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Life sciences reading material in vernacular: Lessons from developing a bilingual (IsiZulu and English) book on South African frogs

Fortunate Mafeta Phaka[1,2]* (ORCID ID: 0000-0003-1833-3156) & Dax Ovid [3] (ORCID ID: 0000-0002-1778-314X)

[1]*African Amphibian Conservation Research Group, Unit for Environmental Sciences and Management, North-West University, Private Bag X6001, Potchefstroom, North-West, South Africa, 2520*

[2] *Hasselt University, Centre for Environmental Sciences, Research Group Zoology: Biodiversity and Toxicology, Diepenbeek, Limburg, Belgium*

[3] *Department of Biology, San Francisco State University, 1600 Holloway Ave, San Francisco, CA, United States of America, 94132*

* Correspondence: Fortunate Mafeta Phaka, mafetap@gmail.com

Abstract

The discussion of African languages as languages of learning and teaching can be traced back to the 1980s. To date, this discussion still continues and efforts to intellectualise African languages have been lax. Here, we present practical South African examples of higher education achievements in African languages that demonstrate the challenges and opportunities of African language planning and corpus development. We particularly focus on the development of a peer-reviewed bilingual (IsiZulu and English) book on the frogs of Zululand, South Africa. The publication under consideration falls within the life sciences, and it is the first comprehensive book on South African frogs to be written in an African language. Developing life sciences reading material in vernacular is a time-consuming process that requires a multidisciplinary team which understands both life and social sciences. Furthermore, when vocabulary relating to a focal species is undocumented, field research is necessary to identify the nuances of a specific language or culture. This language planning effort under discussion demonstrates the IsiZulu language's ability to communicate life sciences and how language planning efforts can be made integrative and inclusive of previously marginalised languages.

Keywords: Community outreach research, Decolonizing curriculum, Ethnoherpetology, Life sciences education, Medium of instruction, Postcolonial science

Word count: 7291 (excluding Abstract)

Introduction

Language planning in Africa, specifically corpus development and intellectualisation of African languages, is a long-standing challenge. In 1982, ministers of education from various African states convened for a conference in which having African languages as languages of education was discussed as a priority (UNESCO, 1982). According to the document for this meeting, having African languages as languages of learning and teaching (LoLT) was a matter that required urgent attention. For African languages to be effective LoLT they must be developed into standard languages (Webb, 2004). The urgency of the intellectualisation of African languages as discussed by the African minsters of education was, however, not translated into action, and the communities speaking these languages remain largely side-lined from language planning. Brock-Utne (2007) reported that little progress had been made towards the seemingly important goal of using African languages as LoLT. Resources are often focused on promoting African culture rather than on the language planning and development required for African languages to be viable alternatives to colonial languages for learning and teaching (Banda, 2009). It is widely agreed that African languages are important for the socio-economic development of the continent, but there is little clarity on how to achieve the desired intellectualisation of these languages to bring them up to par with modern contexts (Prah, 2017). Achieving intellectualisation of African languages, as the African minsters of education envisaged in their 1982 meeting, requires language planning.

Here, we discuss a South African example of socially-integrative African language corpus development and intellectualisation using life sciences reading material developed for IsiZulu speakers as a case study. Traditional language planning places emphasis on corpus development to build a discrete linguistic system of specialised terminology and phrases that enable communication about abstract concepts (Newman, 2021). Banda (2009) contends that the drawback of language planning and policy in Africa is that they are based on Western and colonial notions of multilingualism, which simultaneously promote several monolingual streams of distinctive languages in their homogenous communities. In effect, bilingualism is said to arise through single language education (Banda, 2009). South Africa's move towards a multilingual language policy with African languages as LoLT began when the country came under democratic rule in 1994, thus enabling language policy and planning to start working towards language democratization (Kamwangamalu, 2001). In the country's language planning history, this goes down as an attempt to deconstruct monolingual ideology (Baldauf, 2012). However, minimal progress has been made in implementing this policy (Kamwangamalu, 2001; Webb, 2004).

