explicitly stated—a tuxedo. This expectation may well be justified as valid prior knowledge. However, we contend only for a small segment of the students within the education system: for the rest, the benefit of prior knowledge is eroded. Thus, on the whole, this makes Bourdieu's [44, p. 36] key point that:

> To favour the most favoured and disfavour the most disfavoured, all that is necessary and sufficient is for the school to ignore in the content and teaching it transmits, in the methods and techniques of transmission and the criteria of judgement it deploys, the cultural inequalities that divide children from different social classes.

To be sure, Bourdieu [44] holds that appropriate content, among other things, is key for redress. Equally believing in this view, a pertinent question was: how can we produce this content?—for, indeed, if it were easy to produce, it would already be readily available. With this question in mind, we moved on to consider how easy it would be to get the content (examples). We surmised that to reduce mental overload in the interactions with the platform, it would be vital to create interfaces that allow for the collection of the examples to be done in a structured and dialogical manner.

As part of undertaking the task to design these interfaces, which fit our purpose and context, we sought counsel from a team member of Phaphamani Children's Literature. Looking at some of their work—see, for example, Figure 6.1 on page 87—we were convinced that this entity was producing content that was designed to be helpful to the teachers working in contexts akin to the SLL. Our interest was therefore to understand their rationalisation in the design of their content, which we believed was created to fill the existing gaps in the textbooks and other learning materials. Our interest to seek counsel from Phaphamani was further reinforced by a thinker and entrepreneur, Paul Graham (co-founder of Y Combinator, a *tech* startup incubator), who reminds us that it takes different perspectives to develop new ideas. As he firmly but light-heartedly puts it: "Even

Figure 8.3 – Example Activity Sourced from an Open Textbook by Siyavula

Einstein needed people to bounce ideas off. Ideas get developed in the process of explaining them to the right kind of person" [116].

As a supplementation to our understanding for seamless interfaces, the team member of Phaphamani offered us a reinforcing perspective on the importance of aiming for a design that is not an 'obstacle emotionally'. The emphasis here was about acknowledging and respecting the context. Respecting, in particular, the fact that the complexity of issues within the education system render work itself an obstacle to the teachers. As such, an ingenious design (artefact) for our context has to function in a 'light' manner that taps into what the teachers already know.

With the above in mind and from the perspective of the created personas, we went back to think through the implications of design as summarised in Table 5.1: to work out the key defining features of the artefact we needed to produce. As a bare minimum, we decided that this artefact must enable or support:

➡ **easy navigation** to emphasise the key tasks behind the design.

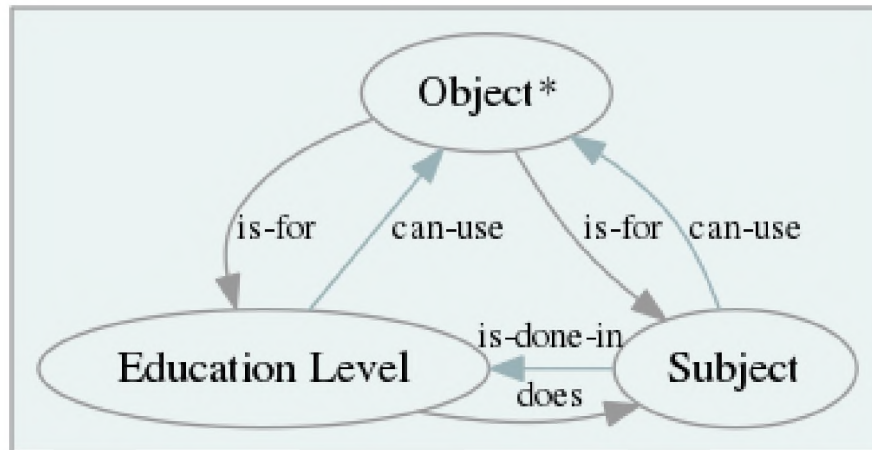➡ **data entry that is structured** to ease the mental load in adding content.

Figure 8.4 – Light Ontology for the Organisation of the Content

➡ **multimedia inclusion** to support the idea of creating rich textbooks. At a minimum, users should be able to upload images, possibly sourced locally.

➡ **keyword searching and tagging** to make it easy for users to locate content. We decided to also consider high level categorisation of the content through use of two parameters: education level and subject. As defined in the current curricula specification (i.e. CAPS), there are three education levels which we could use: foundation, intermediate and senior phases. From the point of view of retrieval, it is important to stress that a flat structure based on an explicit tagging of content by the users would have been sufficient for keyword searches. We decided on a high level categorisation to enhance the conceptualisation of the content by the users. In other words, we decided to create a very light ontology for the benefit of the users. (Our understanding of an ontology was based on Gruber's [120] definition as "an explicit specification of a conceptualization"). Figure 8.4 represents the light ontology, we have just described. The 'object' can practically be anything, but in this case it generically refers to the user's contribution. As conceptually shown in the figure, the object can be related to or a particular subject and/or education level.

➡ **use across multiple devices** to increase access. (While a responsive, portable design is ideal, it must, however, be noted that written contribution on smaller screens is not advisable. For, as we alluded in Chapter 3 mobile phones may not be suited for complicated writing tasks at least until speech-to-text technology has progressed enough and is available for the target language.)

Using the above delineated features, we proceeded to create mockups for the interface. As

suggested in our analysis in Chapter 7, we understood that our users were not homogeneous; for example, there could be a distinction made between the requirements of science and language teachers. Still, we decided it would be best to design for one primary persona. According to Cooper [62], this is ideal in terms of maintaining focus and remembering that:

> We create personas to narrow down the spectrum of users for whom we design. [Thus] if the number of personas grows too much, we are defeating the purpose of creating personas in the first place.

Of the two personas created in Section 8.2, we decided the primary persona should be Themba. This means, to generate ideas for the mockup, we had to ask ourselves at every turn the question of what would make it easy for Themba to use the interface once he came to the point of declaring:

> **‘*Hmmm...futhi*, I must contribute something to ensure that the black child gets to read textbooks that affirm her identity.’**

With Themba, it was important to acknowledge that getting him to use the platform would take convincing. Thus, his first attempt to use the interface would be crucial. Basically, if he failed to fulfil his goal, he would not give the platform another chance. For, his use would be tied—in all likelihood—to the desire to contribute at an ideological level. Aside from ideology, he would otherwise be very clear that he does not *need* to use the platform to tolerate a complex or time-wasting interface. What all this means is that Themba required a simple interface that makes it possible for him to understand, as a novice user, what actions to take to, say, contribute an adaptation of ‘Goldilocks and three bears’. After experimenting with a number of minimalist designs that could be acceptable to Themba, we came up with a mockup depicted in Figure 8.5.

Following the creation of the mockup, the next task was to work out the specific details for realising the design. Before furnishing these details in the next subsection, we must state that the created mockup was but a sketch of the interface and not a blueprint. We were still open to changing it—which, of course, should be expected, given our iterative design approach.
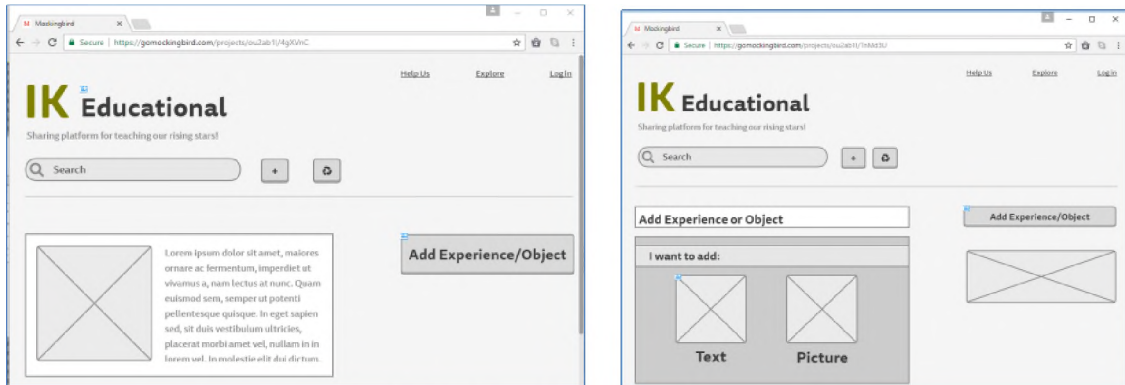
(a) Mockups for Getting Started

(b) Mockup for Content Addition

Figure 8.5 – Initial Mockup

8.3.2 Second Phase: Weighing Implementation Options

In the previous subsection, we went through an exercise of reasoning and developing an idea for the initial design that can serve the goals of the thesis. In short, we reasoned that an apt design would be one that encapsulates the idea of getting content, which can inspire and/or constitute a pipeline for creating textbooks that serve to favour the disfavoured. As a key feature of this design, we stressed the importance of having an interface that can allow the content to be captured without much effort.

The interface, however, is but one aspect of the design: the frontend. Beyond the interface, there is the backend. Hence, one of the questions to ask was: how do we build the backend to have an overall platform that is reliable, easy to use and actually helps to solve our problem (with the identified priorities and constraints in mind)?

As it might be expected, there were a number of considerations to make in search of an appropriate answer. For pragmatic reasons, we decided to start the search by looking closer at our context and the broad empirical lessons gleaned from ICT4D projects in order to investigate the possibility of using an already existing solution. On a philosophical level (of avoiding reinvention of the wheel), this was a natural route to take, given a number of current trends—influenced in part by cloud computing—that indicate a decisive move towards 'lightness'. Lightness in terms of building applications with low user requirements (as in, only a browser is needed for access). Further, lightness in terms of building applications from existing services via, for example, use of Application Program Interfaces (APIs).

Aside from the technical perspective, we were swayed by the recent shift in ICT4D towards placing "more emphasis [...] on the strategy and implementations of projects instead of the infinite potential of technology" [269]. A shift—building on Smallberg's [269] observations—that would suggest ingenuity and not 'technovelty' holds more potential in yielding a fitting and sustainable solution. For our purposes, ingenuity is as captured by Edson [87, p. 38], when he wrote:

> Ingenuity goes beyond mere invention. [...] It's the way that complexity becomes simple elegance [...] to create extreme emotional engagement. [...] Ingenuity doesn't always depend on a new supporting technology. Sometimes ingenious solutions come from applying existing components in new ways.

In terms of design effort, this may mean coming to an understanding that:

> The implementation itself can be very pedestrian and need not involve novelty beyond the state-of-practice for the given artifact; the novelty is primarily in the design, not the construction of the artifact [296, p. 8].

With the above in my mind, our next step involved determining the search space for finding existing components and/or solutions. We had already determined in our priorities that the platform must support collaborative content creation; in part, because the LL philosophy operates on a shared ethos of collaboration and partnership. As a consequence, the thinking within any LL often steers towards opportunities that bolster the importance of collaboration. To hammer the point home, in the case of this thesis, the opportunity was in the observed camaraderie between the teachers across the schools within the SLL rural geographic area. This camaraderie led us to the question of whether or not it was possible to capitalise on the bond of teachers in our goal to collect IK with educational value. This question was answered in the affirmative, as alluded to earlier. The question which was yet to be answered—or, rather one which we were trying to formulate—was: what available and collaborative systems could be used for meeting our goals?

In the KM discourse, wikis featured among popular examples of collaborative systems. We therefore decided to explore their use as our (initial) search space. Simply explained, a wiki is a collaborative software that allows users to add and edit content [161]. To reduce the initial search space, we took to the internet to explore the several existing wiki software packages. Incidentally, one of the useful overviews of what was available came from a Wikipedia article, titled 'comparison of wiki software' [1]. Based on this article, which contained a listing of 47 wikis, we pruned the list almost in half by excluding wikis that did not qualify as 'free and open'; we used this as a starting criteria on the strength that our context demands sensitivity to cost. We then moved on to consider more criteria to narrow our search space. This meant critically looking at how programming language, community base, level of support and maintenance weave together in the big picture of sustainability; while also factoring in the constraints that speak to the actual design artefact in terms of, for example, supporting multimedia materials, which are an imperative for the eventual creation of rich textbooks.

In projects like the SLL which function by involving the 'transient', it is worth flagging that sustainability is something that is always thought about deeply. To be certain, this is not to suggest that transiency is a problem, for it is not—it is the source of fresh energies and

● Good ● Acceptable ● Poor ○ Not Available

	DokuWiki	MediaWiki	Tiki
Development/support	●	●	●
Multilingual support	●	●	●
Popularity/market share	●	●	●
User interface customisability	●	●	●
Search functionality	●	●	●
Supplementary built-in features	●	●	●

Table 8.1 – A Comparison of Candidate Wikis for Use

perhaps much needed creativity. That is, provided the transient actually accept their own transient nature and insignificance: to always remember that the needs of the community take precedence over their own.

With all of the above in mind, we forged ahead with the inherently subjective task of searching for a suitable wiki implementation. Assuming that popularity is somewhat correlated with merit, we opted to limit our search to PHP authored wikis. The assumption here was that it might be easier, if needs be, to find expertise for support and maintenance. This helped us to further narrow down our search space to under 10 choices. Utilising parameters such as maintenance history and market share estimates from a website like BuiltWith.com, which offers trends on usage (see Figure C.1 on page 190), we were able to trim down our selection to the following three top contenders: *DokuWiki [2], MediaWiki* [5] and *Tiki Wiki CMS Groupware* [7].

Figure C.2 on page 191 provides a trend comparison over five years of these three wikis. Table 8.1 similarly provides a high level qualitative comparison of these three wikis. As the table shows, there is but a marginal difference between these wikis. We opted for MediaWiki not simply based on its association to Wikipedia, but because the two other wikis also differentiated themselves using it as the reference point. In a sense, this reinforced that MediaWiki was the de facto standard.

At this point, perhaps we must discuss why a wiki solution had more resonance for us than, say, a blog or a platform such as Facebook, that, anecdotally, was widely used within the SLL communities. Firstly, a wiki fits the *illima* model of collaboration—discussed briefly in Chapter 3. If one metaphorically maps fields to articles, one can see how, over time and through edits by multiple authors, a concept can be grown to maturity in one place/space. This is not the case with blogs or similar platforms that take a strict chronological perspective to content creation; for these platforms, while they may

allow collaboration, there is temporality attached that spreads the growth of a concept to different spaces.

Secondly, use of MediaWiki specifically aligns to a number of projects in education like WikiAfrica Primary School, which aim to provide "students, teachers and families access on Wikipedia to all the documentation needed to obtain the primary school degree of their country, in the language of instruction" [8]. This means the eventual adoption of such projects would make installation of MediaWiki more of a norm, even in localities without internet access. This, in turn, would lower the requirements for our platform and/or create a synergy to bolster the efforts to collect IK relevant for the curricula.

Aside from a wiki based solution, could we, for instance, have considered Facebook?

Given that the 'familiar' is the endogenic position that propels much of the work in this thesis, this particular question on the use of Facebook and other similar platforms is one we could not avoid asking. As it were, many of the SLL community members including the teachers were already using this platform to suggest its use would lower the training needs and encourage easy acceptance. So, why not Facebook, especially given initiatives such as *Internet.org*[17] that nullify the cost argument by making access 'free'?

The answer is, in fact, more ideological on our part; but there is also an argument around functionality that we can make. Ideologically, we position work in ICT4D on the side of the debates that favour the notions of the open internet. In part, because we do not take lightly the arguments that bring in the recognition that existing inequalities are reinforced through ICTs, or more generally the digital divide. As such, for us, there is a profound need to, for example, defend and advance the open egalitarian principles of the Web as per Tim Berners-Lee vision. To put into perspective why Facebook and similar platforms act against the envisioned principles, Tim Berners-Lee [35, pp. 82-83] himself writes:

> [...] must make sure the Web's principles remain intact—not just to preserve what we have gained but to benefit from the great advances that are still to come.... Social-networking sites present a different kind of problem. Facebook, LinkedIn, Friendster and others typically provide value by capturing information as you enter it. [...] The sites assemble these bits of data

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[17]Internet.org is a Facebook-led initiative to make internet free on some level to people living in less developed countries; see `https://info.internet.org/en/`.

into brilliant databases and reuse the information to provide value-added service—but only within their sites. [...] So the more you enter, the more you become locked in. Your social-networking site becomes a central platform—a closed silo of content, and one that does not give you full control over your information in it. The more this kind of architecture gains widespread use, the more the Web becomes fragmented, and the less we enjoy a single, universal information space. [...]

Some people may think that closed worlds are just fine. The worlds are easy to use and may seem to give those people what they want. But [...] these closed, "walled gardens," no matter how pleasing, can never compete in diversity, richness and innovation with the mad, throbbing Web market outside their gates. If a walled garden has too tight a hold on a market, however, it can delay that outside growth.

Tim Berners-Lee makes a number of salient points that we hope explain why we deliberately chose not to develop our system on Facebook. For us, this was not a simple matter of rejecting the fact that Facebook is seen as an important social phenomenon in the SLL context. As an imperative for endogeneity, we considered and took this fact very seriously. We had to balance that, however, against a long term view, in which the creation of silos of content controlled by a corporation undermines the very core of ICT4D.

Ideology aside, we also had to remember that Facebook is not only closed in terms of the information that is put into it, but also in terms of how the platform could be extended or customised to suit specific needs. If at all it has not been clear, in resource limited settings, the ability to work with platforms that can be customised is very key. Ultimately, this is because various customisations may be needed to ensure that the platform fits in with existing systems, and/or works on custom/cheap devices.

The next subsection will offer a consolidated perspective of the resulting design, based on the suggestions and/or decisions made through the two phases of the ideation process.
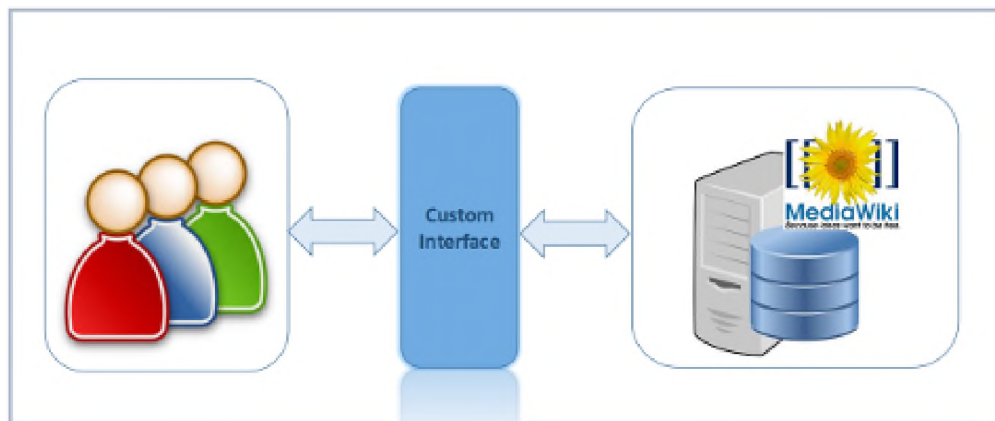
Figure 8.6 – High Level Architecture View of the Platform

8.4 Design Realisation

In the previous section, we concluded that MediaWiki was suitable for building a fitting solution to our problem. A custom interface was proposed to ease and structure the process of getting content from the intended users, the teachers.

Figure 8.6 presents an overview of the system architecture. A simple LAMP (Linux, Apache, MySQL and PHP) based server with MediaWiki, for example, suffices for our needs, provided it has sufficient storage space to cope, particularly, with media related content.

As it were, a LAMP server is standard in SLL implemented networks; it is core to the functionality and the very realisation of broadband island, as discussed in Chapter 3. This is partly the reason we were interested in a wiki that can be used within an intranet for faster and cheaper collection of content.

Once the MediaWiki was installed on the server, all that remained was to implement the custom interface, based on created mockups. In MediaWiki terms, this implementation is known as the skinning process—since the interface is deemed the skin of the wiki. Unsurprisingly, due to the sheer size of the development community, there was thorough documentation around MediaWiki coding conventions and the skinning process to make it a fairly straightforward task of using available 'hooks' to plug in custom code.

The concept of hooks in MediaWiki stems from the deliberate efforts to architecturally make the platform highly extensible and decoupled: so that it is easy to add functionality to the platform, without, of course, interfering with the core. Architecturally, MediaWiki has four layers, summarised in Table 8.2.

