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'iBiotegnologie': A multilingual pedagogy to promote Biotechnology concept engagement and academic literacy in a linguistically-diverse university context

Background and Aim

All higher education institutions in South Africa have adopted language policies that seek to promote and develop indigenous languages (the choice of language regionally-determined) into academic languages of instruction. This is in response to the call for transformation in education in democratic South Africa, through guidelines laid out by numerous Ministerial Policy Documents. Importantly, a key value that guides the latest of these, the 2017 Draft Language Policy for Higher Education, is that multilingualism should not be considered an impediment to teaching and learning, but rather as a resource to 'facilitate cognitive development, epistemic access, inclusiveness, transformation, social cohesion and respect for all languages'. It is upon this ideal that the present research project was based. The pedagogy presented here goes beyond terminology translation, evident in multilingual glossaries, which have been criticised as being particularly insufficient for the sciences (Mesthrie 2008), since a mere translation of terminology does not explore the deeper meanings of scientific concepts (Madiba 2010).

The fact that global scientific knowledge is presented in English remains a primary consideration. To this end, the aim of this project was to evaluate a mechanism that harnesses existing linguistic resources, that uses this to enhance epistemological access to scientific knowledge, simultaneously assists in the construction and development of English literacy skills (Figure 1), towards scientific and academic proficiency. A similar, but more elaborate scheme was presented by Setati (2002) for mathematics education. The present pedagogy, which allows for broader linguistic applicability, is likely to better support student learning, by providing practical and long-lasting opportunities for students to create meaning, navigate and progress through the Biotechnology curriculum.

The pedagogical process captured in Figure 1 expounds on the values of the South African Language Policy, in that multilingualism is seen as 'capital', which, through guided transformation, can be converted to cognitive capital, and into academic capital. The model encourages multi-modal learning, through the engagement of different learning pathways, and grants agency to students to create scientific meaning.

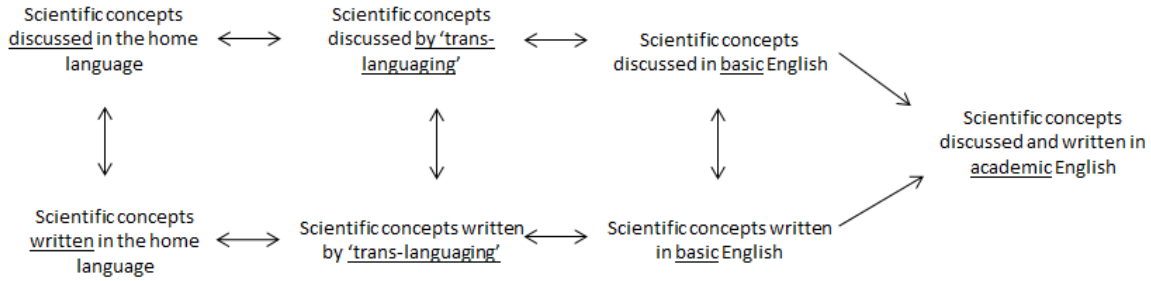

Figure 1: Using the home language to enhance epistemological access, and subsequently develop scientific and academic literacy

METHODS

The research was undertaken during the first semester (February to June) of 2018, in a level 2, Diploma in Biotechnology program at CPUT, in the subject 'Microbiology 2A', which typically enrols 60 students in a semester. The subject content builds upon basic Microbiology from level 1, and covers areas such as bacterial identification using various biochemical approaches, bacterial taxonomy and classification, bacterial metabolism, and some important metabolic genes in bacteria.

The study was designed to take a qualitative, action research approach, drawing on data from assessments, student reflections and focus group discussions. Students were introduced to a usually complex threshold concept in Biotechnology. The practice required students to distribute themselves into the major language groups present in the classroom. The cohort represented various home language groups, which were, in order of largest to smallest: isiXhosa, Afrikaans, Sepedi, isiZulu, French, Setswana, English, Portuguese, and isiNdebele. They were to: **A) Stage 1**: engage with and discuss the concept in the home language amongst their peers (using trans-languaging and/or code-switching), **B) Stage 2**: write down their understanding of the presented concepts, leaving aside the demands of academic and scientific literacy, and in the home language if necessary, and **C) Stage 3**: build upon their conceptual understanding and the written narrative from Stage 2, to enhance their understanding by transferring those concepts into academic English. This pedagogy follows the model outlined in Figure 1. It describes one way to implement the pedagogy, potentially allowing for the deep cognitive development of threshold concepts first, in whatever language or semiotic form that may be dominant in the students' minds. Once the assignments were completed, and after feedback was given on their group understanding, focus group discussions were held.

OUTCOMES

Stage 1: Group discussions

A salient feature of the group discussion recordings was the conversational manner used to engage with the concepts. Through this process of peer-led learning, students create meaning of the concept, correct each other, and arrive at a common understanding of what the scientific concept means. Here is an excerpt of a typical conversation that occurred in an isiXhosa-speaking group, recorded by the students and then transcribed:

Student 1: So ke ngoku after ufake la antigen neh uzofaka iantibody, iantibody er.. er.. iantibody e se yenziwe yabona and then kengoku to.. izaw.. izaw..lo. loo antibody izobinder to that specific antigen and then izosibonisa xana siadde Ienzyme uba when there is a colour change then sizobona ukuba ok kukho enzyme, I mean, kukho (interjection by student 3: antibody) iantigen ethile apha.
Student 2: Oh..
Student 3: Oh… So ezi antibodies zenzwa ecaleni?
Student 1: Eh….eh, antibodies zee..se..sezenziwe zona. Then thina kula antigen siyifumeneyo siye sithathe iantibody le thina sinayo to determine uba yeyiphi antigen i..ipha cause asiyazi uba yintoni la antigen.

