

NSTF

National Science & Technology Forum



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NSTF Discussion Forum

Language and STEM education at school – policy and research

**A discussion forum led by the proSET (Professionals in science, engineering
and technology) sector to the NSTF, representing Professional Bodies and
Learned Societies**

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OPENING AND WELCOME

Ms Jansie Niehaus (Executive Director, NSTF) welcomed everyone to the discussion forum, outlined the purpose of the meeting and provided a background to the NSTF. The NSTF is a stakeholder forum representing Science Councils and Statutory Bodies, Higher Education, Business and State Owned Enterprises, Civil Society and Labour, and Professional Bodies and Learned Societies (proSET). The vision of the NSTF is a transformed country where science, engineering and technology (SET) and innovation contribute to a high quality of life for all who live in South Africa, where the profile of SET professionals is representative of the population's profile, and where the education system is effective, particularly in terms of performance in SET subjects and promoting innovation. The aims and vision of the NSTF are aligned with the goals of the National Development Plan.

The forum is led by the proSET sector of the NSTF. It will address the important area of policy and research in language, and science, technology, engineering and mathematics (STEM) education at schools and aims to provide a platform for the exchange of ideas.

The NSTF's Brilliants Programme recognises 18 students – two from each province, one girl and one boy with above 90% in mathematics and science in the National Senior Certificate examination (Grade 12). The activities of the programme include recognition during a gala dinner in the presence of the NSTF award finalists, SET professionals, VIPs and senior government officials. The students are exposed to SET-related industries and careers and a motivational speakers' forum. Bursaries are awarded to those that need them, and it is pertinent to note that at least six students each year have not been eligible for support from other sources because their lack of language proficiency has brought down their overall average. It is very important to keep in mind what proficiency in language means in recognising all the talents that exist in our country.

The intention of the discussion forum is to make suggestions to the appropriate authorities based on the policy position.

LANGUAGE POLICY FOR BASIC EDUCATION, AN OVERVIEW OF PERFORMANCE IN THE STEM SUBJECTS – MR B MONYAKI (CHIEF EDUCATION SPECIALIST, DEPARTMENT OF BASIC EDUCATION)

There is a popular misconception that those that specialise in mathematics and science are a silent group with no use for language. In fact, language is the key to decoding the complicated formulae that are essential to these subjects. It is therefore essential to protect language through policies and legal frameworks.

South Africa's official languages are well protected by legislation. In Section 6 of the South African Constitution (1996), language is one of the six founding provisions, and the Bill of Rights recognises the equality of all 11 official languages. Section 29(2) of the Bill of Rights gives everyone the right to receive education in the official language or languages of their choice in public educational institutions, where that education is *reasonably practicable*. The National Education Policy Act (No. 27 of 1996) is based on this document and provides for all students to be instructed in their language of choice. The South African Schools Act (No. 84 of 1996) provides for decisions regarding the language policy at schools to be taken by school governing bodies. The Language in Education Policy (1997) promotes multilingualism, including sign language.

The National Curriculum Statement calls for the equal use of all official languages and from this the Language Standardisation Policy was introduced in 2001. The rationale for the standardisation policy was to establish uniformity in the teaching and assessment of all 11 official languages both as home language and first additional language. An unintended consequence of the policy has been that even though English (and possibly Afrikaans) are listed along with the other nine official languages as first additional languages, in fact they are the main languages of learning and teaching (LoLT).

The National Development Plan (NDP) recommends that a learners' home language should be used as the LoLT for longer than is currently the case and that English should be introduced much earlier in the Foundation Phase. According to the National Curriculum Statement, Grade 1–12 learners should learn through their home languages, particularly in the Foundation Phase. A pilot programme is being

run in the Eastern Cape where the LoLT is isiXhosa for longer than just up to Grade 3 or 4, but the results are not yet available. The NDP also proposes a policy that every South African should study one of the nine official black languages at school, but recognises the role of English as a global language and the general language of learning, commerce and administration. The unintended consequence has been that English is still the preferred LoLT, and the only other LoLT is Afrikaans. Neither of which is the home language of the majority of learners. The Department of Basic Education has introduced the Incremental Implementation of African Languages initiative with aim of introducing African languages to schools where previously they were not available. Multilingualism is key to this initiative, enabling learners to communicate not only in Afrikaans and English, but also in at least one African language. The target for implementation is 2018; from that date every learner will be able to study an African language. The concept of code-switching to another language exists, but usually the switch will be to English.

English as the predominant LoLT is a barrier to learning for most learners since it is not their home language. Many educators lack proficiency in English. The lack of proficiency in both interpersonal and cognitive academic skills negatively affects performance in learning outcomes. Most learners struggle with the demands of higher-order language skills such as the reading, viewing and writing required by assessment tasks. Learners find examination questions difficult to understand, as well as the language structures and conventions used in setting examination papers. The standardisation of requirements and what is meant by terms such 'an essay' would assist teachers and learners. Another issue is that language teachers do not always have the specific subject knowledge to prepare learners for assessment.

Curriculum specialists and moderators of the Department of Basic Education diagnose the problems encountered by learners in Grade 12 examinations and compile a diagnostic report. The report is shared with provincial departments of education and provides input into the setting of future examinations. Some of the issues highlighted in the mathematics examination were: candidates struggled with concepts in the curriculum that required deeper conceptual understanding; questions where candidates had to interpret information or provide justification presented the greatest challenge and language could have been a barrier; candidates used inappropriate words in their reasoning; and language associated with financial questions was not well understood. The recommendations included: teachers should use correct language in the classroom and in assessment tasks; teachers should use the correct notation and mathematical language on a daily basis in the classroom; and teachers need to realise that learners' understanding of the concepts is more important than merely performing routine procedures.

The Department of Basic Education introduced the English Across the Curriculum (EAC) intervention to assist learners who face barriers to learning content subjects through the medium of a language that is not their own. The strategy of EAC is to improve the teaching of English as a subject as well as English as LoLT, and is based on the premise that every teacher is a language teacher and that basic language skills such as listening and speaking, reading and viewing, writing and presenting should also be taught in content subjects. The EAC strategy was developed in 2012–2013 and the Manual for Teaching in 2014. Digitised lessons are being developed to demonstrate how language affects learning and to ground basic concepts (e.g. the prefix 'tri' means 'three'). The aim is that learners should be able to fully participate in society, measured as access to education and the economy through equitable and meaningful access to language.

In conclusion, there is often a mismatch between the legal framework and what is actually happening in schools. Often the legal framework is not effectively employed to implement policy. Active engagement is required to strengthen mother tongue education. Language is central to teaching and learning; it enables the expression of concepts formed, and the application of concepts to create a platform across all subjects. Thus, language proficiency means proficient content acquisition.

The chairperson invited Mr Monyaki's colleague from the Department of Basic Education to share her views.

Ms Maroma Masemula

African languages have knowledge embedded in them in idioms, rituals and culture. The pre-colonial history of Africa indicates that early Africans had an understanding of metallurgy and concepts such

as 'buoyancy'. There was considerable innovation, with learning from the environment and other people. There are many different ways of learning, and education goes beyond the classroom.

For scientists, concepts draw a definitive line, but the lines are porous. Why are there so many names for the concept of removing an atom from a nucleus, for example? Should we not bridge the concepts and rewrite the curriculum to make it more easily understood by learners? The development of a classification system could provide a powerful means of engaging a new way of thinking about knowledge, especially science.

Discussion

Question: Was the main point of the presentation to highlight that even though a legal framework for multilingualism exists, in practice school bodies are choosing English as LoLT?

Response: School governing bodies have been strengthened and have the authority to make decisions regardless of what is laid down in the legal framework.

Comment: It is worrying and depressing that we are not able to take action to address these issues. We will never rid ourselves of oppression if we accept the status quo and believe that there is nothing we can do to change the situation. A multilingual dispensation already exists for Afrikaans learners, so why not for black learners? We should not have to live with unexpected consequences. We are attending this forum because we care for our country and our future; we want to influence policy to do things differently.

Response: The purpose of the presentation was to outline the current situation. We are aware of initiatives for change, for example at the universities of KwaZulu-Natal and the Free State. We need to develop this initiative among the community of parents, not through learning from abroad. We need to create awareness of the situation.

MATHEMATICS EDUCATION AND LANGUAGE DIVERSITY: FROM LANGUAGE-AS-PROBLEM TO LANGUAGE-AS-RESOURCE – PROF MAMOKGETHI PHAKENG (VICE CHANCELLOR: RESEARCH AND INTERNATIONALISATION, UNIVERSITY OF CAPE TOWN)

Language does not prevent us from doing things. It enables us to do things. Why is language important for mathematics teaching and learning? We use language to create mathematical knowledge and understanding. Learning mathematics is similar in some respects to learning a language. Mathematics teachers have the dual task of teaching mathematics and mathematics language. Language is essential at all levels of mathematical learning, but it is not the only reason for poor performance. The research is based on the need to address the uneven distribution of knowledge and success in mathematics. We cannot just accept that the problem lies with African learners.

South Africa's language policy promotes multilingualism. Research supports multilingualism and shows that it does not impede learning. In analysing research in this field over the years, prior to 1962 it was believed that multilingualism was a problem but this view changed after 1962 and it was found that it does not impede but supports learning and is an advantage to learners.

If multilingualism is an advantage, why is it not working for us? We tend to look at language just as a tool for communication and learning, but language is also political and is used to polarise, segregate and classify. Historically this is how language was used under apartheid, and language still polarises us; one is judged on how one speaks. The current status of African languages is due to social engineering, and to change this we need another social engineering project. When politics change, language policies also tend to change. We need to consider these aspects in relation to language in determining how to go forward. The political role of language is related to the way in which social goods are distributed based on how people perceive us when we speak. Given the political nature of language, the choices about which languages to use are not only pedagogic and cognitive, but also political choices.

Research shows that despite policy, in South African black schools teachers prefer to teach mathematics in English and learners prefer to be taught mathematics in English, a language that they

are still learning. Why is there an apparent disjuncture between research and practice? Research on language and learning is framed by a cognitive perspective, but the language preferences of teachers are framed by the social context. Language is not benign, and in South Africa it is a powerful social construct.

South Africa has a multilingual policy, but monolingual practice. South Africa's multilingual policy assumes that teachers and learners in multilingual classrooms freely opt for English as the language of learning. The policy states that learners can use any language, but must choose one. The policy seems to take a structuralist and positivist view of language and to assume that language can be free of cultural and political influences. Given the hegemony of English, the choice has already been made long before teachers and parents make their choice. This is an international phenomenon and therefore not surprising. Those with money can buy access to English, which undermines a multilingual policy. Access to English means access to social goods such as higher education, jobs, international opportunities and status, and in the case of English only monolingual teaching. This practice does not allow African learners to be themselves. What is the solution?