Regardless of the little progress made in South Africa's democratic language policy, the LoLT issue continues to be an active discussion. South African language planning has mostly been preoccupied with the mother language debate (Banda, 2009). African languages as LoLT are a regular point of academic, political and conversational discussions in South Africa (Department of Basic Education, 2013; Mkhize & Balfour, 2017; Hadebe, 2020). Some of the ongoing discussions mention numerous advantages and disadvantages of teaching and learning in African languages. There are also discussions that focus on the logistics of corpus development required for African languages to be LoLT. Development of reading materials is a complex issue involving multiple stakeholders (Edwards & Ngwaru, 2012), and the complexity varies according to each subject area and the technical language it uses. Negative attitudes towards African Languages impede efforts to promote them (Kamwangamalu, 2001). The lack of modern terminology in African languages is also a hindrance to their use as LoLT (Madiba, 2001).

South Africa's past of oppression meant that the country was only officially recognised as multilingual, from previously bilingual (Afrikaans and English), when it came under democratic rule in 1994 (Kamwangamalu, 2001). Amidst the backdrop of the historic suppression of indigenous languages, along with oppression of their speakers, there is also negativity towards African languages. Despite the general lack of modernisation of African languages and the long-standing LoLT discussion, there are multiple achievements in indigenous languages emerging from South Africa's academic sector. These achievements, among others, include scientific articles written in Setswana (Baitshenyetsi et al., 2011) and IsiZulu (Gumbi, 2014; Nkosi, 2014), along with Doctoral dissertations written in IsiXhosa (Kunju, 2017), Sepedi (Thokoane, 2008) and Setswana (Pooe, 2019).

The abovementioned academic works bring practical examples to the LoLT discourse, and they can be regarded as successful manifestations of ongoing language planning efforts. A practical example that is of interest here is a bilingual book (written in English and IsiZulu) with the English title 'A Bilingual Field Guide to the Frogs of Zululand' (Phaka et al., 2017), and the IsiZulu title 'Isiqondiso Sasefilidini Esindimimbili Ngamaxoxo AkwelaKwaZulu' (hereafter Zululand Frog Guide). The book is the third in a zoological series of peer-reviewed publications called Suricata which is published by the South African National Biodiversity Institute (SANBI, 2020). As the first comprehensive guide for South African frogs written in an indigenous language, the Zululand Frog Guide is an ideal case study for the process of developing taxon-specific life sciences material in an African language, and gauging how far along the intellectualisation of IsiZulu has come. An intellectualised language is capable of discussing any subject regardless of its complexity (Khumalo, 2020). The lessons learned in developing the Zululand Frog Guide are applicable to other African countries with reasonable consideration of each country's unique culture/language contexts. An understanding of the various processes of corpus planning (i.e., codification and elaboration) forms the basis for development of reading materials (Liddicoat, 2005). In the text to follow, we discuss the issues pertaining to the authors and translators who developed life sciences reading material in IsiZulu.

Language as culture and scientific literacy

How can the life sciences, with a dominant historical narrative entrenched in European colonialism, be translated to advance language planning, scientific research, and education in South Africa? Ngũgĩ wa Thiong'o, who has broadly studied the politics of language in African literature, describes the debates over education and languages, focusing on Kenya but with the rest of the African continent in mind. Decolonizing the Mind (wa Thiong'o, 1992) describes the process and challenges of developing language for African creative literature and theatre. There are also opportunities to develop African languages beyond literary disciplines in the service of supporting science learning and engagement, which we detail in this article.

Because English proficiency is perceived as a necessary prerequisite for engagement with the global scientific community, science in South African schools is taught primarily in English. Historically, language policy maintained English dominance in South African educational institutions. In general, students are still expected to learn English to learn science. Consequently, students trying to learn the English language, as well as new scientific concepts presented in English, may struggle to learn both simultaneously (Webb, 2010). Ideally, the language that students use to learn science should be a language with which they are already familiar. If the language spoken at home is equivalent to the instructional language, a learner is more likely to demonstrate achievement in science and mathematics;

