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Towards Decolonizing and Africanizing Computing Education in South Africa

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Abstract:

Many have called for action to decolonize South African universities. Decolonization focuses on dismantling Western epistemological traditions and practices entrenched in the university culture and knowledge domains. In this paper, we explore decolonization as a site of struggle in national higher-learning institutions not only politically but also epistemologically. More specifically, we examine how hegemonic and neoliberal policies that hinder decolonization and indigeneity govern efforts to Africanize computing education. We conclude with critical recommendations that can support computing departments and faculties in enriching the syllabus with indigenous knowledge.

Keywords: Computing Education, Decolonization, Africanization, Ethnocomputing.

1 Introduction

In 2015, South African universities experienced a series of violent student protests across the country, some of which persist today. These protests emerged due to the inequality and exclusion experienced by predominantly black students who called for, among other things, efforts to decolonize universities in Africa (Le Grange, 2016). Discourse on decolonization focuses on dismantling Western epistemological traditions and practices entrenched in current university culture and knowledge domains (Heleta, 2016). Decolonization involves the epistemologically dismantling higher education from an ethnocentric and monolithic environment and moving toward a more inclusive and heterogeneous space that nurtures diverse cultural groups and indigenous knowledge systems. At a broader level, the decolonization debate represents a reflective conversation about the economic inequalities and exclusions that persist among persons of color in a post-apartheid South Africa (Naicker, 2016).

Local student activists have criticized the slow rate with which South African universities have transformed and the national government for insufficient progress in addressing white economic hegemony in the country (Molefe, 2016). Activists argue that a white minority controls the country's economic wealth and resources, while most black Africans remain in poverty (Heleta, 2016). White hegemony extends beyond economic control; however, while university policies highlight the need for change, equity, and equality, African students continue to experience marginalization in historically white universities (Le Grange, 2016). At historically white or advantaged universities, black African students face structural oppression in terms of language—a critical attributive factor in academic failure (van Rooy & Coetzee-Van Rooy, 2015). By implication, disadvantaged black students must function in a learning culture and syllabus that educators present in contemporary English and that predominantly have their roots in Western history and thought. Indeed, the pressure to become proficient in English, to "talk white", and to "write white"' makes for an alienating experience for many black Africans (Bazana & Mogotsi, 2017).

We reflect on the dialectical relationship of historical colonial policies in education and the praxis of current pedagogies that hinder indigenous knowledge from developing in the computing disciplines at South African universities. Moreover, we argue that computing decolonization cannot exist as a separatist movement. Indeed, "decolonized" curricula should not favor some knowledge domains over others (Heleta, 2016). In this paper's scope, decolonization instead suggests that both Western and non-Western worldviews have important and contributory roles in tackling hegemony in computing education. By deploying hermeneutics as a theoretical framework and document analysis as a research strategy, we discuss the advancements that have been made concerning language policies in the computing discipline and assess the impact that colonial and contemporary neoliberal policies have on the South African higher education sector.

2 Theoretical Framework

We use hermeneutics to theoretically anchor this paper. As a branch of knowledge, hermeneutics deals with interpreting and re-interpreting meaning embedded in text. Hermeneutics initially focused only on interpreting Biblical texts until Friedrick Schleiermacher, in the early 19th century, expanded its application to systematically interpreting texts from other fields. Schleiermacher's hermeneutics separates interpretation into: 1) examining textual language and 2) examining the author's position (i.e., to assume "empathy" in order to understand authors' position and what they mean to communicate through their text) (Svenaeus, 2012). In the hermeneutic theory, a social actor undergoes an intersubjective process whereby, in interpreting text(s), the actor recognizes another person's "horizon" of understanding the world (Mkhize & Ndimande-Hlongwa, 2014). Gadamer (1975) defines "horizon" as everything that an individual can know and cognitively process at a historical point in time and in a specific cultural context. Understanding occurs as a "fusion of horizons" between the cultural, social, historical, and metaphysical perspectives of an individual in dialog. The interpreter engages with the hermeneutic circle to holistically view the "whole", which, in turn, requires an interpretational relationship with its constituent parts to add knowledge in order to understand the whole (Mkhize & Ndimande-Hlongwa, 2014).

In this paper's scope, the "whole" refers to computing curricula's decolonization. We focus on more comprehensively understanding decolonization in computing education by moving between the whole and the parts bi-directionally. We focus on preunderstanding the parts (i.e., text, language, experience, cultural expression, and/or phenomenon in indigenous communities) to newly understand the parts according to dialogues about decoloniality. One needs to more deeply understand the hermeneutic circle to drive the

bi-directional process, unearth new knowledge, and close the hermeneutic circle. We illustrate this process in Figure 1.
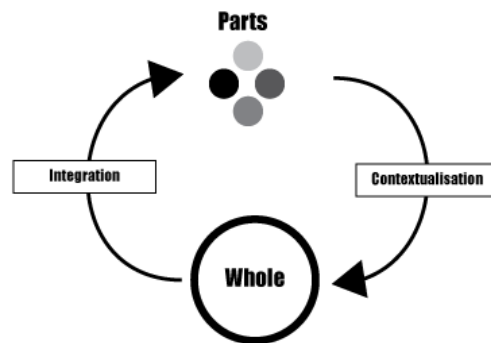
Figure 1. The Hermeneutic Circle of Interpretation (Adapted from Timmer, 2015)

We frame the views and discourses that surfaced since the 2015 student protests in phenomenology, a German philosophical perspective that emerged early in the 20th century. Phenomenology holds the view that humans can assign meaning to a situation and then deliver judgments (Gadamer, 1975). For the phenomenologist, meaning resides not only in language but also in how humans understand, which influences how they shape their actions, views, and thinking. Since human life undergoes various phases of understanding, one can consider phenomenology a form of hermeneutics (i.e., interpreting meaning) (Svenaeus, 2012). Gadamer's (1975) phenomenological hermeneutics offers an analytical framework to examine subjective meaning as it relates to colonization, decolonization, and language and what ramifications such meaning may have for indigenous ways of knowing.

Although we realize that one may regard it as ironic/counter-intuitive that coloniality in computing education receives criticism from a Eurocentric hermeneutic approach, one also has to acknowledge the fact that Western society and epistemology regard themselves as free and, therefore, open to self-critique. Popper (1981) sees self-criticism as the scientific equivalent of Darwin's biological principle of survival of the fittest (i.e., the most adaptable): science progresses due to knowledge revolutions that self-critical thinkers bring about. Learning from our mistakes lies at the scientific method's foundations. Indeed, the scientific method suggests the need for tolerance and freedom in scientific thinking and the need to identify and acknowledge earlier mistakes. Thus, we should subject coloniality and Eurocentrism to self-criticism in addition to critique from African (and other post-colonial) perspectives (see McIntyre & Popper, 1983).

3   Methodology

As the paper's methodological foundation, we adopt document analysis as a research strategy to produce data in an understandable and interpretable form. We analyzed that data to discover trends in the views and discourses that surfaced since the 2015 student protests and, thus, develop guidelines for computing departments that seek to incorporate indigenous knowledge into their curricula. Oates (2006) distinguishes between two document types: found documents and research-generated documents. Found documents refer to documents that existed before researchers conduct a research study (e.g., procedural manuals, annual reports, policies, research publications, and so forth). Research-generated documents refer to documents that researchers create, particularly for a research task (e.g., in some instances of ethnographic research, researchers document their personal observations and thoughts by taking photographs and writing field notes). We consulted the following documents/resources to assess and explore the discourses in computing education in South Africa's higher-education landscape:

1)   Moore (2015). In this paper, the author historically interprets imperial educational policies related to black Africans during the apartheid era.

2)   Berry (2008). In this paper, the author criticizes globalist educational technology initiatives, which, he believes, mostly harm indigenous knowledge.

3)   The Department of Education's (DoE) (DoE, 2004) policy framework, the "White Paper on e-Education". We use this paper as a guideline for using digital technology to address inequality in education.

4) Pillay (2016). In this paper, the author examines how decolonization movements challenge Western epistemological practices that prevail at South African higher-education institutions after South Africa abolished the apartheid system. We discuss several studies (Gqirana, 2016; Jansen, 2017; Liebenberg & van der Walt, 2015; Naicker, 2016; Nudelman, 2015; Nyamnjoh, 2016) to reflect on the impact that decolonization movements (the entrenching language discourse in particular) have on present transformation agendas at universities.

5) Dalvit, Murray, and Terzoli (2008). In this paper, the authors depict a cultural juxtaposition between Western and African knowledge domains as it relates to understanding technology concepts and functionalities.