User layer	Allows interactions with the user and for customisations to be made to the interface.
Network layer	Responsible for mostly handling content delivery and caching.
Logic layer	Essentially serves to detail and implement the various core functions (mostly in PHP) that define the capability of a wiki system. This layer also makes available the hooks for extending the functionality of the wiki.
Data layer	Specifies a comprehensive database schema for the content storage and tracking of content revisions.

Table 8.2 – MediaWiki Architectural Layers (elaborated from [4])

From this table, one may assume that any modifications to the interface lie at the user layer. This assumption is partially valid. In reality, it depends on the nature of modifications that need to be done. Minor modifications to an existing skin may be done at this layer using JavaScript and CSS. However, major modifications that require, for example, an overhaul of an existing skin or creation of a new skin may involve using hooks provided by the logic layer. This is because "in MediaWiki, skins are PHP classes each extending the parent Skin class; they contain functions that gather the information needed to generate the HTML" [4].

One of the initial steps in the skinning process is to provide a name for the new skin being created. We decided to name our skin *IKhwezi*—morning star in isiXhosa—to build on the idea that the learners are at the start of their journey as the stars of the future[18]. The next steps that follow include understanding the essential components to a skin and how they might be realised. The latter, in particular, requires knowledge of files that will be packaged together to have a functional skin with the desired layout.

Figure 8.7 provides a snapshot of these files, which ultimately get packaged into a directory that goes into the skins folder of the MediaWiki installation, once the skinning process is completed. As shown in the figure, a typical skin package includes:

➡ Skin templates together with other files that contain metadata and various definitions of resources used by a skin. Many of these files can be created using boilerplates

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[18]The initial thinking was to find a name that would allow us to build emotional resonance while at the same time making reference to IK. To be sure, we wanted a name that could, perhaps, also pass as a recursive acronym; something along the lines: **I**ndigenous **K**nowledge **H**arvested **W**ith **E**ducation **Z**one **I**ntelligence. In the end, we felt an acronym might not add much value because of initiatives like the Dinaledi Schools Project, which focus on the "improvement in the numbers and quality of passes in Mathematics and Physical Science" [191]. Dinaledi is a word for stars in Sesotho. Ikhwezi referring also to a star ties to the logic and/or spirit in the naming of Dinaledi School Projects.
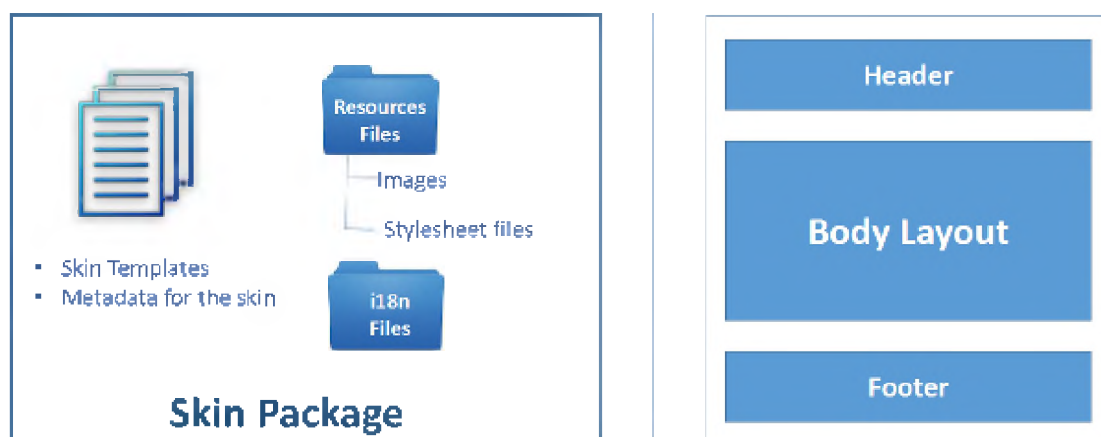
Figure 8.7 – File Structure for Creating a Skin and its Layout

(templates) available from existing documentation and resources. (This, in a sense, crystallises the understanding of MediaWiki as a template based system not simply from the user layer perspective.)

➡ Resource files include images that may be used by the skin and the stylesheets to enhance its look and feel. Using the stylesheets, it is possible to also make the skin responsive and adapt to mobile devices. This was one of the stipulated requirements for IKhwezi, which was achieved as shown in Figure 8.8, with the close up of the design in Figure 8.9.

➡ i18n folder for containing files that help to internationalise or localise wiki messages. For example, had we decided to use the language indigenous to the SLL community, the folder would contain the file for translating the interface to isiXhosa. (We decided, at least initially, to have the interface in English, as a language that is relatable to most teachers and deemed a necessity, as implied by the interview data in Chapter 7. We hoped the naming of the platform would provide the necessary assurance that a contribution could be made in either English or isiXhosa—or, for that matter any language that uses the same character set.)

To support structured data entry—a stated requirement for easing mental load in adding content to IKhwezi—we decided to use an extension to MediaWiki called Page Forms. As briefly explained in the Page Forms documentation, the extension "allows [one] to have **forms for creating and editing pages** on [a] wiki, as well as **for querying data**, all **without any programming**" (emphasis not ours) [3].

Once this extension and the skin were installed, IKhwezi, as a full platform, was activated into being. The different pages that were needed were created via browser access to prepare IKhwezi for testing. (Appendix E on page 203 highlights the syntax provided by Page

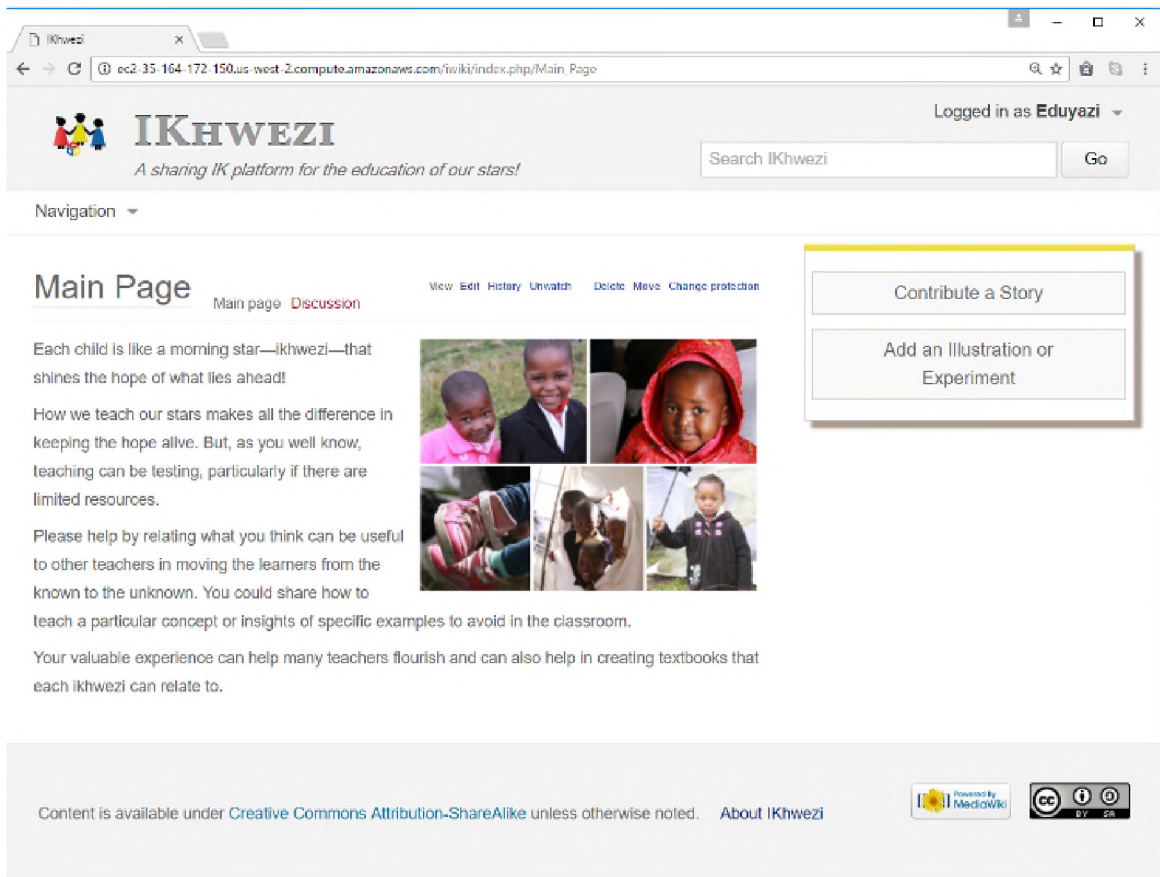**Figure 8.8** – Illustration of Portability—IKhwezi on Different Devices

Figure 8.9 – Pre-test IKhwezi Design

Forms to create a specific looking form. Using the form depicted in Figure E.1 as an example, the syntax demonstrates how to specify the template and define this form; see Figure E.2 and Figure E.3 respectively.)

The next chapter will discuss the testing of IKhwezi. To determine whether or not the design is acceptable for serving its intended purpose.

8.5 Conclusion

This chapter provided details for formalising and realising the platform design for meeting the goals of this thesis. Precisely because context matters, great care was taken to present the details in a sensitive, yet broad manner that attempts to eschew the 'ghettoisation' of the ICT4D. In part, the objective was to reinforce the understanding that design (as, indeed, valued by companies like Apple) should be driven by the commonality of human experience—the lack of resources, while important, should not diminish the importance of creating a solution that is reliable and easy to use. In fact, and to the contrary, the solution should be even more reliable and easy to use (and therefore 'elegant' in the deep sense of the word).

Having worked out the details of the design, the chapter went on to discuss the implementation of the platform deemed fit for the context and purpose. For the most part, the implementation was 'pedestrian' in a sense of not technically involving much novelty. The implementation was done using MediaWiki based, on the one hand, on considerations such as potential for offline use, maintenance and support; on the other hand, it was based in the broad understanding that "ingenious solutions [can] come from applying existing components in new ways" [87, p. 38].

All in all, as a result of the overall process that led to the choice in a platform to use, we can make one key conclusion: open platforms with rich plugin systems, to allow customisations and growth once the creators stop being involved, are fundamental to engineering light solutions that are fit for purpose in resource limited settings.

Chapter 9

Evaluation of the Realised Design

We have come a long way in our journey since the start of this thesis and we feel the need to briefly provide a summary that can provide an anchor to understand this chapter better. The work was motivated by our interest in the broad question of how the educational outcomes of the marginalised may be improved: in part, to redress historical and structural inequalities within the education system. This question has many dimensions to it. We narrowed our focus to but explore how we could strengthen the philosophical goal of teaching learners from the rooted and familiar space of the 'known' to move into the 'unknown'.

As practitioners in ICT4D, the exploration meant finding a possible digital solution. In search of this solution, as our point of departure, we reasoned that everyday local (indigenous) knowledge maps to the background/prior knowledge that can be leveraged in teaching and learning. Thus, it would be worthwhile to digitally collect and make available this knowledge, which, by and large, exists in tacit form.

To realise this objective, we further reasoned that working directly with the teachers would be beneficial because teachers hold the experience to potentially discern better what might qualify as relevant and appropriate IK that could, for example, be used to create fitting textbooks.

From both observations and interviews, we had noted that teachers were primarily concerned about time. This particular concern caused us to think deeply about the social and technical aspects of a fitting design. In our thinking, we took to heart, for example, the advice that 'technovelty' (i.e. technological/technical innovation) does not necessarily take precedence over other forms of innovation.

With the above in mind, and based on our analysis—rooted in ethnography, as dictated by the use of the LL approach—we surmised that a fitting design would be one that allows content sensitive to the local context to be produced collaboratively with due consideration to cost and convenience. In terms of implementing this design, we consciously opted to evaluate the potential to adapt existing solutions instead of starting the construction from scratch. As argued, this was a pragmatic route to follow, especially in an ICT4D context, where it is increasingly becoming clear that it is an onerous task to build any system from scratch such that it is reliable, easy to use, and actually contributes in solving a real problem; unless, perhaps, if the system is built on top of an existing platform.

Precisely because we opted to use an existing solution—which, in a sense, is proven and tested—we deemed it unnecessary to carry out tests pertaining to, for example, performance. We decided that testing the implemented solution at an acceptance and basic usability level would be sufficient. Perhaps, this does not come as a surprise, given that from Chapter 3, we attempted to bring into the conversation the importance of acceptance as key in ICT4D in a broad sense that also considers utility and likeability as important factors to sustaining the use. As we pointed out, acceptance is fundamentally linked to IK in that acceptable interfaces require knowledge about the users and their context.

In this chapter, we will focus almost exclusively on the testing done through a user boarding and piloting workshop. This workshop was organised towards the release stage in the design life cycle, with the aim to both assess and help improve the system designed for meeting the goals of this thesis.

It is imperative to clarify that the testing carried out in this workshop gives but an example of the interactions with users: they were other interactions with the users to test and assess the system. The workshop is significant to us, as an exemplar session, only because it falls chronologically towards the end of the work undertaken in this thesis.

The next section will provide more details on the workshop. Further, it will explain why we deemed the workshop necessary and/or strategic in getting users on board with using the system, IKhwezi.

9.1   A User Boarding and Piloting Workshop

Most, if not all, decisions in design are ultimately about promoting use. This means the question of how to get users on board is integral to the design process—albeit the significance gets magnified towards the end, in an aptly named process called onboarding.

> The term *onboarding* comes from the field of human resources and the common practice of new hire orientation. In that context, the steps in the process are often referred to as accommodate, assimilate, and accelerate—all of which apply quite nicely to how new users ought to be treated in order to bring them into the fold [133, p. 70].

In the field of computing:

> [...] onboarding is understood as the sum of methods and elements helping a new user to become familiar with a digital product—be it a web-based application, mobile app, or another digital application. By providing onboarding mechanisms, users will be enabled to smoothly pass into the efficient usage of the digital product [247, p. 3931].

To initiate the onboarding process, we revisited the following question: what counts as important to the users, i.e., in terms of what is represented and what can help to incentivise them to use the design? This question is important for all designs, but even more so when the ultimate objective is to collect knowledge or insights from the users who also happen to come from a socio-economic and culturally marginalised context. This objective—given that time itself is a cost—begs the question of why users must buy into the idea that their contribution has value. This is not a simple question. Hence, we felt a need to formulate a strategy to test and think through how to build an audience for our platform.

As our strategy, we decided to organise a workshop-cum-testing session to communicate the usage and importance of the platform on the one hand; and, on the other, to test the usability of the design. From our vantage point, a workshop provided a flexible format for getting teachers to jointly experience the novelty of IKhwezi and discuss at some length its potential. We based this on our informal interactions with the teachers, which gave us a sense that workshops were conceptually understood as spaces for discussing and brainstorming ideas for enriching pedagogic practice. This conceptualisation, in fact, was a result of the many interventions that exist to support teachers to become better teachers.

As part of organising the workshop, we actually formalised things by also applying for ethical approval to perform the testing of the system. We submitted our application to the Computer Science and Informations Systems Departmental Research Ethics Committee; this application included the requisite permission from the education district office to approach the schools and the teachers—see Appendix D.

Once the application was approved, we finalised our preparations and, among other things, created a programme for the workshop. This programme was divided into four parts: 1) the start and introductions part; 2) the facilitated dialogue part; 3) the testing session part; and 4) the reflection and closing part.

In this section, we will cover only the first two parts and leave the last two for the next section. The first part perhaps requires little or no elaboration. The goal of this part was to break the ice, affirm and acknowledge our humanness as is encapsulated in the greeting '*sawubona*', I see you. The aim of the second part of the programme was to spark a discussion around the use of IK in teaching.

The discussion was facilitated with the help of a local translator: to ensure that the teachers could speak frankly and freely—for being fundamentally outsiders, we understood that some gap will always remain (even if we had a strong ethnographic footing and cultural proximity than, say, people from Iceland). In another sense, the rationale was to acknowledge that language itself plays a huge role in education in terms of, for example, modelling ideas and shaping conceptualisation. To actually spark the discussion, we posed the question of why banks have suggestion boxes.

This may seem a peculiar starting point, however the idea to use banks was inspired by our work within SLL. In training the community, we came to appreciate that the financial world could be leveraged in many ways. We could, for example, build an understanding of keeping passwords secure by using ATM pins as a metaphor. Further, we could develop a mundane concept like saving a file by creating a mapping of location to a bank (or account) and the name of a file to an amount to be deposited. Based on these mappings, we discussed how the trainees would ensure they got back their deposited money. Basically, we established the importance of being able to search and locate files in an intuitive manner that overall reminds us that literacy around money can exist in the absence of other literacies. This is an obvious point to make, yet fundamental: given that learners can, for example, battle with subtraction but explain brilliantly this concept in a context of financial transactions.
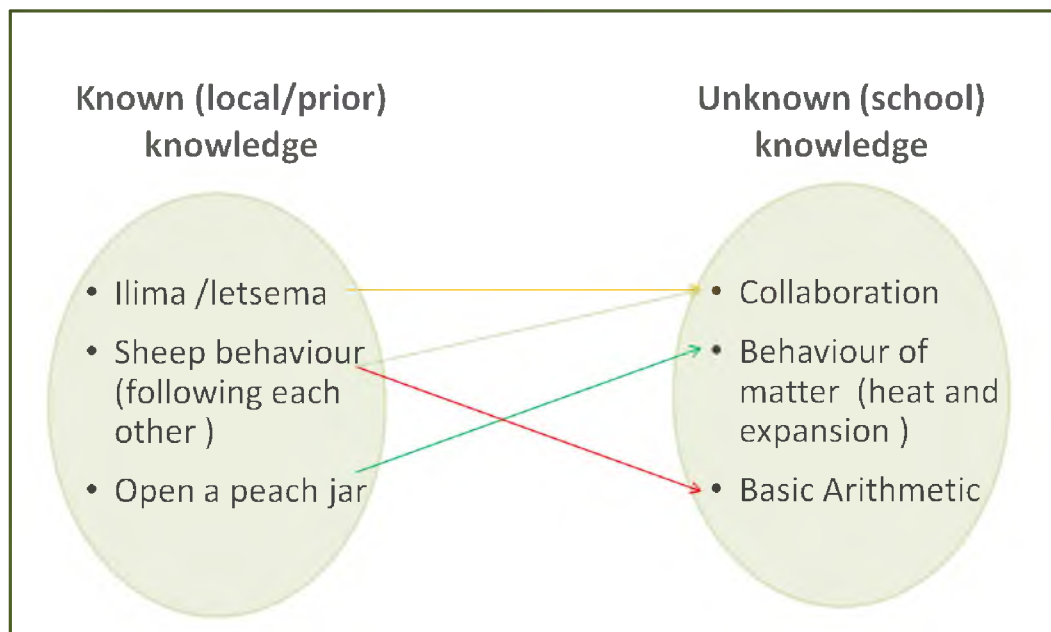
Figure 9.1 – A Map of Known to Unknown Knowledge – an Example for Teaching

In the facilitated workshop discussions, as per our instinct, we got responses that affirmed an understanding that suggestion boxes existed to provide some form of feedback to improve the banking processes. We used these responses to generate a metaphor in which the entire education system and the curricula in particular compares to the banking system and its processes. The teachers were analogous to the clients interested in providing feedback based on their experiences of interfacing with the system, and the IKhwezi platform was cast as the suggestion box. With these different mappings made, in a very conscious manner, we steered the discussion towards the function of metaphors and the role played by local/prior knowledge in teaching.

For example, we used Figure 9.1—generated from the ethnographic and interview data—to talk about how the process of opening a canned jar of fruit using boiling water can act as a basis for teaching the behaviour of matter. Further, we discussed why a learner would respond by saying no sheep will be left behind to the question: if there are twelve sheep in a kraal and three leave, how many will remain behind? As all understood, the learner's answer stemmed from the basic knowledge that sheep follow each other—i.e. one leaves, others naturally follow. In fact, as one teacher pointed out, using goats would have likely increased the odds of the learner getting the expected mathematical answer: since goats are generally perceived to be smarter and more stubborn to be swayed by anything[19].

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[19]This perception is embedded in the logic of why goats are used in performing rituals that require sending an animal into the spirit world to deliver messages to ancestors.

The sheep discussion gave us the hook to cement the understanding of what we meant by everyday IK that can be used for teaching. On the basis of this hook, which we capitalised on, we moved into the testing of the platform. The next subsection will provide more details.

