NATIONAL SCIENCE AND TECHNOLOGY FORUM (NSTF)
PROCEEDINGS OF WORKSHOP ON SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS (STEM) EDUCATION

Date: 10 March 2010
Time: 09:30–13:15
Venue: MTN Sciencentre, Canal Walk, Century City, Cape Town

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WELCOME, ANNOUNCEMENTS AND INTRODUCTION

Ms Niehaus opened the meeting and welcomed everyone. The present workshop was a continuation of a series of workshops on science, technology, engineering and mathematics (STEM) education. The last STEM Education workshop was held in Pretoria on 17 August 2009. An extensive report on that workshop was available, and the proceedings of the present workshop would also be written up and would form part on the ongoing dialogue with the community involved in STEM education as well as the relevant authorities, particularly the Department of Basic Education (DBE).

Ms Niehaus introduced the topic by expressing her personal view. 1994 had ushered in a new democratic era in South Africa. There was much idealism at the time underlying the transition. South Africa's winning the Rugby World Cup in 1995 was a defining moment in the prevailing national optimism at the time.

The education curriculum is a work in progress. There were reasons for implementing it, and it is evolving. Fifteen years ago, Ms Niehaus was working with teachers and trying to convince them of the ideals of the OBE system, which had not yet been established, and had not even yet been fully defined. There was considerable idealism related to the idea of learner-centred teaching, with the needs of the learner as the point of departure. There was also considerable idealism related to the role of the educator (teacher) as facilitator. All these objectives were well documented at the time.

The OBE system had been developed through a consultative process, with contributions of many people throughout the country, and had tried to bring all these threads together, drawing on various practices across the world and combining them with local ideas. Ms Niehaus's view was that OBE was therefore inevitably imperfect and that it was necessary from time to time to revisit the curriculum so as to sharpen and improve aspects of it and make it more flexible in addressing actual needs.

These comments come from the perspective in which there has been much criticism of outcomes-based education (OBE) and of the education reform process. Ms Niehaus stressed the need to maintain an open mind about the type of education system that OBE had been intended to establish and to take responsibility as a collective body of educationalists and educators for having established the OBE system following extensive consultation and groundwork.

A worrying observation was the nostalgia in some quarters for the 'old days', with comments being made such as, "The whites got it right; the education system under apartheid produced numerous mathematicians and scientists. Why did we not simply replicate that system across the board, because we would then have had a perfect education system?"

This view was a complete misconception of where South Africa had came from. The apartheid education system was not a good one; it forbade learners to think for themselves, and anyone with political views that differed from those of the ruling party was not considered worthy of being a teacher. This was not the type of system that present-day South Africa would want to replicate. Apartheid education had entailed a rigid syllabus that teachers were required to follow, as well as a strict system of inspectors. Foundation phase teachers interpreted the syllabus very literally, to the extent that learners were not allowed to count beyond ten in grade 1. This had been the impact of Christian National education (for whites) and Bantu education (for blacks). In high school, learners were not allowed to ask questions on any topic outside the syllabus. Ms Niehaus disputed a view that was prevalent among many that the answer to South Africa's current education problems was simply to replicate Christian National education across the whole country.

The strategic objectives of the NSTF are:
- To influence and catalyse quality delivery of science, engineering, technology and innovation (SETI) policy
- To monitor the health of the SETI system
- To celebrate, recognise and reward excellence within the SETI sector.

It was therefore within the mandate of the NSTF to interact with government on matters of policy as well as to monitor the implementation of policy. The NSTF did not have its own mechanism for doing so and relied for its monitoring responsibility on interacting with the community and gathering feedback from the experience of communities of practitioners.

The NSTF has approximately 110 members divided into the following six constituencies: government; science councils; higher education; professional bodies in science, engineering and technology; civil society; and business. This is the audience that NSTF workshops address. The workshops do not specifically cater for educators, although the NSTF if keen to hear their views and values their opinions. There are other forums for educators, including the MTN Sciencentre, which hosts monthly educators' forums, at which educators can voice their opinions and discuss their concerns, and there are various routes for feedback.

The connection between the NSTF and educators is through professional associations such as the Association for Mathematics Education of South Africa (AMESA). The NSTF provides feedback to government from its constituent sectors through active interaction. The NSTF was working on ways in which to gather the opinions of the different sectors on various policy issues.