6) Work on gamification (von Holy, Bresler, Shuman, Chavula, & Suleman, 2017), Microsoft's Local Language Program (Microsoft, 2012), and "ethnocomputing" (Dalvit et al., 2008; Sutinen & Vesisenaho, 2006; Thinyane & Terzoli, 2011). We use these sources as a potential framework to instill the African experience in computing education.

7) Naudé (2015). In this paper, the author reflects on why and how decolonization research— ironically—contributes to oppressing indigenous knowledge.

8) Gyekye (1988). In this paper, the author presents African philosophical principles that focus on the "African experience" in development initiatives as a shift from Western ontologies.

9) Simonds and Christopher (2013). In this paper, the authors present a case study to empirically guide cultural pluralism in computing education.

By engaging these sources, we critically describe events and dimensions that influence the lived African experience in adopting indigenous knowledge in computing education. Further, our analysis constitutes a comparative and analytical literature review.

4 Education in Pre- and Post-Apartheid South Africa

4.1 The Vestiges of Apartheid

Decolonization has historical significance; it is a reaction to segregation (Pillay, 2016). Therefore, to understand how decolonization evolved into its current form, we adopt a hermeneutical approach in which we examine decolonization's historical embeddedness in a South African context (Gadamer, 1975). Moore's (2015) work in which he analyzes segregated education under the apartheid regime frames this study's historical context. We ground Moore's interpretation in Gadamer's (1975) philosophical hermeneutics, which has the "history of effects" concept at its core. Gadamer describes the history of effects as a succession of interpretations of particular texts throughout its history. In this instance, Moore's (2015) work connects one to the events from which decolonization in South Africa arose.

The Bantu Education Act of 1954 that the apartheid government introduced represents the most noteworthy event (Moore, 2015). According to Moore (2015, p. 19), Bantu Education curricula focused on teaching non-whites to better understand "their masters' orders", replacing black African's preliterate knowledge, and instilling attitudes of servitude to whites. It predominantly did so via subjects that concerned agriculture and handwork. Therefore, blacks with limited skill sets served as a steady supply of low-cost labor for the white-dominated industries. In 1994, the South African Government formally abolished the apartheid system. The end of apartheid initiated educational reform; for example, the South African Schools Act in 1996 dismantled compulsory segregation in education. However, decades of inferior education left black South Africans with immense educational challenges to overcome (Moore, 2015).

4.2 Transformation through Technology

In 2004, the Department of Education (DoE) outlined in its "White Paper on e-Education" its vision to harness information and communication technology (ICT) to redress past inequalities and improve the quality of South African education. Of course, this vision did not preclude other policies that focused on social and economic redress. In this white paper, the DoE considers digital technology a transformative tool and as part a broader political drive for inclusionary, progressive, and innovative development to prepare learners for the competitive global economy. At a local level, the framework emphasizes the importance of mandating government and the private sector to absorb ICT skilled workers in "building a

domestic knowledge economy and promoting online transactional capabilities for the consumer, business, and government sectors" (DoE, 2004, p. 9).

Furthermore, the policy endorses indigenous knowledge creation and indicates that the South African Government needs to introduce "local content development in terms of the number and quality of local websites, local language content and the use of local online content by key sectors" to achieve such an objective (DoE, 2004, p. 9). The white paper calls on the South African Government and the private sector to mobilize investments and funding to secure and sustain education that provides marketable ICT skills, multimedia content creation, and computer hardware and software. The identified funding sources include private-sector donations, international development organizations, institutions sponsoring academic research, and public-private partnerships (DoE, 2004, p. 9).

4.3   The Rise of Student Movements and the Clarion Call for Decolonization

Since the South African Government promulgated ICT, language, and other socio-economic policies, both it and its education departments have generally been apathetic about helping higher-education institutions to intellectualize indigenous languages (DoHE, 2018). During this period, prevailing Eurocentrism in South African universities ignited a growing concern among black South African university students in 2014 and 2015. A group of postgraduate students at the University of Witwatersrand (Wits) mobilized as the #TransformWits movement and penned the Wits Transformation Manifesto to express their dissatisfaction with the slow transformation in South African higher-learning institutions (Earp et al., 2013). This movement initially championed the cause to decolonize universities in the country based on several pillars, such as Africanizing academia away from colonial culture into a more inclusive space, decolonizing university curricula as an impetus for broader societal transformation, and eradicating the financial barriers that black students experience (Wits Vuvuzela, 2015).

The movement gained momentum elsewhere in the country in March, 2015, when a student at the University of Cape Town (UCT), Chumani Maxwele, hurled feces at the statue of Cecil John Rhodes in protest against the public commemoration of colonial figures. Maxwele's act quickly gained attention and the incident went viral on social media, particularly Twitter, with the hashtag #RhodesMustFall. UCT, yielding to public and student pressure, removed the statue in April, 2015 (Pillay, 2016). #RhodesMustFall gained traction as a critique of the inequalities that persisted in post-apartheid South Africa (Pillay, 2016). The protest foregrounded privilege, exclusion, broken political promises, and poverty. Later, another student movement, #FeesMustFall, again raised these narratives. #FeesMustFall started after the University of Witwatersrand (WITS) announced a tuition fee increase of 10.5 percent for the 2016 academic year (Pillay, 2016).

The announcement came in response to the state declaring that it could only subsidize universities at five percent of its net increase in cost for academics' salaries, journal subscriptions, library books, and research equipment. WITS claimed that the subsidy would not sufficiently cover its overall net increase in expenses, research equipment, journal memberships, library manuals, and academics' salaries. In protest to the fee hike and drawing motivation from #RhodesMustFall, students at the University of Witwatersrand launched the #FeesMustFall campaign on 15 October, 2015. Similar to #RhodesMustFall, the #FeesMustFall hashtag gained widespread reach on Twitter and propelled various student demonstrations across South African universities. Following ten days of student protests, the state announced it would not increase tuition for the 2016 academic year (Pillay, 2016).

The #FeesMustFall campaign inspired a nationwide call for free education and placed a renewed focus on efforts to decolonize universities (e.g., the Open Stellenbosch campaign at Stellenbosch University (SU), which commenced mid-April 2015). Students affiliated with the Open Stellenbosch campaign argued that SU, a historically white university, still operated as a colonial institution that alienated black students from institutional culture (Naicker, 2016). Black students at SU felt particularly marginalized because the university used Afrikaans as the primary language medium. Black students felt Afrikaans symbolized, similar to the Cecil John Rhodes statue, a culture of apartheid and colonialism that seemed to persist on campus. For students, the bias towards Afrikaans as an instruction medium perpetuated institutional racism in that it excluded and included individuals based on race (Jansen, 2017).

Students demanded SU to reform its language policy, which led to both it and the University of Pretoria to adopt English as their primary language medium in 2016 (Gqirana, 2016; Nyamnjoh, 2016). Even though many black students did not speak English at home, they demanded that their institutions educate them in English (Liebenberg & van der Walt, 2015). This rhetoric links to the widely held perception about English

as the de facto language that one needs to communicate effectively (verbally and through the written word) in South Africa's political, academic, and business sectors and globally (Nudelman, 2015). English also pervades computing education (Berry, 2008) in that South African students need to hone their English reading and writing skills through group work and communication and problem-solving activities (Ponelis et al., 2012).

One can further attribute English's prevalence in computing to two primary factors: 1) indigenous African terminologies/languages have a limited presence in the discipline, and people have made inadequate effort to develop it in digital literacy; and 2) English constitutes the universal language of science instruction at university level, while everyday communication occurs in various indigenous languages. Moreover, computing departments face pressure to compete in the global industry, which can reinforce the idea that English is superior and that African languages cannot make significant contributions with regard to knowledge building in the global arena (Dalvit et al., 2008).

4.4 Indigenous Languages in African Computing Education

We need to consider the discussion above to understand Western knowledge domains and their influence on formal education Furthermore, we need to problematize Western paradigms to define a decolonized computing curriculum's boundaries and roles such that it will benefit African students. Contemporary English has a significant role in efforts to decolonize South African curricula. As we note in Section 1, Western modes of thought prove especially challenging for computing curricula since Western countries have predominantly created and consumed computing-related knowledge, which means it inevitably reflects Western epistemologies (Muwanga-Zake, 2010). Efforts to decolonize computing curricula face another threat in the form of black African students who willingly embrace English as an instruction medium at university (Liebenberg & van der Walt, 2015).

In this context, language and ideologies developed in the West infringe on some cultural traditions across the diverse African continent. Thus, we employ hermeneutics framed in ethical analyses to understand how sciences, languages, and symbols differ across cultural groups (see Svenaeus, 2012). Svenaeus (2012) suggests that investigations need to steer between ethical relativism (i.e., ethical concepts reflect a specific cultural group's practices) and hegemonic ethical objectivism (i.e., ethic systems that originated in the West concur with truth and apply to any group despite how other groups understand their own ethics). To facilitate meetings of horizons by cultural tradition, we analyze Dalvit et al.'s (2008) classification of indigenous knowledge and its standing in ICT education according to three components: traditional knowledge, common knowledge, and specialized knowledge.