9.2 Workshop Testing, Observations and Analysis

Testing comes with its own conventions. In thinking through these conventions, we attempted as much as possible to consider the implications of combining a workshop with testing through a set of probing questions: to determine how to bring balance to the agenda of testing and that of valorising IKhwezi to promote its use. Examples of questions we asked included:

➡ what parameters to regard as important for the testing?
➡ how to recruit users and how many to have?

These questions gave us a frame for making practical decisions around testing—or, at least, from the vantage point of our context. With regards to user involvement, we decided to align to the many arguments in the User Experience (UX) domain stemming from Nielsen's [205] assertion that five users *might* be sufficient for measuring usability in many projects—as a caveat, provided the five users were not involved in other design iterations. We have stressed 'might' as Faulkner [95] dutifully reminds us that using five users for testing yields superior results basically by luck or mere chance. For the most part, "[i]t is advisable to run the maximum number of participants that schedules, budgets, and availability allow" [95, p. 382]. However, in our context, we knew this would be unlikely: due to the difficulty of finding many participants as suggested in Chapter 7, and the desire to reduce the ill effects of research fatigue within the community. The latter was a serious consideration, given as well the caveat made by Nielsen [205] and that we were in a sense approaching the point of data saturation.

With an understanding that at least five users for the testing might be sufficient, we actively sought to recruit teachers different from those interviewed, but still those who remain fundamentally interested in finding solutions for improving the education system. Again, this was a subjective exercise. But because we had situated knowledge gained from use of LL methodology, we were able to sense who to approach and who to rely on for recommendations for possible participants.

On the day of the testing, we had six teachers—having expected at least ten. As indicated already in the previous section, the testing was organised as part of a workshop that was structured to also foreground the importance of everyday IK as prior knowledge. Our strategy in this regard was to facilitate an organic discussion of how the situatedness of teaching benefits the learners. We summed up already how we executed this strategy to, for instance, find the nuance between using a sheep and a goat in formulating mathematical/arithmetic problems that align well to the lived experience of the students.

To gear ourselves into testing, we rounded off the discussions with an analogy prepared ahead of the workshop that compares the curriculum to a rowing boat lost in the deep sea (of knowledge) on the one hand and, on the other, the oars to the methods and material used to support teaching. Akin to a beast in a traditional folktale that swallowed all villagers, the boat had capacity to accommodate all learners. In this imperfect analogy, the teachers were the boat drivers, the protagonists, charged with the mandate to 'rescue' the learners by taking them to the shore.

With this in mind, we directed the teachers to the URL of IKhwezi with an open request to use the platform as they see fit: to contribute insights relating to both the boat and the oars. In the next subsection, we detail some of our observations and interactions in the testing process.

9.2.1   Details of the Testing Process

For testing purposes, we decided to deploy IKhwezi on a cloud platform—to be precise, Amazon Web Services. While part of the consideration in the design was bandwidth and its cost, in this case, it did not come at a direct cost to the teachers, as we were using the school lab infrastructure.

As alluded already, our emphasis for testing was on the interface. So, to determine the usability, we decided on a simple task-oriented approach, which was to let the teachers run free and bring in their interpretation to the use and purpose of IKhwezi. Partly because adding content to a wiki does not strictly require users to register or log into the system, we purposefully decided to not detail the tasks to be performed, as might often be expected in usability testing of this nature.

We made this choice because we basically wanted to see if there were alternative ways to imagine the use of the interface. Also, it is for this reason that we opted not to include a

single example that may be used as a possible reference. We were aware that this *tabula rasa* approach had the potential to increase the difficulty in use. *Tabula rasa* in this instance points to the empty shell that was IKhwezi; the *tabula rasa* delivery to the users was essentially an act of trust that they can make deposits to fill the emptiness. This disclaimer is important to make in light of the *tabula rasa* argument advanced in Chapter 3, where the concept of *tabula rasa* had a negative connotation. Further, for bringing in clarity that we believed such a state of delivery would not create a constraint to the type of feedback/result we hoped to obtain. But most importantly because our believe and thinking remained stepped in the idea on onboarding, particularly as captured by Hess [133, p. 70] in the following extract:

> Onboarding is the process by which you can help users overcome the cold-start problem—a blank profile, an unfamiliar interface, a general feeling of "what the heck do I do next?" Many websites force users to start from square one and build up content (and value) over time. Social apps in particular are prone to this because so much of their usefulness is derived from person-to-person interaction and user-generated content.

Certainly, we witnessed the cold-start problem. The teachers could intuitively discern how to move from the main page to make their contribution. However, they had to pause and think about the details of their contribution. This created some anxiety, which we dealt with by engaging the teachers in a nudging dialogue. Our objective was to nudge them into verbalising their thinking and actions. In doing this, they all expressed the difficulty of not knowing exactly ("kahle-kahle") what to contribute and what can be regarded as useful. Our responses in this regard attempted to simply encourage the teachers to experiment for knowledge sake and to perhaps draw on the examples they had used recently in their teaching.

With one teacher in particular, we encouraged them to share their expressed resonance with a well known pop culture song by artists Character and Professor called '*X Ongasolveki*'—can't solve for x. This was a decision informed by discussions done prior to the testing. This teacher's narration is captured in Figure F.1 on page 205, but we shall only discuss it later. For now, and to sum up, it is important to state that they were other queries from the teachers which, as they arose, we diligently attended to. For example, we were asked whether it was necessary to log in or confine use to English. To these queries, we simply clarified that the mother tongue could be used and that logging in was a requirement only for multimedia uploading—the contributions could be made

anonymously, assuming the teachers did not overall want credit for their ideas to want to register and log into IKhwezi.

With much anxiety ameliorated, the teachers proceeded with the use for about 30 minutes taking refreshments breaks. Prior to concluding the testing, we duly asked the teachers to offer their impressions of IKhwezi based on these two questions:

1. What aspects of the system did you NOT like or enjoy?
2. What aspects of the system did you like or enjoy?

To finally conclude the testing, we had a short discussion in which the teachers could collectively provide their assessment of IKhwezi. The next subsection will discuss the observations from testing and the teachers' assessment of IKhwezi as users.

9.2.2 Findings and Observations

Through the use of guidelines and principles of design, IKhwezi was designed to have a minimalist interface with subtle visual cues to get the user's attention. The cues were achieved through the use of guidelines and principles of design, as proffered by, for example, Shneiderman [262]. Although not explicit, testing was done to assess the effectiveness of these cues. In this subsection, we shall reflect on the testing observations as part of the analysis of the IKhwezi interface.

To support the purpose of its design, the IKhwezi interface spells out two possibilities for the type of content that can be added to it: 1) experiment or illustrative or 2) open narrative. This was clear to the users; thus, we could confidently assert that they intuitively understood how to deposit their contribution into the system.

From the main page, users could easily navigate and move through the sequence of interfaces as captured in Figure 9.2. It is important to stress that the ease has no correlation to how fast the users can move through the interfaces beyond the main page. The speed depends mostly on whether the users already have a sense of what their contribution will be about.

Not knowing or having a sense of what to deposit, as we have alluded in the previous subsection, did make the use of IKhwezi seem, at first, difficult. But as we noted, the inauspicious start was in fact expected and could be understood from the perspective of the 'cold start problem'. We used Freire's [103] concept of dialogue to overcome this problem and to get our users to explore and make a few trivial deposits into IKhwezi, working alone or in partnership.

(a) Title or Theme Entry

(b) Contribution Details

Figure 9.2 – Task Sequencing for Contribution —Interface Perspective

After trialling out the IK platform, the overall impression from the teachers was that IKhwezi was usable and had potential. Given that our stated methodology puts the testing firmly in the qualitative category, we concluded, in qualitative terms, that IKhwezi was usable and suited for its intended purpose. However, as the teachers opined during the end of testing discussion, a key barrier to its use lied mainly on the fact that it was a network based solution.

The teachers used this fact mainly to offer a reminder that free internet and WiFi connectivity were only available from and around the schools which, as we stated, qualify as PoPs. Basically, while they did, in theory, understand that IKhwezi could be used independent of the internet, strategically (or for some other reason) they deemed it important to provide this reminder: to essentially register the fact that their context is one defined by constraints which, for example, limit their digital participation. Thus, in a very pointed yet delicate manner, the teachers were in fact fusing the practical with the political: to advocate for their digital needs. (As already discussed, it is important to stress that IKhwezi by design can be deployed as an intranet offline solution.)

Aside from the connectivity issue, we also received concrete feedback for improving the interface. According to the users, the interface needed:

➡ **linguistic clarity** — basically, besides the query on whether local languages could be used, there was a fundamental issue around how the interface was semanticised. Clarity was required, for example, to connect better the "contribute a story" request to the idea that curriculum is the 'stories we tell' and, indeed, IK is embedded in these stories.

➡ **a more explicit listing of subjects for content categorisation** — for purposes of better 'recognition', the users felt it was worth naming, for example, each language subject. Of course, in a context like South Africa, with 11 official languages, the users could also appreciate that the scaling of the system may better be served by a generic category; particularly given that there was a field to enter keywords to tag the content such that eventually it would be possible to bring the desired distinction.

➡ **to offer a means (akin to a table of contents) for exploring available content** — aside from the visible search and perhaps the navigation menu, users were interested in a feature that would allow them to systematically view already existing content.

As findings, the above provided impetus for another iteration of refining the interface. The next section provides the details of this iteration in a succinct manner that explains how we used the findings and the knowledge of the context to finalise the design.

9.3 Finalising the Design

With the feedback we received, it was imperative for us to consider how to move into the next iteration(s) of design to refine IKhwezi. Naturally understanding that the refinement should include a key onboarding aspect of how to eventually maximise use of IKhwezi in the free, online space.

In applying our mind to the findings, we relied on our understanding of the context, gained from the use of the LL methodology. For simplicity sake—while remembering that our goal was never to create a solution that maps to the IK epistemology—we started off by considering the suggestion to provide an exhaustive listing of subjects. Given that the users understood on, some level, the practical benefit to having condensed categories, we decided to retain the listing as it was. Firstly, to maintain the ideological alignment that everyday IK has its greatest appeal in foundational teaching, where the number of subjects is deliberately kept low. Secondly, because we believe the less granularity in the presentation of subjects at that level maps to the understanding that a light horizontal ontology has more potential to provide rich aggregated content. Thus, it would be better, in addition to the use of subjects, to encourage a categorisation that is more oriented towards using keywords—if, for instance, we wanted to conceptually build an understanding that history can also be seen as a language.

Next, we reviewed how we could integrate into the design a means to easily access content that was entered through IKhwezi. MediaWiki comes naturally with a number of possibilities for realising this access, which is linked to the indexing function. So, the real consideration was on how to retain the minimalist look of IKhwezi to provide a 'view' to available content. We amended the interface by adding as a visual cues, an additional menu item and a widget to the sidebar for granting access to this content.

Lastly, we moved to consider how we could concisely re-write the *main* and *about* pages to bring linguistic clarity to the purpose of IKhwezi. We were aware that this was an inherently subjectivity task, for which we could not guarantee full approval, even if time was on our side to: 1) organise sessions for co-writing these pages and other areas of the interface that might be deemed a problem , or 2) conduct extensive interviews that could

yield enough data to perform some variant of discourse analysis to be able to increase levels of satisfaction with the writing out of these pages, assisted possibly by a professional writer.

Still, we made an effort to cautiously approach this re-writing task. Again, from an onboarding perspective, we revisited the question of how our would-be users could be triggered or activated into the use of IKhwezi. In this instance, one of our primary concerns was how we could write simply yet propel use without a facilitator being present (which, as discussed earlier, was through the dialogue mediation).

As part of our reflection, we looked through our repository to look at the contributions made. Two narratives shown in Appendix F on page 205 caught our attention. Figure F.2 provided an illustration for teaching a scientific concept using easily available material in the home context of learners. Figure F.1 provided a personal narrative themed around the song 'X Ongasolveki'. This narrative was one which we encouraged the user to share. It speaks to the paradox of the variable x that never varies but remains constant to all mathematical problems. The richness of this narrative lies in its ability to evoke memory and provide insights that may explain the importance of concretising some ideas in building the abstract models. Of course, this is subject for debate; what for us made this narrative interesting was it also acted as a reminder that people essentially find it easy to talk about themselves. A serendipitous reminder that prompted us to also put into perspective the reason people willingly populate Facebook for free. Using this as our frame of reference, we decided to explore how we could create a hook for IKhwezi by writing in a manner to bring this orientation. Through informal interactions, we established that part of the appeal with social media lied in the use of light humour/wit or idioms in the local language. While certainly, and as expected, there was no formula, we rewrote the main page specifically with this in mind.

Overview of the consolidated final design from the above changes are as shown in Figure 9.3. We asked Thembile, pseudonym of one of the teachers we interviewed, to assess this design before releasing IKhwezi as a final product that can be accessed both online and offline (within the broadband island). MediaWiki already has a mechanism to merge these two wikis, if needs be, at any time. We offered the two channels of access to bring some flexibility in use—or rather, to balance the convenience and cost factors.

Once we had released IKhwezi as a final product, we consciously decided to target specific teachers, who could potentially help in promoting the use of IKhwezi in their networks and/or the clusters they were beginning to form for exchanging pedagogic ideas, as reported
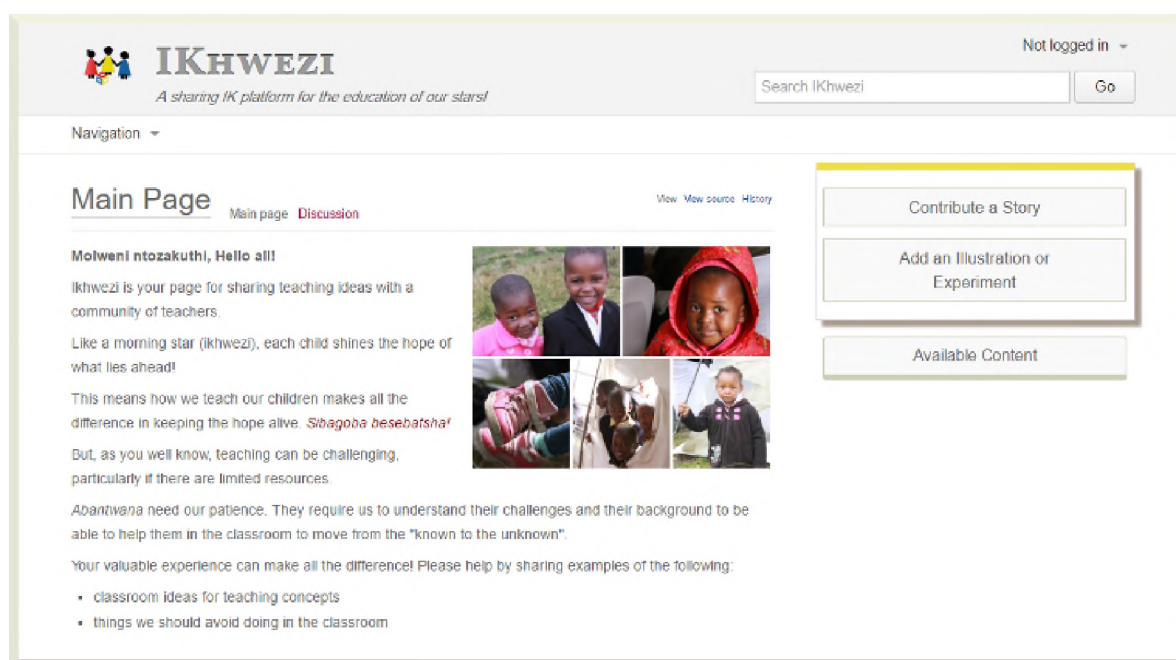
Figure 9.3 – Overview to the Finalised IKhwezi Design

in Chapter 7. This decision was informed by the feedback we received from Thembile, which effectively reminded us that the 'communities of practice' could, by populating and validating content in IKhwezi, help to build a greater confidence in the platform. Our role was ultimately to trust that the teachers have the "capacity to exercise intellectual agency and to engage in self-reflexive knowledge production" [74, p. 125].

9.4 Conclusion

This chapter discussed in detail one of the sessions with teachers to test IKhwezi, a platform for collecting everyday IK for educational purposes. This particular testing session was carried out when IKhwezi was near completion. The testing actually confirmed the importance of creating simple interfaces, which potentially enable emotional resonance to form with users to want to revisit the platform—based, in part, on feeling that their time and effort will not be wasted.

Pointing to the future, work is certainly required to answer the question of how to cultivate interest for the users to populate this platform. (In fact, this should come as a given, because human beings are complex. Hence, their involvement as users always comes with a degree of uncertainty.) Other factors, like timing and the constraints imposed by the context, while important, have to be seen as a different dimension to this uncertainty.

Chapter 10

Conclusion

> We have no right to sit silently by
> while the inevitable seeds are sown for
> a harvest of disaster to our children,
> black and white.
>
> ─────────────────────
>
> W.E.B Du Bois

The introductory chapter provided the rationale and direction for the research undertaken in this thesis. Part of the quest in that chapter was to set the tone for deepening a general understanding that any obstacle or problem towards building a just and humane society must compel us to take action: for, as aptly captured, over a century ago, by Du Bois [84] in the epigraph, to do nothing would be disastrous!

This chapter provides a conclusion to the work done to tackle the specific problem which this thesis sought to address in education and with the aid of ICTs. The next section provides another summary that is slightly more abstract than the one given at the start of the previous chapter. Following this summary, the chapter reviews the contributions of the thesis. Finally, it offers a few recommendations for future research, before providing closing remarks.

10.1 Summary to the Thesis

This work was carried under the banner of ICT4D. Because ICT4D is a multidisciplinary field, the work drew from many other fields and disciplines, not limited to Computer Science.

From the candidate fields and disciplines, we started off by teasing out the important themes of the work undertaken in this thesis. Our objective was to create a frame of reference for finding a fitting, context-sensitive solution. In a very conscious manner, we wanted to strengthen the understanding (before we could build a solution) that engineering as a human endeavour is always rooted in context—or rather, can only be successful if it keeps its focus on the context, and pursues the ideals of endogeneity. Otherwise, we risk moving on the same failed path of many projects in ICT4D, which yielded ICT solutions that were an expensive mismatch between perceived and actual needs.

With the above in mind, we decided to interrogate each theme we deemed important separately, but in a manner that we hoped could build a big picture understanding of the context and the problem we wanted to address. On the strength of this understanding, we came up with a practical, down-to-earth strategy for designing and implementing a fitting solution. Figure 10.1 depicts the essence of this strategy, which incidentally also maps to how the thesis was organised.

As the figure suggests, the first critical piece to building understanding of the context involved an appreciation of how endogeneity fits with ICT4D. IK, that is local knowledge, as argued in this thesis underpins endogeneity. The link to development is one of conscious realisation that IK can help in providing a textured understanding of locality. In ICT4D, this understanding is valuable for relating the complexities and layers of access to the promotion and use of ICTs. The relational work in this thesis was driven by questions around design of an artefact.

As it is well known and accepted, design is an endeavour in making decisions. We embarked on this endeavour to consider how to create a light solution that is easy to use and actually helps to solve a particular problem from a situated understanding of the context and the users. The LL approach was used to situate and ground us in the experiences of our would-be users. These experiences were valuable in illustrating the importance of IK in promoting ICTs, which, to quote Floridi [98, p. 61], are agents that are "re-ontologising our world [and] creating new realities".
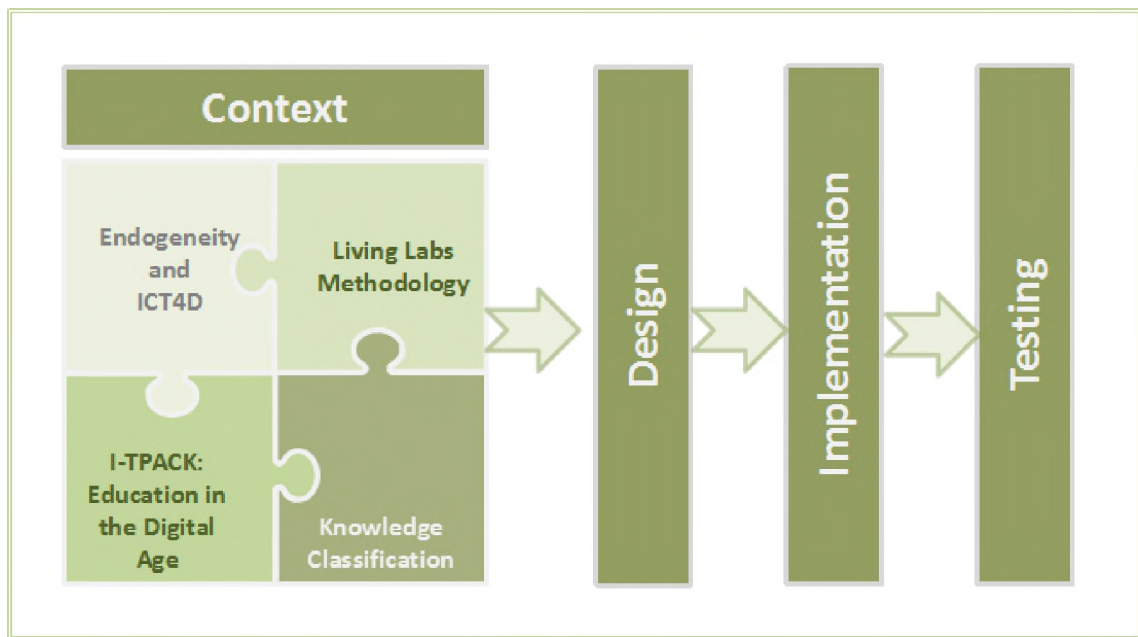
Figure 10.1 – Outline to the Thesis Approach

In pursuit of endogeneity, we attempted to tackle a problem within the educational domain. The key objective was to look into how a specific real life problem could, in general, be solved through a light design that addresses efficiently the 'adapt/adopt' tensions in using ICTs.