Multilingual policy calls for a holistic view of multilingual learners. Multilingual people are not the sum of two or more complete or incomplete monolingual competencies. A multilingual person is like a high hurdler who blends two types of competencies – that of a high jumper and that of a sprinter. The coexistence and constant interaction of many languages in the multilingual person produces a different but complete competence.

How do we make a case for a multilingual approach to mathematics teaching and learning? We have to ask different questions. Given the hegemony of English, how can we teach mathematics in multilingual classrooms to ensure that learners are sufficiently challenged mathematically, and how can we draw on learners' home languages to develop mathematics proficiency? How can we draw on the diversity of languages in the classroom?

In answering the problem of mathematics education, it is important to take a holistic view of multilingual learners. It is important to understand language as a resource. For a resource to be useful, it must be both visible and invisible. If language is to be useful in mathematics education, it must be invisible and not overshadow the mathematics. The principles that should guide a multilingual approach to mathematics education include the deliberate and active use of learners' home language rather than only code-switching, which is limited and reactive. Languages should be used together and all texts should be in two languages, namely the home language and English. Learners should be encouraged to communicate in their language of choice. It is important to use interesting and challenging mathematics tasks and not to downgrade the level of mathematics because of a lack of proficiency in language. A multilingual approach does not entail trying to develop a register or mathematics terminology in African languages. It is also not about developing learners' fluency in English or their home languages, and it is not about teaching only in African languages.

In a multilingual approach, all written texts are in both English and the learners' home languages. Learners are encouraged to use their own language in the classroom, and teachers focus on mathematics rather than language. Learners work in groups in any language they choose and all languages are respected, with the focus being on mathematics and not on language. Learners who had previously been taught only in English and were exposed to two weeks of using many languages were asked to reflect on the initiative. All their feedback focused on the interesting science and mathematics issues that had been presented, and language was not mentioned. In this instance, language had become invisible.

Multilingual approaches to mathematics education offer opportunities such as recognition of the political role of language and current inequalities. Such approaches place the focus on mathematics rather than just on ordinary language and stimulate engagement with high cognitive level mathematics, which in turn encourages learner participation and interest in mathematics.

Expense is a pervasive reason for the introduction of multilingual methods. It is already done for Afrikaans, so why not for other languages? Publishers are willing to take up the challenge, but government must take the lead. There is no need to change the language policy, but it is critical to ensure that it is implemented. It is clear that forcing black schools in poor areas to teach in the home language only in the Foundation Phase does not work but creates more problems.

Discussion

Comment/Question: It is encouraging that learners' perspectives were considered in this project. Often initiatives are launched to test research criteria without taking learners' views of the experience into account. Adults tend to focus on the challenges, but in this process the learners did not look at the challenges but learnt from the experience.

Most teachers are trained at universities. Teacher education has an important role to play in addressing the disjuncture between research and practice in schools. What role will universities play in changing teacher education?

Response: Teacher education is very important. It is important to know what knowledge and skills they will need in order to teach in multilingual mathematics classrooms, as more than multilingualism will be required. Research is currently under way on the needs of teachers. Universities decide on their curricula, but it may be necessary to look at setting standards.

Question: How are you sharing this perspective with other universities? There are differences in thinking between academics, and a paradigm shift is needed. The policy on multilingualism is actually promoting monolingualism, and the hegemony of English is the new social engineering.

Response: The current situation cannot be compared with the financial and other resources that were devoted to Afrikaans during apartheid. Now things are just being allowed to happen. The way in which South Africa arrived at 11 official languages is complicated. Was there a push for individual languages, or was this a reaction to Afrikaans? Because English is so powerful, there is a push for English in order to get access to social goods. Universities are places of ideas but they cannot be allowed to be places of dogma; ideas can and must be challenged.

Comment: As a teacher educator, I believe that I have a deep role to help students understand the importance of language, including indigenous languages, in mathematics teaching. As a parent, I would like to send my children to school where they can interact in many languages. It is not my first choice to send them to an English-medium school.

Question: Most institutions of higher learning have language policies that include multilingualism. Has the language cluster experiment been conducted at university level? Do you believe this approach could be used at undergraduate level?

Comment: I have been involved in two studies on the complexity of language and the dominance of English. The first was on the use of materials. There used to be textbooks for black learners that were simplified with fewer words, but a study showed that simplified text was not useful to learners. A second study analysed imposed text for difficulty of language and difficulty with respect to mathematics. It was found that language did not sway the results.

Question: How is multiculturalism embraced and what is the international reaction to this challenge, or is the hegemony of English predominant?

Comment/ Question: In advocating the use of student language of choice, the importance of teacher education is critical. Often teachers are not aware of how language can water down a subject. In your research, did you engage with teachers on how to use the material? Low levels of content knowledge can be problematic.

Response: Teachers were partners in the project. Data and videos were collected on what was being done in the classroom before the intervention, and regular checks were made during the process. In the process of building, we preferred to work *with* teachers rather than *on* them.

With respect to the international dimension, people all over the world have shown an interest in this experiment. With issues such as migration, there are worldwide issues related to multilingualism. Mathematics has been used all over the world as the catalyst for change in language policy. Africans tend to think that the answer will come from the international community, but everyone is struggling with this and the world sees Africans as an important voice in what we decide to do.

Universities do have language policies. For instance, the medical faculty at the University of Cape Town has made isiXhosa a compulsory subject. The rationale is that doctors will be working with the public and need to speak to people in their own language. The question is why an indigenous language is not compulsory in all professions that deal with the public.

Comment: As an educator I want to embrace language theory and teaching practice, but it is becoming very difficult. After some experience in Khayelitsha, I moved to the University of the Witwatersrand and tried to incorporate multilingualism in a mixed home language class. The idea was that I would explain in English and then the message would be passed from student to student in their home language. This approach results in a 'broken telephone' with a completely different message at the end from the original. Students were unable to present concepts on the board in their mother tongue. Another example of the challenge was in a township class of 68 Grade 11 students. The task was to interpret a parabola and to define and name the various parts. The final exercise was to give the parabola an indigenous name, but the translation was only acceptable to some of the learners in the class. Teachers could also not agree on a name other than the English one. The third example occurred during my PhD studies. I looked at how to make mathematics accessible to township learners and used an affluent school in Cape Town as a control. Learners from both the township school and the affluent school struggled to express themselves when solving problems. Even at university level, students do not understand the mathematics and cannot speak the mathematics language, but the problem is not culturally specific. The problems in this country are not limited to the rural or black population, but are related more generally to vocabulary. The teaching of teachers needs to focus on the language of mathematics as well as multilingualism, since mathematics and English are mutually beneficial.

Some years ago there was a trial using isiXhosa in final examinations, but this was dropped. There seems to be a lot of research on primary schools, but insufficient research at secondary school level.

Response: The broken telephone problem is not related to a particular language but to the way in which we communicate. Our aim is to make language invisible in the teaching of mathematics.

The trial using isiXhosa in the final examination was based on a completely wrong premise. Students that had always been taught in English were tested in isiXhosa and failed, but passed the English test. The outcome of our research is to recommend giving learners both languages as is done with Afrikaans. Black children should not have to choose a single language. A multilingual approach is needed to mathematics teaching, learning and assessment.

ESTABLISHING A CULTURE OF STEM DISCOURSE IN TOWNSHIP AND RURAL HIGH SCHOOLS – MR MPHO MADISHA, (CHAIRPERSON, BLACK SCIENCE, TECHNOLOGY AND ENGINEERING PROGRAMME)

Language is a critical element in understanding physical sciences and mathematics. The Black Science, Technology and Engineering (BSTEP) Programme is a non-profit advocacy organisation that aims to advance black excellence in science, engineering, technology and innovation. South Africa faces the challenge of producing enough people skilled in science. BSTEP has developed and implemented support programmes in student chapters at universities (currently only in Gauteng but soon to be expanded to other areas) and initiatives in STEM fields in townships and rural areas. BSTEP is also involved in the expansion and enhancement of professional and business networks, and entrepreneurship projects that promote black excellence for economic development.

BSTEP is engaged in several intervention projects. One of these is the Saturday School Project, which focuses on mathematics, and enquiry-based learning projects are carried out in partnership with Nka'Thuto Edu Propeller. The teachers are professionals and student chapter members who volunteer, and the structure and curriculum are informed by gaps identified at the university. The aim of the programmes is to identify talent and to improve average marks.

BSTEP has adopted an approach to language developed by Prof Okhee Lee of New York University, namely that language is more than vocabulary; it is a discourse. The discourse of scientists and engineers can be very confusing to students, particularly those already struggling with a second language. There are challenges in applying theories if the basics are not understood. Differences of

nuance and in the use of terms between engineering and mathematics make student understanding even more difficult. Nuances of language are not only challenging to students using a second language, but even to those with English as a first language.

Students have a basic understanding of vocabulary, but there are often problems in applying it. While students may understand the individual words, they may not necessarily understand the discourse, and second language speakers are at a particular disadvantage. The use and understanding of a STEM vocabulary is of concern, and well-trained educators are critical. The BSTEP programmes are designed to augment teaching, but often misconceptions conveyed by teachers have to be unlearned.

The model developed by Prof Lee considers mathematics, science and language together. The discourse and text are presented in conjunction with language. Students need to learn mathematical models, think abstractly, carry out 3D visualisation, and engage in argument and explanation across disciplines, and this is more difficult without adequate language skills.

The Saturday Schools Project has identified some particular vocabulary issues. Mathematical terms are shared with everyday English but have distinct meanings in mathematics, which causes confusion among students. Some standardisation would make difficult subject-specific notation easier to understand. It is important to ensure that learning materials do not deter students.

One of the methods of assisting struggling engineering students at the University of Pretoria is to add an additional year to the course. Gaps identified in the background knowledge of first-year students include concept understanding and problem-solving skills. Language plays an important role and influences student results. Any ambiguity in the language used in tests and examination papers affect the results.

As part of the Nka'Thuto programme, students engage in research and report on their findings. It has been found that students are able to express themselves and align with the underlying concepts in their home languages. Enquiry-based projects allow students to wrestle with the concepts and to find ways to express them. An environment is created in which students can exchange ideas in their own language, and this freedom stimulates depth of thinking.

Some points to consider in realising a return on investment in education include:

- Critical terms and phrases should be identified to establish threshold knowledge, initially in English but also in African languages
- Students need opportunities to speak, read, write and listen to STEM vocabulary.
- Sometimes the words that prevent students from solving tasks are not even STEM related.
- Other socio-economic issues sometimes overshadow the language issues.
- Science has to be fun, and students need to be intrinsically motivated.
- Language has to be part of a learning plan, not an afterthought.

Take-home points for consideration:

- Explore language as discourse and factor in the way people talk. Consider science fiction as a discourse that people can identify with, especially the emerging African science fiction writers. Perhaps have a science fiction novel as a set work.
- Emphasise enquiry-based learning, which provides stimulation and motivation and allows the learning of concepts.
- Emulate the Next Generation General Science Standards of the American Association for the Advancement of Science, which could introduce the concept of discourse in South Africa. These standards are based on learners not using their first language.

