Access to information through translation: a case of multilingual OER robotics project at a South African university

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Translation into indigenous languages has a potential to promote access to information in order to transform the teaching and learning of robotics programmes. Developing open educational resources (OER) for indigenous language speakers is even more beneficial as it provides a choice to access education information in the language of their choice. Though South African has 11 official languages, the indigenous languages are still marginalised in the education sector. This study examines the translation methodology used in rendering the Inspired towards Science Engineering and Technology (I-SET) robotics terminology from English into indigenous language for the purpose of creating a multilingual OER. The study is based on the investigation of indigenous languages translations of robotics terms of the I-SET project. The study aimed to identify the translation techniques used in translating terms in context, and to evaluate the adequacy of the translation equivalents for better access to robotics information through indigenous languages. The examining of the translation of the contextual English robotics terms into indigenous languages took a qualitative, descriptive analytical approach. The findings indicate that individual terms determine the relevant translation techniques used to create the most appropriate and quality contextual equivalents. The products of the robotics translation activities will be catalogued, and an inventory of words are produced as an OER. The contents of the translation process will be included in module curricula to embrace the use of the newly created indigenous robotics words for the awareness and inspiration of science engagement using robotics.

Keywords: access to information, OERs**,** robotics, indigenous language, translation, terminology, technology

1 Introduction

South Africa passed the Promotion of Access to Information Act (PAIA), 2000 (Act No. 2 of 2000) to enable citizens to access information in order to actively promote a society in which the people have effective access to information to enable them to more fully exercise and protect all of their rights. One of the rights enshrined in Section 9 of the South African Constitution is the right to receive education in the official language or languages of one's choice. Where reasonably practicable, people should have a choice to access information or education in the language of their choice. The advent of the Fourth Industrial Revolution (4IR) has introduced robotics and coding in the education sector.

In South Africa, robotics and coding are imported concepts, as such, majority of text for these critical skills comes in English which however poses a challenge on the speakers of other official languages in South Africa. Almost all the official languages, except English and Afrikaans, have been approved just for ceremonial purposes as they are still marginalised in the government, the education sector, the private sector, and the economic sector (Beukes 2014; Nwammuo & Salawa 2018; Madadzhe 2019). English still has a powerful position within the linguistic habitus and linguistic hierarchies (Seti, Bornman & Alvarez-Mosquer 2015), particularly in the domain of science and technology amongst the twelve (12) official languages of South Africa, with a rich terminology. The status of other languages can be elevated with the assistance of English through the processes such as terminology development and translation. The new terms can be developed from a developed language and translating the materials using the already term banks that are already in place, in the context of South Africa that will be English, into a developing or less developed language, i.e., South Africa's indigenous languages.

A revolution in information and communication technology (ICT) is taking place in the world (Bopape 2010) in a form of robotics and coding. Moonasar and Underwood (2018) posit that people need to be more alert to ICT changes and their effect on their respective sectors. ICTs have made it easier to access information and played a pivotal role to disseminate

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OER globally. To address the issue of lack of terminology in specialised fields, Inspired towards Science Engineering and Technology (I-SET), an Engaged Flagship project of the College of Science, Engineering and Technology (CSET), in collaboration with Department of Linguistics and Modern Languages and Department of African Languages at UNISA, developed an open educational resources (OER) that aims to inspire awareness and interest in the fields of science, engineering and technology, and information science through the use of robotics in all of the South African indigenous languages. OER are teaching, learning, and research materials that are in the public domain or licensed under intellectual property licenses that allow for free use, adaption, and dissemination (UNESCO 2002). The knowledge domain of robotics is multi-disciplinary and includes the knowledge domains of engineering and programming and the development of 21st century skills. Moreover, robotics has also been used to promote the development of digital literacy skills and computational thinking, and to enhance the learning of other science domains (e.g., mathematics).

Research in the field of translation of specialised terminology is an important and urgent task, especially in South Africa, aimed at achieving adequate translations, contributing to the solution of many applied problems, and accelerating the exchange of information in the field of the latest achievements of economic science among specialists and scientists from different countries (Perkhach & Petrovych 2020). The study considers the structural and semantic features of the English robotics terminology used in I-SET Robotics workshops and presentations, as texts and ways of translating and versioning the English terminology into Sepedi, Xitsonga, isiXhosa, and Afrikaans.

The article is structured as follows: section 2 provides the problem statement. Literature review is discussed in section 3. Section 4 describes the research methodology used, section 5 presents the findings and discussions while section 6 provides the recommendations of the study. Section 7 concludes the article.

2 Problem statement

Considering the advent of robotics and coding, as the new information and communication technologies (Bopape 2010) in the education space, there is a need for the 21st century skills for learners in the context of 4IR. In the South African context, OER in indigenous languages can play a major role in advancing these skills by providing meaningful access to information, regardless of the speakers' ability to speak, understand, read, or write English fluently; these OERs foster open pedagogy (Weller 2014). The South African Department of Basic Education (DBE) is introducing the Coding and Robotics Curriculum in all South African schools and is embarking on initiatives to equip educators to teach coding and robotics in schools (Mathopo 2022). It is noted that innovative initiatives are required to meet the needs for 4IR and digital skills in developing communities (Dias, Mills-tettey & Nanayakkara 2005). In a multilingual environment like South Africa, a more coordinated approach is required to cater for the diverse language communities. However, with the call for robotics and mother tongue education, minimal attention has been paid to mother tongue robotics education in African languages.