The actual problem centred on the question of the types of knowledge needed by teachers to enrich their pedagogic practice through the use of ICTs. Part of the motivation stemmed from educationalist scholars such as Spaull [270, 271] who have argued that 'teachers cannot teach what they do not know'. Suggesting very clearly that one of the ways for resolving the educational crisis faced by the vast majority of learners in marginalised communities lies in cultivating the different types of knowledge needed by the teachers. We looked into a framework known as TPACK, which aims to grow the different types of knowledge needed by the teachers to teach effectively with technology.

A critique of this framework culminated in a proposal to have I-TPACK, as a means to centre IK in teaching and learning. Given a constant concern about the tacit nature of this knowledge, we reviewed a number of KM concepts to understand how we could classify and explicate IK in our overall effort to build a fitting platform for its collection for educational use within a low resource context.

10.2 Addressing the Research Questions

This thesis is littered with many questions that were asked anew, on the one hand, to attest to the complexity of the problem being addressed; on the other hand, to assist in finding a fitting solution that is rooted in the realities and priorities of its users. The actual core question for the thesis that brought about all the other questions was:

> '*How do we bring in IK and ICT knowledge together to engineer light and viable solutions that help to solve a core problem in education of improving performance outcomes of the marginalised?*'

To address this question, we implicitly assumed that contextualised education is better than de-contextualised education, in terms of moving the students from the 'known' to the 'unknown'. Of course, we might discover this to be a fallacy in the future; but by all indicators, it seems meaningful education globally remains grounded in the ideal of using students' background knowledge (or what we aptly call the everyday IK) to facilitate acquisition of new knowledge. On the strength of our assumption, we formulated two sets of questions, which combine to provide an overall answer to the main research question. In the next subsections, we will look into each set of questions.

10.2.1 Questions for Availing Everyday Educational IK

In the introductory chapter, to consider broadly how to avail the everyday educational IK we sought, we posed three questions. Below we discuss the answers to each of question.

➡ *How can IK be used within formal education settings to bring about endogenous thinking (i.e. thinking that will inspire an inherently inward oriented approach to development)?*

Based on extensive literature review, particularly captured in Chapters 2 and 4, we argued that IK can be used in formal educational settings to inculcate understanding that development stems from being ontologically rooted in the lived conditions to inspire agency and action to change things. Specifically drawing from bell hooks (sic) [136], our basic conclusion was that IK use can enhance pedagogy and the ability for teachers to assist students to "unite knowledge learned in classrooms with life outside" (p.4).

➡ *What counts as important IK for use in teaching and learning?*

The simple answer was all knowledge that resides in the everyday realm of the students qualifies as important, provided the teachers are able to harness such knowledge. What is key is for IK to be understood as existing in flux like all knowledge, even though it may be specific to a locality.

➡ *What qualifies as an acceptable informatics system for collecting IK in the rural context?*

Our primary concern, from a practical point of view, was on the praxis: rather than the theoretical endeavour of possibly creating a digital platform that attempts to also model IK epistemologically. To this end, we were interested on a design, which can harness theories and methods embodied in the field of KM by, for example, reinforcing the idea that:

> [...] use of an Information System (IS) is multi-aspectual [...]. Therefore, in principle, every aspect is important, and knowledge from every aspect should be represented in an IS. If this is to be done easily by 'the people', then the Knowledge Representation Framework (KRF) they use should facilitate, and not hinder, the representation of knowledge of each aspect [30, p. 31].

10.2.2 Questions for Realising Light Design in ICT4D Spaces

Sensitivity to resources is one of the requirements for doing work in ICT4D spaces. This demands thinking about ways to engineer solutions that could be easily implemented, without the 'heaviness' of dwelling on the questions of securing resources. Inherently, this means 'lightness' not simply in cost, implementation or maintenance, but in many other dimensions as well, becomes a natural way of thinking about fitting, context-appropriate solutions within ICT4D spaces. In the introductory chapter, we asked the following questions to help with this thinking:

➡ *How do we (re)imagine engineering of artefacts in an ICT4D context and in an era of myriad frameworks, architectures, methods and other tools that support abstract thinking of solutions: to focus on a problem as opposed to implementation details?*

We argued that the basis for the imagination lies first and foremost in understanding the users'organic, psychological, social and situational reality in order to design an artefact that aligns to their needs. In a very pragmatic manner that is oriented on praxis, the design should inspire an investigation to evaluate what is already available. Inherently, this means the investigation must be carried out with a deep understanding that problems can be solved in concrete and tangible ways by shifting into the mindset that "novelty is primarily in the design, not the construction of the artifact" [296, p. 8]. In selecting what may be deemed useful from the pool of available resources (platforms, APIs, etc.), it is fundamental to remember that any artefact that must work in an ICT4D context is likely to need various customisations to fit in with existing systems, to work on custom/cheap devices, and to have a rich plugin system to allow it to grow once the creators stop being involved.

➡ *How do we build light enough solutions to minimise support and maintenance efforts or overheads?*

As we argued in Chapter 8, the answer lies mainly in finding an open platform that is sufficiently popular to architect an appropriate solution that aligns to the requirements. However, popularity has to be critically investigated to make the assumption that it correlates with merit and any trends that may provide an assurance that the developed system will be easy to support and maintain once the creators stop being involved.

➡ *How do we conceptualise a light design in a context where bandwidth is a challenge?*

As an ideological imperative, we reasoned that a long-term view has to be maintained to ensure that, in focusing on the current reality, we do not risk amplifying the digital divide. We, thus, concluded that an ideal design, at best, is hybrid based to permit internet and offline access.

10.3 Contributions

The work in this thesis has yielded contributions in the educational domain for enriching pedagogic practice through a proposal to augment a teaching and learning framework known as TPACK. Methodologically, the work offers paradigmatic reflections around grounded, light design. In a sense, these reflections contribute to the growth of ICT4D practice and its scholarship. Finally, as a tangible output, the work has resulted in a platform that can be deployed both online and offline as an intranet based solution.

10.3.1 I-TPACK for Education based on IK and ICTs

As mentioned, this thesis critiqued a teaching and learning framework known as TPACK, and proposed for it to be augmented to I-TPACK to explicitly recognise the value of IK.

At its core, I-TPACK promotes Afrocentric, multicultural education using ICTs. Essentially this makes the framework pluralistic in its outlook. Mafeje, the proponent of endogeneity, would see it as very significant. Potentially, the framework can "lead to polycentrism rather than homogeneity/homogenisation" [168, p. 107] which, as Mafeje ultimately holds, is instrumental to ending "the unfavourable educational conditions in Africa and the prevailing dearth of requisite scholarship" [168, p. 106]. This is because, similar to frameworks such as CHAT, TPACK also attempts, at least in its intentionality, to "overcome a range of troublesome dualisms in education: individual versus collective, body versus mind, subject versus object, and theory versus praxis" [248, p. 218].

Further and based on its pluralistic outlook, TPACK presupposes that relational ontologies are essential to achieving inclusivity and developing radical pedagogies which engender criticality and endogenous thought. "Relational ontologies are those that eschew the divisions between nature and culture, individual and community, and between us and them that are central to the modern ontology" [93, p. 139], which "imposes Eurocentric realities as 'universal'" [24, p. 172]. These ontologies make it possible to radically imagine a different future. A future, perhaps, which entails a transformed education system that yields a harvest of success for the majority—not just the few who Bourdieu [44] either calls 'the favoured' or 'the miraculously saved'. In other words, an education system designed for all and/or, as Escobar [93] would contend, designed for a pluriversal world, where dualisms cease to take centre stage. Instead, radical interrelatedness becomes the cornerstone of pedagogical practices that affirm Sen's [257] idea of 'development as freedom'.

To reiterate, through this contribution, it is our belief that I-TPACK, in conjunction with other efforts, can help in the design and realisation of a pluriversal oriented education system. A system, to borrow the words of Zembylas [315, p. 24], that can allow us "to modify curriculum and pedagogical practices in ways that promote positive experiences for *all* students". But most importantly, a system that can deliver on its potential to cultivate and grow the various knowledge required by teachers—for, ultimately, teachers knowledge counts as one of the vital pillars for good quality education.

10.3.2   IK Paradigm of Grounded, Light Design in ICT4D

At the heart of this thesis lies the question of whether we can use Computer Science to support a different way of including IK into the educational processes. This question set out the foundation for exploring how, in a broad sense, we do Computer Science in marginal contexts that lie outside the dominant culture in which ICTs may be deemed a norm—or, as it were, contexts that specifically place the work in this thesis under the banner of ICT4D.

Underpinning this exploration was an implicit supposition that a meaningful answer could be found by striving to solve a core specified problem in a representative real life context. A paradigmatic answer that provides practical, intellectual and scholarly insights on how to create cultural pathways that may channel interest in ICTs in general, and specifically in building systems that resonate with users who happen to live in marginalised communities. As our hypothesis, we held that these cultural pathways could be created by using IK in a manner that ideologically linked to endogeneity.

We followed the LL approach to put our hypothesis to the test. This resulted in clear and deliberate decisions to have what may be deemed a light design artefact. The insights that altogether emerged characterise a novel paradigm for exploring grounded, light design. At a fundamental level, this paradigm advocates for the use of IK to engender rootedness in delineating the needs and priorities of the users in finding fitting solutions that are necessarily aligned to their lived experience. Specifically, the paradigm requires:

➡ Endogenic understanding of the problem with the openness for social innovation to take precedence over 'technovelty', if needs be. Inherently, this means finding a way to place at the centre of analysis the problem being solved such that the use of ICTs serves the goal, rather than be the goal.

➡ Multifaceted understanding of the reality of users to facilitate organic interaction with designed solutions.

➡ Use of practical dialogical methods to engage users in the idiom of their beliefs. And, to be able to resolve the 'adapt/adopt' tensions in selecting a possible solutions from what may already be available.

The use of IK provides an overall integrated understanding to the above core features of the paradigm. This use highlights the value to understanding IK as a strategy for creating cultural pathways for building systems that resonate with users. Systems built through using the 'vernacular' or idiom of the users to negotiate understanding of the context, requirements and everything else that might be important to know. (In the case of this thesis, to involve and gain insights from the users, we, for example, used stories, metaphors and analogies to affirm our ability to relate.)

10.3.3 Actual Digital Platform for IK Collection

Undertaking research in the context of ICT4D and with the requisite openness to other forms of innovation (aside from 'technovelty') suggests it is possible to find an ingenious solution to a problem that requires no building of an artefact. In our case, the solution did require building a light design artefact. The artefact was a MediaWiki skin, which we called IKhwezi. This skin provides a customisation that transforms the MediaWiki offering to a platform for collecting everyday IK for educational purposes in marginalised communities. The building of IKhwezi reinforced the idea that ingenious and effective solutions can be based on already existing components [87], with the caveat that the components are chosen with an eye to the context.

10.4 Discussions and Reflections

As mentioned, this thesis set out to examine how educational outcomes of the marginalised can be enhanced through IK and the use of ICTs—to quote Floridi [99], as 're-ontologizing' or 'radically transforming' tools. Floridi's view suggests that our existence will, eventually, be delocalised. This perspective is contrary to ours with regards to how we see the continued role of IK in onboarding users to the digital realm and making that space intuitive for unlocking its potential. Our point of departure is that in the have-nots side of the digital divide local knowledge (i.e. IK) remains critical: since this knowledge form

provides a means to be ontologically rooted in the conditions of the users to make it possible to get them on on board with ICTs.

To be sure, this view cements Mafeje's [168, 169] arguments around the importance of pursuing endogeneity [11]. It deepens an understanding that situated, local knowledge is fundamental to responding meaningfully to a context in, for example, disentangling the global from the particular. Holding this understanding at each step, or iteration, in the process of building IKhwezi was not always easy.

We often had to consider how to justify the use of this knowledge, which being situated in locality could be deemed to stem from a subjective point of view to qualify as objective. Inevitably this concern sparked a number of questions such as: is it (un)reasonable to apply this knowledge—having used an ethnographic perspective—in a manner that may fail to reveal completely the rhythms, structures or dynamics of the user community? We grappled with this question throughout the journey. In fact, it is through this question that we came to valorise the importance of conversations in a context like the SLL in informing design decisions. We came to understand that engaging teachers in a geographically constrained location within a resource poor and highly degraded educational environment had tight limits for multiple formal engagements—even if we were reaching out to a different cohort for participation each time.

An emerging question at a methodological level was: should the informal interactions be regarded a means "to adjust[ing] our perspective [as designers] from 'somewhere else' to a local perspective" [310, p.454]? If so, to what end—particularly when working with users who are not experts of ICTs and/or live in the impoverished side of the digital divide? Ethically speaking, to what degree do we regard the lack of expertise and the material conditions of the users as a form of vulnerability that unavoidably can lead to the "dominance of the designer's perspective" [310, p.466]?

These questions at a fundamental level pertain to whether or not an argument can be made about the adaptation of design methods using the subjectivity of the designers who are in contexts like the SLL? Further, they are about the recognition of the invisible threads that are weaved into design based on situated and embedded knowledge (IK, in other terms), which emerge from the users organically—i.e. through unplanned interactions that may not be structured into a formal iteration(s). Unfortunately, the answers to these questions are not simple nor easy. They merely point to a need for ICT4D, as a multidisciplinary field, to take seriously any paradigmatic approach that may advance sociotechnical thinking in the formulation of appropriate and fitting solutions for a given context.

10.5 Recommendations and Future Work

Precisely because the work in this thesis is located in the intersection of at least three disciplines, there are a number of layers to it. These layers have multiple implications for advancing the work done from the micro to the macro perspective. In consideration of these implications, we will offer limited recommendations under each perspective—for, as it might be expected, it is not possible to be exhaustive.

10.5.1 Suggestions Framed from the Micro Perspective

As expected from any work in ICT4D, the work in this thesis is multifaceted, and as such the suggestions for the future work are many. In this subsection, we provide directions for future work from a micro level perspective.

Starting with IKhwezi as an artefact, the use of forms for interaction on small screens is less than ideal; some work is certainly required to think through the design for mobile interaction. Some work could also be done to make IKhwezi a fully fledged multimodal platform for collecting IK for educational use. (In this thesis, our orientation was on supplementing the physical learning material, given the fact that ICT infrastructure in marginalised communities remains generally poor to consider, for example, bandwidth intensive solutions.)

With regards to increasing usage of IKhwezi, there is a need to look into ways to promote and market the platform. At an intellectual level, this points to a possible need to develop an onboarding framework for contexts such as the SLL. This framework could be developed using, for instance, a qualitative design science research methodology. The purpose of the framework could be to spell out some of the key parameters for activating organic use of systems designed through centring users' organic, psychological, social and situational reality.

10.5.2 Suggestions Framed from the Macro Perspective

The novelty of this work—in putting teachers centre stage and exploring how ICTs can be used to harness their experiences for the possible development of textbooks and other learning materials that reflect the lived reality of learners—is predicated on different issues. Many of which are structural and require a deep understanding that ICTs are not neutral: they can reinforce existing inequalities.

With the above disclaimer made, it is therefore important to continue with initiatives that promote the use of ICTs in all strata of society, particularly among marginalised communities. Specifically in education, the promotion should be done in a manner that advances the idea of ICTs, similar to black boards, as integral to the the 21st century teaching and learning process. In other words, the question of whether ICTs are required or not in the classrooms should be rendered mute. All effort must be made to ensure that schools have adequate and proper ICTs infrastructure. Further, this effort must also take seriously proposals to, for example:

> [...] provide mobile access to Wikipedia free of data charges [... in order to] put the world's knowledge in the hands of millions of South African youths, especially those without libraries or computers. [272].

Another point to flag is that time is needed to allow teachers to adapt their practice to the use of ICTs in teaching, and to the current national curricula. The latter point requires emphasis given the false starts in transforming education in post-apartheid South Africa [173, 271]. As Mkhize [188] aptly notes, these false starts have contributed to a "normalised dysfunction" in many of our schools (with teachers seemingly disengaged or disinterested in their practice). To undo this normalisation/dysfunction, it is indeed worth stressing that it will take time and effort. Further, as Westaway [308] argues, it will take a distinct understanding that:

> [...] to try to change the functionality of a system could be different to attempting to end dysfunction. The former foregrounds the political interests at play and therefore calls for a political intervention, whereas the latter can present [itself] as a narrowly technicist matter.

With the above in mind, we recommend a pilot study that aims to understand how teachers can be better supported in growing their practice: to become effective teachers and digital

practitioners using a framework like I-TPACK. Basically, this pilot study should be done with the broad intention of facilitating ICT integration within schools—or, more precisely, to facilitating integration that promotes "learning *with* or *through* ICTs [211, p. 256].

Given also that the projected drop out rate of learners before matric will remain high[20] [78, 114, 126], one question for the integration could be: how do we skill our learners such that they can organically acquire technical ICT knowledge? This is a critical and relevant question to ask; for we believe the challenge to close the digital divide lies partly in thinking about how we can end the consumerist culture, which makes it possible for new technological innovations to emerge mostly on the developed side of the divide.

10.6 Concluding Remarks

In a seemingly eclectic manner, this thesis drew insights from different grounding disciplines in pursuit of a meaningful digital solution to a core problem in education. This eclecticness, in fact, should be recognised as a necessary aspect of carrying out ICT4D work in a reflective, endogenously rooted and problem-focused manner that aims to yield solutions closely attuned to the reality and the needs of the intended users.

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[20]High insofar as in 2011, about 50% of learners were dropping out and to the present moment the number remains marginally lower—exact figure is contested.

List of References

[1] Comparison of Wiki Software. Online: `https://en.wikipedia.org/wiki/Comparison_of_wiki_software` [Last accessed: 16 January 2017].

[2] DokuWiki: It's Better When It's Simple. Online: `https://www.dokuwiki.org/` Last accessed: 18 May 2013.

[3] Extension:Page Forms. Online: `https://www.mediawiki.org/wiki/Extension:Page_Forms` [Last accessed: 17 March 2017].

[4] Manual:MediaWiki Architecture. Online: `https://www.mediawiki.org/wiki/Manual:MediaWiki_architecture` [Last accessed: 1 March 2017]. The article builds on a chapter contribution by Sumana Harihareswara and Guillaume Paumier on the MediaWiki's architecture in a book: Architecture of Open Source Applications, 2012.

[5] MediaWiki. Online: `https://www.mediawiki.org/` [Last accessed: 20 May 2013].

[6] Siyakhula Living Lab. Online: `http://www.siyakhulall.org/` [Last accessed: 20 May 2013].

[7] Tiki Wiki CMS Groupware: The Free and Open Source Web Application with the most built-in features. Online: `http://info.tiki.org/Tiki+Wiki+CMS+Groupware` [Last accessed: 20 May 2013].

[8] WikiAfrica Primary School Feasibility Study. Online: `https://meta.wikimedia.org/wiki/WikiAfrica_Primary_School_Feasibility_Study` [Last accessed: 16 May 2015], 2015.

[9] ABRAS, C., MALONEY-KRICHMAR, D., AND PREECE, J. User-Ccentered Design. *Bainbridge, W. Encyclopedia of Human-Computer Interaction. Thousand Oaks: Sage Publications 37*, 4 (2004), 445–456.