Traditional knowledge, another term for indigenous knowledge, often has its roots in occultism, religion, and spirituality (Dalvit et al., 2008; Muwanga-Zake, 2010). The apartheid government intentionally opposed African religious beliefs in order to enculturate the local population into Western-style education. In this way, the government stigmatized indigeneity as an attempt to assimilate the local population into an education system underpinned by Afrikaner nationalism (Dalvit et al., 2008). Similarly, computing scientists emphasize the modernity of computing education and often position it in opposition to traditional knowledge.

Common knowledge refers to general knowledge that everyone applies in their everyday lives. Dalvit et al. (2008) argue that common knowledge forms a fundamental part of a group's culture and, therefore, support classroom instruction using metaphors. However, including common knowledge in classrooms represents a contentious issue since it ostensibly contradicts scientific epistemologies. Consider a computer's graphical user interface (GUI) through which users can operate software applications. GUI icons in a desktop environment generally draw on metaphors related to an office desk and its items in terms of their functions and use. Thus, while an individual from a first-world country might find executing tasks through GUI intuitive, an individual from a developing country or region may find these metaphors meaningless (Dalvit et al., 2008).

Individuals with expertise in a niche field hold specialized knowledge, and culturally bound conventions such as language and color may determine such knowledge. For example, Dalvit et al. (2008) discuss the color red, which symbolizes danger in Western cultures, and green, which indicates safety. In many African cultural groups, red means tradition as opposed to blue, which signifies modernity. The lack of African languages in the computing field also threatens attempts to Africanize computing curricula. Accordingly, one cannot easily translate indigenous common knowledge to specialized knowledge in

computing. Consider a GUI list and menu: these words have a different meaning in English, but, in the African language isiXhosa, the term "uludwe" refers to both list and menu (Dalvit et al., 2008).

The cultural differences that Dalvit et al. (2008) outline make it clear that black African students have a disadvantage due to a disconnect between their common knowledge and Western world metaphors that people typically apply to computer education. Dalvit et al. (2008) further allude to claims that the West deliberately attempts to remove common knowledge by replacing it with specialized knowledge. These claims link with Moore's (2015) assertion that early missionaries intentionally modeled curricula to replace South African indigenous groups' preliterate tribal education. Assimilating specialized Western knowledge into an indigenous culture has attracted heated debate; for example, Dalvit et al. (2008) criticize Gramsci, an Italian Marxist philosopher, who opposes the relativist stance in respect to common knowledge. Gramsci argues that common knowledge perpetuates an ignorant culture in which individuals remain none the wiser to alternative forms of knowledge. Gramsci calls for scientific education to take the moral duty of "rescuing" indigenous societies from their superstitions and folklore. Gramsci suggests specialized knowledge would reveal indigenous groups' social positioning to themselves (Morgan, 2002).

5   Towards Decolonizing South African Computing Curricula

In Sections 1 to 4, we illustrate how challenging it has been in South Africa's post-colonial era to enhance African ways of knowing and creating knowledge in computing education. Fortunately, researchers have conducted research that integrates non-Western worldviews, beliefs, practices, and customs over recent years. In this section, we examine such efforts by scholars from Africa and across the world to decolonize Computing education in response to oppressive Western hegemony in education. We ultimately argue for a balanced view and practical integration of Western and non-Western knowledge in computing education to promote an inclusive and diverse field of science.

5.1   Gamification

Heleta (2016) asserts that curriculums, embedded in prevalent Eurocentric epistemologies, do not contribute much toward meaningfully decolonizing knowledge systems at universities. Thus, the onus falls on progressive academics to decolonize their own curricula to democratize the pedagogy and learning culture. To do so, both educators and students need to collaboratively work together and understand decolonization as a critical process of amassing and reconstructing knowledge systems with indigenous content (Heleta, 2016). African and South African academics have responded to the call for local or indigenous content creation. von Holy et al. (2017, p. 1) designed an online digital library—a project entitled "BantuWeb"—as a tool to motivate users to contribute "resource scarce languages" (RSL) content on a Web-based portal.

von Holy et al. (2017) integrated gamification features to make RSL preservation and contribution an exciting activity and to generate rich content that increases over time. Gamification involves using game elements such as points, badges, ranking systems, and other types of rewards to create an enticing experience for users (von Holy et al., 2017). The researchers found that gamification indeed motivated contributors to add content to the RSL. They proposed that computing lecturers and students jointly use BantuWeb to advance and develop ICT-related terminology. To make such a curriculum reconfiguration possible, computing departments should introduce dual medium instruction. We recommend that computing departments harness software development and software engineering skillsets and models to embed underdeveloped African languages firmly into the field.

5.2   Existing Software

Microsoft's (2012) Local Language Program may be useful in guiding computing departments towards the Africanization of their curriculum. The program makes provision for 108 languages and includes African languages such as Setswana, Sesotho sa Leboa, isiXhosa, isiZulu, Afrikaans, Wolof, Malagasy, Hausa and Kiswahili. For every available language, Microsoft offers a style guide to help localize digital technology solutions in a native tongue. Microsoft provides the guide primarily to help people understand each language's required stylistic and linguistic nuances and help them localize technological products and services. Microsoft (2012, p. 1) describes the program as follows:

> *The Microsoft Local Language Program provides people access to technology in a familiar language while respecting linguistic and cultural distinctions. The program bridges the gap to technology through language and culture as well as empowers individuals in local*

>   *communities to create economic opportunities, build IT skills, enhance education outcomes,*
>   *and sustain their local language and culture for future generations.*

5.3   Ethnocomputing

In Sections 1 to 4, we note that decolonizing computing curricula represents a cumbersome task since the West invented computer technology. As a result, ICTs tend to reflect Western values, cultural characteristics, science, and linguistic models. Many students from black African cultures who speak native African languages find English foreign. Moreover, mere attempts to simplify "scientific language" to "common language" seem inadequate in the local context of indigenous communities. Dalvit et al. (2008) advocate insights from ethnocomputing to enhance cultural pluralism and relativism in computing education. Ethnocomputing promotes applying ICT solutions to address a specific culture's needs. For example, traditional art craft practices can inform computing education (Dalvit et al., 2008).

Ethnocomputing proponents rely on the premise that using technology as an intervention to encode and reflect indigenous knowledge could help to solve problems in indigenous communities (Dalvit et al., 2008). For such interventions to succeed, ethnocomputing shares the philosophical principles that Gyekye (1988) and Gadamer (1975) have presented: indigenous communities mainly need to actively participate in development initiatives, and research domains should respect their knowledge and way of life. In this vein, we propose that curriculum designers who seek to translate the African experience and insights from ethnocomputing to a context-sensitive computing curriculum should draw on common knowledge from indigenous African communities. Sutinen and Vesisenaho (2006) found that they could successfully implement an ethnocomputing-based approach in ICT-related education based on an indigenous community's context-driven principles.

In collaboration with Tumaine University in Tanzania, Sutinen and Vesisenaho (2006) designed a contextualized introductory programming course for second-year students in an undergraduate teacher education program. The course focused on inspiring students to design programs tailored to their own communities' needs. They designed the course's content to represent students' everyday life. For example, they visualized a Web-based instructional interface as a culturally adapted metaphor: a village (see Figure 2). By clicking on people and the huts in the village, students could access and obtain the learning content. Sutinen and Vesisenago deliberately used this symbolism to illustrate that one does not necessarily need to explain programming concepts in "high-tech" Western-styled formats but that one can use concepts and visual symbols that represent students' local socio-cultural context. The authors found that students were enthusiastic about, among other things, the economic and social opportunities that contextualized technology application may enable, such as increasing how quickly teachers and students can develop initiatives and improve communication to address their communities' needs (Sutinen & Vesisenaho, 2006).
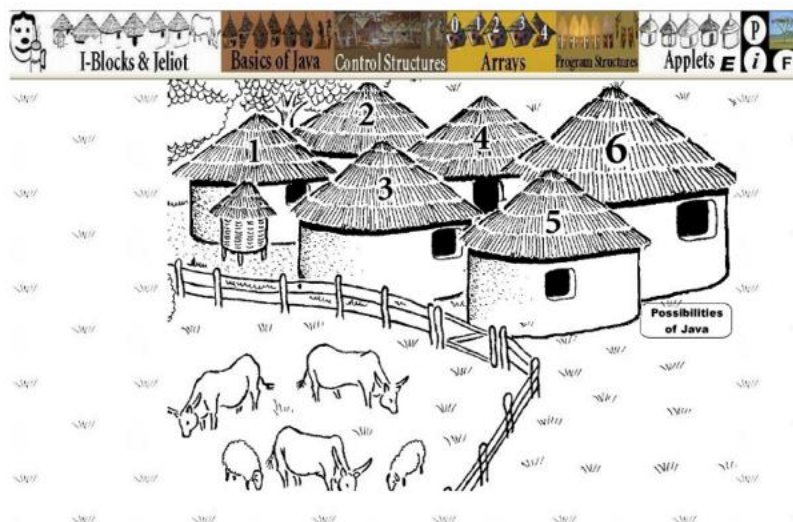
Figure 2. Sutinen and Vesisenaho's (2006) Instructional Interface as a Graphic Metaphor—A "Learning Village"