Discussion

Comment/Question: The importance of using African languages in explaining terminology is noted, but hopefully other non-African languages are not excluded, for example the descriptive nature of Afrikaans which is useful for expressing mathematical concepts. Do students take the help provided by the extended university programme seriously, or do they view the emphasis on the basics as a delaying tactic?

Response: Students have shown mixed responses to extended programmes. Some are appreciative, while others consider such programmes a waste of time. Statistics indicate that extended programmes are helping, however, as throughput has improved. An extended programme is not a bridging course, but the curriculum is spread over an extra year, which reduces the workload.

With respect to language, it is necessary to include as many languages as possible, but this should not be done in a piecemeal way. An extensive programme that includes languages is required. We need to learn from others' mistakes. On the issue of Afrikaans being descriptive, the roots of words that we introduce into vocabulary should receive attention, as many English words have roots in other languages.

Question: Does an academic literacy course empower students in the necessary discourses? What sort of writing do engineering students do (e.g. essays or reports)?

Response: Engineers are trained in professional report writing. Although we might prefer a generic solution to engaging in discourse, this would probably not be realistic and a combination of interventions would be required.

Comment: I disagree that engineers do not have to write much. Engineers face the challenge of having to be convincing about things that the average person does not necessarily understand. It is important to teach young people to communicate not only to engineers but also to non-engineers.

TRACK A: LANGUAGE IN EARLY CHILDHOOD DEVELOPMENT PHASE AND PRIMARY SCHOOL LEVEL

Chair: Ms Jansie Niehaus, Executive Director, NSTF

Changing how the story ends: The role of early reading in South Africa – Ms Jade Jacobsohn, Managing Director, Nal'ibali Programme

Ms Jacobsohn shared her personal philosophy of doing something that scares you every day. She shared some examples of living this philosophy from her own life. After nearly drowning she went on to become a master diver; and having dropped mathematics at school through a fear of numbers she now has an MSc. Her decision to address this STEM forum addressed her fear of public speaking and her fear of numbers. Ms Jacobsohn had kept journals throughout her childhood which included listing her favourite school subjects. In her early years her favourite subject was mathematics, but when she did not understand some of the concepts, she was left behind and was never able to catch up. In the case of reading, it is also essential to get the fundamentals right in the early years. Unfortunately South African children face many challenges in learning to read, and if they do not master reading properly they are excluded from all other subjects.

The South African situation is very sad. Parents' aspirations for their children are hardly ever met. Only 5% of adults agree that it is important to read to very young children, and only 35% of adults read aloud to children at home. This situation can be attributed to low levels of adult literacy and to the widely held view that schools rather than parents are responsible for teaching children. Reading materials are difficult to access; they are expensive and are often available only in English. A small percentage of people use libraries, which are an underutilised national resource. Only 6% of South African children have reading resources at home.

Many parents insist on their children reading in English even though this is not their home language; however, children need to understand what they are reading if they are to become readers. Many children learn to recognise sounds and pronounce words without learning the meaning. Very few pre-school practitioners are qualified, and classes are large (usually at least 35 learners), especially in rural areas. Children are seldom taught to read in their mother tongue. The assumption that when learners transition to Grade 4 they will have learned to read in their mother tongue is not borne out in practice. Fifty-eight per cent of children in Grade 4 cannot read in any language and will always be trying to catch up.

Nal'ibali is involved with USAID in a project in the rural Eastern Cape and KwaZulu-Natal. A baseline study was conducted by the University of Chicago. The study compared the reading speed of children in Scandinavia and South Africa and found that reading speeds in South Africa are painfully slow.

The role of language in STEM education has to be considered. Literacy is essential to achieving science literacy, even if there is no need for much writing in science and mathematics. It is still necessary to engage with the content. Reading and literacy should not be seen as by-products in the national economy but as vehicles for being able to join that economy.

Even though the story is very sad, it can be solved. Four key ingredients for promoting literacy have been identified:

1. Knowledge and awareness of reading and books
2. Reading opportunities at school and at home
3. Role models, since children learn by example
4. Access to reading material in the mother tongue.

It is essential to create an atmosphere of joy around reading rather than the intimidation of sitting in a classroom reading in a language other than the mother tongue and having to answer questions. Stories are an essential medium for encouraging reading, but must be meaningful and experiential so that children remain interested. Play is the work of children, and is important to engaging the minds and imagination of children. Play is integral to learning.

Nal'ibali is the largest reading-for-enjoyment campaign in the country and has materials in different languages, available to everyone free of charge. Nal'ibali wants children to fall in love with books, and is currently partnering with the Department of Basic Education to roll the programme out to schools across the country. Some achievements during the five years that Nal'ibali has been in existence include:

- Thirty-one million bilingual 16-page story supplements have been published in Times Media publications. These supplements include cut-out-and-fold books that can be kept. Each book is published in two languages.
- Stories broadcast on the SABC with 7 million listeners per week.
- Training of 13 854 people on how to involve children in a story
- The creation of a network of reading clubs: 47 150 children attend reading clubs every second week (membership is non-cumulative; each year all members are contacted regarding continuing membership and the list is re-compiled)
- Loud-and-proud events such as World Read Aloud Day; this year 719 627 children were read the same story, in the same language, on the same day.

Reading informs people about their local situation and conveys news from further afield. It would be wonderful to create a shared national narrative with translated stories as well as stories created locally. If we want to build a reading nation, we need to ensure that children meet books. A well-established culture of reading could be a real 'game-changer' for STEM education in South Africa.

Discussion

Question: What does Nal'ibali mean?

Response: It is an isiXhosa word meaning 'hear a story'.

Comment: Some years ago a woman that worked for me decided that her youngest son should be raised in English even though this was her third language. When he had to move to Grade 8, it was impossible to enrol him in a school due to his learning problems. A spokesperson for the Gauteng Department of Education informed me that 30–40% of Grade 1 learners do not reach Grade 8. This percentage might have declined even further since then.

Response: When parents make choices about language, it is important to create space to support culture. It is good for children to read in their own language.

Multilingualism in Foundation Phase mathematics – Ms Ingrid Sapire, University of the Witwatersrand

The speaker's background was in mathematics education; her current interest was multilingualism in Foundation Phase mathematics.

The Language in Education Policy forms the basis for the current situation but is not really working in practice. In interpreting the policy, schools have to make a choice of language, which in fact forces monolingualism. From Grade 4 onwards, the choice often defaults to English, as the final examinations will be in English. The choice of language in the Foundation Phase is influenced by the parent body, but once again it is a choice for monolingualism. In order to ensure that the policy is being implemented, if the choice of LoLT is isiZulu, for instance, then that is the only language that can be spoken. Schools are allowed to choose more than one LoLT, but only where practicable. In many cases children will be taught to count in English at home, then have to count in the chosen LoLT language of the school for three years, and then return to English in Grade 4. There are problems with doing mathematics in other languages as the lexicons are not developed, but we need to move to multilingualism which is not necessarily a problem. It is essential to be able to read in order to do mathematics, so mathematics and language are intertwined. The project that Ms Sapire was currently engaged in explores the use and teaching of language.

Studies on the learning of mathematics in multilingual contexts argue that the emphasis needs to be taken off the LoLT and that the focus should be on learning mathematical concepts. There are also arguments that learners should learn science and mathematics in English as this is easier. This idea is one of the reasons why parents push for learning in English. There needs to be respect for who we are and where we come from. We need to draw on all the languages of the country and not just accept the predominance of English. The Pan South African Language Board (PanSALB) should be involved in advancing these issues.

The current research project will try to answer the question of what would be best for Foundation Phase learners in South Africa. The thinking in this regard is influenced by choices made in other countries, and Singapore is often cited as an example. Singapore chose English, but many studies advocate home language tuition in the Foundation Phase. The transition from the Foundation Phase needs to be carefully facilitated and supported with appropriate multilingual materials.

The current research is a two-year project. The tasks for the first year are:

- Task 1: Status of LoLT – To map the current situation according to the language spoken and taught in the Foundation Phase in South African schools. The report prepared by the Department of Basic Education is outdated and will be updated using data from the period 2008–2016 and possibly even 2017. The findings to date show that having moved away from English as the LoLT, there is now a move back to English, and that the number of parallel-medium schools and the number of languages at parallel-medium schools have increased.
- Task 2: Variations in language use – To investigate anecdotal evidence that there is a lack of standardisation of mathematics vocabulary for certain 'technical' words needed to teach Foundation Phase mathematics. The documents that will be analysed include the Curriculum Assessment Policy Statement (CAPS) of 2011, Department of Basic Education workbooks for Grades 3 and 4, Annual National Assessment (ANA) for Grades 3 and 4, and Platinum Mathematics for Grades 3 and 4. The findings to date show that errors and omissions in the translation of materials could compromise learning and teaching; variations in language use are present; and the transition from Grade 3 to Grade 4 is a leap that may be beyond the capacity of many learners.
- Task 3: Variations in language use (spoken) – This task included a survey to further investigate language spread (Task 1) and use (Task 2) in the school system. The sample for the survey included 30 District Officers, 60 Grade 3 and 4 teachers and 3200 Grade 3 and 4 learners. The findings to date show that in many cases teachers are teaching and learners are learning in a language other than their home language. The knowledge of mathematics vocabulary was found to vary considerably.

The findings and results of these three tasks will form the basis of a report to the Department of Basic Education. Tasks 4 and 5 of the project will be conducted in 2018 and will gather observations and

data to show how Foundation Phase teachers and learners use language in their mathematics classes.

Take-home points for consideration:

- How can the system better provide for the varied language needs of learners in relation to the LoLT?
- How can the system better provide for the varied needs of learners in terms of materials in relation to the Learning and Teaching Support Material Policy of October 2013? What teacher support is needed in the current context to address teachers' needs and their ability to provide optimal learning opportunities for all learners?

We need to get the system right so that it will be possible for all children to learn the mathematics that they need to learn.

Discussion

Comment: The costs of providing appropriate materials in multiple languages may be prohibitive, but can we afford not to do it and mess up our children's lives?

Acquiring new languages – Mrs Wendy Chauke, University of Limpopo

As background, Ms Chauke shared that she is a Xitsonga speaker teaching student teachers at the University of Limpopo, which is located in a rural setting. In 2011, the language department selected ten schools and 20 teachers to participate in a project to develop teaching resources. This project provided valuable insight into student teachers and teaching practice in the Foundation Phase.

Language is essentially a human activity. Communication should strive to minimise barriers and ensure that meaning is not lost. Language is the external and internal representation of thought and is affected by the ability of the user. What are the challenges in the classroom situation and what are the benefits of acquiring a new language? Language is an essential part of the learning process.

Language acquisition is defined as the process whereby humans acquire the capacity to perceive and comprehend language, and to produce and use words and sentences to facilitate communication. Language acquisition relates both to the native language/mother tongue and other languages. In order to become multilingual, it is essential to acquire a language other than the native language/mother tongue.