It is important to note that the crucial importance of the use of the mother tongue and mother-tongue education for the robotics curriculum should not be underestimated and/or ignored. Robotics education is the multi-disciplinary domain consisting of the learning of the engineering fundamentals and the discovery of the programming principles and the development of 21st century skills for the learners (Gouws & Mentz 2021). The principles identified for success in the design of initiative for the advancement of robotics, education and sustainable development include participation, empowerment, sharing of resources, partnerships, sustainability, and evaluation (Dias et al. 2005). Furthermore, DBE plans to move forward with plans to incorporate mother-tongue languages at the country's schools. The importance of the mother tongue, and, more specifically, of mother-tongue education, is recognised globally. Use of the mother tongue is regarded as one of the most effective ways of acting and performing cognitively, socially, and communally (Stoop 2017; Nishanthi 2020), and it provides meaningful access to information for speakers whose competence of English is minimal or non-existence.

3 Literature review

Information access and accessibility in indigenous languages have been subject to investigation in previous years. Scholars such as Cosijin, Pirloka, Bothma and Järvelin (2002), Osborn (2006), Dia (2014) investigated aspects of access and accessibility in relation to African languages. The aspects of access involve questions of choice of language, and these in turn relate to, among other things, basic literacy issues (Osborn 2006). Similarly, Section 9 of the South African Constitution enshrines the right to access education in the official language or languages of one's choice. The use of the English language in African multilingual context has been identified as one of the factors that restrict the accessibility of scientific knowledge (Dia 2014); this is what has relegated African languages to the periphery of the information society (Osborn 2006). However, the advent of 4IR, specifically robotics and coding offer an opportunity for African languages to contest the information space.

There is a growing literature concerning robotics and coding. For many years, this phenomenon was surprisingly not popular in the South African school discourse. Mondada, Bonnet, Davrajh, Johal and Stopforth (2016) posit that the economic factor played a more central role for robotics and coding not to be brought to schools. There has been little incentive to initiate efforts for African languages even where funded initiatives would be more favorably inclined to multilingual ICT (Osborn 2006). However, South Africa generally has some pockets of excellence to drive the education sector into the 4IR, which has the potential to increase education access (Mhlanga & Moloi 2020). Recently, major advances in intelligent autonomous systems (IAS) and educational robotics have been made. Scholars have explored the use of speech recognition technology for indigenous language speakers to facilitate access and accessibility. Though not much work has been done with regards to South African indigenous languages in this part of technology (Mokgonyane, Sefara, Modipa, Mogale, Manamela & Manamela 2019), research in the field of speaker recognition has now spanned over five decades and has shown fruitful results. There have been developments of an automatic speaker recognition system that incorporates classification and recognition of Sepedi home language speakers (Mokgonyane et al. 2019). Furthermore, several studies, to date, have interrogated robotics as a phenomenon and its educational efforts in South Africa. Several authors argue that robotics in schools may be a promising new tool to address the creativity crisis (Mondada et al. 2016; Govender 2021). The introduction of robotics and coding in schools will enhance the ability to generate unique and useful ideas in learners as a crucial challenge for 21st-century problem solving. According to Mondada et al. (2016), this very broad nature of abilities include communication, strategy, planning, coordination, understanding, and programming.

Learning with educational robotics provides learners with opportunities to stop, question, and think deeply about technology. When designing, constructing, programming, and documenting autonomous robots, learners not only learn how technology works, but they also apply the skills and content knowledge learned in school in a meaningful and exciting way (Eguchi 2014). When the students learn how to programme robots in their indigenous languages it becomes more interesting and educational to use digital techniques, and it provides easy access to the education content. The introduction of tablets, personal computers, and apps, together with learning and classroom management systems, has become a favored pedagogical tool (Govender 2021). However, the introduction of these innovative fancy modes of teaching and learning are foreign in the indigenous languages space. Currently, only English and Afrikaans are fully supported through the use digital techniques (Makgopa 2022). The advantages of such innovation can only be realized when students are adept at using digital tools, and when educators integrate the tools meaningfully into their pedagogy (Govender 2021). Robotics has mostly been associated with the field of science, technology, engineering, and mathematics, of which there is still a gap in the indigenous languages space. Existing research in indigenous languages have not played a significant role in using educational robotics to foster creativity. However, studies on 4IR and indigenous languages have been gaining momentum (Mokgonyane et al. 2019; Makgopa 2022).