We support Thinyane and Terzoli's (2011) ethnocomputing strategy, technology adaptation, in teaching, designing, and managing Africanized ICT solutions. Technology adaptation rests on the premise that one should implement linguistic localization, cultural localization, application themes, metaphors, interaction frameworks, and indigenous knowledge integration as related societal constructs to support ICT interventions. Thinyane and Terzoli (2011) describe each component as follows:

- Linguistic localization: to avoid teaching indigenous users a foreign language, linguistic localization contextualizes an information system's or application's interface into the user's local language, which allows them to operate the information system/application in a language they already speak and write proficiently.

- Cultural localization: this strategy refers to integrating an indigenous community's cultural framework into an application. To do so, one designs applications along cultural dimensions such as interaction, beliefs, values, and aesthetics.

- Application themes: different cultures perceive structures such as element positioning, colors, alignment, shapes, and symmetry differently. Therefore, one should consider how one designs and uses structures depending on the culture.

- Metaphors: metaphors exemplify and articulate a culture's worldviews. Black Africans interpret the typical metaphors in computing differently than Westerners (e.g., recall the example from Dalvit et al.'s (2008) about "menu" and "list"). Ethnocomputing denotes that one should identify, deconstruct, and then reconstruct English metaphors in computing as culturally relevant metaphors.

- Interaction frameworks: the way members communicate with each other in a culture also affects how they interact with digital technology. In some cultures, written stories, drawings, and/or songs and dances constitute ways to communicate. Rather than text-based components, it might be more appropriate to place, for example, a drawing native to the indigenous community to communicate the purpose of an information system's functionality.

- Indigenous knowledge integration: applying digital technologies to develop Africanized computing curricula and benefit indigenous groups relies on the assumption that indigenous knowledge developers and users can access and disseminate local knowledge from and through, for example, the Internet. For this assumption to become and remain valid, ethnocomputing practitioners need to provide, maintain, and upgrade ICT infrastructure to help developers and users submit, codify, modify, share, and preserve local knowledge.

Dalvit et al. (2008) used an ethnocomputing intervention into an extended studies program offered at a traditionally white South African university. The program focused on integrating indigenous knowledge into teaching and learning practices. The researchers conducted a focus group with members from a marginalized African community who spoke the African language isiXhosa. More specifically, members included isiXhosa-speaking experts from the linguistics, education, and computer science disciplines. The group drafted a glossary of computer terminology that they translated to isiXhosa. For example, they translated the term "wizard", a function in computing that guides users through a procedure, to "umvumisi", a traditional healer in an isiXhosa community. An umvumisi asks a patient a series of questions to help diagnose a condition or disease.

Another example concerns the relationship between a server and client computer: to explain it, the group used an individual who assists a bride with preparations for her wedding as a metaphor; in IsiXhosa, the term "umxobidi" refers to this relationship. The team also converted the glossary to an online version using the learning management system (LMS) Moodle. Moodle allows students to comment on and rate entries, which creates an interactive experience. System logs make it possible for researchers to monitor the terms students search for the most, which allows them to include and develop new terminology. The team also used multimedia such as images, videos and audio to strengthen the cultural context of terms for students in case they did not know the written version of indigenous terms. Further, the researchers visualized terms from the glossary with a concept map by applying CMAPTools to elucidate taxonomies and relationships between concepts.

Thinyane and Terzoli (2011) designed a software architecture called PIASK that practically embedded theoretical ethnocomputing principles. To counter Western homogeneity that constrains Africans' ability to use ICTs, Thinyane and Terzoli made different media formats (e.g., different devices end-users use) and varied communication modes (e.g., gestures, text, speech, etc.) available in their software application. They used multi-modalities to make the system accessible to different types of users; for example, sound-

based modalities for the visually impaired, character-free interfaces for the dyslexic and illiterate, and character-based modalities to suit various users' preferences. They handled different types of indigenous knowledge, expressed through the different multimedia formats, through a functional access layer that handled requests between the software architecture and end-user devices.

On a functional level, for example, Thinyane and Terzoli (2011) formatted the content for different devices at a presentation level; for example, a request made from a personal digital assistant (PDA) returned, converted, and rendered content in a markup language such as HyperText Markup Language (HTML) to the graphical user interface. An autonomous interaction layer, depending on network signal strength or congestion, returned audio files and textual or graphical descriptors in an alternative format to optimally manage bandwidth use. Given the fact that constructing knowledge takes place in a social context, Thinyane and Terzoli used a functional social networking layer that modeled community members' social behavioral patterns. The layer modeled a protocol similar to the "friend of a friend" standard that popular social media platforms use. As such, the system had a community orientation to create a sense of belonging.

Thinyane and Terzoli (2011) used a knowledge base functional layer that stored knowledge that members populate. Worldviews akin to a local indigenous group predicated this layer. The layer has functions and tools such as an open knowledge base connectivity interface, which allows interoperability among various knowledge repositories and enable members to capture and codify terminologies. Figure 3 illustrates the interaction and dependencies between components of the access, presentation, interaction, social networking, and knowledgebase layers in the software architecture. The rectangles indicate the inward dependencies, and the circles denote the outward dependencies between the functional layers.

Thinyane and Terzoli explain interaction and dependencies as follows: the access layer mainly facilitates the interaction between the architecture and end-user devices. The access layer depends on the presentation layer to process content that a specific device requests. Therefore, the access layer has an outward relationship with the presentation layer. To logically assess and process requests, the access layer depends on the interaction layer. The interaction layer contains the complete architect logic, and, as Figure 3 shows, the interaction layer has the most links. As Thinyane and Terzoli (2011) point out above, knowledge creation and dissemination occur when community members interact with each other (hence the social networking layer's dependence on the knowledge layer). Therefore, the architecture adopts the normative pattern of social life that defines and characterizes how people create new knowledge.
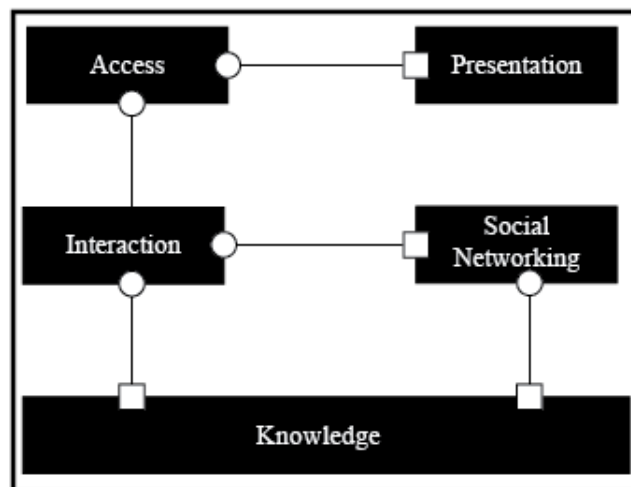

Figure 3. The System-level Interaction (Adapted from Thinyane & Terzoli, 2011)

6 Decolonization Research under Western Epistemological Hegemony

Endeavors such as the ones we describe above cannot alone sustain the larger goal. We base this assertion on Naudé's (2015) notion that decolonization research lacks sufficient insight into how Western epistemological practices hinder indigenous knowledge production. Paradoxically, then, decolonization research contributes to suppressing indigenous knowledge in a Western research tradition. We credit this suppression to two factors: a socio-economic imperative and a mono-epistemic imperative. We discuss

problems relating to the socio-economic imperative in a context of funding norms in academia, and, in discussing the epistemic imperative, we examine how the epistemic power that Western traditions hold reduces indigenous knowledge as inferior.

6.1   Decolonizing Research under the Socio-economic Imperative

Muthama and Mckenna (2017) trace problematic funding formulas back to the apartheid era. The apartheid government used funding formulas for the Bantu Education Act of 1953 to discriminate against the black student population. In Section 4.1, we cite Moore (2015) to highlight how colonial curricula intentionally limited education for black students by training them to perform low-cost manual labor. Again, this carefully coordinated curriculum would ensure that white supremacy's foundations continued. Muthama and Mckenna (2017) conclude that the South African Government financed the Bantu Education Act of 1954 in such a way to achieve a minimum educational effect. Also, the apartheid government discouraged research at historically black universities and considered it not a core function due to restricted budgets (Muthama & Mckenna, 2017).