There are many theories of how a language is acquired, four of which were highlighted in the presentation, namely the behaviourist theory, mentalist theory, cognitive theory and interactionism theory. The behaviourist and mentalist theories apply mainly to the acquisition of a native language, and the cognitive and interactionism theories to foreign language acquisition. The various theories of language acquisition complement one another; however, it is true of all theories that one cannot acquire a second language if the first language is missing.

The behaviourist theory focuses on native language learning and is concerned with language identity and culture, learning from role models through imitation and reward; this is essentially informal learning. Learning institutions provide a more formal learning environment. The relationship between the formal and informal learning areas is essential, starting from the known and moving to the unknown.

The challenges to multilingualism include: the possibility of diminishing the value of the home language; lost registers (technical terms) and the simplification of concepts for the sake of understanding; the dominance of idiolects and regional dialects; code-switching and code-mixing. Code-switching and code-mixing are not really a problem as this is the current norm, but should be used with care.

The Constitution of South Africa recognises 11 official languages plus sign language and Mandarin. The Constitution talks about redress and the equitable use of languages, multilingualism and the development of language policies in different sectors. The framework allows a degree of freedom of

language choice, but this is largely abused and does not promote multilingualism. The question of who will implement the policy remains. It cannot be left to the government alone but depends on individuals to assist with implementation, since the government cannot have a presence in every village.

The factors that affect language learning include:

- Motivation: The individual has to have the desire to learn another language.
- Attitude: This includes beliefs and opinion and the need to sustain the motivation to learn.
- Personality: Language is intrinsically linked to cultural values and norms, in which it is important to take a pride. There is no strong evidence of a consistent relationship between personality variables and achievement of a second language.
- Climate of the classroom: Realistic expectations should be developed for each individual learner.
- Teacher factor: The quality of conversation and discourse between teachers and learners is important.
- Time: The structure of school timetables results in the allocation of insufficient time for language learning.
- Opportunities for learning: In order to promote multilingualism and awareness of other languages, it is important to use other languages in the classroom
- Age: There are no age restrictions in learning a language.

Some observations and questions to think about:

- The social influence on language learning is not satisfactorily explained.
- To what extent and at what rate do the social surroundings promote language learning?
- Language without real communication is as useless as Valentine's Day without lovers, or children's day without children.
- There is value in incorporating a language module in specialisation streams (e.g. language modules in each year of a technical course).

Science Made Sensible Programme: A tier mentoring model for increasing STEM engagement in US and South African schools – Mr Dirk van Schalkwyk, Educator

The Science Made Sensible Programme was initiated by the University of Miami where multiculturalism and multilingualism pose similar problems to those in South African schools. The main problem is that the LoLT is English, which is not the mother tongue of the students. We were invited to visit schools in the Miami-Dade county of Florida, and an important initiative of pairing American and South African undergraduates was initiated. The current programme is small, with only three schools in the inner City of Tshwane and one in Mamelodi participating.

Learner interest in science in the participating schools is low and there are significant gaps in mathematics and science along ethnic lines. The Miami-Dade schools cater for mixed populations and the interest in STEM disciplines is low. In South African schools, there is a lack of diversity in STEM curricula and a tendency to teach the same things every year. There are four strands in the science curriculum: matter and material, energy and change, Earth and beyond, and life and living. A teacher could start with Earth and beyond in Grade 1, and the same strand could be taught again in Grade 7. Other issues that impact on STEM education include scientists' failure to communicate sensibly. We say the right words, but these do not necessarily make sense to children and school teachers who lack a grounding in science. Students' interest in science declines in the middle school between Grades 4 and 8.

The goals of the Science Made Sensible Programme are to improve the communication and teaching skills of STEM graduate and undergraduate students at the University of Miami; and to enhance the professional development of teachers.

The original design of the programme was the pairing of a PhD student with a middle school teacher working with learners in Grades 6, 7 and 8, funded by a grant from the National Science Foundation. At the end of this phase, the University of Miami was approached for further funding but their requirement was the use of undergraduate students, so the programme was modified in 2012. Now undergraduate students are paired with a middle school teacher and they are mentored by a graduate student for one academic year. It has been found that the greatest impact of the programme is not on

the teachers but on the learners, who made very positive comments about having a scientist in the classroom.

After the programme had been modified, a partnership was formed between the University of Miami and the Tshwane School District. The University of Miami selected students to pair with selected students from the Groenkloof campus of the University of Pretoria. Initial contact was made through the sharing of lesson plans. Students from Miami visited Pretoria for three weeks. The students were paired and mentored during their time in the classroom. South Africa was chosen to participate in this programme because of existing partnerships with universities and science organisations, the similar achievement gap between ethnic groups, and the language barriers in both areas.

The differences between Pretoria and Miami schools as perceived by the US students were:

- Sense of community embodied in a school
 - Stronger in Pretoria schools
 - Teachers work together sharing resources and responsibilities
 - Learners respect the teachers
 - Learners accept praise and discipline
- Educational curriculum
 - Pretoria curriculum was vaguer
 - Miami curriculum was much more conducive to streamlined instruction, which facilitates interactive teaching, implementing problem-based learning and teaching analytical skills
- Methodology
 - In Pretoria, instruction was less enquiry based
 - In Miami, instruction was more process based.

It is clear that when learners have grasped the concept, they start to have a deeper understanding, but they need the background and good teachers to bring all students to full understanding.

A programme in Miami called the Miami Zoo Magnet School was very impressive. Certain schools partner with a zoo and take classes there for hands-on learning. Perhaps some aspects of that programme could be replicated in South Africa.

Take-home comments:

- As a primary school teacher, Mr van Schalkwyk misses being able to keep track of what happens to learners and what benefit their primary school teaching is to them as they continue through their schooling.
- There is a need for a paradigm shift from teacher-centred learning to student-centred learning.
- Any programmes that are implemented need to be sustainable.

Discussion

Question: What are the differences between a scientist teaching science, and a teacher teaching science?

Response: Learners were happy to be taught by a scientist, and there was no apparent difference from being taught by a teacher.

Comment: There is great value in bringing practising science professionals into classrooms. Teachers have the task of completing the curriculum, and science professionals can bring a different perspective and experience from the field into the classroom.

TRACK B: LANGUAGE IN SECONDARY SCHOOL (HIGH SCHOOL) AND TERTIARY LEVEL

Chair: Mr Dawie Botha, proSET Chairperson, NSTF

Teacher training for language in science teaching at secondary school level – Prof Samuel Oyoo, Director: Institutional Language, University of the Witwatersrand

Research on the role of language in science education is a neglected area both in South Africa and in the global arena. The presentation was based on data collected over four years exploring learners'

understanding of everyday English words presented in a science context as explorations of linguistic issues in teaching science in South Africa. The aim of the project is to create a better understanding of language-related difficulties that science learners in South Africa encounter, or could encounter, with the LoLT of school science.

There are multiple issues related to language, but for the purposes of this presentation the following four have been selected:

- Science is a distinct language, and science has its own language.
- Success in science is not only dependent on competence in the LoLT; learners must also be competent in science concepts.
- Science teachers/educators are generally unaware of the impact of the classroom language on science learning.
- Curricula used in the initial and continuing education of science teachers need to be restructured to incorporate issues on the role and nature of language in relation to learning science.

The lack of infrastructure in most South African schools means that teachers take central stage during the teaching process and try to convey the concepts as clearly as possible. The instructional language in a science classroom also has a non-technical component made up of words that define or give identity to the particular LoLT in use in a classroom or the language of a science text, to the extent that we are able to tell which language is in use (whether the language is isiZulu, English, Afrikaans or any other).

The technical component of the language of instruction comprises technical words, including concepts such as 'mass' or 'force', or the names of chemical elements, minerals or plants. In essence, learning or teaching school science is about mastery of this science classroom language. The non-technical component of science teaching is the classroom language, in other words, the medium of classroom instruction as opposed to the technical terms. All categories of words in the language of the science classroom/texts, whether technical or non-technical, are generally difficult for science learners.

The focus of the South African study is based on the findings of many studies that all categories of words are generally difficult for all learners. Two questions were addressed in the student component of the larger exploratory study, namely:

- Do South African learners encounter difficulties with non-technical words when they are used in the science context?
- What are the sources of the difficulties with non-technical words when used in the science context?

The participants in the study were 715 physical science learners in Grades 10, 11 and 12 with English as their second language, and their respective educators and teachers who were qualified and experienced. Data were obtained over a period of four years through a word test, group interviews and face-to-face interviews with each physical science teacher. The meaning of specific terms was tested, as was the frequency of use and familiarity. In analysing the data, the word test was marked against correct answers; the easiest and most difficult words were identified; and student and teacher comments were recorded and transcribed.

The conclusions and implications of the findings of the study include a recommendation that urgent steps need to be taken to help teacher and teacher educators to recognise that everyday words cease to be mere words of the LoLT when used in the science context. The findings strongly suggest that focusing on contextual proficiency in the LoLT during teaching perhaps holds more promise for enhanced learner outcomes in science. Teachers need to be encouraged to take more cognisance of the functional value of the non-technical words in the science teacher's language.

Some solutions to the problems include mentoring and collaboration between teachers from different disciplines, possible reorganisation of the teacher training curriculum, in-service training programmes and further research.

Discussion

Question: How can the scientific meaning of everyday words be learned? Should one try to define a term in some way and then use it in a concept?

Response: The word 'spontaneous', for example, is not considered a technical word but can become so in the science class. There is a need for awareness that words can be misconstrued, and the context of use must be borne in mind.

Comment: If one understands the word in the first place, the concept will be clear. It is important that children understand the context of the words that are used.

Preaching versus practice: Language and mathematics, science and technology teaching and learning – Prof Satsope Maoto, University of Limpopo

At the core is the question of who is the South African child? We should first clarify the core, but from which perspective? Do we have one South African child or many South African children? In most African cultures, the child is raised by a community. Thus, mother tongue/home language is a complex phenomenon in cases where the mother's actual language is not the language of the community. We need to clarify and move to a shared understanding of who this South African child is in order to be able to move forward. How can we ensure that the relevant and correct resources are made available to these children when we have not shared our understanding of who they are? Perhaps we should aim for a composite child who can speak all the languages, but then we would also need composite teachers who could speak all the languages.

It is essential to have a shared understanding of language before one goes into specific disciplines. In engaging with colleagues whose children are studying, their views highlight some of the problems that we face with regard to teaching science and technology. Some responses from parents included:

- "How would we deal with the diversity of African languages? Do we have textbooks in African languages that are currently being used at schools and universities? If not, how long will it take to develop such materials?"
- "A learner should have a choice to study in a language that s(he) prefers. We, however, have a responsibility to ensure that the learners with their parents make an informed choice about their language of instruction."
- "Challenges for free language choice are: How well developed is the language to engage mathematics, science and technology students in the academic discourse?"
- "Teaching in a particular language as a medium of instruction is different from the curriculum in that language."