The NSTF had convened a workshop on STEM education in Pretoria on 17 August 2009 at which the following speakers made presentations:
- Dr Nhlanhla Nduna-Watson, Department of Basic Education
- Dr Eric Khoza, Denel Youth Foundation Training Programme (DYFTP)
- Aarnout Brombacher, Brombacher and Associates
- Dr Vijay Reddy, Director: Education, Science and Skills Development Programme, Human Sciences Research Council (HSRC)

The following issues were identified from the presentations and discussions at the workshop on 17 August 2009 for the purpose of formulating recommendations to government and follow-up discussions:

Teacher training and development

- A national initiative to support and capacitate teachers in the system is urgently needed (in other words, in-service training). Ms Niehaus observed that considerable in-service training had taken place under the Department of Education (DoE) as well as the provincial departments of education. The issue was how best to support teachers without removing them from the system and without saying that the issue could be addressed only at pre-service level. This recommendation recognises that there are many initiatives around the country that need to be coordinated, drawing on the expertise and support of, for example, science centres and subject specialists in higher education. The science centres are largely funded by the Department of Science and Technology (DST), which has good relations with the DBE, but the means and mechanisms still have to be found for the science centres to assist with effective teacher support and training.
- Ways should be found of replicating successful models and teaching practice. There are many models in South Africa that could be replicated, and mechanisms have to be found to filter successful examples to the areas of greatest need.
- Incentives may be needed to keep capable mathematics and science teachers in the teaching profession (for example, lucrative bursaries). This might not necessarily be purely in terms of salaries, as differentiated salaries would give rise to a number of other problems.

Effective teaching

- It is important to consider how learners learn rather than simply measuring the outputs in terms of examination results. Understanding should be valued, rather than just results. We should start concentrating on improving skills and abilities. The curriculum is ambiguous in this regard. On the one hand, it is outcomes based, and on the other hand there are many indications of the importance of the teaching process itself. Teachers are in a quandary as regards how to interpret their role. Since outcomes are important, assessment is emphasised, but there is then less time for teaching itself, and the process suffers.
- Consideration was given to adding an additional year of school to enable learners to achieve the requirements to get into tertiary education. Understanding and concept building at school level build an important foundation for learners' further studies and careers.

Early childhood development and the Foundation phase

- The importance of early learning as a foundation should not be overlooked. The earlier the interventions are made, the higher the returns on that investment.

Life orientation

- Life Orientation must be effectively taught in schools, and the career counselling aspects should not be neglected. Career counselling should empower learners by giving them a vision of what they can become.
- A weakness of Life Orientation and career guidance is that learners are not adequately advised which subjects to take in order to follow a particular career. Links need to be made between Life Orientation in schools and the many successful career counselling initiatives in the country. State support might be required for meaningful Life Orientation teaching.
- The NSTF workshops on education topics have tended to focus on the subjects of mathematics, physical science and Life Orientation teaching without considering in much detail the broader issue of language, which is critical for concept formation (a view that is supported by research).
- Learners also lack an understanding of the broader context and that mathematics, science, technological skills and innovation are vitally important if South Africa is to be competitive in a global world. It is not clear whether teachers across the board understand this or where it should be addressed in the curriculum. One of the ways in which this might be addressed is through the Eskom Expo for Young Scientists, which gives learners an opportunity to experience the relationship between mathematics and science on the one hand and useful technology on the other. School projects alone do not seem to help in this regard, and a more planned and guided intervention seems to be necessary.

Mathematical literacy

- We need to develop a shared sense of what it means to do mathematics literacy.
- In early discussions between higher education and the DoE, there was an agreement that higher education would be able to ask the DoE for the marks on the second mathematics literacy paper, which would be used as the basis for admission to certain university programmes. This discussion should be resumed from the perspective of the skills with which mathematics literacy equips learners. Mathematics literacy was never meant to be a subject that learners take by default if they struggle with mathematics.
- Consideration should be given to making mathematics literacy compulsory, as initially envisaged, as a separate life skill from Life Orientation. Considerations in doing so might include lower time allocation and credit allocation than for other subjects, as well as examination by means of an internal portfolio.