Public attitude towards new intelligent technologies is generally positive. The advent of 4IR present an opportunity for transformation with the intention of salvaging indigenous languages (Makgopa 2022). However, there is still a myth that indigenous languages are incapable of being incorporated in the technological space and providing access to scientific knowledge. If the 4IR is to be considered as a true reality, indigenous languages should be provided with space and supported with digitization and digital humanities resources (Makgopa 2022). In the social structure that are becoming more and more complicated by technological innovations such as robotics, language remains the primary tool to facilitate communication since there is an intersection between African languages and information communication technologies (Dia 2014). In the context where indigenous languages are still lagging as compared to western languages, it is crucial to use every tool possible to create space for indigenous languages in the technological arena. One of the tools that can be used to position indigenous languages in the information science space is translation. Through translation, resources such as robotics glossaries or terminology lists and dictionaries can be made available and accessible in indigenous languages.

The application of translation in robotics involves identifying the specific robotics data categories which are to be included in the glossaries or dictionaries and store the relevant terminological information in a predefined format. Since indigenous languages are yet to develop and they are still faced by a lack of technical terms, translators are forced to create their own working terms whilst in the process of translating (Sageder 2010). However, the determination of terminology collection and the format to systematize the information require a coordinated approach. Muñoz (2012:82) argues that “despite the fact that most of the available terminological resources do not fulfil translators’ requirements, there are different applications and resources which are aimed at translators or, at least, can be considered as somehow translation-oriented which have been developed in the last few years.” Authors in the field of linguistics are coming up with strategies and approaches of standardizing terminologies of previously disadvantaged languages. The aim is to make communication easier, better, and quicker. This was done in response to the need for indigenous language speakers’ participation in different arenas or spheres of life such robotics.

Developments in industrial revolutions, of late 4IR, continue to have a considerable impact on the translation services sector, thus, increasing the demand for translation services for effective access to information to enable them to fully exercise and protect all of their rights, as articulated by the Promotion of Access to Information Act (PAIA), 2000 (Act No. 2 of 2000). For translators to be able to apply terminological methodology to the translation process, Muñoz (2012) asserts that they need to possess a number of competencies such as translating, research, technical, cultural, linguistic and textual competence. The competencies involve knowing which translation approach is suitable for a specific terminology project. This entails situating the text within the target culture system, looking at its significance or acceptability and determining its accessibility. The present study falls within the scope of Cultural Translation Studies (CTS) strand of research, as it seeks to investigate the translation of specific items into various target culture. Part of its aim is to determine access and accessibility of robotics information in indigenous languages.

4 Research methodology

In examining the translation of the contextual English robotics terms into indigenous languages, the study adopted a qualitative descriptive approach (Kim, Sefcik & Bradway 2017). In this study, a case study design (Heale & Twycross 2018) was adopted to allow a deeper insight into the Learning to Speak Robotics Indigenously translation project as a case. Purposive sampling (Patton 2015) was used to identify fifty-nine robotics words that refer to the components that are used to build the robot (e.g., wheel, axle, sensor, beam) and to the technology and engineering fundamentals that are applied (e.g., friction, traction, meshing, engineering design process). Given that robotics is considered a domain of specialized concepts, a combination of images and words were used in the translation process (Faber, Araúz, Velasco & Reimerink 2007). Documents were used as a data collection tools since they represent data which is thoughtful in that authors have attention to compiling them; they are also an unobtrusive source of information (Creswell, 2009).

The first stage of the data collection process required the collaboration of linguistic experts and members of the I-SET Robotics team (subject experts) in a systematic approach to the translation of the robotics parts and activities (Benítez, Linares & Expósito 2005). The synthesis of a translation-based terminology (Muñoz 2012) and frame-based process (Benítez et al. 2005) were applied during the translation. The collected data were translated from English into Sepedi, Xitsonga, isiXhosa, and Afrikaans. Secondly, a purposive collection of robotics terms from these languages and pictures of the components were presented to the members of the I-SET Robotics community. The translated term from any of the other official languages had to be accepted by participants during I-SET Robotics Workshops for it to be included in the OER glossary.

5 Findings and discussions

In reviewing the literature, limited data was found on the use of indigenous languages to develop OER for robotics terminology in South Africa. Furthermore, the use of indigenous languages to promote access to scientific knowledge is limited. However, there are some pockets of excellence in as far as indigenous language and technology is concerned (Mokgonyane et al. 2019; Mhlanga & Moloi 2020; Makgopa 2022). Given that robotics is a domain of complex terminology and specialized concepts, a combination of images and words were used in the translation process (Benítez et al. 2007). The findings of the study are presented and discussed below.

5.1 Robotics terminology development process

5.1.1 Translation method in terminography

Term development, as a complex subject, and in most cases, presents different types of challenges to language practitioners. With the resourceful list of methods that provide solution to the problems in their hands, there is usually a motive to choose a certain strategy. Furthermore, there is no single method which can be said to be the correct one. There are factors that dictate the method to be used. According to Chimhundu (1996), terminology development is a two phased process: decoding and encoding phase. This includes two major processes, scanning and balancing. The language practitioner constantly scans the source language and culture as he searches or attempts to create the target language equivalent; also tries to strike a balance between meaning and form throughout the term-creating process (Mheta & Muhwati 2009). In essence, there should be a continuous in-and-out movement from the culture-specific source text, language and culture into the culture-specific target text, language, and culture (Mambambo 2011). The scanning and balancing acts are done in six main stages of terminology creation. These stages are (1) source language (SL) term, (2) general understanding, (3) interpretation/analysis, (4) general understanding, (5) interpretation/analysis, and (6) translated language (TL) term (Mheta & Muhwati 2009).