We have heard that language is a political issue, but does government have the commitment to place all 11 languages on an equal footing?

Teaching is not simplistic, and we should avoid simplifying the issues and claiming success. Whatever language is used for teaching, if it is developed enough to incorporate the necessary concepts, then it should be used for specific disciplines. The main challenges centre around language development, curricular development, teacher education and language in schools. We need that picture of the composite South African child and the composite mathematics/science teacher, a teacher who is able to use all 11 languages to assist learners in the classroom. We are researchers, yet we make recommendations on behalf of the teachers who must implement policies. This also raises questions around teacher education.

Policy-makers respected the professional freedom to choose the LoLT but did not take into account the possible challenge of having to translate what we have in English into each official language. We can all share ideas, but ultimately there are just a few who can write them down. It is important to decide on the specific proposal regarding the language policy and STEM education. Are we saying that South African learners can choose to be taught in their home language, or are we saying that we just need language to assist in learning? Implementation is a challenge, yet teachers who are required to implement the curriculum are not involved in the development of the curriculum. The implementers need to become developers if policy is to be successfully implemented.

A possible solution would be to teach mathematics as a language, since it provides a way of encountering the world. The use of African languages must be considered and taken seriously, and we should work to strengthen the language of each discipline. It is also important for teachers of the same discipline to interact and exchange ideas, successes and failures. Code-switching is a possible source of help in teaching, but it must be applied sensitively.

Nurturing indigenous languages – Ms Khethiwe Marais, Masihlangane

Many initiatives have been launched to try and nurture indigenous languages and promote multilingualism, but there is no coordinated approach to using indigenous languages in education. Frameworks were put in place to create the environment for multilingualism, including the National Language Policy Framework and the Language Policy Framework for Higher Education, but these various tools have not been finalised or accepted. Other initiatives included study tours to gather information for the preparation of the South African Language Bill, which was never passed.

An example of the types of initiatives launched is a project undertaken by the University of South Africa (Unisa). The focus of the project was to identify 28 at-risk modules, which had a high student intake and high failure rate. The university undertook a pilot project to translate the materials for selected modules into all the indigenous languages, but the project met with varying levels of success. The greatest challenge in executing this project was capacity, since there were too few competent freelance language practitioners to do justice to the modules, especially the technical modules. It was found that being a trained language practitioner and being bilingual are not enough for this type of project. Another reason for the failure of the project was a lack of buy-in from stakeholders.

Based on the experience of Unisa, the following recommendations were made for projects to promote indigenous languages:

- Subject specialists must work with language practitioners.
- Glossaries should be provided for learning materials across all subject fields.
- Short focused training programmes should be implemented for language practitioners.
- Specific terminology should be developed in all the official languages for all subject fields.
- Internal quality control is necessary.
- All departments should be actively involved in the translation process.
- Appropriate translation software should be used.

Frameworks are in place to support indigenous languages, but political will and commitment are lacking to ensure that policies are implemented and monitored. There is no motivation for multilingualism in current policy. Changes of attitude will be required to promote indigenous languages and realise multilingualism. There has not been enough effort to develop appropriate material. Material is being developed for the Foundation Phase, but very little is being done for the subsequent schooling levels, and definitely not for the tertiary level.

We have not thought about developing indigenous languages and English in parallel. There is a demand for education in English because of the opportunities that this offers, but English does not have to be the only language of instruction.

Training is another issue. Many universities offer excellent language courses, but students often graduate instead with a degree in linguistics because they felt it was an easier option. Universities do not turn students away from these courses as they do not want to lose their subsidies. Training should be based on needs. Ms Marais appealed to the STEM community to work with university linguistics departments to address the problems and develop appropriate training materials.

We need strong political activism; we must insist that our children are taught in indigenous languages. If we stand together, we can insist that our languages are used in higher domains. The responsibility for using indigenous languages does not lie only with government but also with the private sector.

The reality of post-Grade 12 learners' language proficiency – Ms Carina Coetzer, Stellenbosch University

The Ukuqonda Institute's university and technology preparedness programmes are designed for students who want to acquire a deeper understanding of mathematics and physical science, and improve their academic and general English language communication skills. The institute works with post-matriculation students.

It is widely believed that problems arise because of a gap in education, but the reality is that there are skills gaps. Language skills are lacking and it is time to introduce soft curricula teaching to bridge these gaps. Language is a huge stumbling block globally with the current generation. The challenges include the level at which language is used and the levels of communication. Functional language is extremely important to successful learning.

Students entering the institute have an underdeveloped ability to express themselves and low levels of language proficiency, which inhibit their progress. There is also a disjuncture between students and teachers/lecturers, as students with a low sense of self-esteem do not have the confidence to approach lecturers with their problems. With the pervasiveness of social media, students lack practice in communication skills, and their ability to converse meaningfully suffers.

Language is essential for communication, but it is also the bridge to making sense of reading and writing. Given the social background of many students, they have learned to think in one language and communicate in another language whilst still trying to maintain the sense of the discourse, which is very challenging.

Another problem is that we live in a world of 'quick fixes'. People are impatient and children do not want to sit and engage with text, as they find this too slow. The deep learning approach of the institute engages children in communication and application of their knowledge. When the children are enrolled at the beginning of the year, they have no academic language. Through the creation of a spontaneous informal space for sharing ideas, confidence and skills can be nurtured. The level of the students is assessed, and interventions are designed to meet them at a level with which they are comfortable with before progressing to higher levels.

Informal discussions in which students share and participate form an important means of starting the process of communication. Discussions are based on a frame of reference that is closest to the particular student, for instance their biggest fear or happiest moment. When students start the year, they can hardly formulate a sentence, but by the middle of the year they are much more competent. Grammar can then be refined.

The students' response to a visit to a mine shaft is an example of the confidence and enhanced skills that they develop, they visited a mine shaft. Unfortunately there was a labour dispute in progress so the students could not actually visit the shaft but were still able to write wonderful paragraphs about the new experience, even expressing their emotions. Students begin to realise that they need to speak English in order to improve.

The work of the institute is based on getting students to become aware of their senses and what is around them. Once they are comfortable with social conversation, they need to grasp the importance of language and keep track of their thinking. The programme is designed to inspire confidence to socialise and speak informally, and then to progress to academic language. Reading is another essential skill to be developed, and most students read very slowly at the beginning of the course. Contextual reading takes time to acquire and students are trained to become reading fit. The approach is multidisciplinary and interdisciplinary, and students take responsibility for their own progress.

Everyone has to buy in and work together in a multidisciplinary approach.

COMMENT ON POLICIES – DR LEBS MPHAHLELE (DEPUTY DIRECTOR-GENERAL, LIMPOPO DEPARTMENT OF EDUCATION)

The subject of policy covers a very wide area. This presentation focused on trying to make sense of how policies that are made at national level are applied in the provinces, particularly in respect of language. Limpopo province is a very complex environment with many cultural groups and languages, which makes the language question very challenging.

At undergraduate level, pure scientists tend to feel somewhat superior to students in mixed courses including the social sciences, but by postgraduate level it becomes obvious that the pure scientists were disadvantaged. Science lecturers require only phrases to describe chemical processes, for instance. In moving into the field of education, it becomes clear that the thoughts that underpin the phrases also need to be made visible. In teaching science, the challenges of language over and above describing the laboratory processes become obvious. It is essential to find language to communicate across the disciplines of education and science.

South Africa's language policy since 1994 is underpinned by multilingualism. The policy assumes a Foundation Phase education in language X and an Intermediate Phase in language Y. It is based on the premise that since a language structure has been established in the Foundation Phase, it is not necessary to continue with language X. The question, however, is how this is applied in the schooling system and the intended and unintended consequences.

Most children in Limpopo start school in Grade 1 as not all schools in the province offer the option of Grade R. There is a push to achieve 100% Grade R availability at schools by 2019. Grade R does not fall under the control of the Department of Basic Education but the Department of Social Development, so there are no Grade R teachers, only Grade R practitioners. The implications of introducing Grade R in all schools are that there will have to be qualified teachers, and posts will need to be created. It will be necessary to ensure that the current Grade R practitioners are properly prepared, and they will need to be converted into teachers. Because of the lack of Grade R facilities, Grade 1 teachers generally have to take responsibility for this part of the Foundation Phase, and the teacher:student ratio often exceeds national standards. Standards for class size that are set at national level can often not be met in practice. Multi-grade classes, with several grades in one class, are common and present other sets of problems. These classes tend to be small with only a few learners in each grade.

It is necessary to address the realities in laying the foundation for STEM language development. If a school is located between several villages, the situation could occur that the predominant language of each of the villages is different, which further complicates language choice. It has also been shown that the performance of learners drops after receiving tuition up to Grade 3 in their home language, and then switching to English in Grade 4.

It is not economically sustainable to have many small schools, so there is a necessary closing and merging of schools. Parents flock to schools that are performing well, which are predominantly the previous English-language schools. Schooling is completely free in Limpopo province, and learning and teaching support materials have to be maintained and managed across all 3900 public schools (primary and secondary) in the province.

Recently, 192 teachers of physics, mathematics and business studies in the province attended a three-week workshop. They were required to write a pre-workshop test and achieved an average of 30%. In the post-workshop test, the average increased to 50%. The results of this intervention are being analysed to identify where additional interactions are needed. The teaching situation is further complicated by the Curriculum Assessment Policy Statement of 2011, which calls for indigenous language systems to be valued. The reality is that teachers tend to focus on their own areas of expertise and curriculum coverage where they feel most comfortable. This is the situation in public schools. In private schools, no additional languages are offered and learners start with English or Afrikaans from Grade R. In special needs schools, English and Sepedi are largely the LoLT in the Foundation Phase. The numbers of public schools are diminishing, while private schools are increasing.

There are 11 official languages in South Africa underpinned by additive multilingualism, which is applied in public and special schools in order to build on the foundation laid by the home language (which is not necessarily mother tongue), which is used from Grade R to Grade 3. The tenacity of the historical legacy is evident in the language choices made by school governing structures when deciding on language policy in public, special and private schools. Changing this legacy will require a great deal of work and advocacy. The language legacy is even more pronounced in the teaching of STEM subjects. The government has launched the Incremental Introduction of African Languages pilot programme. A great deal of work with communities would be required for this programme to be successful. It would also need a budget resolution to provide additional teaching posts. Sectors such as those represented by the NSTF need to play an active role in these efforts.

Discussion

Comment: Higher education is the sole provider of teacher education. If we ignore or do not pay enough attention to higher education institutions (HEIs), we may not succeed in what we want to accomplish. There are distinct challenges for HEIs in starting a programme for Foundation Phase teaching. In order to provide quality and to increase the number of Foundation Phase teachers, there is a need for more government support for HEIs. There is a fear that if we do not address this problem, we will perpetuate the current challenges. If the government wants to see a change in the current situation, it must provide support to HEIs to enable funding and attract appropriate staff.