Mathematics

- We need to develop a shared sense of what it means to do mathematics in the modern world. Other countries have developed tailor-made mathematics courses at secondary school level for different purposes (for example, those that intend to go into vocational careers). South Africa already has mathematics service courses at tertiary level, for example, different mathematics courses for those studying biology or engineering. South Africa might need to consider this type of approach.
- Higher education institutions need to start documenting the skills gaps among students so that these issues can be addressed in the school curriculum.
- Developing problem-solving skills must not be neglected in the teaching of mathematics. The curriculum establishes the development of problem-solving as an intention, but there are deficiencies in implementation. A systematic approach to guidance and practice is important in building confidence among learners in their problem-solving ability, especially in the context in which many have illiterate parents.

Physical science

- Higher education institutions need to start documenting the skills gaps among students so that these issues can be addressed in the school curriculum.
- There may be a need to institute an alternative physical science subject that is more engineering oriented for learners that intend to enter the vocational world and exercise a trade after leaving school.

Assessment

- The issue of assessment and over-assessment in the education system was raised. The place of regular assessment must be considered. Ms Niehaus observed that the DBE had already acknowledged the validity of the view that there is too much assessment in schools.

Exemplar papers

- There may have been too much repetition between the exemplar papers and the final papers prepared for the 2008 national senior certificate examination.

Second opportunities

- There is support for second opportunities at various stages in education. We should perhaps consider which stages those should be, as well as what kind of second opportunities to promote.
- We do not seem to give enough hope to children that fail grade 12 or do not get sufficiently good marks to get into their chosen course of study.
- Consideration must be given to how to replicate successful examples of second chance opportunities, focusing on mathematics, science and language.

Focusing on the ultimate objective of education

- Effective education in science and technology prepares learners for the world of work. The important issue is not so much the results that learners achieve in matric but what they go on to do afterwards.
- Science, technology, engineering and mathematics (STEM) learning is a means to an end, with the goal of sending learners into society to make a useful contribution. It should be borne in mind that the majority of learners do not continue to higher education.
- Bursaries at secondary school level are important, as are FET colleges. Information and funding are required to address the various purposes of education.

There is clearly a need for a turnaround strategy in education, given the recognition that there are many shortcomings in the course that has been charted. It should be borne in mind that this cannot be done quickly or perhaps even within ten years. There is a need for a new long-term plan in education.

Consideration needs to be given to:

- The good aspects of OBE that should be retained. The workshop should consider recommendations to the DBE in this regard.
- How to manage textbooks: For some time, the education system had been uncomfortable about using textbooks, but it is now recognised that textbooks are needed in the classroom again.
- How to manage teacher training and in-service training
- How the NSTF can assist in addressing the issues that face education and what it can do to interact with the department and help coordinate efforts.

It was hoped to take these insights and issues to a new level through the discussions at the present workshop, which would include the opportunity for interaction with the Western Cape Education Department and the National Department of Basic Education, so as to contribute to policy formulation and implementation.

Ms Niehaus introduced Mr Mosuwe from the DBE and expressed her appreciation for the opportunity for dialogue with the department during the present time of transition.

PRESENTATIONS

Review of the implementation of the National Curriculum Statement (Mr Edward Mosuwe, Chief Director: Further Education and Training: Schools, Department of Basic Education)

Mr Mosuwe commented that the report by Ms Niehaus suggested that education might be under siege and that the workshop came at an appropriate time for the DBE to engage with the issues. He noted the importance of considering the point that South Africa had reached as a country as well as in terms of its education system and commented on the need to review the direction set for the future.

The purpose of this presentation was to provide a perspective on the current direction in education in order to enable the education community to make meaningful contributions to the process.

Since the 2009 general elections, the Presidency and all commentators were in agreement that there were areas where the schooling system was underperforming. It had been reported that young people in the education system cannot read and write at appropriate levels. Major interventions had become necessary, and the question was whether they would yield the desired results.

Questions had been raised in parliament as to whether OBE was dead. Mr Mosuwe commented that until South African children could read, write and calculate appropriately, it would not matter much whether education was based on OBE or some other system. It should be noted that from the Presidency down, the focus of the government was on outcomes, and in the current administration, there was a Ministry dealing with monitoring and performance evaluation. Its focus was primarily on the kinds of outcomes that must yield the desired form of citizenship. The implications of having that ministry in place had been that all other ministries had been required to reorganise themselves so as to influence their sectors.