During the decoding phase (stage 1-3), the language practitioner searches and decodes everything related to the source language term. In the context of the source language culture, (1) the language practitioner is confronted with source language term; (2) he tries to find the general meaning of term; then (3) begins to register more information about the source language term, i.e., synonyms, antonyms, gender, case, number, tense, aspect, and mood. According to (Mheta & Muhwati 2009), it should be noted that the most crucial analysis of the source language term is done during stage (3).

Stages (4) and (5) constitute the encoding phase taking place in the target language culture. It is in this phase where a balance between meaning (SL) and form (TL) is maintained. During stage (4), the language practitioner explores general ideas of the options existing in the target language for the source language term. The options include (a) selecting an existing target language term closely related to the source language term, or (b) opting for a strategy that can be used to create a term in the case of zero-equivalence. The choice of a particular method depends on the relationship between SL and TL in as far as the term in question is concerned. It is important to note that if a method works in solving problem A, it does not necessarily mean that it will do the same in solving problem B. The practitioner can opt for semantic transfer (Finegan 2008), new word form (Finegan 2008) or paraphrasing (Cabré 1999). In essence, the term carries contextual guidance.

In stage (5), the practitioner creates or reconstructs the concept of the source language through a selected strategy. The output appears in stage (6). It is important to note that during this process one can move in and out of both languages where permissible. The basic rule is that the term-creator should understand his role as that of constantly moving in and out of the source language (SL) and target language (TL) to find or create equivalent terms and then match or balance these in terms of meaning and form (Mheta & Muhwati 2009). The process may be diagrammatically represented as follows:

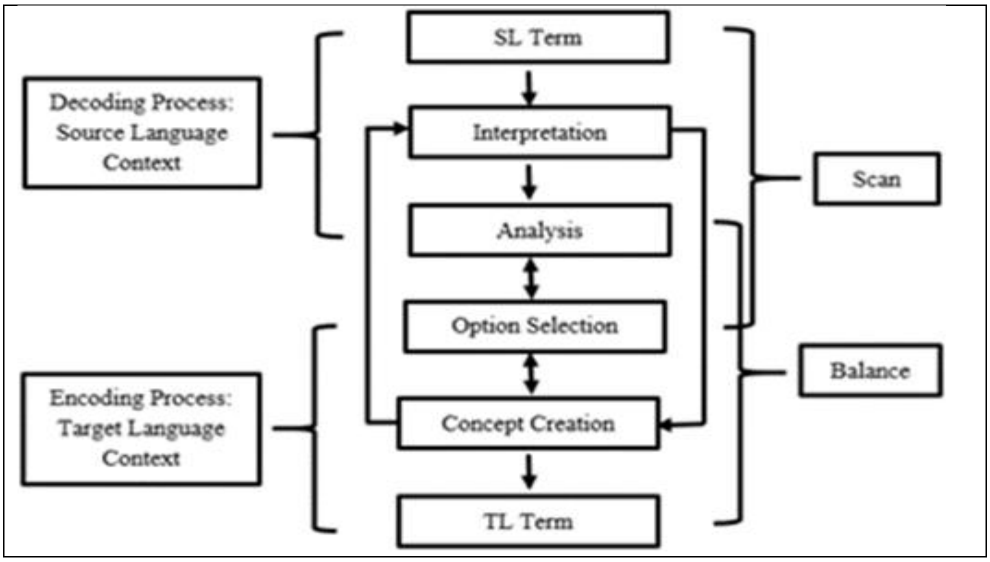

Figure 1: Scans and Balance of Translation Process

According to (Chimhundu 1996), all problems in translation are ultimately reducible to the cultural factor. As such the scan and balance theory can assist the practitioner to find user-friendly equivalents.

In the Sepedi case for example, the language practitioner when confronted with ‘buttons’ as the SL term at stage (1). At stage (2), he searches for the general meaning of the term ‘buttons’ which he decodes as small devices on a piece of electronic equipment which is pressed to operate it. Moreover, as he continues searching for the meaning of the SL term, he begins to register more information about the term at stage (3). Such information may include other lexical items related to the term such as knob sewn onto a garment. In essence, he scans the source language to find anything related to the term. As a result, he finds that ‘button’ in robotics is related to electronics. At stage (4), he starts to scan the target language guided by the source language information obtained in stage (3). In the scanning process, he finds that the English term ‘button’ has no equivalent in Sepedi. During this stage he tries to find an equivalent in the target language; if there is no equivalent, he explores different strategies to help him with term creation. Then proceeds to stage (5) where he recreates the concept of button through a transliterated equivalent, dikonope, which is the output that appears at stage (6). The meaning intended by the lexical item ‘buttons’ at stage (1) is the same meaning signified by the output dikonope at stage (6).