however, students with non-equivalence of home and instructional languages are at a disadvantage when learning science (Rollnick, 2000; Prinsloo et al., 2018; Prinsloo & Harvey, 2020). Further, it is argued that the technical vocabulary, status, acquisition, usage, and prestige of African languages should be developed to advance equitable science learning and national integration (Dlodlo, 1999; Webb et al., 2010). The University of KwaZulu-Natal have been exemplary in their successful development and implementation of policy for IsiZulu to be one of its LoLT alongside English, thus making it possible to learn and teach in either IsiZulu or English (Kamwendo et al., 2014). The corpus development resulting from the University of KwaZulu-Natal's promotion of IsiZulu plays a major role in intellectualisation of this African language (Khumalo, 2020).

The process of developing the Zululand Frog Guide promotes community engagement in language development while also including cultures/languages/communities that are generally excluded from wildlife-related matters. Furthermore, publishing material in more than one language allows for freedom of choice to opt for a language that one is most comfortable with while also promoting bilingualism. Having lessons available in English and an African language makes lessons accessible regardless of the learner's home language (Kamwendo et al., 2014). This article showcases an integrative approach of materials development in language planning by engaging with life sciences as an alternative to learning English to learn science. In this case study, life sciences teaching is grounded in the intricate relationship between South African wildlife and indigenous cultures/languages. South Africa's biodiversity provides its citizens with nature-based cultural traditions (Department of Environmental Affairs, 2015). These nature-based traditions are evident in many aspects of culture including lore, spirituality, idioms, praise poetry, and totemism. The Zululand Frog Guide in particular focuses on cultural knowledge alongside the taxonomy of frogs. In turn, the reading material not only presents amphibians in a language with which the Zululand community is most familiar but also frames amphibians according to how the community experiences and relates to them. Focusing on animals from the everyday contexts of the community interacting with them helps with the sampling of animal-related vocabulary and dialects, which contributes to determining a local language's orthography and standardisation principles. The sampling described here is shown to be an important step in language planning by Keränen (2018) in the case study of Kven language maintenance through corpus planning.

Time and a multidisciplinary team are essential

The Zululand Frog Guide was developed as a pilot study in South Africa's KwaZulu-Natal province. If successful, the pilot would be expanded to include the rest of South Africa and its other indigenous languages (Phaka et al., 2019). The process of developing the book started with field research to record local knowledge about frogs along with frog species names, the spelling of these names, and their pronunciation. Within language planning, this field research was vital to determining IsiZulu orthography and standardisation principles relating to the life sciences domain. The recording of the mostly undocumented species names contributed to understanding standardisation principles that specifically relate to taxonomy. Later in the article, the principles of standardisation are shown to be important in both linguistic and scientific contexts. In a multicultural country such as South Africa, another consideration for developing this type of vernacular reading materials is that the wildlife being discussed is likely to have regional and culturally-specific names and associations.

To make such reading materials engaging and relatable, it is important to include vernacular names instead of solely using scientific names, popular English names, or direct translations of English names. In many instances, these indigenous names are not documented and are passed down by word of mouth over the generations. If there are multiple names or dialect variations in the spelling of indigenous names for one species, then standardisation will be required. Dialects of the various languages are unlikely to be published, so they must be recorded through field research in different areas within a region where habitants speak the same language. The indigenous knowledge recorded through field research requires reframing for life sciences contexts, and this field research may also record life sciences terminology. We later find out that further field research was required in order to explicitly document the technical language necessary for explanations in the life sciences domain. The IsiZulu lexicon proved mostly adequate for writing a comprehensive guide for wildlife (particularly frogs), and only a few terms were borrowed. This process of recording terminology is expensive and generally overlooked thus resulting in the stereotype that African languages are incapable of coining terminology for abstract concepts (Alberts, 2010). Recording terminology through field research might reveal IsiZulu words for the borrowed terms shown in Table 1. For example, the Zululand community practices cattle farming and are thus likely to have an indigenous name for a livestock sickness called Nagana. This Nagana is one of the borrowed terms in the Zululand Frog Guide (see Table 1).