School education (basic education) is a concurrent competence, which is the responsibility both of the national DoBE as well as the nine provincial departments of education, each of which prescribes its own policy. When the matric results are announced, it is incumbent upon the Minister of Basic Education to respond, although the DoBE is not responsible for determining priorities or for spending on education in the provinces. In the current government planning process, there were indications of the need to move away from a silo approach and begin to integrate systems. The Minister of Basic Education had hence reported that in 2010, a schooling improvement plan was to be developed to serve as a blueprint for the agreed way forward for the national and provincial departments of education. It was hoped that more information on the envisaged plan would be included in the Minister's budget speech on 23 March 2010.

It was acknowledged that there was a need to revisit and assess the National Strategy for Mathematics and Science Education (which had run from 2001–2009) and possibly to refocus this strategy on the basis of the lessons learnt, the identified mistakes and the way in which the implementation of the strategy could be improved. The community of roleplayers in mathematics and science education would be called upon to engage on the process to be taken forward.

The Dinaledi schools projects had operated since 2002, and involvement had increased from 200 to 500 schools. The project had demonstrated not only how to improve the quality of school education in mathematics and science (which had been its focus) but also how to increase the numbers of learners in these subjects. The Dinaledi project had been subjected to independent evaluation, and the report showed that the mean scores were more positive than for other schools of a similar nature and in similar environments. It would seem that there were lessons to be learnt from the project. The department intended to communicate this information more clearly.

The Minister had stated that school education was in crisis, but not all aspects of the system were gloomy, and there were many schools that were performing well. When Naledi Pandor had been Minister of Education, she had constituted a task team to investigate the schools that were doing well and the reasons for their performance; the exercise had yielded some valuable lessons.

However, South African education still faced challenges, particularly with respect to mathematics and science. The new Minister (Mrs Angie Motshekga) had established a task team to investigate the curriculum, which was central in guiding the way forward. The task team had comprised a number of distinguished South Africans, including Prof. John Volmink (chairperson of the Umalusi council), Fatima Dada (textbook writer and publisher) and Dr Ursula Hoadley (University of Cape Town), Sue Müller (NAPTOSA, a curriculum expert), Tsedi Dipholo (South African Council of Educators), Penny Vinjevold (HOD for Education, Western Cape), Palesa Tyobeka (DGG: General Education Branch, DBE) and Elspeth Campbell (AMESA).

The role of the task had been to investigate the challenges that teachers face in light of the implementation of the National Curriculum Statement (NCS). The terms of reference for the task team were to listen to the voice of the teacher for guidance on what had to be done. The task team was therefore required to hold public hearings with teachers in order to identify the challenges they faced, consider how they could be addressed and recommend how the education system could respond in a practical and meaningful way. The reason for the investigation had been to ensure the centrality of the improvement of the quality of teaching and learning. It is clearly understood that in the majority of South African schools, particularly black schools, the learning achievement outcomes are far below expectations. The task team had visited all nine provinces and listened to more than 700 teachers; in addition, just short of 500 electronic submissions had been received from members of the public.

The findings of the report included:

- The existence of confusion within the education system with respect to the long-term goal for schools. The report had proposed that the department provide a vision for the schooling system, particularly with respect to what the curriculum was intended to achieve.

- The need to support teachers in the classroom as fundamental to achieving educational objectives.
- The need for mechanisms to monitor the extent to which the milestones in the education plan were met in order to ensure learner performance.
- The fact that teachers have to refer to too many documents – subject statement, subject assessment guidelines, learning programme guidelines – which sometimes detracts from the imperative to do teaching and learning in the classroom
- Some lack of coordination and coherence in the curriculum between different learning phases.

The recommendations of the report included:
- A five-year plan for education
- The need for a set of simple and coherent curriculum documents, comprising a single overview curriculum and assessment policy document from grade R–12, specifying for the teacher the type of content to be taught, the skills learners were expected to learn and the assessment requirements for different topics
- The need to address identified knowledge gaps.

The assessment was not intended to be a full curriculum review. The department intended to address the recommendations by compiling current documents in a more streamlined and more accessible way. In areas where specific gaps had been identified, the department intended to consider how they could be addressed.

Mr Mosuwe observed that the mathematics fraternity had not been sufficiently able to assist the department by providing guidance on whether Euclidean geometry should be included in mathematics paper 2 (which was compulsory) or mathematics paper 3 (which was voluntary).