[10] ACKRILL, J. L. *Aristotle's Categories and De Interpretatione: Translated with notes.* Oxford University Press, New York, 1963.

[11] ADESINA, J. Sociology Beyond Despair: Recovery of Nerve, Endogeneity, and Epistemic Intervention. *South African Review of Sociology 37*, 2 (2006), 241–259.

[12] ADESINA, J. Archie Mafeje and the Pursuit of Endogeny: Against Alterity and Extroversion. *Africa Development 33*, 4 (2008), 133–152.

[13] ADESINA, J., GRAHAM, Y., AND OLUKOSHI, A. *Africa and Development Challenges in the New Millennium: The NEPAD Debate.* Africa in the New Millennium. Zed Books, 2006.

[14] AGRAWAL, A. Dismantling the Divide Between Indigenous and Scientific Knowledge. *Development and Change 26*, 3 (1995), 413–439.

[15] AGRAWAL, A. Indigenous and Scientific Knowledge: Some Critical Comments. *Indigenous Knowledge and Development Monitor 3*, 3 (1995), 3–6. For a detailed version of this article see: [14].

[16] AHLQUIST, J. Trending Now: Digital Leadership Education Using Social Media and the Social Change Model. *Journal of Leadership Studies 8*, 2 (2014), 57–60.

[17] ALAVI, M., AND LEIDNER, D. E. Review: Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues. *MIS Quarterly* (2001), 107–136.

[18] ALMIRALL, E., AND WAREHAM, J. Living Labs and Open Innovation: Roles and Applicability. *The Electronic Journal for Virtual Organizations and Networks 10*, 3 (2008), 21–46.

[19] ALMIRALL, E., AND WAREHAM, J. Living Labs: Arbiters of Mid- and Ground-Level Innovation. *Technology Analysis and Strategic Management 23*, 1 (2011), 87–102.

[20] ALSHENQEETI, H. Interviewing as a Data Collection Method: A Critical Review. 39–45.

[21] ANGELI, C., AND VALANIDES, N. Epistemological and Methodological Issues for the Conceptualization, Development, and Assessment of ICT-TPCK: Advances in Technological Content Knowledge (TPCK). *Computers & Education 52*, 1 (2009), 154–168.

[22] ARONOWITZ, S., AND GIROUX, H. A. *Education Under Siege: The Conservative, Liberal and Radical Debate Over Schooling.* Routledge, 1985.

[23] ARONSON, J. A Pragmatic View of Thematic Analysis. *The Qualitative Report 2*, 1 (1995), 1–3.

[24] ASANTE, M. K. The Afrocentric Idea in Education. *Journal of Negro Education* (1991), 170–180.

[25] ASANTE, M. K. Afrocentricity: The Theory of Social Change. Online: `http://multiworldindia.org/wp-content/uploads/2010/05/Afrocentricity.pdf` [Last accessed: 7 Jan 2015], 1995. Speech delivered at Guadeloupe.

[26] AVGEROU, C. Discourses on ICT and Development. *Information Technologies & International Development 6*, 3 (2010), 1–18.

[27] BALLON, P., PIERSON, J., AND DELAERE, S. Test and Experimentation Platforms for Broadband Innovation: Examining European Practice. *Studies on Media, Information and Telecommunication (SMIT) – Interdisciplinary Institute for BroadBand Technology (IBBT)* (2005).

[28] BARTLETT, L. Dialogue, Knowledge, and Teacher-Student Relations: Freirean Pedagogy in Theory and Practice. *Comparative Education Review 49*, 3 (2005), 344–364.

[29] BASDEN, A. Cosmonomic Philosophy—With Special Relevance to Information Technology. Online: `http://kgsvr.net/dooy/summary.it.html` [Last accessed: 18 November 2015], 1998.

[30] BASDEN, A. Aspects of Knowledge Representation. In *In Search of an Integrative Vision for Technology.* Springer, 2006, pp. 19–38.

[31] BELL, G., AND DOURISH, P. Yesterday's Tomorrows: Notes on Ubiquitous Computing's Dominant Vision. *Personal and Ubiquitous Computing 11*, 2 (2007), 133–143.

[32] BENNETT, L. Learning from the Early Adopters: Developing the Digital Practitioner. *Research in Learning Technology 22* (2014).

[33] BERG, B. L. *Qualitative Research Methods for the Social Sciences.* London: Pearson, 2007.

[34] BERGVALL-KÅREBORN, B., IHLSTRÖM ERIKSSON, C., STÅHLBRÖST, A., AND SVENSSON, J. A Milieu for Innovation–Defining Living Labs. In *2nd ISPIM Innovation Symposium - Stimulating Recovery - The Role of Innovation Management* (2009).

[35] BERNERS-LEE, T. Long Live the Web. *Scientific American 303*, 6 (2010), 80–85.

[36] BERNSTEIN, B. On the Classification and Framing of Educational Knowledge. In *Knowledge and Control: New Directions for the Sociology of Knowledge*. Collier-Macmillan, London, 1971, pp. 47–69.

[37] BERNSTEIN, B. *Class, Codes and Control–Volume IV: The Structuring of Pedagogic Discourse*. Routledge, 1990.

[38] BERNSTEIN, B. Vertical and Horizontal Discourse: An Essay. *British Journal of Sociology of Education 20*, 2 (1999), 157–173.

[39] BERNSTEIN, B. *Pedagogy, Symbolic Control and Identity. Theory, Research, Critique*. Rowman Littlefield Publisher Lanham, Maryland, USA, 2000. First edition 1996 by Taylor & Francis.

[40] BEST, M. L. Understanding Our Knowledge Gaps: Or, Do We Have an ICT4D Field? And Do We Want One? *Information Technologies & International Development 6*, SE (2010), 49–52.

[41] BEVAN, N. Usability is Quality of Use. *Advances in Human Factors Ergonomics 20* (1995), 349–354.

[42] BLOCH, G. *The Toxic Mix: What's Wrong with South Africa's Schools and How to Fix It*. Tafelberg, 2009.

[43] BLOMBERG, J., GIACOMI, J., MOSHER, A., AND SWENTON-WALL, P. Ethnographic Field Methods and their Relation to Design. *Participatory Design: Principles and Practices* (1993), 123–155.

[44] BOURDIEU, P. *Political Interventions: Social Science and Political Action*. Verso Books, 2008.

[45] BOURDIEU, P., AND PASSERON, J. *Reproduction in Education, Society and Culture*. No. 5 in Sage Studies in Social and Educational Change. Sage Publications, London, 1977.

[46] BOYATZIS, R. E. *Transforming Qualitative Information: Thematic Analysis and Code Development.* Sage, 1998.

[47] BOYCE, C., AND NEALE, P. *Conducting In-depth Interviews: A Guide for Designing and Conducting In-depth Interviews for Evaluation Input.* Pathfinder International Watertown, MA, 2006.

[48] BRAUN, V., AND CLARKE, V. Using Thematic Analysis in Psychology. *Qualitative Research in Psychology 3*, 2 (2006), 77–101.

[49] BREIDLID, A. Culture, Indigenous Knowledge Systems and Sustainable Development: A Critical View of Education in an African Context. *International Journal of Educational Development 29*, 2 (2009), 140–148.

[50] BRIGGS, J. The Use of Indigenous Knowledge in Development: Problems and Challenges. *Progress in Development Studies 5*, 2 (2005), 99–114.

[51] BROWN, A. E., AND GRANT, G. G. Highlighting the Duality of the ICT and Development Research Agenda. *Information Technology for Development 16*, 2 (2010), 96–111.

[52] BUCK, J. N. *The House-Tree-Person Technique: Revised Manual.* Western Psychological Services, 1966.

[53] CHAMBERS, R. *Rural Development: Putting the Last First.* Longman, 1983.

[54] CHAMBERS, R. The Professionals and the Powerless: Whose Reality Counts? *Choices: The Human Development Magazine 4*, 1 (1995), 14–15.

[55] CHAMBERS, R. *Whose Reality Counts?: Putting the First Last.* Intermediate Technology Publications Ltd (ITP), 1997.

[56] CHAMBERS, R. Beyond "Whose Reality Counts?" New Methods We Now Need? *Studies in Cultures, Organizations and Societies 4*, 2 (1998), 279–301.

[57] CHAMBERS, R. The World Development Report: Concepts, Content and a Chapter 12. *Journal of International Development 13*, 3 (2001), 299–306.

[58] CHEN, Y., AND RUBINSTEIN-AVILA, E. Code-Switching Functions in Postcolonial Classrooms. *The Language Learning Journal*, 0 (2015), 1–15.

[59] CHILISA, B. *Indigenous Research Methodologies.* Sage Publications, 2012, ch. Situating Knowledge Systems, pp. 1–40.

[60] CLARK, C., AND GORSKI, P. Multicultural Education and the Digital Divide: Focus on Race, Language, Socioeconomic Class, Sex, and Disability. *Multicultural Perspectives 3*, 3 (2001), 39–44.

[61] CONRADIE, P., AND JACOBS, S. Bridging the Digital Divide. *Engineering Management Journal 13*, 1 (2003), 30–33.

[62] COOPER, A. *The Inmates are Running the Asylum:[Why High-tech Products Drive Us Crazy and How to Restore the Sanity].* Sams Indianapolis, 2004.

[63] CREARY, N. M. *African Intellectuals and Decolonization.* Ohio University Press, 2012.

[64] CRESWELL, J. W. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches.* Sage, 2009.

[65] CUBAN, L. *Teachers and Machines: The Classroom Use of Technology Since 1920.* Teachers College Press, 1986.

[66] CUBAN, L. Techno-Reformers and Classroom Teachers. *Education Week 16*, 6 (1996), 37–38.

[67] DALVIT, L., MURRAY, S., AND TERZOLI, A. The Role of Indigenous Knowledge in Computer Education in Africa. In *Learning to Live in the Knowledge Society*, M. Kendall and B. Samways, Eds., vol. 281 of *IFIP International Federation for Information Processing.* Springer Boston, 2008, pp. 287–294.

[68] DALVIT, L., MURRAY, S., AND TERZOLI, A. Localising Gramsci's Views of Folklore in an African Context. *Southern African Journal for Folklore Studies 19*, 1 (2009), 109–122.

[69] DALVIT, L., MUYINGI, H., TERZOLI, A., AND THINYANE, M. The Deployment of an e-Commerce Platform and Related Projects in a Rural Area in South Africa. *Strengthening the Role of ICT in Development* (2007), 27.

[70] DALVIT, L., SIEBÖRGER, I., AND THINYANE, H. The Expansion of the Siyakhula Living Lab: A Holistic Perspective. In *The 3rd International ICST Conference on e-Infrastructure and e-Services for Developing Countries (AFRICOMM 2011).* Springer, 2012, pp. 228–238.

[71] D'AVIGNON, R. W., AND STONE, G. D. Knowledge. In *Encyclopedia of Environment and Society*, P. Robbins, Ed. SAGE Publications, Inc., 2007, pp. 986–990.

[72] DAVIS, R., SHROBE, H. E., AND SZOLOVITS, P. What is a Knowledge Representation? *AI Magazine 14*, 1 (1993), 17–33.

[73] DEI, G. J. Indigenous African Knowledge Systems: Local Traditions of Sustainable Forestry. *Singapore Journal of Tropical Geography 14*, 1 (1994), 28–41.

[74] DEI, G. J. S. Rethinking the Role of Indigenous Knowledges in the Academy. *International Journal of Inclusive Education 4*, 2 (2000), 111–132.

[75] DEI, G. J. S. *Teaching Africa: Towards a Transgressive Pedagogy*, vol. 9. Springer Science & Business Media, 2009.

[76] DEI, G. S. Indigenous Anti-Colonial Knowledge as 'Heritage Knowledge' for Promoting Black/African Education in Diasporic Contexts. *Decolonization: Indigeneity, Education & Society 1* (2012), 102–119.

[77] DEPARTMENT OF BASIC EDUCATION. Curriculum and Assessment Policy Statement (CAPS). Online: `http://www.education.gov.za/Curriculum/CurriculumAssessmentPolicyStatements/tabid/419/Default.aspx` [Last accessed: 18 January 2015], 2011.

[78] DEPARTMENT OF BASIC EDUCATION. Education Statistics in South Africa. Tech. rep., 2014.

[79] DEPARTMENT OF SCIENCE AND TECHNOLOGY (DST). Indigenous Knowledge Systems. Online: `http://www.dst.gov.za/images/pdfs/IKS_Policy%20PDF.pdf` [Last accessed: 17 November 2014], 2004.

[80] DIGITAL DIVIDE INSTITUTE. 'Digital Divide' Defined (Hint: it's not about access.). Online: `http://www.digitaldivide.org/#!dd-defined/c1dh0` [Last accessed: 9 September 2014].

[81] DIRECTORATE-GENERAL FOR THE INFORMATION SOCIETY AND MEDIA. Living Labs for User-Driven Open Innovation: An Overview of the Living Labs Methodology, Activities and Achievements. Tech. rep., European Commission, Unit F4 New Infrastructure Paradigms and Experimental Facilities, January 2009.

[82] DIX, A., FINLAY, J., ABOWD, G. D., AND BEALE, R. *Human-Computer Interaction*, 3rd ed. Prentice Hall, 2004.

[83] DOURISH, P., AND BELL, G. *Divining a Digital Future: Mess and Mythology in Ubiquitous Computing.* MIT Press, 2011.

[84] DU BOIS, W. *The Souls of Black Folk.* Signet Classics, 1903.

[85] DYAKALASHE, S. Cultural and Linguistic Localization of the Shop-Owner Interfaces to an E-Commerce Platform for Rural Development. Master's thesis, Fort Hare University, 2010.

[86] DYSON, A. Full Service and Extended Schools, Disadvantage, and Social Justice. *Cambridge Journal of Education 41*, 2 (2011), 177–193.

[87] EDSON, J. *Design Like Apple.* Wiley Online Library, 2013.

[88] ELLEN, R., AND HARRIS, H. Concepts of Indigenous Environmental Knowledge in Scientific and Development Studies Literature – A Critical Assessment. East-West Environmental Linkages Network Workshop 3, Canterbury 8-10 May 1996: draft paper. Online: `http://lucy.ukc.ac.uk/rainforest/SML_files/Occpap/indigknow.occpap_TOC.html` [Last accessed: 7 September 2013].

[89] ENGLANDER, M. The Interview: Data Collection in Descriptive Phenomenological Human Scientific Research. *Journal of Phenomenological Psychology 43*, 1 (2012), 13–35.

[90] ERIKSSON, M., NIITAMO, V. P., AND KULKKI, S. State-of-the-Art in Utilizing Living Labs Approach to User-centric ICT Innovation - a European Approach, 2005. Online: `http://www.vinnova.se/upload/dokument/Verksamhet/TITA/Stateoftheart_LivingLabs_Eriksson2005.pdf` [Last accessed: 29 February 2012].

[91] ESCOBAR, A. Development, Trans/Modernities, and the Politics of Theory. *Focaal 2008*, 52 (2008), 127–135.

[92] ESCOBAR, A. *Encountering Development: The Making and Unmaking of the Third World.* Princeton University Press, 2011. First published in 1995.

[93] ESCOBAR, A. Sustainability: Design for the Pluriverse. *Development 54*, 2 (2011), 137–140.

[94] EVANS, B. Warm Analog Tones by Photoshop's Own @bradee, 2015. Online: `https://medium.com/startup-study-group/my-two-years-as-an-anthropologist-on-the-photoshop-team-e700acb7d3d5` [Last accessed: 1 September 2015].

[95] FAULKNER, L. Beyond the Five-user Assumption: Benefits of Increased Sample Sizes in Usability Testing. *Behavior Research Methods, Instruments, & Computers 35*, 3 (2003), 379–383.

[96] FENSEL, D., LAUSEN, H., POLLERES, A., DE BRUIJN, J., STOLLBERG, M., ROMAN, D., AND DOMINGUE, J. *Enabling Semantic Web Services: The Web Service Modeling Ontology.* Springer, 2007.

[97] FEREDAY, J., AND MUIR-COCHRANE, E. Demonstrating Rigor Using Thematic Analysis: A Hybrid Approach of Inductive and Deductive Coding and Theme Development. *International Journal of Qualitative Methods 5*, 1 (2006), 80–92.

[98] FLORIDI, L. A Look into the Future Impact of ICT on Our Lives. *The Information Society 23*, 1 (Dec. 2007), 59–64.

[99] FLORIDI, L. *Information: A Very Short Introduction*, vol. 225 of *Very Short Introductions.* Oxford University Press, 2010.

[100] FORD, M., BOTRA, A., AND RERSELMAN, M. ICT4RED 12–Component Implementation Framework: A Conceptual Framework for Integrating Mobile Technology into Resource-Constrained Rural Schools. In *IST-Africa Conference Proceedings, 2014* (2014), IEEE, pp. 1–11.

[101] FOTH, M. Urban Informatics, Ubiquitous Computing and Social Media for Healthy Cities. In *Proceedings of the 4th Making Cities Liveable Conference* (2011).

[102] FREEMAN-MOIR, J., AND SCOTT, A. *Shaping the Future: Critical Essays on Teacher Education*, vol. 12 of *Educational Futures–Rethinking Theory and Practice.* Sense Publishers, 2007, ch. Introduction, pp. 1–5.

[103] FREIRE, P. *Education for Critical Consciousness*, vol. 1. Bloomsbury Publishing, 1973.

[104] FREIRE, P. *Pedagogy of the Oppressed: 30th Anniversary Edition.* Bloomsbury Academic, 2000. First published in Portuguese in 1968, translated by Myra Ramos into English and published in 1970.

[105] FROST, A. Lack of a Universal Definition of Knowledge Management. Online: `http://www.knowledge-management-tools.net/nodefinition.html` [Last accessed: 15 January 2015], n.d.

[106] FUKUDA-PARR, S. *Are the MDGs Priority in Development Strategies and Aid Programmes? –Only Few Are!* No. 48 in Working Paper. International Poverty Centre, 2008.

[107] FUKUDA-PARR, S., AND KUMAR, A. S., Eds. *Readings in Human Development.* Oxford University Press, 2003.

[108] GAVAZA, T. Culturally-Relevant Augmented User Interfaces for Illiterate and Semi-Literate Users. Master's thesis, Rhodes University, 2012.

[109] GODUKA, N. Re-discovering Indigenous Knowledge - Ulwazi Lwemveli for Strengthening Sustainable Livelihood Opportunities within Rural Contexts in the Eastern Cape Province. *Indilinga African Journal of Indigenous Knowledge Systems 11* (2012), 1–19.

[110] GORDON, R., AND GRANT, D. Knowledge Management or Management of Knowledge? Why People Interested in Knowledge Management Need to Consider Foucault and the Construct of Power. *Tamara Journal for Critical Organization Inquiry 3*, 2 (2013).

[111] GOUGH, N. RhizomANTically Becoming-Cyborg: Performing Posthuman Pedagogies. *Educational Philosophy and Theory 36*, 3 (2004), 253–265.

[112] GOULDNER, A. W. *The Coming Crisis of Western Sociology.* Basic Books, New York, 1970.

[113] GOURLAY, S. The SECI Model of Knowledge Creation: Some Empirical Shortcomings. In *4th European Conference on Knowledge Management* (2003).

[114] GOVENDER, P. School Dropout Numbers Blamed on Poor Learning in Early Grades. Online: `http://mg.co.za/article/2016-06-06-school-dropout-numbers-blamed-on-poor-learning-in-early-grades` [Last accessed: 24 November 2016], 2016.

[115] GRAHAM, C. R. Theoretical Considerations for Understanding Technological Pedagogical Content Knowledge (TPACK). *Computers & Education 57*, 3 (2011), 1953–1960.

[116] GRAHAM, P. Ideas for Startups. Online: `http://www.paulgraham.com/ideas.html` [Last accessed: 1 Jan 2017], 2005.

[117] GRAMSCI, A. *Selections from the Prison Notebooks of Antonio Gramsci.* International Publishers, 1971.

[118] GRENIER, L. *Working with Indigenous Knowledge: A Guide for Researchers.* International Development Research Centre (IDRC), 1998.

[119] GROSFOGUEL, R. The Epistemic Decolonial Turn: Beyond Political-Economy Paradigms. *Cultural studies 21*, 2-3 (2007), 211–223.