Stages 2 and 3: From conceptual to academically-appropriate English understanding

As mentioned above, the teacher or researcher is not required to understand all of the languages represented in the classroom. Through peer-led learning, groups of students construct meaning for themselves. By writing their understanding of the concept, in a trans-language manner, and through reciprocal confirmation, the actual scientific meaning of the concept is built. The value of this approach is evident in the accurate interpretation of the concept as it is eventually presented in scientific and academic English, in Stage 3. The example that follows is an excerpt taken from a Sesotho-speaking group of students:

Stage 2: "DNA ke molekhule ho boloka genetic information ho di species a le nakong. E nale di arrangements tsadi chemicals tsebitswang di nucleotides tse bontshang kapo tsebitswang (A,T, C le G). Di arrangements tsena dirijwetsa hore di organism ledi organism tse ding dinale code kepo tsela eo disebedisang code kateng hade sebedisi code elengwe engwe le engwe organism inali yayona."

Stage 3: "DNA is a molecule responsible for preserving genetic information across species and across time. It consists of a meaningful arrangement of nucleotides that are symbolised by A, T, C, and G. Those arrangements tell a story of each organism or individual in that the code they produce represents a detailed instruction book for that particular organism or individual."

The extent of trans-languaging differed among groups, but it was evident that students weren't translating directly from the home language to English. Instead, the knowledge is being *transferred* and *developed* from Stage 1, re-represented and reinterpreted in Stage 2, to a more complete and deeper understanding of the concept in English, in Stage 3.

Using this pedagogy, the lecturer facilitates understanding by drawing on linguistic resources already present, possibly dominant, and active in the students' minds. This resource is harnessed to engender understanding (the first cognitive step), upon which the correct scientific and academic language is built, in the subsequent communicative step. In this way, students are afforded the agency to develop deep understanding, but guided by prescribed material.

Selected feedback from focus group discussions*(*Texts in italics are those of students, transcribed verbatim)

The focus group discussions covered a broad range of themes, only a few of which are presented here. Students were aware of the dominance of English in the Biotechnology curriculum, but did not necessarily oppose this: "*I think it's beneficial in English because we study Biotechnology, so we're going to have to go to other countries and we won't be able to speak our own languages. So English as the medium of instruction I think is ok. It's alright*". Another student added "*I think English is ok because of, if I was to do a research and then I write it in my own language, will the next generation know what I've written? Maybe from China, they will not understand it and my research won't be public…"* .

Whilst students agreed that English is the most viable means of scientific instruction in higher education, they raised concerns over their understanding of concepts presented in English, as one student responded "*Like English is ok but we need our home language at least for understanding*". One response was "*…when it comes to explaining, if you can find someone who can explain for you with your own language then it's*

ok". This was the idea behind grouping the students into their home languages, so that peer-led learning may guide group understanding. About this practice, one student felt "*I think that it is the best because we get to understand because if he knows it in isiXhosa and he can explain to me better than English then I can get it better. I think group discussions whereby we discuss a certain topic using our own languages, it's even better than using English because we understand better. Then it's easy for us to translate it…*". Most students were in agreement with this sentiment, echoing *"You speaking about something that you know, then when you speak it you become confident when you know something in your own language…"*. Students explained that conversational language is often quite different to the way they write. This difference guided the practice in the present work to get students to discuss a concept, orally, in a group setting, before attempting to write down their understanding.

A key advantage of this approach is that with deep conceptual understanding in the home language, students are better equipped to then present the knowledge in English, or in the wider applicability of the multilingual pedagogical model, in whatever the medium of instruction happens to be. Students explained that if they understand a concept (based on cognitive assistance in the home language), they are then able to present the concept in different ways. This phenomenon has been previously reported (Cook 1992) and its acquisition is vital: "*Yes, you can put it in a different way but think the same thing*", which is a key indicator of creative, higher order learning (Bloom 1956). Once the understanding of a concept has been realised, the next step is to transfer this knowledge such that is can be accurately represented in the medium of instruction. Students were aware that this transfer is not a simple linguistic translation, "*(This way of) doing things only helps in understanding, but when it comes to writing, 'ja', it's difficult because you have to write in English.*" However, the practice presented here encourages students to first write or present their understanding in the home language, to solidify their understanding of the concept. Once this is in place, the English is developed therefrom, and in doing this, students are again made to engage with the concepts to deepen their understanding enough to present it in English. One student explains, "*Like in my own language I write a page because I know what I am writing. But when it comes to English […] I have to try like step by step to like get it to English*".

Conclusion

A multilingual pedagogy is not the same as a simple translation from the home language into English, or vice versa. Instead, meaning and understanding is created using multiple linguistic and/or semiotic means, whichever is useful. It draws on the many linguistic tools available in a diverse classroom, cooperatively informing each other as they are presented in the minds of learners, to eventually accrete towards a common understanding of a presented concept. Meaning can be constructed in a myriad ways, and varies among disciplines. The multilingual pedagogical model presented here can therefore be tailored for a range of teaching and learning applications. In those disciplines that lend themselves to semiotic modes of developing understanding, the multilingual pedagogy model remains relevant. It grants agency to students to use whatever cultural, linguistic, or other resources they may possess, and harness these to create meaning, advance understanding, and develop a culture of deep learning.

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