5.1.2 Translated robotics terminology

The table below presents the educational robotics terminology developed through the Unisa I-SET robotics project in collaboration with the Department of Linguistics and Modern Languages, and the Department of African Languages. This project show that there are some pockets of excellence to drive the education sector into the 4IR, which has the potential to increase education access (Mhlanga & Moloi 2020). The project developed this terminology list as an open educational resource to foster easy access.

Table 1: Translated Terms for Robotics

English	Afrikaans	Sepedi	Xitsonga	isiXhosa
axle	as	mokerenke	mphiselo	intonga-ntsimbi
beam	balk	tlhomešo	nseve	umqadi
buttons	knoppies	dikonope	tikunupu	amaqhosha
colour sensor	kleursensor	sensammala/ sekwammala	sensara ya muhlovo	isiva-mbala
gear	rat	kere	gere	igiya
motor	motor	mmotho	motoro	injini
touch sensor	raak sensor	sekgwathwo	sensara yo khoma	isiva-kuchukumisa
ultra-sonic sensor	ultra-soniese sensor	sensakelo	sensara ya mpfhuka	isiva-sandi esigqithisileyoe
wire	draad	motato	ntambhu	ucingo
wheel	wiel	leotwana	vhilwa	ivili

This study set out to examine the translation methodology used in translating the I-SET robotics terminology from English into Sepedi, Xitsonga, and isiXhosa. The terminology for South African's indigenous languages should be created using appropriate methods so that the speakers of those languages can use the terminology that belongs to them for an international technical source language when they communicate (Ngobeni 2013). From the data gathered, there is no specific strategy that can be used across the board to develop terminology for robotics. Consistent with the literature, this study found that the choice of the strategy is dependent on the type of term in question. The kind of word to be developed is a guide on how to approach the task as it carries the contextual guidance.

What can clearly be seen in the table above is that some terms across the three languages were translated through the same strategy though they had to conform to the orthography rules of respective languages, e.g., kere, gere, igiya. On the other hand, the Sepedi term leotwana and the isiXhosa term ivili were developed using different translation strategies. What is interesting is that two languages can use the same strategy and the other language employ its own strategy. This is evident in the equivalents of the English terms wheel and motor. Sepedi and Xitsonga used the same strategy for the motor equivalents, while in the wheel equivalents it was Xitsonga and isiXhosa that used the same strategy. In the colour sensor equivalents, Sepedi and isiXhosa used the same strategy.

The striking observation is that in other languages, terms were translated from Afrikaans instead of English. The Sepedi term mmotho derives from English motor while Xitsonga term motoro derives from Afrikaans motor. Similarly, while the equivalents of the term gear derive from English, the Sepedi and Xitsonga equivalents for the term buttons actually derive from the Afrikaans term knoppies. It also stands out that Sepedi has two options for the equivalent for colour sensor. The first option sensammala follows the same structure as the equivalent for ultra-sonic sensor which is sensakelo. Both the equivalents derive from English. However, it is notable that the second equivalent for colour sensor comes from the same strategy employed in isiXhosa. The Sepedi equivalent sekwammala and isiXhosa one isiva-mbala are structurally the same. Therefore, the Sepedi equivalent might have been influenced by isiXhosa or vice versa.

5.2 Strategies of robotics terminology development

It was determined in the section above that different problems will require different solutions or approaches. In translation-informed terminology development, language practitioners are spoilt for choice with strategies available for term creation. There are situations where developers will find themselves having to make choices on which strategy can best suit the problem on hand. The selected strategy must be able to deliver user-friendly target language words. It is argued that the South African language practitioners' mission should be informed all the times about the important terminology and emerging developments in robotics so that mother tongue equivalents can be made readily available for communicating to the vast number of new concepts that are to be mastered in order to develop indigenous languages (Malele 2021.). For terms to be user friendly, developers need to pay careful consideration to the choices that they make and be able to apply the necessary skills when coining terms. This will result in meaningful and usable equivalents.

The data reveal that some terms are developed through borrowing as a method of term development. Sepedi, Xitsonga, and isiXhosa borrow from English and Afrikaans since the latter two languages are the underdeveloped languages in South Africa. Borrowing is opted for most of the time because it is a quick method of solving the problem of lack of terminology. However, the borrowed word must follow the rules of the target language such as phonological and morphological rules.

The source language plays a crucial role in the development of the target language terminology. The borrowed words must retain the stem of the original term but will conform to the consonant-vowel pattern of the target language. For example:

motor (English) > mmotho (Sepedi)
motor (Afrikaans) > motoro (Xitsonga)
wiel (Afrikaans) > ivili (isiXhosa)

In English the term ‘motor’ is formally pronounced as /ˈməʊtə/, which has two syllable mo-tor. In Sepedi the word has the ‘mm’ sound at the beginning because the first syllable ‘mo’ in the English term is stressed. This allows the Sepedi equivalent to follow one of the canonical syllables CCV-CV. The Xitsonga equivalent follows the rule consonant-vowel consonant-vowel or CV-CV. The isiXhosa example is written based on the pronunciation of the Afrikaans term. The Afrikaans term wiel is pronounced with a ’v’ not ‘w’. Hence ivili in isiXhosa and not * iwili.