Another area in which the department required guidance, following the large percentage of failures in grade 12 science in 2009, was whether there was curriculum overload. After engaging with the examiners and markers, it seemed to the department that there might have been specific challenges in the examination. The physical science paper had been quality assured, moderated and approved at all levels, but the problems had only become evident when the paper had been written.

In the current context, learners whose home language is not English are often exposed to English only at grade 4 level, placing those learners at a disadvantage. The report recommended that the education system should provide for the effective teaching of home languages and strengthen mother tongue instruction in the early grades, but that at the same time, the teaching of English should be expanded into the Foundation phase, introducing English (First Additional Language) for learners whose mother tongue was not English. Although this recommendation may be contested, the rationale is to prepare learners who have not yet encountered English so that they can use English as their language of learning and teaching in later years.

In some parts of the country, teachers have to teach multi-grade classes. Such schools are mostly found in the rural areas. The issue is to provide specific guidelines to support teachers in that situation.

White Paper No. 6 stated the need to ensure inclusion. Since the publication of that White Paper, one of the major shortcomings had been that the system had been unable to translate its recommendations into implementation. The task team had therefore recommended that teachers need to be assisted in understanding how to identify learners that experience barriers to learning.

The report indicated the usefulness of the Foundations for Learning Campaign, which had been launched in 2008 with the aim of improving numeracy and literacy among learners in grades 1–6. Mr Mosuwe's personal view was that the Campaign had begun to demonstrate challenges in the

curriculum at the lower levels. Because of the broad way in which the curriculum had been written, teachers were not certain what they had to teach. It was therefore proposed that more clarity should be provided on the kinds of outcomes required in each phase and in each grade. Teachers had welcomed the Foundations for Learning Campaign because it had begun to provide direction in this regard. The report of the task team recommended that the Foundations for Learning Campaign be replicated as a programme in all schools and incorporated in the curriculum.

The issue of assessment had emerged during the review. In his State of the Nation address, the President had indicated the need to focus attention and energy on making learners in the lower grades comfortable so that they could achieve in respect of literacy and numeracy. If the competencies required for mathematics and science had not been fostered in the lower grades, it was too late to try to teach these skills in grades 10, 11 and 12. There would be annual external assessments of mathematics and home languages as well as English (First Additional Language) in grades 3, 6 and 9. These assessments were scheduled to start in 2010. They would be externally set and would be administered in all schools.

The Common Task Assessment (CTA) used to be conducted for learners in grade 9. The Minister had proposed that the CTA should be discontinued as from the present year. The CTA had contributed 25% of the total mark for promotion to grade 10. If the CTA were removed, it would have to be replaced with a different form of assessment. The annual external assessment could potentially replace the CTA, but would cover only mathematics and language, whereas CTAs had covered all eight learning areas. There was a view that in the interim, as the system developed, schools would set their own examinations in the other areas.

Another issue was to finalise the promotion and progression requirements for grades 7–12 as well as the grading descriptors. In the past, the GET phase had used a four-point rating scale and FET a seven-point scale. The report recommended a uniform policy in respect of grading descriptions as well as indicating the promotion and progression requirements. The current policy view was that learners should progress with their age cohort but must demonstrate competencies to move from one grade to the next.

The report recommended establishing a balance between the year mark and the examination mark at the level of 50:50, whereas currently in grade 9, continuous assessment counted 75% and the CTA 25%. Conversely, in the FET phase, continuous assessment counts 25% of the promotion mark and the final examination 75%. In order to be promoted from grade 9 to grade 10, a learner must achieve level 3 in one of the languages and mathematics. In the past, a learner either passed of failed, whereas in the current system, different levels of achievement are recognised (for example, moderate achievement; outstanding achievement).

Currently, the performance requirements in the FET phase are:

- Four compulsory subjects, namely a language at home language level, another language (which can be taken at first additional language level), mathematics or mathematics literacy, and life orientation. One of the issues is whether mathematics literacy should be offered as an alternative subject to mathematics or whether it should be taught to all learners as part of life orientation. A learner will fail the National Senior Certificate if he/she achieves less than 40% in the home language, or another language that taken as the first language.
- Three other subjects.

Another issue in education is the transition from one phase to another.