Question: What impact has the Incremental Introduction of African languages pilot project had?

Question: Could you please expand on the Incremental Introduction of African Languages programme?

Question: How many Foundation Phase schools in Limpopo province have a multilingual policy? How can the national policy on multilingualism in classrooms for STEM education be reconciled with the power of school governing bodies to make decisions regarding language use?

Response:

On the issue of higher education, a two-day conference was held in Limpopo during October 2017 to revisit the strategy on STEM education. The participants included the NSTF and HEIs (including Tshwane University of Technology, the University of South Africa and others). By the end of the conference, we had developed a statement of commitment from universities and trade unions and will now formalise the collaboration. The aim is for teacher centres in the province to focus on in-service training, and for universities to focus on professional training. We are working with the South African Council of Educators, which is concerned about the professionalisation of educators. The council has a continuous professional development system for teachers, who have to achieve a minimum number of points. Teachers who do not could lose their teaching licence. Final-year teacher education students have also been included in the points system. Since practical work is not included in the academic curriculum, this provides a standard for assessment when employing newly qualified teachers.

The aim of the Incremental Introduction of African Languages pilot project was to investigate policy implications regarding issues such as budgets and new posts. It is too early to assess the impact.

In the area of technology, the province is introducing technical schools in several areas. The general curricula do not prepare children well for technical subjects, and there is a need for tailor-made programmes in schools to meet industry needs. This is being done on an incremental basis as posts become available. A similar approach is being taken to appointing indigenous language teachers.

The issue of school governing bodies and language policy is very complex. The provincial Department of Education's institutional governance section is working with schools, and training managers and school management bodies. The managers are permanent appointments and easy to work with as they understand the issues, but the environment is fluid and dynamic and subject to political change. All schools receive funding that is managed by the governing bodies, who decide on priorities for spending. In a stable community, it does not matter much who serves on the management committee, but in poor communities the situation is different and may become subjective.

CIVIL ENGINEERING UNDER THE SOUTHERN CROSS – DAWIE BOTHA (SOUTH AFRICAN ACADEMY OF ENGINEERING AND PROSET CHAIRPERSON)

Communication does not entail only writing or talking; most senses are involved when we want to communicate. Engineers' talk is a specialised form of communication. It could take non-engineering administrative years to understand what engineers are saying.

Non-verbal communication is another way of communicating. In 1994 South Africa was very visible to the world and there was considerable interest in what was happening in the country. On a South African Institution of Civil Engineering visit overseas in 1995, gifts and ties displaying the South African flag were taken and openly displayed. The flag was often recognised, and instantly opened communication channels. This was an example of the power of non-verbal communication. The institution ran a competition to find a logo and motto, and the winning motto was 'We bridge the gap', which provides another way of communicating an important message.

It is important to respect the language of others. Not long ago, many Afrikaners lived on farms and had to go to English schools where they were considered dunces. There are three official languages in the Western Cape: English, Afrikaans and isiXhosa. In the Overstrand Municipality all advertisements appear in all three languages, and there are translators in council meetings to facilitate the use of all three languages. This was initially difficult and slow, but people have become used to the process. The introduction of African languages is possible, but it needs effort, time and respect.

Mr Botha's presentation borrowed from one that he had made recently in the 61st Snape Memorial Lecture.

There is an anonymous saying that is often quoted, 'Those that turn up will rule the world', so if policy change is required, 'turn up and get involved'. Perhaps we have lost momentum. As scientists, engineers and technologists, are we leading or following? Are we preparing young people for a world that *is* or for a world *gone by*? Has development overtaken our ways of teaching and education? It is difficult to know what direction to take because the future is unsure, but we cannot stand still and wait for it to happen.

In today's world, teachers need to be magicians to be keep the attention of students and learners. We live in a world of symbols and brands, which are also strong means of communication. Even road signs and cartoons can be used to get the attention of young people.

An example of positive communication comes from the Netherlands. On an 8 km stretch of roadworks, there was a picture every kilometre plus some words to update travellers on the distance under roadworks still to be covered. The first poster showed a very angry face and 8 km to go, and the final poster showed a happy person. This communication changed the attitude of travellers to the roadworks, as they began looking forward to the next poster rather than becoming angry.

Civil engineers belong to a family known as 'built environment professionals'. A picture was developed to illustrate the professions involved in this domain. Through visual presentation, it was easy to explain the scope of the civil engineering domain. It is important to find similar ways to visually depict the science and mathematics professions in order to enable understanding.

Concepts are often very difficult for students to grasp. A lecturer who was struggling to convey the concept of 'a specification' to a class of final-year technicians/technologists asked them to prepare a specification and a methods for producing vetkoek. The students presented their specification of ingredients and the method for cooking the vetkoek, and agreed that this exercise helped them to thoroughly understand the concept of a specification. It is essential to ensure that the end product is understood before writing the specification. The multilingual environment is difficult and education sometimes suffers as a result, but it is possible to use relevant examples to reinforce messages.

The American Society of Civil Engineers realised that the professional of the future will look different from the current one and developed the Vision 2020 and a Body of Knowledge to help prepare engineers. This work shows the new direction of moving towards a 'Supermanwoman' of the future. It is interesting to note that not only mathematics and natural sciences were included in the foundational outcomes, but also the humanities and social sciences and the need to build trust.

Some thoughts to ponder:

- Crossed fingers do not hold up bridges.
- Teachers are very special people, but we want them to be super humans.
- There is no time to experiment; we only have one chance at education.
- We live in a world of branding and we need to embrace it.
- Never underestimate the responsibility of educators.
- There is a language gene, and some of us are better at it than others.
- Engineers are attracted to the discipline because of the mathematical aspects, but they must also be writers.
- Never underestimate the unintended results of your deeds and actions.

In conclusion, Mr Botha shared a quote from a speech by Thabo Mbeki to the South African Institution of Civil Engineering in 2003: 'You are the Leonardo da Vincis of the 21st century, but remember who you serve; not only the modern and emancipated arrived society of today, but also those with the broken fingernails and those from the gutters of life, those who still aspire to become respected and well-to-do citizens'.

ROLES OF LANGUAGE IN FORMING MATHEMATICAL KNOWLEDGE – PROF PIET HUMAN, UKUQONDA INSTITUTE

Mathematically, two-fifths is equivalent to eight-twentieths. 'Equivalent to' is mathematical language, and students who do not acquire this and other mathematical expressions will be excluded from ever learning mathematics. It is important to introduce learners to the different genres of text. The teaching of mathematics is the teaching of language.

There are various ways of saying the same thing:

- **Description of actors, material objects and material actions:** Ben cuts a loaf of bread into five equal slices and eats two of the slices. Tembi cuts a loaf into 20 equal slices and eats eight of the slices. They eat the same amount of bread.
- **Condensed description of actors, material objects and material actions:** Ben eats two-fifths of a loaf, and Tembi eats eight-twentieths of a loaf. They eat the same amount of bread.
- **Description of a relationship between conceptual objects:** Two-fifths is equivalent to eight-twentieths.
- **Descriptions of a relationship between forms of representation:** Two-fifths and eight-twentieths are two different ways of representing/describing the same *quantity*. Two-fifths and eight-twentieths are two different ways of representing/describing the same *number*.

The ability to condense long clauses into short descriptors becomes a tool for a way of thinking. High school mathematics is mostly about actions on material objects, but learners need to be able to assign words and language to the concepts.

There is a school of thought that suggests that primary school discourse should focus on numbers rather than quantities. Most teachers are not even aware of the language, however, so this is unlikely to happen. Moreover, teachers will not be able to support learners in accessing other forms of discourse.

There are different ways of talking in hard scientific disciplines and mathematics. To progress in mathematics, learners thus need to use different genres of text. This will not happen by itself, and mathematics teachers need to take responsibility for introducing learners effectively to these genres. Language is more than a means of communication: it is also as a vehicle for thinking, a carrier of concepts and a mathematical method.

Various options for LoLT have been mentioned: English as LoLT (monolingual); home language as LoLT (monolingual); English and home language by code-switching or trans-languaging (parallel and multilingual). It is important to leave the choice of LoLT to teachers rather than to governing bodies. This would provide teachers with the space to use the approach that they are most comfortable with. Mathematics education specialists should spend their energy and time promoting the progressive development of mathematics irrespective of the choice of LoLT. Demanding change from teachers and policing implementation will not necessarily promote language in the classroom. There is a great deal of work required in analysis and in the training of teachers.

What should the classroom discourse be? It should be about language and representation; for example, a linguistic discourse to change the current flawed classroom language of two over five, which inevitably generates incorrect answers, to the correct terminology of two-fifths.

A complete set of mathematics textbooks for Grades 4 to 9 has been developed for the Department of Basic Education. A similar set of textbooks is also available for science and technology. The intention is to distribute these books to learners. The books have been written to incorporate in a single book the language that the teacher should use in teaching the particular subject.

TRACK A REPORT BACK AND DISCUSSION: LANGUAGE IN EARLY CHILDHOOD DEVELOPMENT PHASE AND PRIMARY SCHOOL LEVEL

Chair: Ms Jansie Niehaus, Executive Director, NSTF

Four presentations were made in Track A:

Ms Jade Jacobsohn told the story of Nal'ibali (isiXhosa for 'here's the story'), a national reading-for-enjoyment campaign to spark children's potential through storytelling and reading. They have achieved some significant successes in their five years of operation, including the publication of 31 million bilingual story supplements, seven million radio listeners per week, 13 854 people trained in reading stories, 47 150 children at reading clubs and 719 627 reading the same story, on the same day, in the same language on World Read Aloud Day. An important parting message was that reading can be a real game-changer for STEM education in South Africa.

Ms Ingrid Sapire of the University of the Witwatersrand reported on a two-year project that focuses on multilingualism in Foundation Phase mathematics. The research project has five research tasks: the current situation in primary schools; inconsistencies in the mathematical register (isiZulu, Setswana and English); variations observed in the use of language patterns; what model (monolingual/bilingual/multilingual) of language use is perceived by teachers and learners to be dominant; and, in the multilingual South African context, and what strategies, techniques and resources Foundation Phase mathematics teachers use. The take-home points proposed were: How can the system better provide for the varied needs of learners in terms of language (LoLT)?; How can the system better provide for the varied needs of learners in terms of learning and teaching support material?; What teacher support is needed? It is clear that much more research is required.

Ms Wendy Chauke of the University of Limpopo presented theories of language acquisition. Four of the theories that are advanced to describe how language is learned and taught are the behaviourist theory, the mentalist theory, the cognitive theory and the interactionism theory. The behaviourist theory and the mentalist theory are applicable to the acquisition to native language, and the cognitive theory and interactionism theories are applicable to the acquisition of foreign languages. The factors that affect language acquisition include: motivation, attitude, personality, climate in the classroom, the quality of the teacher conversation, time available for learning, and the opportunity for learning.