Unlike other methods of term development, borrowing is a favoured method because of its quick nature of solving the problem of zero equivalence. However, this is not the encouraged first choice method in the development of terminology because the source language grows into the target language; the less developed language starts sounding more foreign. When borrowing is resorted as the first-choice method, an opportunity to use strategies which can be used to coin new words is missed. There are other strategies that can be first resort such as compounding, semantic transfer and derivation. Take the following example for instance:

touch sensor (English) > sekgwathwo (Sepedi)

With respect to the term ‘touch sensor’ borrowing is not an option. A term is created based on the way this garget is used. This garget is a type of device that captures and records physical touch. The equivalent of the word touch in Sepedi is ‘kgwatha’. Touch sensor is a term which requires the process of derivation to obtain its Sepedi equivalent. Therefore, because of how it is used, it gets a Sepedi term. The process of derivation happens as follows:

touch (English)> kgwatha (Sepedi) (verb)

The word sensor refers to a thing, in Sepedi a thing is ‘selo’ and things usually fall in the noun class that has the prefix ‘se-‘. Since the sensor receives the action of being touched then it takes the passive suffix -w-; therefore;

touch sensor (English) > sekgwathwo (Sepedi) (noun)

Sometimes when a new concept appears in the target language, it finds that already there is a similar concept used in the target language. Therefore, a new word cannot be coined to accommodate the new concept, but the meaning of the new concept is transferred to the existing word in the target language. Semantic transfer is when a word from the general vocabulary acquires a more technical meaning (Gauton, Taljard & De Schryver 2003). This is the case with the robotics term button – a knob on a piece of electronic garget which is pressed to operate it. In English, a button is also a knob on a clothing used to fasten it or for decoration. In the three indigenous languages, Sepedi, Xitsonga and isiXhosa, words that refer to a knob on a clothing already existed; to follow the same strategy employed in English, the robotics concept was transferred to the existing words, i.e. dikonope, tikunupu and amaqhosha. However, this new meaning does not replace the earlier one but extends the range of application of the word. In this way, the words become polysemous. In this strategy (semantic transfer), the common word extends its general meaning and embraces a new concept which it did not refer to before (Sager 1990). Thus, general words acquire new additional meanings, that is, special meanings in specialised subject fields.

Some of the words in the table above were created by combining words that already existed in the languages. This strategy is called compounding – a word formation process of creating new words by putting existing words together (Finegan 2008). The evidence of this can be seen in the Sepedi and isiXhosa equivalents of colour sensor, i.e., sekwammala and isiva-mbala respectively. The equivalents show that compounds are not only formed by joining only words, but any grammatical categories can be used.

Categories	**combinations**	**equivalent**
noun class 1 prefix + verb + noun	se- + kwa + mmala	colour sensor
noun class 7 prefix + verb + noun	isi- + va + mbala	colour sensor

These examples were created through a combination of noun class prefix, a verb and a noun as illustrated above. In the Sepedi example, se- is a noun prefix, kwa is a base form of a verb which is equivalent to sense in English, then mmala is a noun equivalent to colour. Similarly, isi- is an isiXhosa noun prefix, va is a base form of a verb, and mbala is a noun.

The strategies discussed above were used to develop a multilingual digital open educational resource. This OER is freely accessible with an open license that allows users to adapt it to suit their learning needs. It can also equip educators with indigenous language terminologies to facilitate the teaching of robotics in the languages of the learners.

6 Recommendations

The knowledge domain of robotics is multi-disciplinary and includes the knowledge domains of engineering and programming and the development of 21st century skills. In a multilingual country like South Africa, resources need be made available in various languages to equip the populace. As the South African Department of Basic Education (DBE) prepares to introduce the Coding and Robotics Curriculum in all South African schools, it important to ensure access for all learners from various speech communities and socio-economic context. There should also be initiatives to equip educators to teach coding and robotics in schools. Open Educational Resources are one of the initiatives that can be used to ensure equal access to coding and robotics content. One such resources which was used as a case of this study can be freely accessed from this link: https://uir.unisa.ac.za/handle/10500/28361.

7 Conclusion

The study was designed to examine the translation techniques used in translating terms in context, and to evaluate the adequacy of the translation equivalents for better access to robotics information through indigenous languages. It highlights strategies used in developing robotics terminology for indigenous languages to enable speakers to access to information to enable them to fully exercise and protect all of their right to receive educational content in the official language of their choice. The evidence shows that there is no specific strategy that can be used across the board to develop terminology for robotics if accessibility is the goal. It notes that some terms across the indigenous languages are translated through the same strategy though they must conform to the orthography rules of respective languages. What was interesting is that two indigenous languages could use the same strategy to develop equivalents for one target language term while the other language employ its own strategy for the same target language term. The striking observation was that in other languages, terms were translated from Afrikaans instead of English. It was also observed that indigenous languages can also influence each other but the cases are rare. There is a need for the use of indigenous languages in science related field such as robotics to facilitate access of native speakers to scientific knowledge in the mother tongue.