Post-apartheid funding policies formulated to redress research capacity building at historically black universities had unintended consequences because universities increasingly conformed to international success metrics (e.g., cross-country rankings) and orientated themselves to global institutional management and funding structures. They did so to cultivate a positive impression among foreign institutions and donors and, thus, obtain more funding. But embracing international metrics and associated incentive models meant that their associating problems could also manifest locally (Nattrass & Seekings, 2015). Such problems emerge in the form of rent-seeking, an economic concept whereby one manipulates monetary policy as a strategy to increase financial incentives (Muller, 2016).

Muller (2016) views rent-seeking in universities as a relevant concern in that scholars often state unwarranted claims regarding their research's societal benefits to secure research funds. Academics would obtain funding for research projects ostensibly to highlight indigenous epistemologies while guiding outputs towards subjects that funders favored. This practice contributed little the communities under inquiry. Muller considers rent-seeking as a neoliberalist construct. Neoliberalism has its roots in the ideas of traditional liberalism, which itself had its origins in the 1800s. Liberalism in its traditional form hinges on the idea that people favor free-market capitalism; it emphasizes the right to accumulate wealth and pursue one's own interest. Neoliberalism expands liberalism by transforming its precepts to a contemporary global and postmodernist form of capitalism (van der Walt, 2017).

According to Berry (2008), one cannot distinguish neoliberal globalization from Western epistemological systems. Because computing had its origins in the West, it has close links to Western epistemology. Berry opines that technological development—especially for education reform—has foundations in neoliberal globalization principles. In essence, capital fuels technological development and implementation; in turn, capitalists generate capital via profit. In this view, one can find the argument that the ideological constraints of capitalistic expansionism contain epistemological elements. While many perceive global education to progress based on how much digital technology it procures, one often hides the destructive potential when considering using such technology to emancipate and empower indigenous research. In Berry's view, viewing progress in this way fundamentally represents a manifestation of neo-liberalism. Neo-liberalists tend to define a Western and hegemonic degree of authentic "knowledge" as a global standard. For Berry, one cannot separate these dominant knowledge domains from the neoliberal ideals that govern them.

6.2   Decolonization Research under the Mono-epistemic Imperative

Many scholars who participate in decolonizing research have good intentions. Investigated critically, however, their attempts transpire in the confines of Western epistemic traditions in which cultural emancipation occurs alongside further harm to indigeneity (Berry, 2008). Decolonization researchers face a reality in which they cannot escape the well-developed epistemologies that accompany Western science. The intellectual "journey" to decolonization research always begins in the West. Researchers undertake a metaphorical journey to the West to first come to terms with the complex and rich tradition of research ethics, philosophical paradigms, theories, and methodologies. They learn about, for example, great thinkers such as Gadamer. Once they understand such a tradition, they have developed discernible hermeneutical lenses. They then direct their gaze to a decolonization inquiry to reflect on indigenous values. They have only Western intellectual points of departure because they will have to discuss their

local findings in English and in an established Western theoretical ambit so that outsiders can understand them (Naudé, 2015).

Naudé (2015) outlines three models of research ethics and philosophy that emerge when one conducts decolonizing research: the transfer model, the translation model, and the substantive model. Naudé specifically discusses these models in the context of "African" business ethics (i.e., how one can develop business ethics from an "African" perspective). In the explanation that follows below, we generalize these three models to decolonizing studies that focus on indigenizing Western environments.

Transfer model: in this model, one adopts Western philosophy as the norm and presents it as the ideal standard of ethics and philosophy. Thus, one reads and transfers Western philosophy as the dominant academic tradition to the indigenous context. Little transpires regarding contextual adaptation or critical reception. In this mode, one presents a case as nothing more than a geographical reading location (e.g., "Africa"). That is, it makes no difference whether one reads, for example, Aristotle and Kant in Cape Town, Cairo, or Berlin. Naudé (2015) observes that researchers who adopt the transfer model usually mention (if at all) indigenous approaches to philosophy and ethics after placing emphasis predominantly on Western academic traditions. Consequently, they subordinate indigenous approaches. It then becomes impossible to circumvent Western science. We consider Microsoft's (Microsoft, 2012) Local Language Program to exemplify the transfer model. Although Microsoft claims that the program focuses on extending and sustaining local culture and language, the following goals in the isiXhosa style guide aligns with how Naudé (2015) conceptualizes the transfer model: "to highlight where Microsoft has specific preferences…and learn how to address all of the necessary linguistic and stylistic nuances of isiXhosa during the localization of your products and services" (Microsoft, 2017, p. 4).

Translation model: Naudé (2015) distinguishes between three types of translations from reading decolonization literature. First, one critically appraises Western ethics from an African perspective. In such instances, one normatively harnesses Western insights to comprehend a local context with the consequence that one elucidates the Western perspective itself. We see von Holy et al. (2017) as applying this method in investigating how one can develop South African indigenous languages using a Web-based repository. Thus, one translates digital technology into an indigenous context with specific implications for digital archives. Second, one uses local case studies to contribute indigenous knowledge (that one interprets in the frameworks of Western principles) to a body of knowledge. Sutinen and Vesisenaho (2006) apply this method in examining the design process of a community-based ICT course at a Tanzanian university. Third, one addresses context-specific African moral dilemmas by deploying Western theories. Mbithi (2014) applies this method in investigating how one can explain African philosophy by referring to Gadamer's philosophical Hermeneutics. In this instance, Mbithi focuses on moral dilemmas such as the lived experiences of African people that struggle to deal with ubiquitous influences of the West's economic and cultural imperialism. Because attempts to decolonize knowledge rely on Western theories for their construction, Naudé (2015) concludes that the translation model makes a minimal contribution at best. Language as "translation" that occurs in "English"' which Naudé considers a Western epistemic tradition, compounds the problem.

Substantive model—Ubuntu ethics: in this model, one acknowledges Western tradition as valuable; however, one also seeks to advance theories unique to Africa. Researchers typically advance Ubuntu as a competing and alternative theoretical perspective to Western versions. The aforementioned informs the naming convention; namely, "substantive". Ubuntu expresses the communalism approach in contrast to the Western individualistic tradition. We can summarize Ubuntu ideology as follows: an action is acceptable to the extent that it encourages a common identity among members grounded on benevolence; conversely, an action is inadmissible insofar as it fails to do so while encouraging malevolence. Ubuntu additionally upholds the notion of universal respect for being-through-the-other or "I am, because we are" whereby "we" shape "I" towards a particular ethnic kinship; put differently, in an African tribe, an individual is defined through other members close to the individual who benefit from the individual's patronage.

Naudé (2015) questions these claims. First, he rejects the communitarian view of Ubuntu, which refuses to acknowledge African personhood (i.e., individualism). Researchers who support this view would argue that the individual cannot possibly exist alone. Arguing against this view, Naudé holds that, even in the social confines of an indigenous community, social construction exists as a prominent individuated activity. This notion maintains that individuals in an indigenous community have personal agency on the premise of moral agency and autonomy as dynamic negotiated entities. Second, Naudé decries the notion of humanness, which implies that others' humanness validates an individual's humanness. Naudé

attributes being-through-the-other as inherent to other societies, not a distinguished property of Ubuntu, but indeed integral to Western philosophy as well.

In response, Naudé (2015) recommends three decolonization acts. First, he recommends replacing Eurocentrism with Afrocentrism. In other words, one can contextualize knowledge from African perspectives regardless of its origins. Decolonization researchers should, in addition, reject the notion of indigenous knowledge as an extension that merely adds an interesting dimension to Western philosophy. Second, he recommends acknowledging the value of Western tradition and criticizing it as misappropriated in decolonization research. He states that, for one to consider knowledge universal, one must also view it as "pluriversal"; therefore, we must convert universities into "pluriversities". Third, he recommends inquiring about the scientific knowledge's epistemic nature. Western scientific knowledge would assume that customs (observable across Western and non-Western cultures) such as songs, dance, stories, and so forth constitute tacit knowledge. However, one should acknowledge (as ethnocomputing research demonstrates) that these social customs, for indigenous communities, constitute a valid way to generate knowledge.