[120] GRUBER, T. R. Towards Principles for the Design of Ontologies Used for Knowledge Sharing. In *Formal Ontology in Conceptual Analysis and Knowledge Representation* (Deventer, The Netherlands, 1993), N. Guarino and R. Poli, Eds., Kluwer Academic Publishers.

[121] GRUDIN, J., AND GRINTER, R. E. Ethnography and Design. *Computer Supported Cooperative Work (CSCW) 3*, 1 (1994), 55–59.

[122] GUMBO, S., NTŠEKHE, M., AND TERZOLI, A. e-Literacy Training in Deep Rural Areas: The Siyakhula Living Lab Experience. In *e-Skills Conference* (2014).

[123] GUMBO, S., TERZOLI, A., AND THINYANE, M. Living Labs as South Africa's Enabler for ICT Services Creation: The Siyakhula Living Lab Experience. In *Southern Africa Telecommunication Networks and Applications Conference (SATNAC)* (2013), pp. 277– 281.

[124] GUMBO, S., THINYANE, H., THINYANE, M., TERZOLI, A., AND HANSEN, S. Living Lab Methodology as an Approach to Innovation in ICT4D: The Siyakhula Living Lab Experience. In *IST-Africa 2012 Conference Proceedings* (2012), P. Cunningham and M. Cunningham, Eds.

[125] GURSTEIN, M. B. Enabling the Local as a Fundamental Development Strategy. *The Journal of Community Informatics 2*, 2 (2006).

[126] GUSTAFSSON, M. The When and How of Leaving School: The Policy Implications of New Evidence on Secondary Schooling in South Africa. Tech. rep., University of Stellenbosch, 2011. Stellenbosch Economic Working Papers: 09/11.

[127] HARHOFF, D., HENKEL, J., AND VON HIPPEL, E. Profiting from Voluntary Information Spillovers: How Users Benefit by Freely Revealing their Innovations. *Research policy 32*, 10 (2003), 1753–1769.

[128] HAYS, J. Learning Indigenous Knowledge Systems. In *Learning/Work: Turning Work and Lifelong Learning Inside Out*, L. Cooper and S. Walters, Eds. HSRC Press, 2009, pp. 194–207.

[129] HEEKS, R. Information Systems and Developing Countries: Failure, Success, and Local Improvisations. *The Information Society 18*, 2 (2002), 101 –112.

[130] HEEKS, R. ICT4D 2.0: The Next Phase of Applying ICT for International Development. *IEEE Computer 41*, 6 (2008), 26–33.

[131] HEEKS, R. *The ICT4D 2.0 Manifesto: Where Next for ICTs and International Development?* Development Informatics: Working Paper No. 42. University of Manchester, Institute for Development Policy and Management, 2009.

[132] HEEKS, R. *ICT4D 2016: New Priorities for ICT4D Policy, Practice and WSIS in a Post-2015 World.* Development Informatics: Working Paper No. 58. Centre for Development Informatics Institute for Development Policy and Management, SEED, University of Manchester, 2014.

[133] HESS, W. *Onboarding.* O'Reilly Media, Inc., 2009, pp. 70–72.

[134] HOADLEY, U., AND MULLER, J. Codes, Pedagogy and Knowledge: Advances in Bernsteinian Sociology of Education. In *The Routledge International Handbook of Sociology of Education*, M. W. Apple, S. J. Ball, and L. A. Gandin, Eds. Routledge, 2010, pp. 69–78.

[135] HOFISI, C., HOFISI, M., AND MAGO, S. Critiquing interviewing as a data collection method. *Mediterranean Journal of Social Sciences 5*, 16 (2014), 60.

[136] HOOKS, B. *Outlaw Culture: Resisting Representations.* Routledge, 1994.

[137] HOUNTONDJI, P. J. *Endogenous Knowledge: Research Trails.* CODESRIA, Dakar, Senegal, 1997.

[138] HOUNTONDJI, P. J. Knowledge Appropriation in a Post-Colonial Context. In *Indigenous Knowledge and the Integration of Knowledge Systems: Towards a Philosophy of Articulation*, C. A. Odora Hoppers, Ed. New Africa Education, 2002, pp. 23–38.

[139] INTERNATIONAL TELECOMMUNICATION UNION (ITU). World Summit on the Information Society. Online: `http://www.itu.int/wsis/index.html` [Last accessed: 17 September 2014].

[140] INTERNATIONAL TELECOMMUNICATION UNION (ITU). World Summit on the Information Society: Outcomes Documents. Online: `http://www.itu.int/wsis/outcome/booklet.pdf[Lastaccessed:17September2014]`, 2005.

[141] INTERNATIONAL TELECOMMUNICATION UNION (ITU). The Digital Divide and the MDGs. Online: `https://www.itu.int/newsroom/media-kit/story9.html/` [Last accessed: 24 April 2014], 2009.

[142] JACOB, E. K. Classification and Categorization: A Difference that Makes a Difference. *Library Trends 52*, 3 (2004), 515–540.

[143] JACOBS, K. R. *The Classroom Implementation of Indigenous Knowledge in the Science Curriculum by Science Teachers in the Western Cape Province, South Africa.* PhD thesis, 2015.

[144] JUNGNICKEL, K., AND HJORTH, L. Methodological Entanglements in the Field: Methods, Transitions and Transmissions. *Visual Studies 29*, 2 (2014), 136–145.

[145] JURISICA, I., MYLOPOULOS, J., AND YU, E. Ontologies for Knowledge Management: An Information Systems Perspective. *Knowledge and Information systems 6*, 4 (2004), 380–401.

[146] KELLY, K. *Interpretive Methods.* University of Cape Town Press, 1999, pp. 123–146.

[147] KENNY, C. What Should Follow the Millennium Development Goals? *BMJ 346* (2013).

[148] KIMBELL, L. Beyond Design Thinking: Design-as-Practice and Designs-in-Practice. In *CRESC 5th Annual Conference: Objects - What Matters? Technology, Value and Social Change* (Manchester, September 2009).

[149] KIVUNIKE, F. N., EKENBERG, L., AND DANIELSON, M. Perception of the Role of ICT Towards the Quality of Life of People in Rural Communities in Uganda. In *Proceedings of the 10th International Conference on Social Implications of Computers in Developing Countries* (2009), Dubai School of Government.

[150] KLEIN, H. Understanding WSIS: An Institutional Analysis of the UN World Summit on the Information Society. *Information Technologies & International Development 1*, 3-4 (2004), 3–13.

[151] KLEINE, D., AND UNWIN, T. Technological Revolution, Evolution and New Dependencies: What's New About ICT4D? *Third World Quarterly 30*, 5 (2009), 1045–1067.

[152] KOEHLER, M. J., AND MISHRA, P. Introducing Technological Pedagogical Content Knowledge. *Annual Meeting of the American Educational Research Association 32*, 2 (2008), 1–16.

[153] KOEHLER, M. J., AND MISHRA, P. *Introducing TPCK*. Routledge, 2008, pp. 3–29.

[154] KOS, S., SAM, M., DALVIT, L., TERZOLI, A., AND THINYANE, M. Creating a Multimedia, Web-based Glossary to Promote Multilingualism in Education. In *Kenton Conference* (2006), vol. 28.

[155] KRAUSS, K. E. Towards Self-Emancipation in ICT4D Research: Narratives about Respect, Traditional Leadership and Building Networks of Friendships in Rural South Africa. *The African Journal of Information Systems 4* (2012), 46–60.

[156] KVALE, S., AND BRINKMANN, S. *Interviews: Learning the Craft of Qualitative Research Interviewing*. Sage, 2009.

[157] KWASNIK, B. H. The Role of Classification in Knowledge Representation and Discovery. *Library Trends 48*, 1 (1999), 22–47.

[158] LATHER, P. Critical Frames in Educational Research: Feminist and Post-Structural Perspectives. *Theory into Practice 31*, 2 (1992), 87–99.

[159] LEE, Y., LEUNG, D. H. K., YUEN, B. L. P., LAM, W., AND DIB, P. Design.Lives Lab: A Case to Introduce Solution-Focused Design Methodology in Participatory Design for Social Inclusion. In *Diversity and Unity: Proceedings of the 4th World Conference on Design Research* (Delft, the Netherlands, 31 October - 4 November 2011).

[160] LEECH, B. L. Asking questions: Techniques for semistructured interviews. *PS: Political Science & Politics 35*, 4 (2002), 665–668.

[161] LEUF, B., AND CUNNINGHAM, W. *The Wiki Way: Quick Collaboration on the Web*. Addison-Wesley Professional, 2001.

[162] LINCOLN, Y., AND GUBA, E. Paradigmatic Controversies, Contradictions, and Emerging Confluences. In *Handbook of Qualitative Research*, D. NK, Ed. Sage, Thousand Oaks, CA, 2000, pp. 163–188.

[163] LIU, S.-H. Factors Related to Pedagogical Beliefs of Teachers and Technology Integration. *Computers & Education 56*, 4 (2011), 1012–1022.

[164] LYTRAS, M. D., AND POULOUDI, A. Towards the Development of a Novel Taxonomy of Knowledge Management Systems from a Learning Perspective: An Integrated Approach to Learning and Knowledge Infrastructures. *Journal of Knowledge Management 10*, 6 (2006), 64–80.

[165] MADON, S., REINHARD, N., ROODE, D., AND WALSHAM, G. Digital Inclusion Projects in Developing Countries: Processes of Institutionalization. *Information Technology for Development 15*, 2 (2009), 95–107.

[166] MAEMA, M., TERZOLI, A., AND THINYANE, M. A Look into Classification: Towards Building an Indigenous Knowledge Platform for Educational Use. In *IST-Africa 2013 Conference Proceedings* (2013), P. Cunningham and M. Cunningham, Eds., IIMC International Information Management Corporation.

[167] MAFEJE, A. *The Theory and Ethnography of African Social Formations: The Case of the Interlacustrine Kingdoms.* CODESRIA Book Series, 1991.

[168] MAFEJE, A. Africanity: A Combative Ontology. *CODESRIA Bulletin* (2008), 106–110. First published in CODESRIA Bulletin, No. 1, 2000, p 66-71.

[169] MAFEJE, A. Culture and Development in Africa: The Missing Link. *CODESRIA Bulletin*, 3 & 4 (2008), 59–61. First published in CODESRIA Bulletin, No. 1, 1988, p 7-8.

[170] MAILA, M., AND LOUBSER, C. Emancipatory Indigenous Knowledge Systems: Implications for Environmental Education in South Africa. *South African Journal of Education 23*, 4 (2003), 276–280.

[171] MAMDANI, M. There Can Be No African Renaissance Without an African-Focused Intelligentsia. In *African Renaissance: The New Struggle*, M. W. Makgoba, Ed. Mafube and Tafelberg, 1999, pp. 125–136.

[172] MANSELL, R. Power and Interests in Information and Communication Technologies and Development: Exogenous and Endogenous Discourses in Contention. *Journal of International Development 26*, 1 (2011), 109–127.

[173] MARAIS, H. *South Africa Pushed to the Limit: the Political Economy of Change.* UCT Press, 2011.

[174] MARAIS, M. An Analysis of the Factors Affecting the Sustainability of ICT4D Initiatives. In *IDIA2011 Conference Proceedings* (2011).

[175] MASEKO, P., AND VALE, P. The Struggles Over African Languages. *Arts and Humanities in Higher Education 15*, 1 (2016), 79–93.

[176] MATON, K., AND MULLER, J. A Sociology for the Transmission of Knowledges. In *Language, Knowledge and Pedagogy: Functional Linguistic and Sociological Perspectives*, F. Christie and J. Martin, Eds. Continuum London, 2007, pp. 14–33.

[177] MAZRUI, A. A. Pan-Africanism and the Intellectuals: Rise, Decline and Revival. In *African Intellectuals: Rethinking Politics, Language, Gender and Development* , T. Mkandawire, Ed. Zed Books, 2005, ch. 3, pp. 56–77.

[178] MBEKI, T. Opening Statement of the Debate in the National Assembly, on 'Reconciliation and Nation', May 1998. Online: `http://www.dfa.gov.za/docs/speeches/1998/mbek0529.htm` [Last accessed: 5 April 2014].

[179] MCGREGOR, D. Traditional Ecological Knowledge and Sustainable Development: Towards Coexistence. In *In the Way of Development: Indigenous Peoples, Life Projects and Globalization*, M. Blaser, H. A. Feit, and G. McRae, Eds. IDRC, 2004, p. 72.

[180] MCINTOSH, P. White Privilege: Unpacking the Invisible Backpack. *Peace and Freedom* (1989), 9–10.

[181] MCQUOWN, N. A. *Language, Culture, and Education: Essays*. Stanford University Press, 1982.

[182] MERTENS, D. M. *Research and Evaluation in Education and Psychology*, 4th ed. Sage, 2015.

[183] MICHAEL L. BEST, R. K. Sustainability Failures of Rural Telecenters: Challenges from the Sustainable Access in Rural India (SARI) Project. *Information Technologies & International Development 4* (2008).

[184] MISHRA, P., AND KOEHLER, M. J. Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. *Teachers College Record 108*, 6 (2006), 1017–1054.

[185] MKABELA, Q. Using the Afrocentric Method in Researching Indigenous African Culture. *The Qualitative Report 10*, 1 (2005), 178–189.

[186] MKANDAWIRE, T. Introduction. In *African Intellectuals: Rethinking Politics, Language, Gender and Development* , T. Mkandawire, Ed. Zed Books, 2005, ch. 1, pp. 1–9.

[187] MKANDAWIRE, T. Running While Others Walk: Knowledge and the Challenge of Africa's Development. *Africa Development 36*, 2 (2011), 1–36.

[188] MKHIZE, N. A Low-Fee, Low-Cost Private School Model. BBC World Service: The Forum [Podcast], 2014.

[189] MOERAN, B. From Participant Observation to Observant Participation: Anthropology, Fieldwork and Organizational Ethnography. *Creative Encounters* (2007), 1–25. Working Paper 1.

[190] MORRIS, D. Indigenous Knowledge Systems (IKS) and the Teaching of History: Case Studies in a Museum Archaeology Context. Online: `http://www.museumsnc. co.za/aboutus/depts/archaeology/pdf/IKS.pdf` [Last accessed: 16 November 2014], 2005.

[191] MOSES, J. What is a Dinaledi School? Online: `http://edulis.pgwc.gov.za/ index.php/dinaledi-articles/352-dinaledi-mst-strategy` Last accessed: 20 January 2017, 2012.

[192] MOTSEMME, N. The Mute Always Speak: On Women's Silences at the Truth and Reconciliation Commission. *Current Sociology 52*, 5 (2004), 909–932.

[193] MPHAHLELE, E. Living Writers, Living Culture. *Scrutiny2: Issues in English Studies in Southern Africa 2*, 2 (1997), 40–42.

[194] MPHAHLELE, E. K. Africa in Exile. *Daedalus* (1982), 29–48.

[195] MUGO, M. G. African Culture in Education for Sustainable Development. In *African Renaissance: The New Struggle*, M. W. Makgoba, Ed. Mafube and Tafelberg, 1999, pp. 210–232.

[196] NATIONAL PLANNING COMMISSION (NPC). National Development Plan 2030: Our Future–Make it Work. Tech. rep., Presidency of South Africa, 2012.

[197] NDEBELE, N. S. *Rediscovery of the Ordinary: South African Literature and Culture*. Congress of South African Writers (COSAW), 1991.

[198] NDLOVU, M. *Unite or Perish: Africa Fifty Years after the Founding of the OAU*. Africa Institute of South Africa, 2014, ch. What, Fundamentally, is Pan-African Education?, pp. 131–145.

[199] NDLOVU, M. Why Indigenous Knowledges in the 21st Century?: A Decolonial Turn. *Yesterday and Today*, 11 (2014), 84–98.

[200] NDOYE, M. Globalization, Endogenous Development and Education in Africa. *Prospects 27*, 1 (1997), 79–84.

[201] NGŨGĨ, T. *Decolonising the Mind: The Politics of Language in African Literature*. East African Educational Publishers *in association with* James Currey and Heinermann Educational Books, 1994. First published by East African Educational Publishers KLLtd in 1986.

[202] NGŨGĨ, T. Europhone or African Memory: The Challenge of the Pan-Africanist Intellectual in the Era of Globalization. In *African Intellectuals: Rethinking Politics, Language, Gender and Development* , T. Mkandawire, Ed. Zed Books, 2005, ch. 7, pp. 155–164.

[203] NICKOLS, F. W. The 'Knowledge' in Knowledge Management. In *The Knowledge Management Yearbook 2000-2001* (Boston, USA, 2000), J. Cortada and J. Woods, Eds., Butterworth-Heinemann, pp. 12–21.

[204] NIELSEN, J. *Usability Engineering*. Elsevier, 1994.

[205] NIELSEN, J. Why You Only Need to Test with 5 Users.

[206] NIELSEN, L. Personas. *The Encyclopedia of Human-Computer Interaction* (2012).

[207] NIESS, M. L. Investigating TPACK: Knowledge Growth in Teaching with Technology. *Journal of Educational Computing Research 44*, 3 (2011), 299–317.

[208] NIITAMO, V.-P., KULKKI, S., ERIKSSON, M., AND HRIBERNIK, K. A. State-of-the-art and Good Practice in the Field of Living Labs. In *Proceedings of the 12th International Conference on Concurrent Enterprising: Innovative Products and Services through Collaborative Networks. Italy: Milan* (2006), pp. 26–28.

[209] NISBETT, R. E., AND WILSON, T. D. The Halo Effect: Evidence for Unconscious Alteration of Judgments. *Journal of Personality and Social Psychology 35*, 4 (Apr. 1977), 250–256.

[210] NJIHIA, J. M., AND MERALI, Y. The Broader Context for ICT4D Projects: A Morphogenetic Analysis. *MIS Quarterly 37*, 3 (2013), 881–905.

[211] NKULA, K., AND KRAUSS, K. E. The Integration of ICTs in Marginalized Schools in South Africa: Considerations for Understanding the Perceptions of In-service Teachers and the Role of Training. In *8th International Development Informatics Association (IDIA) Conference* (2014), S. J and D. Van Greunen, Eds., pp. 241–261.

[212] NONAKA, I. The Knowledge-Creating Company. *Harvard Business Review 69*, 6 (1991), 96–104.

[213] NONAKA, I. A Dynamic Theory of Organizational Knowledge Creation. *Organization Science 5*, 1 (1994), 14–37.

[214] NONAKA, I., AND KONNO, N. The Concept of 'Ba': Building a Foundation for Knowledge Creation. *California Management Review 40*, 3 (1998), 40–55.

[215] NONAKA, I., AND TAKEUCHI, H. *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation.* Oxford University Press, 1995.

[216] NONAKA, I., TOYAMA, R., AND KONNO, N. SECI, Ba and Leadership: a Unified Model of Dynamic Knowledge Creation. *Long Range Planning 33*, 1 (2000), 5 – 34.

[217] NONAKA, I., AND VON KROGH, G. Perspective-Tacit Knowledge and Knowledge Conversion: Controversy and Advancement in Organizational Knowledge Creation Theory. *Organization science 20*, 3 (2009), 635–652.

[218] NORMAN, D. A. *The Psychology of Everyday Things.* Basic Books, 1988.

[219] NTULI, P. P. The Missing Link Between Culture and Education: Are We Still Chasing Gods that Are not Ours? In *African Renaissance: The New Struggle*, M. W. Makgoba, Ed. Mafube and Tafelberg, 1999, pp. 184–199.

[220] NTULI, P. P. Indigenous Knowledge Systems and the African Renaissance: Laying a Foundation for the Creation of Counter-Hegemonic Discourses. In *Indigenous Knowledge and the Integration of Knowledge Systems: Towards a Philosophy of Articulation*, C. A. Odora Hoppers, Ed. New Africa Education, 2002, pp. 53–66.

[221] NTULI, P. P. *Towards an African Identity of Higher Education.* Vista University and Skotaville Media Pretoria, 2004, ch. The African Renaissance, IKS & Globalisation: The Challenge for a Truly African University, pp. 171–184.

[222] NTŠEKHE, M., TERZOLI, A., GUMBO, S., AND THINYANE, M. ICT Skills Training in Marginalised Communities: A Gendered Journey with Lessons or Not? In *4th International Development Informatics Association (IDIA) Conference* (2014).