Developing life sciences reading materials in an African language requires contributors from various disciplines to ensure that the materials are scientifically and orthographically sound. Initial work on the Zululand Frog Guide began in 2015, and the book was published in 2017. From the start of field research to the book going to print, there was a process of continuous consultation between the various stakeholders involved in this language planning effort. The field research, data analysis, content development, and species descriptions were carried out by authors with qualifications in the life sciences and experience in the social sciences. The existing IsiZulu taxonomy of frogs did not include all frog species from the focus area. To extend the taxonomy to be inclusive of all Zululand frog species first required expertise in life sciences to interpret the recorded taxonomy. Following interpretation, the development from local taxonomy to a comprehensive list of locally relevant and scientifically appropriate names required joint expertise from life sciences, IsiZulu language studies, and wildlife tourism for communicating wildlife concepts to non-specialist audiences. Additionally, the IsiZulu language expert was required to have experience with technical vocabulary for the life sciences. This development of the local taxonomy was based on principles of standardisation and is fully explained in the sections to follow.

Dialects and technical language

Before recording dialects through field research, the multidisciplinary team first needed to identify where different dialects of the focal language occurred. Within the area covered by the Zululand Frog Guide, there are variations in the way IsiZulu is spoken and subtle differences in the way animal names are pronounced and spelled. In recognition of these dialects, local frog names from five different areas of the Zululand region were recorded (Phaka et al., 2019). The dialects had three major differences in frog names. Some Zululand locals referred to frogs in general as ‘amaselesele’ while others used the shortened ‘amasele’. Most of the Reed Frog species (i.e., frogs from the Hyperoliidae family) are called ‘umgqagqo’ in some parts of Zululand while in other areas they are called ‘umgqagqa’. Burrowing frogs (of the families Brevicipitidae and Hemisotidae) were either called ‘isnana’ or ‘isinana’. The Zululand Frog Guide opted to use ‘amasele’, ‘umgqagqa’, and ‘isinana’ as the standard names because they were more widely used among the IsiZulu dialects.

Choosing the most widely used alternative applies the majority principle in the corpus planning principles about the relationship between people and their language, as outlined by Vikør (1993).

Conversational proficiency in indigenous languages is insufficient for their adaptation as LoLT because the ability to use a language in social settings does not equate to an ability to use that language for academic purposes (Webb, 2004). Proficiency in academic languages requires knowledge of academic and technical vocabulary (Cummins, 2001). What languages are considered to be technical and academic results from an imperial imposition of Eurocentrism, what Ngũgĩ wa Thiong'o calls colonial alienation (1992). Since the prevalent academic languages are colonial in origin, the development of indigenous languages into academic languages has been ignored, thus extending the colonialist ways for disregarding local communities and their languages. To temporarily solve the problem of insufficient IsiZulu technical terms, the Zululand Frog Guide borrowed some technical vocabulary from English and science to advance understanding of frog biology (Table 1). **[Table 1 near here]** Borrowing was limited to terminology which the book's writing and translations team did not know the IsiZulu equivalents, and explanations for these borrowed terms are included in the book's glossary. Besides the 11 borrowed terms shown in Table 1, the IsiZulu lexicon was capable of providing the detailed and descriptive language required for scientific descriptions of wildlife.

Caution is necessary when defining and borrowing English or scientific terms for use in IsiZulu or other African languages. For example, the term 'tympanum' refers to a structure used for hearing in frogs and might be translated to an 'ear' in IsiZulu which would, in the academic sense, be inaccurate as a tympanum and an ear are not the same structure even though they are similar in their function. Due to the absence of an IsiZulu equivalent for tympanum, the Zululand Frog Guide borrowed the term (Table 1) and provided an IsiZulu definition that differentiates it from an ear. As IsiZulu language development advances, borrowed words such as those in Table 1 will be seen less frequently and eventually replaced. If South Africa's language policy ambitions of additive multilingualism (Kamwangamalu, 2001) are realised, then development of IsiZulu will progress until there is no need for borrowing technical terms. Since African languages are developing languages, they are likely to experience more problems with terminology than developed languages (Van Huyssteen, 1999). The policy required to enable development of IsiZulu and other indigenous South African languages is already in place, but the establishment of a systematic procedure for developing these languages has been slow (Madiba, 2001). It is also possible some technical terms exist but are unrecorded, or the authors missed already recorded terminology. Various terminology already exists in different domains of African languages, and it is likely undocumented and unstandardised (Alberts, 2010).