Mr Dirk van Schalkwyk outlined the Science Made Sensible Project, which is a tier mentoring model for increasing STEM engagement in US and South African schools. The goals of the project are to improve communication and teaching skills, to enhance the professional development of middle and high school teachers and to advance the scientific curiosity of learners. Schools in the Miami-Dade county of Florida share similar problems of multiculturalism and multilingualism to South Africa, and the shared learning of coping with these challenges is very valuable. The project recently brought students from the University of Miami to South Africa. They were paired with students from the University of Pretoria Groenkloof campus, and spent three weeks at four schools in the City of Tshwane, with very positive results for both learners and students.

Discussion

Comment: It is important to think about what proSET will do with what has been learned at this forum, and how we advance and spread the important messages that emerged. Story telling is critical: we need to write more stories and possibly also share stories and relevant clips on the NSTF website.

Response: There is a lot of material accessible on the Nal'ibali website.

Comment: Teachers and teacher training professionals need to be aware of some of the latest thinking in evolutionary biology on literacy and how language acquisition occurs. One learns differently between the ages of five and eight years, certainly with regard to both the first and possible second language. It has been found that under optimal conditions, the brain is capable of being trilingual and tri-literate if learning takes place through the first mode of oral immersion exposure. After the first five to eight years, the plasticity of the brain decreases and further languages can only be learned in a structured manner. This refers to the time–age factor and implies that reaching oral reading fluency by Grade 3 is critical.

TRACK B REPORT BACK AND DISCUSSION: LANGUAGE IN SECONDARY SCHOOL (HIGH SCHOOL) AND TERTIARY LEVEL

Chair: Mr Dawie Botha, Chairman of proSET, NSTF

Four presentations were made in Track B:

Prof Samuel Oyoo of the University of the Witwatersrand focused on teacher training for secondary school, and specifically on language in science teaching. The instructional language in a science classroom has a non-technical component made up of non-technical words that define or give identity to the particular language of learning and teaching (LoLT) in use in a classroom or the language of the science text. The implications of Prof Oyoo's research are that urgent steps need to be taken to help teachers and teacher educators to recognise that everyday words cease to be mere words of the LoLT when used in a science context. A focus on contextual proficiency during teaching holds the promise of enhanced learner outcomes in science. Other conclusions included the importance of teacher classroom practice, mentoring, the teacher education curriculum and in-service programmes; and the need for further research on teacher educators' conceptions of the nature of science.

Prof Satsope Maoto of the University of Limpopo posed the questions of 'Who is the South African child? Is there one, or are there many?' In most African cultures, the child is raised by a community. Thus mother tongue/home language is a complex phenomenon as it becomes a community language embedded in engagements. The challenge is whose language to choose and how to deal with the diversity of African languages. Do we have mathematics, science and technology textbooks written in African languages that are currently been used at schools and universities? If not, how long will it take to develop them? Current research and trends suggest that indigenous languages can be used to teach science and technology, but the government lacks the will and commitment to place all languages on an equal footing. More than 20 years into democracy, English and Afrikaans are still the predominant languages of assessment.

Key challenges in identifying and raising the African child include curriculum development, implementation in schools, language development and teacher education. Some thoughts on moving forward include:

- Mathematics should be taught as a language.
- The quality of teaching African languages should be considered in the dilemma of STEM languages and the nurturing of home languages.
- The language of each discipline should be strengthened.
- Groups of teachers should be taught in schools to create a community of practice.
- Team teaching and code-switching should be taken into account.

Ms Khethiwe Marais of Masihlangane shared some experiences of nurturing indigenous languages and in particular a module translation project at the University of South Africa. One of the biggest challenges is the lack of qualified language practitioners in indigenous languages. Some of the factors

that limit the development of indigenous languages are the lack of development and availability of attractive literature sources, language activism and activists, and the hegemony of English. In order to overcome these limitations, it is essential to build strong political and linguistic activism, develop political will in both the public and private sectors, and train language practitioners.

In order to conduct successful projects in indigenous languages, subject specialists should work with language practitioners; glossaries should be developed across subjects; short and focused academic workshops for language practitioners should be presented; specific terminology should be developed across all languages; all stakeholders should be actively involved; and memory-based translation software should be used.

Ms Carina Coetzer of Stellenbosch University focused on the language proficiency of post-Grade 12 students (millennials) and the experience of developing deeper learning of science and technology languages and increasing English language proficiency. The Ukuqonda English language proficiency programme incorporates academic and general language as well as communication skills. Millennials are characterised as the 'Me, Me, Me generation'. There are 80 million of them in the USA and 2.5 billion worldwide. They grew up alongside technology and they matter as they will comprise 50% of the workforce by 2020 and 75% by 2030. They aspire to make a difference through their work.

Language makes a huge impact on students, who need to articulate, apply and analyse information. The inability to cope with these pressures has an adverse effect on confidence, self-esteem and security. Language proficiency enables post-Grade 12 students to build confidence.

Discussion

Comment: The presentations provided an excellent spread of information, emphasised the enormity of the challenges, and highlighted the question of how to take the issues forward.

Comment: Being aware of what one does not know is a step in the right direction. It is essential to make learners believe in themselves and to provide encouragement. It is also important to make subjects interesting. There are significant challenges regarding the availability of appropriate material. Perhaps there could be a link from the NSTF website to material that teachers could access.

Response: Mathematics, science and technology workbooks are available online and a link will be added on the NSTF website.

Comment: We need to encourage people to write, as we are currently in a vicious circle – people do not read because there is no material available, because people do not write. Some effort is being made at the Foundation Phase level, but there is a great need for more effort later in the school system.

Comment: It is shocking that the issues and challenges related to language in teaching mathematics are new to some of the delegates at the forum. A key issue is teacher education. Teachers only know that language is a barrier, but generally do not know that language can be harnessed to promote understanding. A glossary of terms in different subject areas would be a useful tool in the interests of standardisation.

Response: Afrikaans was developed that way. Through discussion and consensus, standardisation was agreed upon and words coined to provide for the language to be used in all situations.

Comment: Afrikaans is the youngest language in the world. Through political intervention and the efforts of the Afrikaans people, it is possible to use it for all purposes. We need to make this happen in the African languages too.

Comment: Perhaps proSET could start a dedicated web page for discussions, posting of tips and suggestions with relation to materials for educators. To quote David Nhlapo: "Success comes in a can and failure comes in a cannot".

Comment: There seems to be a lot of work on multilingualism in presenting mathematics in the Foundation and Intermediate Phases, but much less is being done about mathematics language at

the Further Education and Training level. There is a great need to develop that end of the schooling system. There is a critical issue of low pass rate and proficiency, and language has a huge part to play in improvement in proficiency.

Comment: It seems that after public consultation, an additional section has been added to the new White Paper on Science, Technology and Innovation, focusing on STEM education with attention to language.

CLOSURE

The chairperson thanked everyone for their participation in the discussion forum. A list of recommendations would be developed and presented to the proSET committee, which would decide on the way forward.

The information from the forum would be available on the NSTF website at www.nstf.org.za.

Mr Dawie Botha thanked Ms Niehaus and NSTF staff on behalf of proSET for their hard work in organising the forum.

APPENDIX A: LIST OF ACRONYMS

BSTEP	Black Science, Technology and Engineering Professionals
DBE	Department of Basic Education
EAC	English Across the Curriculum
GDE	Gauteng Department of Education
HEI	Higher Education Institution
HSRC	Human Sciences Research Council
LoLT	Language of learning and teaching
NDP	National Development Plan
NSTF	National Science and Technology Forum
proSET	Professionals in Science, Engineering and Technology
SABC	South African Broadcasting Corporation
SET	Science, Engineering and Technology
STEM	Science, technology, engineering and mathematics
TUT	Tshwane University of Technology
UCT	University of Cape Town
UJ	University of Johannesburg
UKZN	University of KwaZulu-Natal
UL	University of Limpopo
Unisa	University of South Africa
USAID	US Agency for International Development
VIP	Very Important Person
Wits	University of the Witwatersrand

APPENDIX B: LIST OF DELEGATES

	Name	Organisation
1	Mr Mpho Madisha	Black Science, Technology and Engineering Professionals (BSTEP)
2	Mr Itumeleng Phage	Central University of Technology (CUT)
3	Mr B Monyaki	Department of Basic Education (DBE)
4	Ms M Masemula	DBE
5	Mr Dirk van Schalkwyk	Educator
6	Mr Leon Faurie	Gauteng Department of Education (GDE)
7	Mrs Linda Forson	GDE
8	Mr Pranay Devchand	GDE
9	Dr Sibusiso Manzini	GreenMatter
10	Mr Tony Dhlamini	Hartebeesthoek Radio Astronomy Observatory (HartRAO)
11	Mr Matthews Makgamatha	Human Sciences Research Council (HSRC)
12	Dr Cas Prinsloo	HSRC
13	Ms Debbi Schulz	Independent communications expert
14	Dr Lebs Mphahlele	Limpopo Department of Education
15	Ms Khethiwe Marais	Masihlangane
16	Mr Joseph Taetsane	Moipone Academy Science Centre
17	Ms Jade Jacobsohn	Nal'ibali Programme
18	Miss Nozipho Maome	National Advisory Council on Innovation (NACI)
19	Mr Mpho Matlala	ORT SA
20	Mr Fannie Matumba	Programme for Technological Careers (PROTEC)
21	Mr Dawie Botha	South African Academy of Engineering (SAAE)
22	Ms Matshidiso Matabane	South African Council for Natural Scientific Professions (SACNASP)
23	Mrs Marie Ashpole	South African Institution of Civil Engineering (SAICE)
24	Mr Armand Aime Eroko A Zintchem	Tshwane University of Technology (TUT)
25	Prof Thapelo Mamiala	TUT
26	Prof Piet Human	Ukuqonda Institute
27	Prof Mamokgethi Phakeng	University of Cape Town (UCT)
28	Mrs Babele Moletsane	University of the Free State (UFS)
29	Miss Karabo Padi	University of Johannesburg (UJ)
30	Mr Molf Paul Molefe	UJ
31	Mr Mphiriseni Khwanda	UJ
32	Miss Makie Kortjass	University of KwaZulu-Natal (UKZN)
33	Dr Nonhlanhla Mthiyane	UKZN
34	Mrs Wendy Chauke	University of Limpopo (UL)
35	Prof Satsope Maoto	UL
36	Mr Oscar Eybers	University of Pretoria (UP)
37	Ms Carina Coetzer	University of Stellenbosch (SU)
38	Prof Bhukumusa Khuzwayo	University of the Western Cape (UWC)
39	Dr Anthony Essien	University of the Witwatersrand (Wits)

	Name	Organisation
40	Dr Audrey Msimanga	Wits
41	Dr Pieter van Jaarsveld	Wits
42	Mr Ashraf Patel	Wits
43	Prof Samuel Oyoo	Wits
44	Ms Ingrid Sapire	Wits
45	Ms Cynthia Malan	Write Connection (Scribe)

APPENDIX C: SUMMARY OF RECOMMENDATIONS

Recommendations of Mr B Monyaki (Chief Education Specialist, Department of Basic Education)

- Language proficiency is required for proficient content acquisition.
- Learners often find examination questions difficult to understand, including the language structures, conventions and vocabulary (e.g. what is meant by 'an essay'). The standardisation of requirements would assist teachers and learners.
- Language teachers need to be thoroughly familiar with specific subject knowledge to prepare learners for assessment.
- Teachers should use the correct language in the classroom and in assessment tasks.
- Teachers should use the correct notation and mathematical language on a daily basis in the classroom.
- Teachers need to realise that learners' understanding of the concepts is more important than merely performing routine procedures.