The preceding passages illustrate how decolonization research mimics the same coloniality from which it tries to escape. We illustrate how decolonization research, entangled in a socio-economic imperative, sets a new power asymmetry where both international and local funding institutions control educational reform. Decolonization researchers often target indigenous groups as people whom they perceive in most need of educational reform. However, they pay mere lip service to cultural diversity under the guise of humanitarian rhetoric, which essentially amounts to a neoliberal ethos to serve global financial elitism (Berry, 2008). We also show how this problem is intertwined with a mono-epistemic imperative. In conflicting with indigenous empiricism, Western epistemologies subordinate one way to generate knowledge. In Section 6.3, we examine the principles of the African lived experience to explore the potential of a multi-epistemic approach to generate knowledge in decolonization research.

6.3   The "African Experience"

We believe that constructing indigenous knowledge in the post-colonial and globalization era of computing education requires insight into the so-called "African experience's" fundamental principles and values We draw on Gyekye's (1988) work in which he critically explores traditional African life as normative and eclectic. Gyekye argues for philosophically analyzing and interpreting African experience concepts that he views as neglected and misunderstood in contemporary African political and socio-economic life. Given the slow rate with which South African universities have moved away from Western knowledge systems, we advance Gyekye's views that he gave in an inaugural lecture at the University of Ghana in 1987 as a contemporary anti-colonial theory that remains pertinent for research that calls the traditionally embraced colonial experience into question.

6.3.1   Situating Philosophy, Science, and Ideology

Gyekye (1988) does not consider "development"—a primary goal for governments in the Global South—as a clearly defined concept. For Gyekye, these governments emphasize economic development too much; he argues that these governments also need to embody development as a behavioral concept that can channel itself morally, socially, culturally, and so forth. Indeed, the goals in the "White Paper on e-Education" (DoE, 2004) capture how Gyekye (1988) conceptualizes development to address South Africa's history of oppression. To repeat: in the white paper, development involves harnessing the benefits of digital technology to produce quality education for social development, economic growth, and access to learning content to benefit and represent a broad array of cultures and languages (DoE, 2004).

But, considering the current decolonization discourse, promoting such a diverse education system seems merely symbolic and to lack remarkable progress. We can link the over-emphasis on economic development to the South African Government's adoption of neoliberalism in education, which has had unintended consequences (van der Walt, 2017). Nattrass and Seekings (2015) assert that neoliberal ideology in higher education allows the government to manage public educational institutions along corporate management lines and view students as human capital. The government strives to enculturate students with market-driven knowledge to service the capitalist-driven economy, compete in global economic markets, and attract foreign investment (Nattrass & Seekings, 2015).

Therefore, the South African Government expresses and executes the values that underpin development initiatives in such an "academic society" through the concept of ideology. Gyekye (1988) also finds the

way that contemporary philosophy conceptualizes ideology problematic. Ideology has a somewhat derogatory connotation, which, according to Gyekye, Karl Marx perpetuated. Marx believed ideology defiles how humans understand social reality. For Marx, therefore, ideology constitutes the hegemonic class, and its values have a strong denigrating effect on how researchers view the concept in contemporary interpretations. Researchers understand it as biased, subjective, partisan, and impractical (Morgan, 2002). Gyekye (1988) rejects this notion of ideology and proposes we revisit the term's origins.

Gyekye (1988) traces the first use of ideology back to 1796 when French academic de Tracy described it as the "science of ideas". According to Gyekye, de Tracy holds that the science of ideas results in comprehensive knowledge of human nature from which we can formulate social practices, laws, and institutions to optimally serve a society's needs. Therefore, ideology (the science of ideas) has its foundations in the principle that we can improve humans' political and social wellbeing through designing socio-political criteria. In Gyekye's view, ideology, with reference to how de Tracy's described the concept, holds a positive connotation, and one should understand it as a morally associated system of normative, practical, impartial, and actionable ideas.

In this vein, Gyekye (1988) conceptualizes ideology as "a dominant set of ideas about the nature of the *good* society" (p. 21). Gyekye posits that one cannot conduct a profound inquiry into development and its underlying ideology (if based on a system of a society's collective moral value system) by using special sciences (and methods) such as sociology, political science, economics, anthropology, and so forth. Although Gyekye acknowledges that these sciences can make valuable contributions, he maintains that fundamental inquiry should be a philosophical reflection.

Like the question "What is truth?", Gyekye (1988) considers the question "What is development?"—a philosophical question. He argues that one cannot address such questions using empirical methods. Gyekye suggests that questions about political loyalty arise because citizens reflect on their moral values system and free will that motivate support for a government's policies and political strategies. For Gyekye, methods such as observation and experience cannot yield answers to questions about the extent to which or the sense in which humans have free will. Gyekye's views concur with Gadamer's (1975) ideas of truth and method in relation to philosophical hermeneutics. Both authors conceive truth as a fundamentally ontological phenomenon and refute the assertion that one can apply the scientific method to address truth.

Gadamer rejects scientific methods in solving truth and argues that experience of truth transcends both the natural and social sciences, resides outside the sciences, and cannot be confirmed using methodologies from the sciences. In line with Gyekye's (1988) thinking, Gadamer (1975) favors arriving at the truth via experience based on subjectivism. In this way, an inquirer experiences truth jointly with a subject through their joint participation rather than through subjective self-certainty from applying the scientific method. As we highlight in Section 2, understanding plays a central role in hermeneutics to bridging horizons, and attempts to understand a society revolve around linguistic and historical constructs of the society in question.

Henceforth, we ground our goals to advance the African experience as a concept to decolonize Western epistemologies and promote indigenous knowledge in computing education on Gyekye's (1988) and Gadamer's (1975) philosophical views. We challenge views that perceive indigenous languages and knowledge as "primitive" and unscientific and, thus, that hinder indigeneity's development in academic spaces (Kaya & Seleti, 2013). As Gyekye argues, "how philosophy can and should conceptually interact with the African experience cannot be said to be different from how this has been done for other societies and cultures" (1988, p. 12).

7 Advancing Cultural Pluralism in Computing

Throughout this paper, we emphasize the importance of cultural pluralism for inclusive computing education; that is, the importance of integrating non-Western worldviews with Western worldviews to digitize indigenous knowledge. We highlight initiatives such as von Holy et al.'s (2017) gamification strategy, Microsoft's (2012) Local Language Program, and ethnocomputing (Dalvit et al., 2008; Sutinen & Vesisenaho, 2006; Thinyane & Terzoli, 2011) as useful departure points towards cultural pluralism. von Holy et al. (2017) and Microsoft (2012) focus on translating ICT-related terminology to African languages, while ethnocomputing principles advance efforts to adapt software architecture to culturally suitable contexts.

Worldviews, however, encompass more than just language and, in addition, differ depending on the epistemic context. Mascolo (2014) defines a worldview as "philosophical belief systems that pre-figure and guide scholarly inquiry…[and a] personal and socio-cultural belief system about the physical and social world" (p. 2). Following how Gyekye (1988) defines philosophy as critically, rationally, and systematically examining the fundamental notions that underlie human thought and experience, the empiricism comprised in indigenous knowledge then positions African philosophy as equivalent to Western philosophy. With regard to socioculturalism, sociocultural sources—besides languages—also include semiotic sources such as art, writing, storytelling, and so on (Palincsar & Scott, 2009).

In our view, ethnocomputing yields the most successful results from efforts to indigenize computing education. Ethnocomputing recognizes the importance of integrating diverse sociocultural elements for indigenous knowledge creation in computing education. As evident in the ethnocomputing discussion, reconciling indigenous socioculturalism with Western constructs such as computing requires active community involvement. Indeed, the successful results of ethnocomputing studies (Dalvit et al., 2008; Sutinen & Vesisenaho, 2006; Thinyane & Terzoli, 2011) mainly arose because researchers used community-based research approaches. Ethnocomputing research strongly emphasizes implementation methods to capture indigenous knowledge via software architecture; on a philosophical level, however, such research does not mention how its researchers deductively collected and analyzed qualitative data.

Kaya and Seleti (2013) would perhaps criticize these studies for emphasizing practical knowledge and system architecture at the expense of indigenous community engagement and knowledge generation. The key concern here concerns the fact that non-Western research does not sufficiently comprehend the holistic nature of indigenous knowledge because the underlying methods and theories of Western epistemologies are fundamentally not indigenous (Kaya & Seleti, 2013; Naudé, 2015). Thus, in this perspective, Simonds and Christopher (2013) note that researchers cannot use Western research approaches as is in indigenous communities. Furthermore, even epistemologies that are unique to a specific indigenous community cannot be used indiscriminately across all indigenous communities as indigeneity has considerable diversity in terms of customs and norms.