It is worth noting that there are words used interchangeably in conversational language, but the same words should not be interchanged in life sciences writing as they differentiate between species. Safeguarding against the potential problems that can result from interchanging words is possible when there is a multidisciplinary team working on language intellectualisation. They can consult each other on the suitability of coversational words as technical terms in various disciplines. 'Stripes' and 'bands' are words that are sometimes used interchangeably in conversational IsiZulu, but they should not be interchanged in life sciences contexts, for they form part of the unique names of different species. If 'stripe' is interchanged with 'band' in the species name Striped Grass Frog (IsiZulu name: 'Uvete olunemigqa'), then this name might be confused with that of a different species known as the

Broad-banded Grass Frog (Isizulu name: 'Uvete olunomugqa obanzi'). Interchanging IsiZulu words for 'dots' and 'blotches' in life sciences text would result in confusion, due to these words being key to accurate descriptions of various species. Dots on the underside of the body are a defining characteristic of the Northern Pygmy Toad while blotches on the underside are a defining characteristic of the Southern Pygmy Toad, and interchanging between dots and blotches would create confusion about the species of Pygmy Toad under discussion. The potential confusion in the field of animal studies that could result from interchanging terms which are part of conversational language only highlights the technicality of life sciences. The fact that such terms can be used in technical contexts for a previously marginalised language is a testament to IsiZulu's ability to communicate concepts in different contexts—a vital requirement for language intellectualisation.

A basic understanding of taxonomy is necessary

Numerous research articles show that cultures across the world have their own taxonomies for wildlife (Berlin, 1973; Ulicsni et al., 2016; da Silva & Barbosa Filho, 2018). South African cultures also have their own taxonomies with wildlife names that are unique to each culture. Using indigenous wildlife names enables indigenous language speakers to more easily recognize different species. Indigenous taxonomies are established; however, they are not comprehensive for all groups of wildlife. Plants generally have more specific indigenous names for individual species in comparison to animal species, which tend to be grouped together under one indigenous name based on their similarities (Phaka et al., 2019). An understanding of taxonomy and its related orthography and standardisation principles is necessary in order to interpret indigenous naming and classification rules. These indigenous naming and classification rules can be applied to extend taxonomies that may not be comprehensive. A particular nuance of recorded IsiZulu frog names that may have been missed by someone without an understanding of taxonomy are the two names used as generic terms for frogs; 'amasele' versus 'amaxoxo'. In Zululand, the word 'ixoxo' or 'amaxoxo' is used for frogs with warty skin (which are mostly toads), while 'isele' or 'amasele' is used for smooth-skinned frogs. This differentiation of frog species is one of the IsiZulu standardisation principles relating to taxonomy; this principle makes provision for the differentiation and grouping of frog species based on their similarities. Scientific taxonomy guidelines also make provision for classification of species based on similarities. Therefore, the standardisation principles for IsiZulu species names have scientific merit.

Our case study published IsiZulu names of 58 frog species occurring in Zululand and a subsequent publication by Phaka et al. (2019) details the corpus development process of creating this comprehensive list of IsiZulu species names from the non-comprehensive folk taxonomy recorded during field research for the Zululand Frog Guide. Guidelines of folk taxonomy in Zululand were found to have similarities to scientific taxonomy as both taxonomies group frogs according to observed traits (e.g., the aquatic frogs collectively called *Xenopus* in scientific taxonomy are grouped under the name 'idwi' in folk taxonomy), IsiZulu uninomial frog names are folk taxonomy's equivalents of scientific genera or families (e.g. the frog genus *Breviceps* has an equivalent folk-generic grouping called 'isinana' and the family Ptychadenidae's folk-generic equivalent is 'uvete'). Zululand folk taxonomy mostly conforms of the International Code of Zoological Nomenclature as species are grouped together using a uninomial name, and the groupings are based on similarities on the defining traits of various species (Phaka et al., 2019). The organising principles of folk taxonomy are said to be a predecessor of the hierarchical structure used in scientific taxonomy (Ross, 2014). Since there are overlaps between folk and modern taxonomy, the principles of modern taxonomy were used by Phaka et al. (2019) as a supplement to refining