[223] NTŠEKHE, M., TERZOLI, A., AND THINYANE, M. Beyond Broadband: Internet Use, Indigenous Knowledge and Development. In *IST-Africa 2014 Conference Proceedings* (2014), P. Cunningham and M. Cunningham, Eds., IIMC International Information Management Corporation.

[224] NTŠEKHE, M., TERZOLI, A., AND THINYANE, M. Towards Building an Indigenous Knowledge Platform to Enable Culturally-Sensitive Education Underpinned by Technological Pedagogical and Content Knowledge (TPACK). In *e-Skills for Knowledge Production and Innovation Conference* (2014).

[225] NYOKA, B. Mafeje and 'Authentic Interlocutors': An Appraisal of his Epistemology. *African Sociological Review 16*, 1 (2012), 4–18.

[226] ODORA HOPPERS, C. A. Indigenous Knowledge and the Integration of Knowledge Systems. In *Indigenous Knowledge and the Integration of Knowledge Systems: Towards a Philosophy of Articulation*, C. A. Odora Hoppers, Ed. New Africa Education, 2002, pp. 2–22.

[227] ODORA HOPPERS, C. A. Culture, Indigenous Knowledge and Development. Tech. rep., Centre for Education Policy Development, 2005. Occassional Paper No. 5.

[228] ODORA HOPPERS, C. A. Education, Culture and Society in a Globalizing World: Implications for Comparative and International Education. *Compare: A Journal of Comparative and International Education 39*, 5 (2009), 601–614.

[229] ODORA HOPPERS, C. A., MOJA, T., AND MDA, T. Making This Our Last Passive Moment: The Way Forward. In *African Renaissance: The New Struggle*, M. W. Makgoba, Ed. Mafube and Tafelberg, 1999, pp. 233–239.

[230] ORTBALS, C. D., AND RINCKER, M. E. Fieldwork, Identities, and Intersectionality: Negotiating Gender, Race, Class, Religion, Nationality, and Age in the Research Field Abroad: Editors' Introduction. *PS: Political Science & Politics 42*, 2 (2009), 287–290.

[231] OWUOR, J. A. Integrating African Indigenous Knowledge in Kenya's Formal Education System: The Potential for Sustainable Development. *Journal of Contemporary Issues in Education 2*, 2 (2007), 21–37.

[232] OWUSU-ANSAH, F. E., AND MJI, G. African Indigenous Knowledge and Research. *African Journal of Disability 2*, 1 (2013), 1–5.

[233] PADE, C., PALMER, R., KAVHAI, M., AND GUMBO, S. Baseline Study Report. Tech. rep., Siyakhula Living Lab, 2009.

[234] PADE, C., AND SEWRY, D. The Practice and Need for Rural ICT for Development Evaluation: An Experience of the Siyakhula Living Lab Baseline Study. In *3rd International Development Informatics Association (IDIA) Conference* (2009).

[235] PADE-KHENE, C., PALMER, R., AND KAVHAI, M. A Baseline Study of a Dwesa Rural Community for the Siyakhula Information and Communication Technology for Development Project: Understanding the Reality on the Ground. *Information Development 26*, 4 (November 2010), 265–288.

[236] PADE-KHENE, C., AND SEWRY, D. The Rural ICT Comprehensive Evaluation Framework: Implementing the First Domain, the Baseline Study Process. *The Electronic Journal of Information Systems in Developing Countries 51* (2012), 1–34.

[237] PALMER, R. ICT4D and the Siyakhula Living Lab: An Anthropological Contribution to Digital Development. *Anthropology Southern Africa 33* (2010), 19–32.

[238] PALMER, R., TIMMERMANS, H., AND FAY, D. *From Conflict to Negotiation: Nature-based Development on the South African Wild Coast.* Human Sciences Research Council, Pretoria, 2002.

[239] PASSARO, J. 'You Can't Take the Subway to the Field!': 'Village' Epistemologies in the Global Village. *Anthropological Locations: Boundaries and Grounds of a Field Science* (1997), 147–162.

[240] PHIRI, A. C., FOKO, T., AND MAHWAI, N. Evaluation of a Pilot Project on Information and Communication Technology for Rural Education Development: A Cofimvaba Case Study on the Educational Use of Tablets. *International Journal of Education and Development using Information and Communication Technology 10*, 4 (2014), 60.

[241] PIERSON, J., AND LIEVENS, B. Configuring Living Labs for a 'Thick' Understanding of Innovation. In *Ethnographic Praxis in Industry Conference Proceedings* (2005), vol. 2005, Wiley Online Library, pp. 114–127.

[242] PITYANA, B. The Renewal of African Moral Values. In *African Renaissance: The New Struggle*, M. W. Makgoba, Ed. Mafube and Tafelberg, 1999, pp. 137–148.

[243] POLANYI, M. The Logic of Tacit Inference. *Philosophy 41*, 155 (1966), 1–18.

[244] POLANYI, M. *The Tacit Dimension*. Doubleday, Garden City, NY, 1966.

[245] RAITI, G. C. The Lost Sheep of ICT4D Literature. *Information Technologies and International Development 3*, 4 (July 2007), 1–8.

[246] RAMPHELE, M. Unleashing the Power of Communities to Confront Health Inequity. Online: http://www.phasa.org.za/wp-content/uploads/2012/02/

`Ramphele_Unleashing-community-the-power.pdf` [Last accessed: 13 December 2014], 2012.

[247] RENZ, J., STAUBITZ, T., POLLACK, J., AND MEINEL, C. Improving the Onboarding User Experience in MOOCs. *EDULEARN14 Proceedings* (2014), 3931–3941.

[248] ROTH, W.-M., AND LEE, Y.-J. "Vygotsky's Neglected Legacy": Cultural-Historical Activity Theory. *Review of educational research 77*, 2 (2007), 186–232.

[249] SCHOSTAK, J. *Interviewing and Representation in Qualitative Research.* McGraw-Hill Education (UK), 2006.

[250] SCHUMACHER, J., AND FEURSTEIN, K. Living Labs – The User as Co-Creator. *Methods* (2006).

[251] SCHUURMAN, D., BACCARNE, B., KAWSAR, F., SEYS, C., VEECKMAN, C., DE MAREZ, L., AND BALLON, P. Living Labs as Quasi-Experiments: Results from the Flemish LeYLab. In *XXIV ISPIM Conference: Innovating in Global Markets: Challenges for Sustainable Growth, Proceedings* (2013), p. 15.

[252] SCHUURMAN, D., DE MAREZ, L., AND BALLON, P. Open Innovation Processes in Living Lab Innovation Systems: Insights from the LeYLab. *Technology Innovation Management Review 3*, 11 (2013), 28–36.

[253] SCOTT, S. V. *Lived Methodology: A Situated Discussion of "Truth and Method" in Interpretive Information Systems Research.* Working Paper No. 91. Department of Information Systems, London School of Economics and Political Science, 2000.

[254] SEMALI, L. Community as Classroom: Dilemmas of Valuing African Indigenous Literacy in Education. *International Review of Education 45*, 3-4 (1999), 305–319.

[255] SEN, A. Development as Capability Expansion. *Journal of Development Planning 19* (1989), 4–58. Reprinted in: [107].

[256] SEN, A. Capability and Well-Being. In *The Quality of Life*, M. Nussbaum and A. Sen, Eds. Clarendon Press, Oxford, 1993, pp. 30–53.

[257] SEN, A. *Development as Freedom.* Anchor Books, New York, 1999.

[258] SESAME WORKSHOP. Online: `http://www.takalanisesame.com/about.html` [Last accessed: 13 March 2013].

[259] SETATI, M., ADLER, J., REED, Y., AND BAPOO, A. Code-Switching and Other Language Practices in Mathematics, Science and English Language Classrooms in South Africa. In *Challenges of Teacher Development: An Investigation of Take-up in South Africa*, J. Adler and Y. Reed, Eds. Van Schaik, 2002, ch. 5, pp. 72–93.

[260] SEYMOUR PAPERT: PAPERT.ORG. Works by Papert. Online: `http://www.papert.org/` [Last accessed: 6 March 2013].

[261] SHIVA, V. Monocultures of the Mind. *Trumpeter 10*, 4 (1993).

[262] SHNEIDERMAN, B. *Designing the User Interface: Strategies for Effective Human-Computer Interaction*. Pearson Education India, 2010.

[263] SHULMAN, L. Those Who Understand: Knowledge Growth in Teaching. *Educational Researcher 15*, 2 (1986), 4–14.

[264] SIEBÖRGER, I., AND TERZOLI, A. Field Testing the Alvarion BreezeMAX as a Last Mile Access Technology. In *Southern African Telecommunication Networks Applications Conference (SATNAC)* (Sugar Beach, Mauritius, 9 - 13 September 2007).

[265] SIEBÖRGER, I., AND TERZOLI, A. WiMAX for Rural South Africa: The Experience of the Siyakhula Living Lab. In *Southern Africa Telecommunication Networks and Applications Conference (SATNAC)* (Spier Estate, South Africa, 5 - 8 September 2010).

[266] SIEBÖRGER, I., TERZOLI, A., AND HODGKINSON-WILLIAMS, C. The Development of ICT Networks for South African Schools. In *Learning to Live in the Knowledge Society*. Springer, 2008, pp. 167–170.

[267] SINGH, P. Pedagogising Knowledge: Bernstein's Theory of the Pedagogic Device. *British Journal of Sociology of Education 23*, 4 (2002), 571–582.

[268] SIYAVULA EDUCATION. Technology-Powered Learning. Online: `http://www.siyavula.com/index.html` [Last accessed: 31 October 2015].

[269] SMALLBERG, E. Thankfully, ICT4D is Now About Strategy and Implementations, Not Technovelty. Online: `http://www.ictworks.org/2012/08/15/thankfully-ict4d-now-about-strategy-and-implementations-not-technovelty/` [Last accessed: 30 September 2015], 2012.

[270] SPAULL, N. Education in SA: A Tale of Two Systems, 31 August 2012. Online: `http://www.politicsweb.co.za/politicsweb/view/politicsweb/en/page71619?oid=323272&sn=Detail&pid=71616` [Last accessed: 21 February 2013].

[271] SPAULL, N. South Africa's Education Crisis: The Quality of Education in South Africa 1994-2011. Tech. rep., Centre for Development and Enterprise (CDE), 2013.

[272] SPAULL, N. THIS Youth Day, Three Companies Have the Power to Change the Lives of 12 Million South African Children with the Stroke of a Pen. Online: `http://www.sowetanlive.co.za/youthtube/2013/06/13/let-pupils-roam-info-highway` [Last accessed: 30 December 2016], 2013.

[273] SPAULL, N. Schooling in South Africa: How Low Quality Education Becomes a Poverty Trap. In *South African Child Gauge 2015*, A. De Lannoy, S. Swartz, L. Lake, and C. Smith, Eds. Children's Institute, University of Cape Town, 2015.

[274] SRIKANTAIAH, D. Education: Building on Indigenous Knowledge. *IK Notes*, 87 (December 2005).

[275] STÅHLBRÖST, A., AND HOLST, M. The Living Lab Methodology Handbook. *Luleå University of Technology and CDT* (2013).

[276] SUBASHINI, R., RITA, S., AND VIVEK, M. The Role of ICTs in Knowledge Management (KM) for Organizational Effectiveness. In *Global Trends in Information Systems and Software Applications*. Springer, 2012, pp. 542–549.

[277] SUTINEN, E., AND TEDRE, M. ICT4D: A Computer Science Perspective. In *Algorithms and Applications*, T. Elomaa, H. Mannila, and P. Orponen, Eds., vol. 6060 of *Lecture Notes in Computer Science*. Springer Berlin/Heidelberg, 2010, pp. 221–231.

[278] TARWIREYI, P. Design and Implementation of a Network Revenue Management Architecture for Marginalised Communities. Master's thesis, University of Fort Hare, 2007.

[279] TAYLOR, N. Priorities for Addressing South Africa's Education and Training Crisis. *Joint Education Trust* (2011).

[280] TEFFO, L. Moral Renewal and African Experience(s). In *African Renaissance: The New Struggle*, M. W. Makgoba, Ed. Mafube and Tafelberg, 1999, pp. 149–169.

[281] TERPSTRA, M. *TPACKtivity: An Activity-Theory Lens for Examining TPACK Development*. Springer US, Boston, MA, 2015, pp. 63–88.

[282] TERZOLI, A. The Siyakhula Living Lab (Eastern Cape). In *Enhancing Innovation in South Africa: The COFISA Experience*, T. James, Ed. Department of Science and Technology, Government of South Africa, 2010, pp. 82–85.

[283] THE ES'KIA INSTITUTE. The Es'kia Institute—Inspired by the life and work of Professor Es'kia Mphahlele. Online: `http://www.eskia.org.za` [Last accessed: 21 May 2015], 2002.

[284] THINYANE, M. *A Knowledge-Oriented, Context-Sensitive Architectural Framework for Service Deployment in Marginalized Rural Communities.* PhD thesis, Rhodes University, 2009.

[285] THINYANE, M., DALVIT, L., AND TERZOLI, A. The Internet for Rural Communities: Unrestricted and Contextualised. In *ICT Africa* (Addis Ababa, Ethiopia, 13 - 15 February 2008).

[286] THOMAS, D. R. A General Inductive Approach for Analyzing Qualitative Evaluation Data. *American Journal of Evaluation 27*, 2 (2006), 237–246.

[287] THOMPSON, M. Discourse, 'Development' & the 'Digital Divide': ICT & the World Bank. *Review of African Political Economy 31*, 99 (2004), 103–123.

[288] THORNTON, S. J. Aspiration and Practice: Teacher as Curricular-Instructional Gatekeeper in Social Studies, 1989. Paper presented at the Annual Meeting of the American Educational Research Association.

[289] TONGIA, R., AND SUBRAHMANIAN, E. Information and Communications Technology for Development (ICT4D)–A Design Challenge? In *Information and Communication Technologies and Development, 2006. ICTD'06.* (2006), IEEE, pp. 243–255.

[290] UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT (UNCTAD). The Digital Divide Report: ICT Diffusion Index 2005, 2006. Online: `http://unctad.org/en/Docs/iteipc20065_en.pdf` [Last accessed: 15 March 2013].

[291] UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP). *Human Development Report 1990.* Oxford University Press, 1990.

[292] UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP). *Human Development Report 1999.* Oxford University Press, 1999.

[293] UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP). *Human Development Report 2001: Making New Technologies Work for Human Development.* Oxford University Press, 2001.

[294] UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZA-
TION (UNESCO). Indigenous Knowledge and Sustainability. Online: `http://`
`www.unesco.org/education/tlsf/mods/theme_c/mod11.html` [Last accessed: 10
March 2013].

[295] UNWIN, T. *ICT4D: Information and Communication Technology for Development.*
Cambridge University Press, 2009.

[296] VAISHNAVI, V. K., AND KUECHLER, W. L. Design Science Research in Information
Systems. *AIS* (2004), 1–45.

[297] VON HIPPEL, E. The Dominant Role of Users in the Scientific Instrument Innovation
Process. *Research Policy 5*, 3 (1976), 212–239.

[298] VON HIPPEL, E. Lead Users: A Source of Novel Product Concepts. *Management
Science 32*, 7 (1986), 791–805.

[299] VON HIPPEL, E. Democratizing Innovation: The Evolving Phenomenon of User
Innovation. *Journal für Betriebswirtschaft 55*, 1 (2005), 63–78.

[300] VON HIPPEL, E., AND KATZ, R. Shifting Innovation to Users via Toolkits.
Management Science 48, 7 (2002), 821–833.

[301] VOOGT, J., FISSER, P., PAREJA ROBLIN, N., TONDEUR, J., AND VAN BRAAK, J.
Technological Pedagogical Content Knowledge–A Review of the Literature. *Journal
of Computer Assisted Learning 29*, 2 (2013), 109–121.

[302] VYGOTSKY, L. S. *Mind in Society: The Development of Higher Psychological
Processes.* Harvard University Press, 1978.

[303] WALFORD, G. Classification and Framing of Interviews in Ethnographic Interviewing.
Ethnography and Education 2, 2 (2007), 145–157.

[304] WALSHAM, G., ROBEY, D., AND SAHAY, S. Foreword: Special Issue on Information
Systems in Developing Countries. *MIS Q. 31*, 2 (June 2007), 317–326.

[305] WALSHAM, G., AND SAHAY, S. Research on Information Systems in Developing
Countries: Current Landscape and Future Prospects. *Information Technology for
Development 12*, 1 (2006), 7–24.

[306] WANE, N. N. African Indigenous Knowledge: Claiming, Writing, Storing, and
Sharing The Discourse. *Journal of Thought 40*, 2 (2005), 27–46.

[307] WARREN, D. M. Linking Scientific and Indigenous Agricultural Systems. In *The Transformation of International Agricultural Research and Development*, J. L. Compton, Ed. Lynne Rienner Pub, 1989.

[308] WESTAWAY, A. On Using Service Delivery as a Launch Pad into Advocacy: The Case Study of GADRA Education. Paper presented at the *Thinking Africa* colloquium, on "NGOs and Social Justice in Africa", 28 September 2014, 2014.

[309] WILLIS, A.-M. Editorial: User-Centred Design. *Design Philosophy Papers 2*, 1 (2004), 1–5.

[310] WINSCHIERS-THEOPHILUS, H., JENSEN, K., AND RODIL, K. Locally Situated Digital Representation of Indigenous Knowledge. In *Cultural Attitudes Towards Technology and Communication* (Australia, 2012), M. Strano, H. Hrachovec, F. Sudweeks, and C. Ess, Eds., Murdoch University, pp. 454–468.

[311] WORLD BANK. What is Indigenous Knowledge? Online: `http://www.worldbank.org/afr/ik/basic.htm` [Last accessed: 6 September 2013].

[312] WORLD ECONOMIC FORUM. *Global Information Technology Report 2008-2009: Mobility in a Networked World*. SRO-Kundig, Switzerland, 2009.

[313] WOYTEK, R., GORJESTANI, N., AND IK INITIATIVE TEAM. Indigenous Knowledge for Development: A Framework for Action. Tech. rep., World Bank, November 1998.

[314] YAÚ, Y. Z. *Confronting the Digital Divide: An Interrogation of the African Initiatives at Bridging the Gap*. CODESRIA in association with Zed Books, 2006, ch. 7, pp. 178–196.

[315] ZEMBYLAS, M. *ICT for Education, Development, and Social Justice*. Information Age Publishing Inc., 2009, ch. ICT for Education, Development, and Social Justice: Some Theoretical Issues, pp. 17–29.

[316] ZORN, T. Designing and conducting semi-structured interviews for research. *Waikato Management School* (2008).

Appendix A

Accompanying CD-ROM

The following are contained within the accompanying CD-ROM:

➠ **Thesis Document** – The electronic copy of this thesis in pdf format.

➠ **IKhwezi Skin** – The skin to be used to change the look and feel of a MediaWiki instance that is intended to serve the goals of collecting IK that can be used to enhance educational outcomes. With MediaWiki installed, the skin must be placed in the skins folder and should be enabled in LocalSettings.php:

```
wfLoadSkin( 'IKhwezi' );
$wgDefaultSkin = 'IKhwezi';
```

To derive the full functionality for IKhwezi, image uploads must be enabled in LocalSettings.php. Also the Page Forms extension must be installed.

A demo for IKhwezi is temporarily available on Amazon Web Services, `http://35.164.172.150/iwiki/`.

