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Economic Analysis of Developing Scientific Registers in African Indigenous Languages: Challenges, Opportunities, and Economic Perceptions in the Context of IsiNdebele and Natural Sciences

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Abstract
This interpretive qualitative case study analyzes the economic implications of developing scientific registers in African indigenous languages—specifically IsiNdebele—for natural science education. Data were collected through interviews and diary notes from stakeholders. The findings reveal that IsiNdebele remains economically underdeveloped due to the lack of scientific terminology, which limits its potential as a tool for human capital development. Stakeholders expressed divergent perceptions regarding the economic value of using a scientific register in IsiNdebele for teaching natural sciences. Some supported its use, seeing potential benefits in enhancing learning outcomes and educational efficiency through mother-tongue instruction. However, despite evidence of pedagogical benefits, many stakeholders still reject the use of a scientific register in IsiNdebele, preferring English instead. This preference is rooted in the perception of English as a global language of power and economic opportunity, considered essential for economic mobility and labor market access. Such perceptions significantly affect the economic viability of indigenous languages and hinder investments in their development. It is recommended that targeted investments be made to develop scientific registers in indigenous languages. This could shift stakeholder perceptions regarding the economic value of African languages as mediums of instruction and learning, thereby improving the economic participation of their speakers.

Keywords: IsiNdebele, scientific register, natural sciences, language economic development, human capital, economic value perception.

INTRODUCTION

Africa, the world's second-largest continent by population and land area, is home to immense linguistic diversity, with approximately 2,000 native languages. While research supports the notion that learning is most effective in the mother tongue—which can significantly enhance human capital—Africa remains the only continent where the majority of formal education is conducted in a foreign language for most students and teachers (Oyoo, 2017). Dominant foreign languages (English, French, Spanish, Portuguese) are colonial legacies that continue to shape economic structures and access to opportunities (Brock-Utne, 2014). South Africa, one of Africa's 54 countries, mirrors this trend by using English as the dominant language of learning and teaching (LoLT), despite recognizing 11 official languages (Motloung, Mavuru & McNaught, 2021).

South Africa's cultural and linguistic diversity should serve as an economic asset, yet this potential remains largely untapped in the education system. Schools often require teachers to use registers (primarily English) unfamiliar to them and their students, especially in rural areas (Motloung et al., 2021). This creates inefficiencies in learning and poses a significant challenge, particularly in teaching complex subjects like natural sciences in a language not mastered by students.

Although the South African Constitution guarantees the right to education in an official language of choice, implementation is lacking. From Grade 4 onwards, English or Afrikaans becomes the de facto LoLT, and all teaching materials are printed in these two languages. This

renders constitutional provisions mere "policy on paper" (Oyoo & Nkopodi, 2020), effectively limiting equitable access to quality education and, consequently, economic opportunities for indigenous language speakers.

The language issue has significant economic dimensions. Research (McKinney & Tyler, 2019; Mweli, 2018) shows that lack of English proficiency is a major barrier to student achievement in natural sciences (Adesemowo, 2017; Oyoo, 2017), which directly impacts the development of STEM skills essential for modern economic growth. Students are pressured to master English (Roy-Campbell, 2019; Motala, 2014), and learning technical subjects in a second language has proven to be more difficult (van Pinxteren, 2022). The Minister of Basic Education has acknowledged that one of the primary reasons for low reading comprehension is that students are taught in a foreign language (Writer, 2022), indicating a waste of human resource potential.

Despite these challenges, English remains the LoLT due to the lack of investment in indigenous language teacher training and the absence of teaching materials in these languages (Phiri, Kaguda & Mabhena, 2013). This lack of resources creates economic barriers to adopting indigenous languages. The situation is exacerbated by parental preferences for English, driven by the belief that it is key to economic emancipation and success in the corporate sector (Roy-Campbell, 2019). English proficiency is viewed as a valuable asset providing a competitive advantage in the labor market (Oyoo, 2017).

Practices such as bilingualism have been adopted with the hope that first-language (African language) proficiency can transfer to second-language (English) learning (Cummins, 2008). While some studies show cognitive advantages of bilingualism (Bialystok, Craik & Luk, 2012), this practice does not address the fundamental issue of the underutilization of indigenous languages, which could maximize cognitive development and students' economic potential.

Awareness of the potential economic benefits of using indigenous languages is growing. The Department of Basic Education (DBE) is moving toward changing the status quo. Calls from President Cyril Ramaphosa (Zulu, 2019), Chief Justice Mogoeng Mogoeng, and political analyst Dr. Somadoda Fikeni (Sithole, 2020) stress the importance of mother-tongue education for identity, history, and mastery of basic skills—foundational for lifelong learning and economic participation. The South African Democratic Teachers Union (SADTU) also supports mother-tongue instruction to improve student performance (Jordaan, 2018), which will indirectly enhance the quality of the future workforce. Academics such as Professor Pitika Ntuli and Veronica McKay (Ngobeni, 2020) argue that learning in one's mother tongue improves comprehension and performance, reducing learning barriers caused by foreign languages.