IsiZulu taxonomic principles into principles for the standardisation of IsiZulu frog names. This was necessary for the compilation a comprehensive list of Zululand frog species. The taxonomic principles in discussion here are mainly the domain of life sciences, but they do overlap into grammatication; they involve extraction and formulation of rules for structuring language (Baldauf, 1989). These principles of taxonomic standardisation used by Phaka et al. (2019) are as follows:

> "(1) Avoid coining completely new names and give priority to existing appropriate names. (2) Formulating individual species names should rather involve modification or extension of existing indigenous names to improve their meaning. (3) Habit, habitat, or appearance should preferably be used whenever there is a need to coin a new name. (4) Use of call descriptions in names should be limited to frogs that are commonly observed calling. (5) Wherever possible, the coined indigenous names should bear a similar meaning to scientific names or other vernacular names published in a different language. (6) Dialects of the language in use should be considered and species' names made understandable across different dialects of the same language."

The uninomial IsiZulu nomenclature used for groups of frog species with similar traits is extended by additional words, which serve as epithets to differentiate among the various species that belong to a folk-generic grouping (Table 2). The folk-generic uninomial names are indicated by underlining in the example of extended IsiZulu species names provided in Table 2. **[Table 2 near here]** For the sake of continuity and standardisation, these extended names are descriptive of their respective species. Furthermore, the extended names have a meaning similar to scientific names or already published names in other languages. The specific names constructed by extension of existing folk-generic names are new to both life sciences and IsiZulu, and they constitute what Baldauf (1989) calls terminological modernisation; regular development of new terminology in order for a language to be capable of being expressive in every domain. Developing terminology that is specific to a discipline is vital to the intellectualisation of a language. The lack of such specific terminology is often cited as the reason African languages cannot be used as LoLT (Prah, 2017). The uninomial IsiZulu name remains part of the extended name to ensure that this new name is recognisable to IsiZulu speakers and also maintains its original function of grouping similar species together (Table 2). The IsiZulu language expert on the materials development team ensured that the extended names conform to IsiZulu language rules. The publication of these comprehensive frog species names initiates a process to put IsiZulu names on par with the developed Afrikaans and English names, which are published alongside scientific names in many South African wildlife books. Efforts to develop and standardise Afrikaans and English names of South African frog species were already underway in the 1970s (Jacobsen, 1978; Passmore & Carruthers, 1978; Van Dijk, 1978a, 1978b). Working towards standardised and comprehensive species names can help make communities aware of the biodiversity that exists in their immediate environment, especially for species that may not be fully expressed in the local language. The standardisation of IsiZulu names can also contribute to citizen science projects to ensure that non-scientists' conservation efforts are targeting the correct species beacuse scientific names or popular English names may not be familiar to all non-scientists.

Setting guidelines for the extension of indigenous taxonomy, within the boundaries of both science and an African language, contributes to a systematic approach to language modernisation that Madiba (2001) highlighted. Furthermore, it moves closer to the realisation of the multilingual ambitions of South Africa's post-apartheid language policy with indigenous taxonomy guidelines that are applicable to other African languages in South Africa. By documenting frog names that are familiar to the speakers of the language and then developing the indigenous names to conform to scientific naming guidelines, the book extends the indigenous taxonomy with specific names for each of the 58 species. Without an understanding of taxonomy, this vernacular reading material would be less robust, for it would be overlooking the familiarity offered by indigenous names and specificity gained by extending the indigenous names.