Appendix B

Classroom Poster Material

Figure B.1 – Business Plan Poster

Appendix C

Wiki Comparisons

Top Site Market Share ⓘ

	MediaWiki	70%
	DokuWiki	13.7%
	Atlassian Confluence	11.8%
	Tiki Wiki CMS Groupware	2.1%
	JSPWiki	0.5%
	Wikispaces	0.5%
	TWiki	0.4%
	XWiki	0.3%
	ScrewTurn Wiki	0.3%
	Foswiki	0.2%

Figure C.1 – Top 10 Wikis based on Trends Analysis from BuiltWith.com
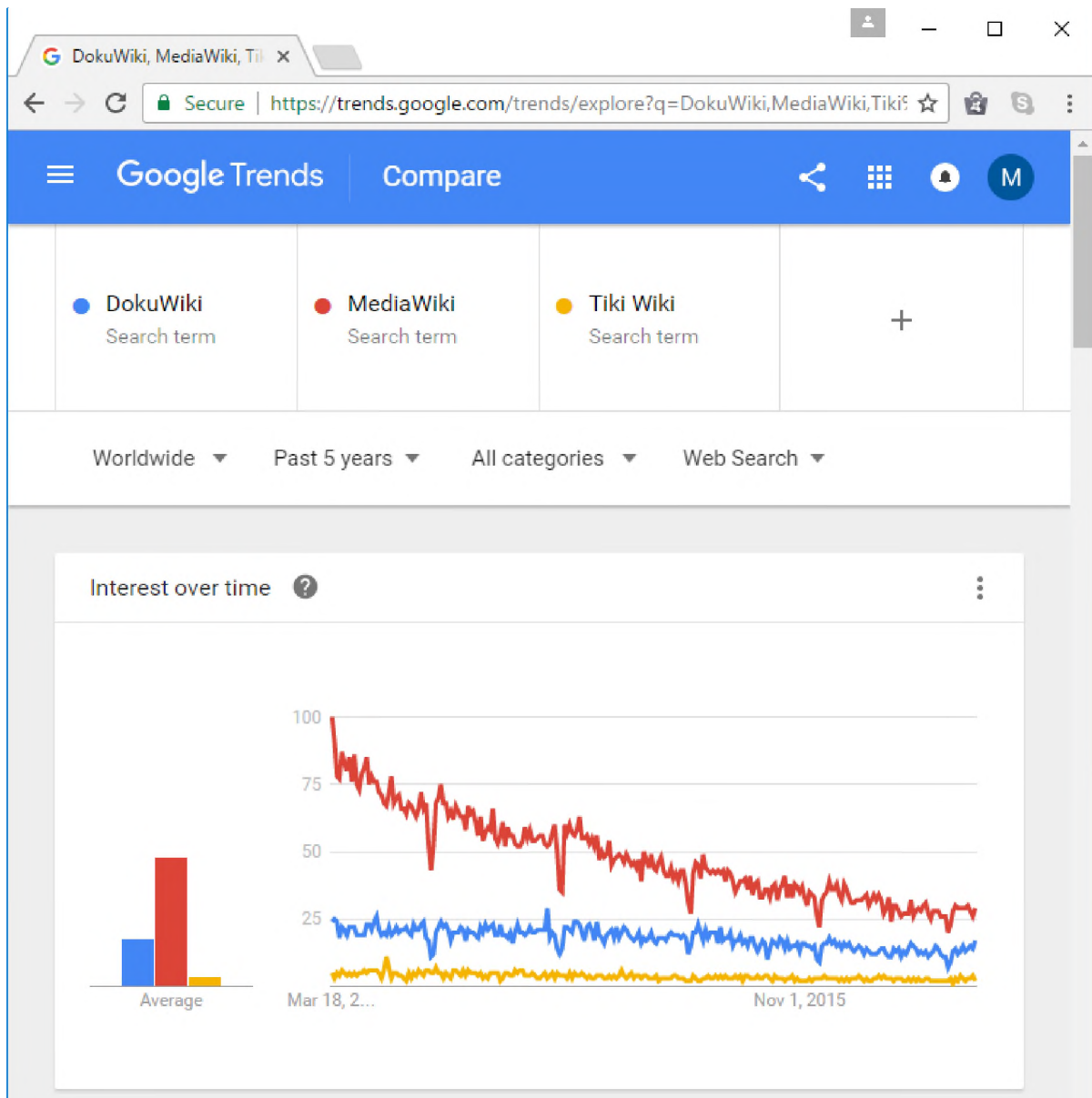
Figure C.2 – DokuWiki, MediaWiki and Tiki Wiki Google Trends Comparison

Appendix D

Ethics Approval Application

Ethical considerations are deemed important in any research that involves human participants. Below is an application that was made for the last leg of the research to evaluate the final design.

The application was reviewed by the Departmental Research Ethics Committee and was accompanied by letters of consent from, for example, the educational district head and school principals.

In the application, an explicit undertaking was made to seek informed consent from the participant-teachers. Indeed, once the application was approved, this consent was sought before engaging the participant-teachers. In seeking consent, we made sure to stress that participation is voluntary and all data collected will be treated as confidential and anonymous.

RHODES UNIVERSITY
Where leaders learn

ETHICAL STANDARDS: RESEARCH PROTOCOL

Departmental Research Ethics Committee Review (Official Use Only)	
Track Number:	.... YEAR DEPARTMENT NUMBER
Date Received:	
Resolution:	☐Approved ☐Refer to Ethical Standards Committee
Resolution Date:	
Authorized by:	

Instructions
Any project in which **humans** are the subject of research requires completion of this form and submission, for approval, to the appropriate **Departmental Research Ethics Committee** or where such committee does not exist or cannot unanimously approve the research protocol, to the University's **Ethical Standards Committee** **Note:** Ethical clearance is required **before** any research participants are involved or consulted!

Please read the following documents:
    1) Ethical Guidelines: Human Subjects
    2) Ethical Standards Policy: Human Subjects
    3) Ethical Standards Procedures: Human Subjects
Available from http://www.ru.ac.za/research/research/ethics/

How to fill in this form:
    1) Complete all sections in typescript. Handwritten forms will **NOT** be accepted.
    2) Append all necessary documentation.
    3) Hand the signed copy and all attachments to the Departmental Research Committee representative.

General Particulars	
Title of project:	**Platform design for capturing everyday indigenous knowledge for educational purposes**
Name of principal investigator(s):	**Mathe Victoria Ntsekhe**
Contact details:	Institution: **Rhodes University** Department: **Computer Science** Address: **P.O. Box 94, Grahamstown 6140** Email:**mathevic@gmail.com** Telephone:Click here to enter text.
Name of supervisor(s):	**Prof Alfredo Terzoli**
Contact details:	Department: **Computer Science** Address: **P.O. Box 94, Grahamstown 6140** Email: **a.terzoli@ru.ac.za** Telephone: **046 603 8602**
Research type:	**Local Research, Student Research, Doctoral**
Funding:	**No Funding**
Purpose of research:	**The main purpose of the research is to explore how everyday local or indigenous knowledge fit for the educational context may be cultivated and made readily available via a digital platform.**

Methodology

Briefly state the methodology and the procedures in which participants will be asked to participate:
The study is framed using the Living Lab research concept. This concept is premised on involving users within a real life context and at every stage of the research, inclusive of the development and innovation processes.

According to Bergvall-Kareborn et al (2009:3), a "Living Lab is both a milieu (environment, arena) and an approach (methodology, innovation approach)". The two dimensions to the living lab create a leaning towards the use of ethnographic methods under the pragmatic research paradigm. Essentially, this means the living lab approach adopts a mixed methods approach. Based on the purpose of the research and use of the living lab approach, there is a need to gain insights about users to be able to engage them in the design process. These insights will be gained in line with ethnographic practice and, to be precise through observations and informal interactions. (These interactions are made possible by the fact that the researcher and research assistant under the Siyakhula Living Lab are already interfacing with the schools in which the teachers will be selected from. The interfacing is through carrying out activities such as carrying out ICTs skills training and helping out with the maintenance work of the computer lab and Internet infrastructure)

On the strength of the above interactions, participants will be recruited for in-depth interviews and for participation in the testing of the platform. The criteria for recruitment will be gauged on expressed interest in taking some action to improve the curricula in a manner that brings inclusivity and/or promotes the idea of multicultural education.

The actual design itself will still involve an iterative process that involves users and/or insights gleaned from the participants during the phases of their engagement. The evaluation of the design will be done through usability testing. For the testing, participants will be invited into a session akin to a workshop and asked to use the designed platform while being observed.

State the minimum and maximum number of Participants needed:
Min: **5**
Max: **20**

Justify the numbers in terms of the methodology chosen and proposed data analysis requirements:
As the above indicates, the participants will be engaged in the process of either obtaining qualitative data or performing platform (usability) testing. In both instances, the minimum of five is deemed acceptable.

In qualitative research, it must be noted that the number of participants is deemed irrelevant, as the objective is to employ depth and not sampling strategies. By convention Englander (2012), for example, notes that three participants are therefore regarded an acceptable minimum.

For usability testing, Nielson similarly in arguing for depth—as in insights matter more than statistics—has suggested that five participants are sufficient. In fact, he argues that five in many cases that with fives participants it is possible to almost achieve "user testing's maximum benefit-cost ratio".

The given maximum is informed by above arguments, and has largely been suggested based on time constraints.

Information to Subject

What information will be afforded to participants **before** they consent to participate?
We will explain the purpose of the research and the role of the participant after granting consent.

As part of explaining the role of the participant, we will discuss any risks and benefits, if any, attached to participation. The discussion would attempt to stress the social implications of the research on the one hand, and on the other the importance of maintaining confidentiality and privacy. The latter will serve to highlight the methods that will be employed to protect and safeguard both the identity and privacy of participants.

Additionally, we will explicitly inform the participant that the data obtained will be stored and may be used in future research and that any published information will be available from the researcher and the research supervisor. If the participant requires further information they can request more details from the research supervisor.

Who will provide this information?
I, the researcher, will provide the necessary information with the possible help of a translator and/or research assistant, Mr Thozamile Ngeju.

Will the information provided be complete and accurate? **Yes**
If NO, describe the nature and extent to which it will not be complete:
Click here to enter text.

Participant Groups (Sample)

Are particular characteristics of any kind required in the participant group (e.g. age, cultural derivation, background, physical characteristics, disease states, etc.)? **Yes**
If YES, specify the characteristics:
Participants should have some teaching experience; otherwise no specific characteristic required.

Are participants drawn from Rhodes student body at large? **No**

Are Participants drawn from specific groups of Rhodes students? **No**
If YES, specify the groups:
Click here to enter text.

Are Participants drawn from a school population? **Yes**
If YES, identify school:
Fikizolo Primary School
Samuel Ntsiko Primary School

Are Participants drawn from an institutional population (e.g. Hospital, Prison, Mental Institution)? **No**
If YES, identify institution:
Click here to enter text.

Will any records be consulted for information? **Not applicable**
If YES, specify source of records:
Click here to enter text.

Will participants know their records are being consulted? **Not applicable**
State how these records will be obtained and whose permission is required:
Click here to enter text.

Are all participants over 18 years of age? **Yes**
If NO, justify the inclusion of minors:
Click here to enter text.

Risks and Benefits of Project

Is there any risk of harm, embarrassment or offence, however slight or temporary, to the participant, to third parties, or to the community at large? **No**
If YES, specify:
Click here to enter text.

Are all risks reversible? **Not applicable**
If NO, specify:
Click here to enter text.

Are remedial measures available, if risks are not reversible? **Not applicable**
If YES, specify:
Click here to enter text.

Has the person administering the project previous experience with the particular risk factors involved? **Not applicable**

Are any benefits expected to accrue to the participant personally (e.g. improved health, mental state, financial, etc.)? **Not applicable**
If NO, specify:
Click here to enter text.

Will you be using equipment of any sort? **Yes**
If YES, specify:
Computer lab machines of Fikizolo Primary School will be used for performing user testing of the prototype platform. A voice recorder may also be used for the interviews provided the participant offers consent.

Will any article of property, personal or cultural, be collected in the course of this project?
No
If YES, specify:
Click here to enter text.

Consent of Participants

Is consent to be given in writing? **Yes**
If NO, state reason why not:
Click here to enter text.

Do any participants suffer from a legal disability preventing them from giving effective informed consent (e.g. under 18 years, declared insane by a court of law, unconscious, etc.)? **No**
If YES, indicate what measures will be taken to obtain informed consent:
Click here to enter text.

Do any participants operate in an institutional environment which may cast doubt on the voluntary aspect of consent? **No**
If YES, specify:
Click here to enter text.

Will participants receive remuneration for their participation? **No**
If YES, state the basis on which remuneration is calculated, and indicate what measures have been taken to ensure that it cannot be considered a persuasive incentive:
Click here to enter text.

Do you require consent of an institutional authority for this project? **No**
If YES, specify:
Click here to enter text.

Privacy, Anonymity and Confidentiality of Data

Are provisions made to protect participant's rights to privacy and anonymity and to preserve confidentiality with respect to data? **Yes**
If YES, specify:
Voice recording will be used if and only if consent is provided.

Will mechanical methods of observation be used (e.g. one-way mirrors, recordings, videos, etc.)? **No**
If YES, specify:
Click here to enter text.

Will participants' consent to such mechanical methods of observation be obtained? **Yes**
If NO, give reasons:
Click here to enter text.

Will data collected be stored in any way? **Yes**
If YES, specify: 1) by whom, 2) how many copies, 3) for how long, 4) for what reasons, and 5) how will subject's anonymity be protected:
I, the principal investigator, together with my supervisor (Prof Terzoli) will store the data on a hard drive for one year. These data will be used for analysis and for inclusion in the thesis and possibly for an article publication. No personally identifiable data will be captured or needed for the analysis process.

Will stored data be made available for re-use? **No**
If YES, how will participants consent be obtained for such re-usage:
Click here to enter text.

Will any part of the project be conducted on private property (includes shopping centres)? **Yes**
If YES, state how consent of property owner is to be obtained:
A verbal request will be made to the principal of Fikizolo primary school. As it is, there is a working understanding between the school and the department of Computer Science (under the Siyakhula Living Lab) that lays the foundation for making this request in the stipulated manner.

Feedback

Will feedback be given to participants? **Yes**
If YES, state whether this is to be given to each individual immediately after participation; to each participant after the entire project is complete; to all participants in a group setting; or other manner and specify whether feedback will be written, oral or by other means:
Feedback that is specific to task completion in performing usability testing will be immediately available to individuals after participation. Overall feedback will be offered in the form of a written report that will be circulated to the participants after the completion of the research.

If you are working in a school or other institutional setting will you be providing teachers, parents, school authorities or equivalent a copy of your results and/or report? **Yes**
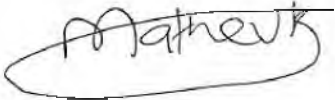If YES, specify:
The participating teachers and the principal(s) will receive the report.

Declaration

If any changes are made to the above arrangements or procedures, we will bring these to the attention of the chairperson of the ethical standards committee or appropriate Departmental Human Ethics Committee.

The undersigned declare themselves accountable to the ethical standards committee for conducting this research project in the manner herein described and in accordance with the spirit of the ethical guidelines of this university. We undertake to assume responsibility to advise the ethical standards committee promptly of any deviations, waivers, irregularities or harm occurring during the conduct of this research project.

I have read and understood the Rhodes University Ethical Standards Committee Handbook.

Principal investigator	Supervisor
Signature: Name: **Mathe Ntsekhe** Date: **10 December 2016**	Signature: Name: **Alfredo Terzoli** Date: **10 December 2016**

Appendices

In order to avoid delays in the processing of this application, please ensure that all the appropriate information (if applicable) is attached to your application:

1) Research instruments (e.g. questionnaires, interview questions, etc.)
2) Informed consent form
3) Written information given to participants prior to participation (e.g. invitation to participate)
4) Institutional permissions

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RHODES UNIVERSITY
Where leaders learn

26ᵗʰ January 2017

District Director of Education

Private Bag X 1001

Grahamstown, 6140

Dear Madam/Sir,

Re: Request of Approval to conduct research with teachers under the iRhini district

I am a Computer Science postgraduate student (under the supervision of Prof Alfredo Terzoli) doing PhD at Rhodes University.

I write to humbly request permission to contact teachers within the district of iRhini to aid me in the design and testing of a digital system designed to collect everyday local (indigenous) knowledge that is useful in fulfilling the goal of teaching learners from *'the known into the unknown'*.

One of the key aims of this research is to foreground the importance of local knowledge as background knowledge in the promotion of a frameworks like Technological Pedagogical and Content Knowledge (TPACK), which promotes the various important knowledges in teaching effectively with technology.
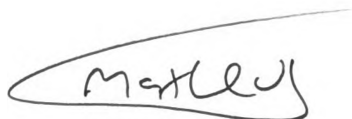
The data to be collected from this research will be treated with complete confidentiality and on the basis of voluntary consent. The collection of this data will require from each participant about 45 minutes to acquire.

Attached for your information is a copy of the participant's Informed Consent Form. If you have questions or wish to verify the research, please feel free to contact us.

If you would you approve, please complete and return the attached form.

Thank you for your time and I hope that you will find our request favourable.

Yours sincerely,

Mathe Ntšekhe

Research Student

Alfredo Terzoli

Supervisor

Institution Consent Form

Participation Consent
I consent for you to approach teachers to participate in a research that aims to <u>design a digital platform for capturing everyday indigenous knowledge for educational purpose</u>.

I acknowledge and understand:

- The role of the department is voluntary.
- I may decide to withdraw the department's participation at any time without penalty.
- Teachers in the schools will be invited to participate and that permission will be sought from them too.
- Only teachers who consent will participate in the project.
- All information obtained will be treated in strictest confidence.
- The teachers' names will not be used and individual teachers will not be identifiable in any written reports about the study.
- Participants may withdraw from the study at any time without penalty.
- A report of the findings will be made available to the department.
- I may seek further information on the project from Mathe Ntšekhe on 074 306 7143 or mathevic@gmail.com.

Full Name:	*Nomgcobo Perseverance Futshane*
Position:	*Acting District Director*
Signature:	*Futshane* DEPARTMENT OF EDUCATION PRIVATE BAG X1001 GRAHAMSTOWN, 6140 **2 7 JAN 2017**

Appendix E

The Essence of Form Creation Using Page Forms Extension

Figure E.1 – Visual Representation of the Sample Form to be Created

To create the above form, Page Forms requires form definition pages to be created, shown below. These pages can be created through helper pages.

```
! Narration
| {{{Narration|}}}
|-
! Education Level
| {{{Education Level|}}}
|-
! Image
| [[File:{{{Image|no-image.png}}}|175px|left|]]
```

Figure E.2 – Template Specification for the Sample Form in Figure E.1

```
{{#forminput:form=Story}}
<includeonly>

{{{for template|Story}}}
{| class="wikitable"
! style="text-align: left;"| *Narration
|-
| {{{field|Narration|input type=textarea|mandatory|
        autogrow|placeholder=Type out your story...}}}
|-
! style="text-align: left;"| Education Level
|-
| {{{field|Education Level|input type=checkboxes|
        values= Foundation, Intermediate, Senior}}}
|-
! style="text-align: left;"| Image
|-
|{{{field|Image|uploadable|default filename= }}}
|}
{{{end template}}}

{{{standard input|save}}} {{{standard input|preview}}}
{{{standard input|changes}}} {{{standard input|cancel}}}

</includeonly>
```

Figure E.3 – Form Definition for Creating the Form in Figure E.1

Appendix F

Extracts from the Use of IKhwezi

My mathematical life has always been difficult. I have the ability to use basic mathematical skills such as addition, subtraction, division and multiplication and actually did well at school when these were the only skills required. The dreaded period of my mathematical life was the introduction and practice of 'solving for X'.

I should never solve for X. not because I do not have the skills required but because, as I asked my teacher repeatedly 'what IS X?'. Her answer was always 'it's a variable, it could be anything' and this did not satisfy me nor did it give me impetus to solve the problem. I use the skills required for 'solving for X' all the time in real life when I am required to find the value of something I need and care about and yet, give me an equation now and somehow these skills do not come into play.

I believe that if the teacher had replaced 'x' with something I care about: 'x is your mathematics mark/ x is a new dress that is on special/ x is....' I might have been able to carry those skills over as I do now in everyday life.

Another aspect of 'solving for X' that I found difficult was that it was demoralising. No matter how many times you came into class and 'solved for x', whether you got it wrong or right, GUESS WHAT? the very next day or the very next equation would ask you to 'solve for x' and so, in my mind, X became a placeholder for mindless solving of problems that will never matter, that are unsolvable and will keep recurring no matter how adept you get at solving them.

How can the teaching of 'Solving for X' work to make 'X' more relevant and more encouraging to solve for?

Figure F.1 – U 'X' ongasolveki!—Cannot Solve for X

➡ **Materials:** Retangular Food Tray, Ruler, Curved Surface, Water

➡ **Process:**

⇥ Put the tray on a flat surface. Pour some water into the tray.

⇥ To create circular waves, tap the water continuously with a finger or the tip of a round pen

⇥ Watch the waves form.

⇥ To illustrate interference, create a straight barrier with the ruler and watch the behaviour of the waves as they hit the barrier.

⇥ Create other types of barriers for example with the curved surface and observe the behaviour near this surface.

⇥ Tapping with two fingers at the same time will also show what happens when two waves collide.

⇥ Draw Diagrams to illustrate all of the above.

Figure F.2 – Teaching Wave Theory in Science