7.1   Adapting Western Epistemology to Indigenous Knowledge: Lessons Learned from a Case Study

To advance our call for integrating non-Western worldviews on equal footing with Western worldviews, we reflect on the "lessons learned" from a decolonizing case study that Simonds and Christopher (2013) conducted. In their case study, based on an intervention project called Messengers for Health (MFH), the authors focused on decolonizing community-based participatory research (CBPR). In particular, the CBPR approach generates knowledge regarding cancer prevention and planning grants for cancer survivors among Native Americans. The collaborative research team, named the Community Advisory Board (CAB), included tribal leaders and cancer survivors from the Native America tribe, the Crow Nation, and researchers from the Montana State University. The researchers published various research papers based on the project in which they reflected on the experience of a graduate student who further analyzed qualitative interviews conducted with Crow Nation community members in 2006. The doctoral student contributed the data toward a doctoral dissertation.

The student, together with CAB, used the PRECEDE-PROCEED model to organize interview responses into themes. They handed CAB members interview transcripts and asked them to read through the documents at home to identify salient themes using short phrases, words, and sentences. They reconvened over two follow-up meetings to discuss the themes identified from the transcripts; however, little conversation and exchange occurred. As such, a university partner asked: "Why is it so hard to analyze these interviews?" (Simonds & Christopher, 2013, p. 2187). A Crow Nation elder responded that the Crow Nation members found the transcripts difficult to read, and, when categorized into themes, everything became scattered, which confused them. The elder added that Crow people do not break things apart. This comment prompted lively and energetic conversation; the members emphasized that storytelling is a tradition in Crow culture and an essential way to generate knowledge (Simonds & Christopher, 2013).

They elaborated that a story underpins all Crow Nation activities as an essential means to teach others. For them, stories lose meaning and understanding if one breaks them apart into scattered themes. In addition, a story has more impact the more experienced and knowledgeable the storyteller is in the tribe's cultural practices. For example, a story from a respected in the community will have a significant impact on the audience at large based on the elder's position. In this vein, the relevance of anonymity in Western

scientific tradition comes into question. Withholding an elder's identity severs the connection between the story and the elder, which means the story loses a vital part of its impact. In this light, the research team considered narrative analysis; however, they (rather than the storyteller) would have interpreted the data (Simonds & Christopher, 2013).

In the end, the university partners conceptualized a culturally representative metaphor, the Crow tipi (see Figure 4). Crow people see the Crow tipi, a symbol of home, as sacred, and it has many stories and traditions. The four base poles represent four main themes from the data: a patient's visit context, expectations, history, and time. The poles connecting at the top metaphorically represent the primary theme, trust. The team did not keep members' stories as part of the model; however, the members did affirm that the model resonates with their experience and expressed excitement about using the tipi as a symbol of trust in medical encounters. For some members, the strength of the tipi structure also symbolized the strength of trust during medical encounters. In retrospect, Simonds and Christopher (2013) stated that no "how-to" roadmap for collecting data in indigenous communities exists; hence, they inferred that a method applied in one indigenous context might not be successful in another indigenous context. The lessons learned from these decolonization studies follow below. We contextualize these lessons in ethnocomputing (Simonds & Christopher, 2013).
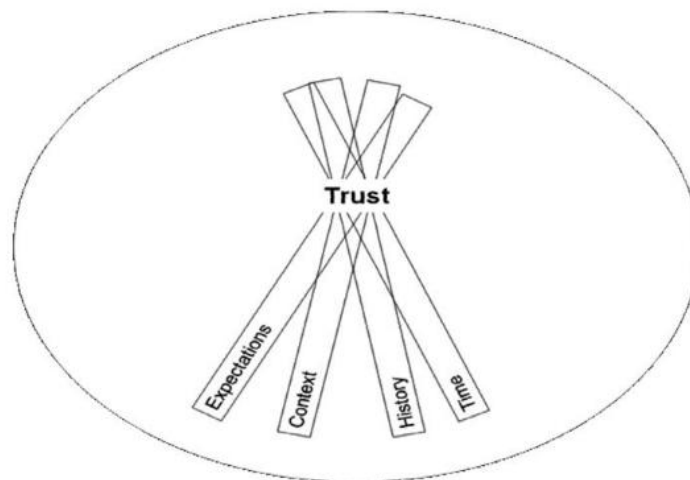
Figure 4. A Culturally Significant Symbol used as a Model of Patient-provider Interaction (Simonds, Christopher, Sequist, Colditz, & Rudd, 2011)

7.1.1 Lesson 1: Clarify Worldviews from the Start

Partners need to deliberate and articulate assumptions regarding the role that indigenous epistemologies play in research on decolonization. The level of trust in the collaboration space determines the extent to which community members will share indigenous knowledge with outsiders. Thus, researchers should explicitly acknowledge that they are committed to generating culturally focused research methods. In indigenous communities, people consider knowledge sacred, and, to access it, outsiders must earn their respect; conversely, Western knowledge is often open to anyone (Simonds & Christopher, 2013). To gain access to such knowledge, researchers must respect elders' knowledge and acknowledge the position they hold in their community. But, according to Simonds and Christopher (2013), the history of social science shows that the West has not respected indigenous epistemologies.

In the context of decolonizing South African higher-education curricula, Kaya and Seleti (2013) echo the sentiments that we express above. According to these authors, Western approaches to decolonizing South African higher education are "too academic". Furthermore, they criticize the lack of confidence and respect for indigenous ways of knowing. Consequently, the bias for Western methods leads to their uncritical adoption and use in African communities. By respecting indigenous knowledge, researchers not only gain access to productive and valuable data that community members will feel free to share but also equip universities with the agency to transfer indigenous socioculturalism and epistemologies from one generation to the next.

To promote mutual respect and epistemic pluralism from the African experience perspective, Gyekye (1997) encourages computing researchers to transfer technology from the technologically developed world to indigenous settings. If one considers Berry's (2008) presupposition that ICT is inherently a neoliberal construct imbued with colonial tenets, one can argue that transferring technology to indigenous settings is paradoxical. Such a presupposition would also explain why South African higher-learning institutions uncritically adopt digital technology (Kaya & Seleti, 2013). Gyekye (1997), however, expresses confidence in an epistemic pluralistic approach to overcome such a paradox. He states that one needs to reject the assumption that indigenous societies desperately need Western technology.

Gyekye's "organ transplant" metaphor explains the respect-based concern for indigenous knowledge that arises in the way that one transfers technology. One cannot simply transfer the "foreign" cultural artefact to recipients (what Gyekye refers to as "cultural borrowing") because they may not adequately assimilate what one transfers—a notion he refers to with a "transplant" metaphor. Such an approach simply verges on passivism on the part of the receiver who, thus, has little say regarding "quality" of "the foreign body to be sewn into his body, and that there is no knowing whether the physical constitution of the recipients will accept or reject the new body tissue" (Gyekye, 1997, p. 284). Analogically, the indigenous group's goals and needs would guide a technological artefact whereby they make decisions about which foreign technological tools they wish to acquire and become active participants who positively and willingly engage with the process of appropriating such tools.

7.1.2   Lesson 2: Decolonizing Research is a Process

CBPR approaches facilitate ideal conditions for community engagement; however, using such approaches does not indicate that one has appropriately used an indigenous method. In contexts where indigenous epistemologies do not sufficiently promote indigenous ways of knowing, Western theories and methods can help one accomplish such an endeavor. Researchers need to attain respect in order to establish trust to allow indigenous members to speak out in case Western epistemologies do not work or the research process reaches an impasse. As such, cultural pluralism require respect and trust as the partnership can identify common ground where Western and non-Western methodologies complement each other (Simonds & Christopher, 2013).

In an ethnocomputing context, Dalvit et al. (2008) suggested that decolonization researchers identify people from both a computing and indigenous background to help them reach common epistemological ground with indigenous communities. They noted that such individuals in an African context might be hard to come by since Africans with knowledge in the computing domain typically form part of the elite and have internalized Western worldviews. In his seminal *Decolonizing the Mind*, Ngugi wa Thiong'o (1986) articulated much concern about the unquestioningly internalizing Western worldviews. Decolonizing the mind requires a change in mindset since one should not new indigenous means of knowledge production as an alternative epistemology but an epistemology in its own right (wa Thiong'o, 1986). In related vein, researchers should distance themselves from assumptions that the "modern" should replace the "traditional"—African researchers and collaborators must value knowledge about their indigenous ancestry as the foundation for developing indigenous communities (Kaya & Seleti, 2013).

7.1.3   Lesson 3: Critically Assess Methods to be Used

Storytelling as a traditional custom appears to be a popular teaching and knowledge creation method in both African (Kaya & Seleti, 2013) and American indigenous communities (Simonds & Christopher, 2013). While researchers might think that narrative analysis possibly represents a suitable method in relation to storytelling, they would essentially speak for indigenous people. However, as we mention in Section 7.1, such a re-interpretation—not from a valued and respected indigenous "source" such as an elder—would in all likelihood lose meaning. However, some Western methods could potentially be congruent with indigenous storytelling. Simonds and Christopher (2013) identify and espouse qualitative artistic methods such as using photographs as compatible across paradigms.