Enthusiasm about the finished product leads to greater willingness to learn

One of the advantages of community-based and collaborative documentation of indigenous languages is multigenerational involvement, such as including both students and parents (Webb, 2004). Zululand locals showed eagerness to be involved in the development of the Zululand Frog Guide as early as the field research stage, despite their inhibitions towards frogs. This enthusiasm fostered learning about amphibian biology and presented the chance to dispel the misconceptions that affect the conservation of amphibians. In addition to having a book in their home language, the Zululand locals who were involved in the field research phase were appreciative that they were consulted about their knowledge of frogs prior to writing about frogs in the Zululand context. Once the book was published, it was delivered to schools in Zululand, and some of these schools sent letters of thanks to the authors to acknowledge receipt of the books. Even though the Zululand Frog Guide is specifically developed for one province, the book has also been bought by people from eight of South Africa's nine provinces. At the time of writing this article, the book had been read 2,712 times from the authors' ResearchGate (https://www.researchgate.net/) profile. The book was subsequently awarded and featured in news reports (Saayman, 2017; BizCommunity, 2019; Beautiful News SA, 2021). The evidence above mostly illustrates the enthusiasm about the book. To determine if the language accessibility of the book increased students' willingness to learn from it would require follow-up surveys to be carried out at the schools where the book was delivered. Here, we speculate that the communities' sentiments increased the likelihood of the book being embraced and thus a greater chance of engaging with the reading material. Based on previous findings, we might expect that use of African languages enables better engagement and increased participation in learning (Webb, 2004).

The process of developing the Zululand Frog Guide can be situated in a national agenda to support "identity reconstruction and innovation, human rights, sustainable development and democratization in South Africa and throughout the African continent" (Odora Hoppers, 2011, p. 388). Civic science, or public engagement in scientific knowledge production, not only bolsters trust in science but also supports efforts in sustainability when integrated with indigenous knowledges (Bäckstrand, 2011). The Zululand Frog Guide practices aspects of civic science and engages the local community in matters of ecological conservation. Furthermore, this approach responds to the challenges previously described by Prinsloo et al. (2018). Instead of compromising scientific literacy by simultaneously learning English, communities use home languages and local ecology to develop languages for the life sciences. This case study demonstrates value in documenting Zululand fauna in the local language. Community members are engaged in the co-development of corpus about local wildlife. The product of these efforts, the Zululand Frog Guide, aims to serve as an impetus for the community to protect the species that were named and described as co-habitants of the immediate environment and instil pride in an African language. The next section addresses the value of community engaged documentation of indigenous knowledge systems, and how these efforts can advance the global scientific enterprise.

Global perspectives on postcolonial science and indigenous ecological knowledges

Language planning research and implementation, with corpus planning as a subset therein, share a history of international planning efforts and compromises based on ever-changing, socio-political power structures (Fishman, 2004). As postcolonial power structures continue to promote decolonised ideologies, there is also an increase of indigenous methodologies in various disciplines. In relation to language planning efforts, indigenous methodologies tend to be concentrated on social science research. There is a gap for how such methodologies could be extended to contexts of life, physical, and technical sciences (Smith, 2012) The Zululand Frog Guide is among examples of how to extend decolonized methodologies into both language planning and life sciences. We can find comparable examples in other parts of the world. For example, in Polynesia, Māori research their own value-practice systems using indigenous methodology and are executing indigenous language planning through revitalization projects (Smith, 2012).

Beyond shaping language planning research, Indigenous knowledge systems can shape how we understand science, the scientific process, and disciplinary boundaries (Nader, 1996). It is important that indigenous knowledge is extended into the classroom. Semali (1999) argues that "the curriculum [be] flexible enough to include space for indigenous literacy as part of local history, indigenous languages, metaphors, and folklore to nurture and support African identity" (pp. 316) without succumbing to rote memorization of facts. The challenges and opportunities of science learning in South African schools are two-fold—developing scientific literacy for local scientific advancement and English proficiency for global participation (Prinsloo et al., 2018; Prinsloo & Harvey, 2020). A comparison can be made with the dualisms between uniqueness and internationalization, as described by Fishman (2004). The language of scientific discourse can benefit from projects like the Zululand Frog

Guide by acknowledging the uniqueness of local language planning in concert with the inevitable internationalization of the binomial nomenclature of the life sciences. For example, local indigenous names can serve as alternatives to counter the global invasive labels applied to frogs sourced from South Africa and distributed around the world. An exemplar for this is using the IsiZulu name ‘idwi’ alongside references to the African Clawed Frog, *Xenopus laevis*, when teaching and learning about this globally-distributed species that is also a model organism in scientific research (Ovid & Phaka, 2021).