However, realizing the DBE's vision requires significant investment in developing indigenous language resources. A key question is: Is there a market and infrastructure for these resources? Currently, the answer is no. Only English and Afrikaans possess well-established scientific registers for natural sciences. This lack of resources risks rendering the DBE initiative another "policy on paper" with no real economic impact. Therefore, this study aims to address this market gap by developing a scientific register for natural sciences in IsiNdebele. This register is expected to serve as a seed investment to support DBE initiatives, aligning with previous research findings on the potential economic benefits of using African indigenous languages as mediums of instruction (Motloung et al., 2021; Oyoo & Nkopodi, 2020; Adesemowo, 2017). This paper focuses on the economic challenges (costs, market resistance), economic opportunities (human capital enhancement, efficiency), and

stakeholders' perceptions of economic value regarding the use of IsiNdebele in natural science education.

METHOD

This study employs a qualitative phenomenological approach using a multi-case study design, a method selected for its efficiency in deeply exploring the perceptions and lived experiences of diverse stakeholders (teachers, students, and parents) within real-world contexts concerning the value and economic viability of using IsiNdebele. Purposive sampling was utilized to select information-rich participants relevant to the research questions, thereby ensuring cost-effective and manageable data collection. Data were gathered through semi-structured interviews—despite their recognized time and cost demands, this method was chosen for its ability to capture the complex nuances of economic perceptions—alongside diary entries documenting the time and expertise invested in the development of a scientific language register. Content analysis was applied to identify key themes, including the challenges and opportunities from the perspective of language economics.

Key findings highlight significant economic barriers in the development of a scientific register for IsiNdebele. Despite its official status, the language has historically suffered from underinvestment in the creation of scientific terminology, as affirmed by consultations with experts (e.g., the Chairperson of PANSLAB IsiNdebele). The lack of native scientific terms, reliance on borrowings from Afrikaans or direct translations from English, and the difficulty in generating one-word equivalents all point to high development costs and an insufficient linguistic infrastructure. Existing multilingual terminology lists are more reflective of temporary efforts than sustained investment, reinforcing the view that IsiNdebele is economically less prepared for advanced technical use compared to English.

Stakeholder perceptions reveal a conflict in economic value assessment between IsiNdebele and English. Some stakeholders (teachers, parents, students) see economic potential in IsiNdebele, arguing that improved comprehension in one's mother tongue enhances learning outcomes (human capital), classroom participation, and content relevance, potentially leading to long-term educational efficiency. However, other groups (including some teachers, parents, and students) favor English, driven by the belief that it holds greater market value as a language of global economic opportunity and access to higher education and employment. This preference is also shaped by concerns over the costs of adapting to underdeveloped IsiNdebele terminology and a strong desire for children to master English as a key competitive asset—effectively creating market signals that discourage the adoption and further investment in indigenous languages.

RESULTS AND DISCUSSION

The findings confirm that IsiNdebele faces substantial economic barriers due to its underdeveloped status in the scientific domain, characterized by limited terminology and dependence on borrowed or translated terms from Afrikaans and English. This underinvestment in the development of a scientific lexicon directly influences how stakeholders perceive its economic value. Many tend to choose English not only because of its more established vocabulary but also due to the strong perception that English is essential for international mobility, linguistic superiority, and most importantly, economic gain (Roy-Campbell, 2019). This preference reflects a devaluation of indigenous linguistic assets in favor of a dominant language perceived to have greater economic leverage, a phenomenon criticized

for overlooking the potential for economic success through one's own language, as evidenced in other developed nations (see criticisms by Chief Justice Mogoeng Mogoeng).

Nonetheless, the argument that investing in indigenous language development is economically unviable can be challenged. The history of Afrikaans, which also went through borrowing processes, demonstrates that adequate resource allocation can elevate a language from mere social use to an effective medium of instruction. The preference of some parents and students for English, even when comprehension is limited, underscores the strength of market signals associating English with future economic success, often at the expense of hidden costs such as learning inefficiencies and the potential loss of human capital due to language barriers. On the other hand, positive stakeholder perceptions supporting IsiNdebele reveal potential economic benefits through improved learning efficiency, better conceptual understanding (enhancing human capital quality), and greater parental engagement in children's educational of which are drivers of improved long-term economic outcomes.

CONCLUSION AND RECOMMENDATIONS

In conclusion, while the current lack of scientific terminology in IsiNdebele represents a real economic barrier, it is not a permanent condition. The language's development potential is evident from initial investments that have produced resources such as bilingual dictionaries and terminology lists, albeit limited in scope. This study reveals that some stakeholders perceive further investment in developing IsiNdebele as a medium of instruction in science as potentially yielding returns in the form of improved student performance—a key indicator of more effective human capital formation. Existing negative perceptions, often grounded in the status quo and the dominant market value of English, significantly hinder the economic development potential of IsiNdebele.

Therefore, it is recommended that strategic and sustained investments be made to develop IsiNdebele—and other African indigenous languages—so that their status evolves from merely being official languages to becoming economically valuable languages of instruction, including in science. This will require substantial resource allocation to build the necessary linguistic infrastructure, such as comprehensive scientific language registers. Although this presents a challenge demanding skilled labor input (from linguists and scientists), such efforts should be viewed as crucial capital investments aimed at unlocking the full economic potential of South Africa's human resources and ensuring equitable access to economic opportunities through more effective and culturally relevant education.

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