Using photos as a participatory visual methodological tool uses visual images to elicit social and cultural meaning (Akther, 2015; Dolezal, 2013). Simonds and Christopher (2013) argued that these methods can equip collaborators to write their own stories. Akther (2015) used photovoice to examine how one can appropriate ICT as an instrument to develop indigenous communities in rural Bangladesh; Dolezal (2013) used photovoice to investigate how cultural assumptions regarding ICT impact the role that ICT plays in heritage preservation in a Native American community (the Choctaw Nation). Photovoice involves

collaborators taking photographs of sociocultural artefacts and customs in order to enhance, represent, and identify their socioculturalism through photos (Akther, 2015; Dolezal, 2013).

Both studies concluded that participatory visual methodologies illustrate the potential of digital technology to depict and empower indigenous cultural groups. Similar to Simonds and Christopher (2013), Akther (2015) reported how difficult participants found it to initially share their experiences. But, when the authors elucidated viewpoints, experiences, and perspectives via photos (e.g., "Please explain the context of this photo?'), participants actively engaged in discussion. The positive claims of photovoice in decolonization research seem consistent with image use in ethnocomputing research. According to Sutinen and Vesisenaho (2006), ethnocomputing's use of imagery derived from students' socioeconomic context allows students to easily grasp computing concepts. Combining images with verbal explanations can strengthen this teaching or learning method further, especially for students from a predominantly oral indigenous group. In this vein, photovoice represents a relevant and appropriate methodology for individuals who seek to advance cultural pluralism in computing education.

Simonds and Christopher (2013) also highlighted the issue of rendering indigenous methods acceptable to Western-based paper reviewers. They recommended that universities train academics in indigenous theory and methods to allow them to produce conceptual instruments to determine how sociocultural value systems underpin theories and methods and value non-Western epistemology.
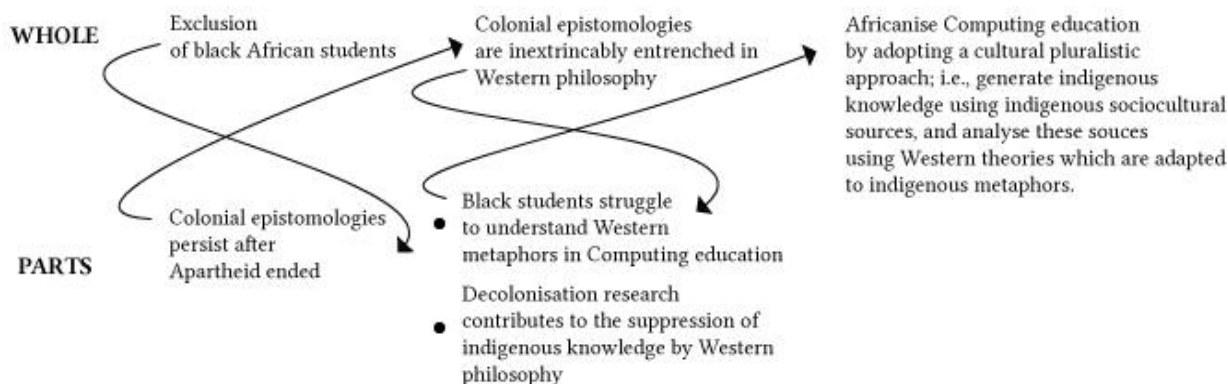
7.2 Cultural Pluralism in Computing Education: The Whole and the Parts

Throughout this paper, we use hermeneutics to advance efforts to Africanize computing education. We adapt the way in which Gummesson (2000) explains the hermeneutic circle to illustrate how we understand the "whole" of Africanizing computing education. According to Gummesson, researchers approach an investigation with a certain preexisting understanding (preliminary understanding of the whole). By analyzing and interpreting others' experiences, researchers gain understanding and insights (at least partially) about a research problem. New understanding gives rise to new research avenues to explore and, thus, may trigger successive hermeneutic cycles. New understanding acquired during a cycle essentially represents "preunderstanding" when furthering investigation with each consecutive cycle (see Figure 5).
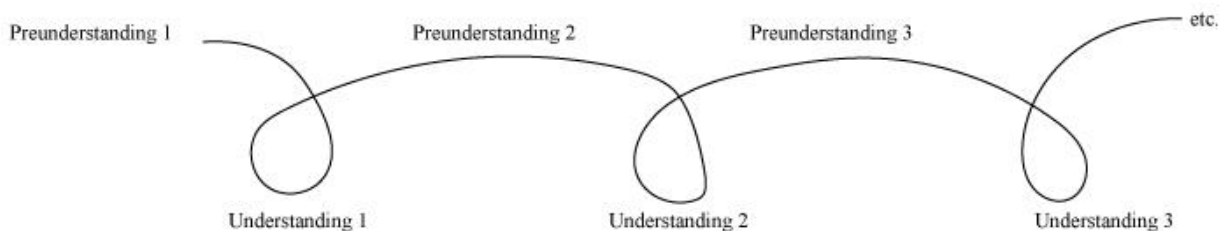
Figure 5. Gummesson's (2000) Hermeneutic Loop

Figure 6 illustrates the way we finally hermeneutically interpret Africanizing computing curricula. We show that the call for decolonization in South Africa stems from the slow rate with which higher education in the country has moved away from colonial-era policies and, by extension, Western academic tradition. Consequently, indigenous students view computing education as hegemonic insofar as it lacks epistemic diversity and disregards other knowledge traditions. Moreover, students struggle to grasp Western theory, epistemology, symbolism, and metaphor that inform computing education. Paradoxically, one cannot decolonize computing education without Western knowledge given that the West invented ICT. Notwithstanding this reality, we espouse the view that one can possibly develop, in concurrence with Western tradition, indigenous knowledge in computing education.

Figure 6. Hermeneutic Interpretation of Africanization of Computing Education (Based on Gummesson, 2000)

We found that one can generate indigenous knowledge in computing using indigenous sociocultural sources. However, decolonization has yet to produce an alternative, non-Western paradigm to validate indigenous "data" (Naudé, 2015). Naudé (2015) points out how Ubuntu's "credibility criteria"—which many exhort as a distinct African theory to interpret indigenous knowledge—remains contested. Simonds and Christopher (2013) show, however, that one can validate indigenous generated data in Western paradigms without abandoning its epistemic authenticity. In Section 7, we illustrate how the authors, in collaboration with their indigenous participants, developed a conceptual, culturally metaphorized model (a form of thematic analysis) to understand participants' views (revert to Figure 4).

8   Concluding Thoughts

In this paper, we examine computing science decolonization in South African higher education. We wrote this paper due to discourses that have criticized South African universities for moving too slowly away from colonial policies. As a consequence, black students feel excluded in academic spaces, which, student activists argue, remain entrenched in colonial-era policies. We point out how black students' frustration culminated in the #FeesMustFall and the #RhodesMustFall student protests. And, despite efforts by the post-apartheid government to redress past inequalities through ICT and funding policy frameworks, students felt the apartheid and colonialism culture persists on university campuses.

We examine empirical evidence from previous research that has contributed to attempts to decolonize computing education. These studies share one sentiment: one cannot decolonize computing education without Western epistemologies. Thus, decolonization researchers must adopt both non-Western and Western philosophical pluralism. These studies—especially the ones that use ethnocomputing as an approach—have seemingly achieved significant gains to indigenize computer knowledge. A primary concern Naudé (2015) expresses towards such studies represents the universal approach insofar as generalizations regarding the indigenous experience. These generalizations, filtered through Western epistemological lenses, distort the lived experience of indigenous people and paradoxically center around expressing Western truth in indigenous sociocultural forms. In this light, Naudé (2015) asserts that decolonization research actually illuminates the value of Western epistemologies at the expense of interiorizing indigenous knowledge.

Naudé's (2015) concerns manifested in a decolonization case study that Simonds and Christopher (2013) conducted. The Western epistemological ethical principle of participants' anonymity, for example, lacks relevance in some instances, such as occurred with a Native American tribe (Naudé, 2015). Indeed, the lived experience of the Native American community, from which indigenous knowledge emanates, concurs with Gyekye's (1988) African philosophical views. Gyekye fundamentally argues that one cannot necessarily answer the "truth" (a philosophical question) about indigenous ways of knowing through Western science but that one requires feedback from indigenous people who participate in their own everyday experiences. We show that these everyday experiences embody sociocultural sources such as imagery, storytelling, song, and dance. To follow a congruent cultural pluralistic approach, Dolezal (2013) suggests, for example, that visual methodologies such as photo-voice can effectively complement and combine indigenous epistemic sources such as storytelling and imagery.

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