Recommendations of Prof Mamokgethi Phakeng (Vice Chancellor: Research and Internationalisation, University of Cape Town)

- Given the political nature of language, the choices about which languages to use are not only pedagogic and cognitive, but also political choices.
- A multilingual approach is needed to mathematics teaching, learning and assessment.
- Multilingual policy requires a holistic view of multilingual learners. Black children should not have to choose a single language; learners should be given more than one languages as is done with Afrikaans.
- The principles that should guide a multilingual approach to mathematics education include:
 - Learners' home language should be deliberately and actively used rather than only code-switching, which is limited and reactive.
 - Languages should be used together and all texts should be in two languages, namely the home language and English.
 - Learners should be encouraged to communicate in their language of choice.
 - It is important to use interesting and challenging mathematics tasks and not to downgrade the level of mathematics because of a lack of proficiency in language.
 - A multilingual approach does not entail trying to develop a register or mathematics terminology in African languages. It is also not about developing learners' fluency in English or their home languages, and it is not about teaching only in African languages.
 - In a multilingual approach, all written texts are in both English and the learners' home languages.
 - Learners are encouraged to use their own language in the classroom, and teachers focus on mathematics rather than language.
 - Learners work in groups in any language they choose and all languages are respected, with the focus being on mathematics and not on language.
- Teacher education has an important role to play in addressing the disjuncture between research and practice in schools. It may be necessary to consider setting standards.

Recommendations of Mr Mpho Madisha, (Chairperson, Black Science, Technology and Engineering Programme)

- Mathematical terms are shared with everyday English but have distinct meanings in mathematics, which causes confusion among students. Some standardisation would make difficult subject-specific notation easier to understand.
- It is important to ensure that learning materials do not deter students.
- Critical terms and phrases should be identified to establish threshold knowledge, initially in English but also in African languages
- Students need opportunities to speak, read, write and listen to STEM vocabulary.
- Sometimes the words that prevent students from solving tasks are not even STEM related.
- Other socio-economic issues sometimes overshadow the language issues.
- Science has to be fun, and students need to be intrinsically motivated.
- Language has to be part of a learning plan, not an afterthought.

- Language as discourse should be explored, factoring in the way people talk. Science fiction could be considered as a discourse that learners can identify with, especially the emerging African science fiction writers. Perhaps have a science fiction novel as a set work.
- Enquiry-based learning should be emphasised, which provides stimulation and motivation and allows the learning of concepts.
- The Next Generation General Science Standards of the American Association for the Advancement of Science could be emulated in South Africa. The purposes of the standards include combatting ignorance of science, creating common standards for teaching, and developing greater interest in science among students so that more of them choose to study science and technology at tertiary level. The guidelines are intended to help students deeply understand core scientific concepts, to understand the scientific process of developing and testing ideas, and to have a greater ability to evaluate scientific evidence. Curricula based on the standards may cover fewer topics, but go more deeply into specific topics.
- It is necessary to include as many languages as possible, but this should not be done in a piecemeal way.
- The roots of words that we introduce into vocabulary should receive attention, as many English words have roots in other languages.

Recommendations of Dr Lebs Mphahlele (Deputy Director-General, Limpopo Department of Education)

- A great deal of advocacy and work with communities will be required to overcome the historical legacy related to language policy (e.g. the language choices made by school governing structures when deciding on language policy in schools).
- It is essential to find language to communicate across the disciplines of education and science.
- South Africa's language policy since 1994 is underpinned by multilingualism. The policy assumes a Foundation Phase education in language X and an Intermediate Phase in language Y. It is based on the premise that since a language structure has been established in the Foundation Phase, it is not necessary to continue with language X. The application of this policy in the schooling system, however, may have unintended consequences.
- Grade R should be introduced in all schools. The implications of introducing Grade R include the creation of posts and the training of sufficient Grade R teachers, for which the necessary budget would be required.

Recommendations of Dawie Botha (South African Academy of Engineering and proSET Chairperson)

- The introduction of African languages is possible, but it needs effort, time and respect.
- Through visual presentation, it was easy to explain the scope of the civil engineering domain. It is important to find similar ways to visually depict the science and mathematics professions in order to enable understanding.
- The multilingual environment is difficult and education sometimes suffers as a result, but it is possible to use relevant examples to reinforce messages.
- Crossed fingers do not hold up bridges.
- Teachers are very special people, but we want them to be super humans.
- There is no time to experiment; we only have one chance at education.
- We live in a world of branding and we need to embrace it.
- Never underestimate the responsibility of educators.
- There is a language gene, and some of us are better at it than others.
- Engineers are attracted to the discipline because of the mathematical aspects, but they must also be writers.
- Never underestimate the unintended results of your deeds and actions.

Recommendations of Prof Piet Human, Ukuqonda Institute

- It is important to introduce learners to the different genres of text. The teaching of mathematics is the teaching of language.
- Language is more than a means of communication: it is also as a vehicle for thinking, a carrier of concepts and a mathematical method.

- It is important to leave the choice of LoLT to teachers rather than to governing bodies. Various options for LoLT include English as LoLT (monolingual); home language as LoLT (monolingual); English and home language by code-switching or trans-languaging (parallel and multilingual).
- Mathematics education specialists should spend their energy and time promoting the progressive development of mathematics irrespective of the choice of LoLT.
- Demanding change from teachers and policing implementation will not necessarily promote language in the classroom.

Recommendations of Track A related to language in Early Childhood Development phase and primary school level

Ms Jade Jacobsohn, Managing Director, Nal'ibali Programme

- A well-established culture of reading could be a real 'game-changer' for STEM education in South Africa.
- Four key ingredients for promoting literacy are:
 - Knowledge and awareness of reading and books
 - Reading opportunities at school and at home
 - Role models, since children learn by example
 - Access to reading material in the mother tongue.
- A shared national narrative could be created with translated stories as well as stories created locally.

Ms Ingrid Sapire, University of the Witwatersrand

- We need to draw on all the languages of the country and not just accept the predominance of English.
- The Pan South African Language Board (PanSALB) should be involved in advancing these issues.
- The system must provide better for the varied needs of learners in terms of materials in relation to the Learning and Teaching Support Material Policy of October 2013
- Teacher support is needed to address teachers' needs and their ability to provide optimal learning opportunities for all learners.

Mrs Wendy Chauke, University of Limpopo

- The social influence on language learning must be taken into account.
- Language without real communication is useless.
- There is value in incorporating a language module in specialisation streams (e.g. language modules in each year of a technical course).
- The factors that affect language acquisition include: motivation, attitude, personality, climate in the classroom, the quality of the teacher conversation, time available for learning, and the opportunity for learning.

Mr Dirk van Schalkwyk, Educator

- There is a need for a paradigm shift from teacher-centred learning to student-centred learning.
- Any programmes that are implemented need to be sustainable.
- Scientists' failure to communicate sensibly impacts on STEM education. We say the right words, but these do not necessarily make sense to children and school teachers who lack a grounding in science.

Recommendations of Track B related to language in secondary school (high school) and tertiary level

Prof Samuel Oyoo, Director: Institutional Language, University of the Witwatersrand

- Urgent steps are required to help teacher and teacher educators to recognise that everyday words cease to be mere words of the language of learning and teaching (LoLT) when used in the science context.
- Focusing on contextual proficiency in LoLT during teaching holds the promise of enhanced learner outcomes in science.

- Teachers need to be encouraged to take more cognisance of the functional value of the non-technical words in the science teacher's language.
- Some solutions include mentoring and collaboration between teachers from different disciplines, possible reorganisation of the teacher training curriculum, in-service training programmes and further research on teacher educators' conceptions of the nature of science.

Prof Satsope Maoto, University of Limpopo

- Current research and trends suggest that indigenous languages can be used to teach science and technology, but the government lacks the will and commitment to place all languages on an equal footing.
- Teachers who are required to implement the curriculum are not involved in the development of the curriculum. The implementers need to become developers if policy is to be successfully implemented.
- A possible solution would be to teach mathematics as a language, since it provides a way of encountering the world.
- The use of African languages must be considered and taken seriously.
- The language of each discipline should be strengthened.
- Mathematics should be taught as a language.
- Teachers of the same discipline should interact and exchange ideas, successes and failures to create a community of practice.
- Code-switching is a possible source of help in teaching, but it must be applied sensitively.

Ms Khethiwe Marais, Masihlangane

- Strong political activism is required; we must insist that our children are taught in indigenous languages.
- It is essential to develop political will in both the public and private sectors.
- The training of language practitioners should be a priority. One of the biggest challenges is the lack of qualified language practitioners in indigenous languages.
- In order to conduct successful projects in indigenous languages, subject specialists should work with language practitioners; glossaries should be developed across subjects; short and focused academic workshops for language practitioners should be presented; specific terminology should be developed across all languages; all stakeholders should be actively involved; memory-based translation software should be used; and suitable training materials must be developed.

Ms Carina Coetzer, Stellenbosch University

- Language makes a huge impact on students, who need to articulate, apply and analyse information. The inability to cope with these pressures has an adverse effect on confidence, self-esteem and security. Language proficiency enables post-Grade 12 students to build confidence.
- Functional language is extremely important to successful learning.

Recommendations from the floor

- The impetus for change needs to come from the parent community
- In advocating the use of student language of choice, the importance of teacher education is critical.
- It is important to prepare students not just to communicate with others in their own profession, but also with non-specialists.
- After the first five to eight years, the plasticity of the brain decreases and further languages can only be learned in a structured manner. This refers to the time–age factor and implies that reaching oral reading fluency by Grade 3 is critical.
- We need to encourage people to write, as we are currently in a vicious circle – people do not read because there is no material available, because people do not write.
- Teachers only know that language is a barrier, but generally do not know that language can be harnessed to promote understanding. A glossary of terms in different subject areas would be a useful tool in the interests of standardisation.

Recommendations related to the role of the NSTF

- Mathematics, science and technology workbooks are available online and a link will be added on the NSTF website.

- Perhaps proSET could start a dedicated web page for discussions, posting of tips and suggestions with relation to materials for educators.
- Story telling is critical: we need to write more stories and possibly also share stories and relevant clips on the NSTF website.