References

Benítez, P.F., Linares, C.M. and Vega Expósito, M.V. 2005. Framing Terminology: A Process-Oriented Approach. *Meta*, 50(4). [online] https://doi.org/10.7202/019916ar (13 January 2006).

Beukes, A.M. 2014. ‘Challenges for South Africa’s Medium-Sized Indigenous Languages in Higher Education and Research Environments’. In Vila, F and Bretxa, V. (eds) *Language Policy in Higher Education and Research Environments: The Case of Medium-Sized Languages*. Bristol: Multilingual Matters: 132-152.

Bopape, S. 2010. Utilisation of information technology to support information and knowledge management by lawyers in Polokwane City. *South African Journal of Libraries and Information Science*, 76(2): 129-140.

Cabré, M. 1999. *Terminology: Theory, Methods and Applications*. Amsterdam: John Benjamin.

Chimhundu, H. 1996. Translation in African LLDs and communication for development. *Proceedings of the XIV World Congress of the Federation Internatile des Traducteaurs (FIT).* 9-16 February 1996. Melbourne: International Federation of Translators. 448-459.

Cooper, R. 1989. *Language Planning and Social Change*. Cambridge: Cambridge University Press.

Cosijn, E., Pirkola, A., Bothma, T. and Järvelin, K. 2002. Information access in indigenous languages: a case study in Zulu. In: Bruce, H & Fidel, R. & Ingwersen, P. & Vakkari, P. (eds.), Emerging Frameworks and Methods. *Proceedings of the fourth International Conference on Conceptions of Library and Information Science* (CoLIS 4), July 21-25, 2002, Seattle, USA. 221-238.

Crystal, D. 1991. *A Dictionary of Linguistics and Phonetics*. Cambridge: Basil.

Dia, I.M. 2014. African languages, and ICT and development. *International Journal of the Sociology of Language*, 225: 113-130.

Dias, M.B., Mills-tettey, G.A and Nanayakkara, T. 2005. Robotics, Education, and Sustainable Development. *Proceedings of the 2005 IEEE International Conference on Robotics and Automation*. 18-22 April 2005. Barcelona. 4248-4253.

Eguchi, A. 2014. Educational Robotics for promoting 21st century skills. *Journal of Automation, Mobile Robotics & Intelligent Systems,* 8(1): 5-11.

Faber, P., Araúz, P.L., Velasco, J.A.P. and Reimerink, A. 2007. Linking images and words: The description of specialized concepts. *International Journal of Lexicography*, 20(1): 39-65. [online] https://academic.oup.com/ijl/article/20/1/39/931641?login=true (12 December 2006).

Finegan, E. 2008. *Language: Its Structure and Use*. 5th ed. Boston: Thomson Wadsworth.

Fromkin, V., Rodman, R. and Hyams, N. 2011. *An introduction to language*. 9th ed. Australia: Wadsworth.

Gauton, R., Taljard, E. and De Schryver, G. 2003. Towards strategies for translating terminology into all South African languages: a corpus-based approach. *6th International Terminology in Advanced Management Applications Conference*. 19-21 February 2003. Pretoria: UNISA Press. 81-88.

Gouws, P.M. and Mentz, J.C. (2021). Towards a Comprehensive Conceptual Framework for Robotics Education. In T. Bastiaens (Ed.), *Proceedings of EdMedia and Innovate Learning*. 06 July 2021. United States: Association for the Advancement of Computing in Education (AACE). 554-560.

Govender, R.G. 2021. 'Embracing the Fourth Industrial Revolution by Developing a More Relevant Educational Spectrum'. In Naidoo, J. *Teaching and Learning in the 21st Century: Embracing the Fourth Industrial Revolution*. Leiden, The Netherlands: Brill. 30-49.

Haugen, E. 1966. Dialect, language, nation. *American Anthropologist*, 68(4): 922-935.

Heale, R. and Twycross, A. 2018. What is a case study? *Evidence-Based Nursing*, 21(1): 7-8

Kim, H., Sefcik J.S. and Bradway, C. 2017. Characteristics of Qualitative Descriptive Studies: A Systematic Review. *Res Nurs Health*, 40(1): 23-42.

Madadzhe, R. 2019. Using African Languages at Universities in South Africa: The Struggle Continues. *Stellenbosch Papers in Linguistics Plus (SPiL Plus*), 58: 205-218.

Makgopa, M. 2022. 'Implications of the Fourth Industrial Revolution (4IR) on the Development of Indigenous Languages of South Africa: Challenges and Opportunities'. In Tshifhumulo, R and Makhanikhe, T. J. (eds). *Handbook of Research on Protecting and Managing Global Indigenous Knowledge*. IGI Global: Hershy, PA. 152-161.