Concluding remarks

The Zululand Frog Guide as a case study demonstrates that it is possible, albeit time-consuming, to develop life sciences materials in an African language. A multidisciplinary team is required for the materials to be orthographically accurate, scientifically sound and also widely embraced by local language users. Life sciences experts, language practitioners with experience in life sciences terminology, and community members that use life sciences subjects in conversational contexts can collaboratively develop materials by bringing together their collective experiences of language use in different domains.

The book also demonstrates that IsiZulu has the technical capabilities for developing content in a comprehensive wildlife guide. With continued corpus development, currently lead by the University of KwaZulu-Natal, IsiZulu may soon be developed enough to not require use of borrowed technical terms from other lexica. It is hoped that the corpus planning lessons learned through the development of this book can support the future development of IsiZulu life sciences materials in particular and other African languages in general. The integrative approach in the development of this material helped instil a sense of pride in the Zululand community. The lack of pride in African languages is often cited as a hindrance to their intellectualisation. The general interest shown in scientific material that presents life sciences in an African language suggests that there may be increasing interest in learning in African languages. A positive perception coupled with interest and continued corpus development are positive results in language planning efforts. They contribute to the promotion of IsiZulu as a language of learning and teaching.

African languages theoretically have the capacity to function as media of instruction in education, but in practice, they have not been adequately adapted and standardised to function effectively in formal educational contexts (Webb, 2004). Efforts like the Zululand Frog Guide can contribute to adapting and standardising African languages for life sciences education. Given the minimal use of borrowed words for this technical life sciences material, IsiZulu has proven to be capable of functioning effectively in formal education. Significant progress has been made in adapting and standardising IsiZulu to a point where it can be used for teaching and learning in an institution of higher education (i.e., University of KwaZulu-Natal). The Zululand Frog Guide contributes to IsiZulu corpus development and intellectualisation in general, while specifically advancing taxonomy with standardisation principles (Phaka et al., 2019). The lessons learned about language planning processes for developing this technical material are applicable across different languages.

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Tables and table captions

Table 1. A list of technical terms that Phaka et al. (2017) borrowed for use in IsiZulu life sciences text.

	Borrowed technical term	**IsiZulu form of technical term**
1	Amphibians	Imfibiya
2	Diameter	I-diameter
3	Diaphragm	I-diaphragm
4	Dinosaur	I-dinosaur
5	Genus	I-genus
6	Nagana	I-nagana
7	Pathogen	I-pathogen
8	Taxon	I-taxon
9	Toxin	I-toxin

10	Tympanum	I-tympanum
11	Virus	Ivirusi

Table 2.

Table 2: Text from Phaka et al. (2017) showing IsiZulu frog species names extended from folk-generic names (alongside scientific names). The underlined part of the IsiZulu species name is the uninomial folk-generic name recorded during field research.

Amaxhaphozi	*Afrixalus aureus* – Umgqagqa Oyigolide
	Hemisus marmoratus – Isinana Esipendiwe
Avukuzayo	*Breviceps adspersus* – Isinana Sehlathi
	Breviceps bagginsi – Isinana SikaBilbo
	Breviceps carruthersi – Isinana SakwaPhinda
	Breviceps passmorei – Isinana SakwaNdumo
	Breviceps mossambicus – Isinana SaseMozambique
	Breviceps sopranus – Isinana Sekhwela/Isinana Somtshingo
	Leptopelis mossambicus – Isele Lasezihlahleni Elinsundu
Ichibi	*Amietia delalandii* – Isele Lasemfuleni Elijwayelekile
	Hyperolius marmoratus – Umgqagqa Opendiwe
	Hyperolius pusillus – Umgqagqa Weminduze
	Hyperolius semidiscus – Umgqagqa Wemigqa Ephuzi
	Schismaderma carens – Ixoxo Elibomvu