Malele, N.J. 2021. The use of corpora in the compilation of a specialised English-isiNdebele glossary of medical terms. Ph.D. Thesis. Pretoria, University of South Africa.

Mambambo, J. 2011. Untranslatability is a Myth. *The Dyke*, 5: 150-169.

Mathopo, M. 2022. Coding, robotics curriculum resumes at SA schools. *Emerging Technologies*. [online] https://www.itweb.co.za/content/8OKdWMDXN95MbznQ (27 May 2022).

Mheta, G. and Muhwati, I. 2009. The Use of Loan Translation as a term-creation strategy in Duramazwi reMimhanzi. *Lexikos*, 19: 150-156.

Mhlanga, D. and Moloi, T. 2020. COVID-19 and the Digital Transformation of Education: What Are We Learning on 4IR in South Africa? *Education Sciences*, 10(7): 180. [online] https://doi.org/10.3390/educsci10070180 (9 July 2020).

Mokgonyane, T.B., Sefara, T.J., Modipa, T.I., Mogale, M.M., Manamela, M.J. and Manamela, P.J. 2019. Automatic Speaker Recognition System based on Machine Learning Algorithms. *Southern African Universities Power Engineering Conference/Robotics and Mechatronics/Pattern Recognition Association of South Africa* (SAUPEC/RobMech/PRASA). 28-30 January 2019. Bloemfontein: Institute of Electrical and Electronics Engineers. 141-146.

Mona, B. 2018. *In Other Words: A Coursebook on Translation.* 3rd ed. London: Routledge.

Mondada, F., Bonnet, E., Davrajh, S, Johal, W. and Stopforth, R. 2016. R2T2: Robotics to integrate educational efforts in South Africa and Europe. *International Journal of Advanced Robotic Systems*, 1-13. [Online] https://doi.org/10.1177%2F1729881416658165 (16 October 2016).

Moonasar, A. and Underwood, P.G. 2018. Continuing Professional Development opportunities in Information and Communication Technology for academic librarians at the Durban University of Technology. *South African Journal of Libraries and Information Science*, 84(1): 47-55.

Muñoz, I.D. 2012. Meeting translators' needs: translation-oriented terminological management and applications. *The Journal of Specialised Translation*, 18: 77-92.

Ngobeni, M. 2013. An analysis of zero equivalence in the translation of scientific terms from English into Northern Sotho. Mankweng, University of Limpopo.

Nishanthi, R. 2020. Understanding of the importance of mother tongue learning. *International Journal of Trend in Scientific Research and Development,* 5(1): 77-80.

Nwammuo, A. and Salawa, A. 2018. Media Roles in Disseminating Strategies for Teaching and Learning Indigenous Languages: The Case of South Africa's language-in-education policy in post-apartheid era. *Cogent Arts and Humanities*, 5(1). [online] https://www.tandfonline.com/doi/full/10.1080/23311983.2018.1553653 (8 December 2018).

Osborn, D.Z. 2006. African Languages and Information and Communication Technologies: Literacy, Access, and the Future. *Selected Proceedings of the 35th Annual Conference on African Linguistics.* 2-4 April 2004. Somerville, MA: Cascadilla Proceedings Project. 86-93.

Patton, M.Q. 2015. *Qualitative Evaluation and Research Methods*. Thousand Oaks, CA: Sage.

Perkhach, R. and Petrovych, I. 2020. Abbreviations in Modern Linguistic Studies. *Proceedings of the 18th Scientific and Practical Conference - Modern Science, Practice, Society.* 25-26 May 2020. Boston: International Science Group. 140-141.

Rosa, A. 2010. 'Descriptive Translation Studies (DTS)'. In Gambier, Y. and Van Doorslaer, L. (eds) *Handbook of Translation Studies.* Amsterdam: John Benjamins. 94-104.

Sageder, D. 2010. Terminology Today: A Science, an Art or a Practice? Some Aspects on Terminology and Its Development. *Brno Studies in English*, 36(1): 123-134.

Sager, J. 1990. *A Practical Course in Terminology Processing*. Amsterdam: John Benjamin.

Seti, V., Bornman, E. and Alvarez-Mosquer, P. 2015 Opinions on Indigenous Languages as Languages of Learning and Teaching in Africa. *International Journal of Communication and Linguistic Studies*, 14(1): 17-31.

Stoop, C. 2017. Children's Rights to Mother-Tongue Education in a Multilingual World: A Comparative Analysis between South Africa and Germany. *Potchefstroom Electronic Law Journal*, 20(1). [Online] https://doi.org/10.17159/1727-3781/2017/v20i0a820 (11 May 2017).

UNESCO, 2002, 'Forum on the impact of open courseware for higher education in developing countries: Final report', United Nations Educational, Scientific and Cultural Organization, Paris.

Weller, M. 2014. *Battle for Open: How openness won and why it doesn't feel like victory*. London: Ubiquity Press.