Teachers have spoken of being overloaded with respect to assessment. In the past, learning outcomes and assessment standards were applied. Teachers were expected to record a mark for each learner against each of the assessment standards. It is difficult to divide knowledge up in that way.

There was a view that there were too many learning programmes in the Intermediate phase (eight learning areas) compared with the Foundation phase, where learners do only the three learning programmes of literacy, numeracy and life skills. The report recommended reducing the number of learning areas in the Intermediate phase; it recommended that aspects of technology should be incorporated in the natural sciences and that general studies should be introduced, which would include religion. 'Religious education' is in contravention of the national policy; only 'religion education' can be taught.

The Minister had established a ministerial project committee to consider the recommendations of the report of the task team that reviewed the curriculum. The role of the committee was to develop the Curriculum and Assessment Policy documents. The Minister is mindful of the implications of the recommendations, since reducing the number of subjects would impact upon those that currently teach those subjects. If the recommendation were implemented, attention would have to be paid to what to do with those teachers – whether to deploy them in other areas, and if so, how to reskill them. No final decisions had been taken in respect of the recommendations.

The report recommended the need for targeted in-service teacher training, which would focus on making the various players in the system aware of the areas for which they are responsible. It is important to define roles and responsibilities at every level of the education system, including curriculum advisors, subject advisors, provincial department officials, national department officials, principals and teachers.

The report found that higher education teacher training programmes are not necessarily in line with classroom requirements and recommended that higher education institutions be required to align their programmes with the national curriculum documents.

The DoBE had tried to integrate the recommendations from a teacher summit held in 2009 with the recommendations of the task team. Working groups are addressing these matters.

The report had also addressed the issue of textbooks. Given that most schools are poverty stricken and are located in depressed socioeconomic circumstances, often in rural areas where they do not have ready access to the facilities available in metropolitan areas, textbooks ensure that learners have access to quality beyond the classroom. Although there had been a view at the time of the introduction of the NCS that textbooks were not required, the role of textbooks was being reassessed. A well-written textbook introduces basic concepts and also covers material at higher levels of complexity. A mechanism is required to manage the pricing of textbooks.

The Minister has established three task teams:

- Ministerial project committee to oversees the development of the process
- Committee responsible for investigating the implications of the implementation of the reduction of learning areas in the Intermediate phase
- Task team reviewing recommendations with respect to textbooks and learning teaching support materials (LTSM).

No major decisions had yet been taken yet on the basis of the report. During 2010, schools would use the same documents as in the past until the Curriculum and Assessment Policy document had been formally launched and gazetted as policy. The Minister had taken some immediate decisions to reduce the administrative load on teachers as a means of improving the quality of teaching and learning.

The issues covered in the presentation, while they might not necessarily be specific to mathematics and science, certainly impact on the teaching of these subjects. There would be an opportunity for subject specialists to comment on the documents that were to be produced. It was also important for the DoBE to access the views of those that were interested in the products emerging from the schooling system. It was hoped that the documents would be ready by the end

of August. The DoBE would liaise with the NSTF with a view to further participation. The DoBE also hoped to engage more extensively with the NSTF with respect to the Mathematics and Science Strategy.

Discussion

Dr N Govender (School of Science, Mathematicss and Technology Education, University of KwaZulu-Natal): With respect to the curriculum, which is at the heart of teaching, I believe that deep learning experiences take place at the chalk face, where teachers and learners are involved, and we need to spend considerable time and money in supporting this. Because of the importance of the link between the learner and teacher, we at UKZN are involved in in-service and the pre-service teacher education. The teacher's experiences of learning and teaching are very important. The university has therefore offered formal in-service programmes in science and mathematics since 2001. These programmes have been funded by the Kwazulu-Natal provincial department of education. Over the last four years, 1200 mathematics literacy teachers have been trained; there have been 250 in-service physical science teachers in the last year and 450 mathematics teachers. The way in which the departmental budgets for in-service programmes is managed is a matter for concern. Institutions may be invited as late as October to be ready to present in-service programmes from January the next year. There is thus a lack of coordination with respect to formal programmes between the national and provincial departments of education and the higher education institutions. In-service programmes have proven value in enhancing the pedagogic content knowledge of teachers at different levels. I believe that investments in such programmes should therefore be better coordinated.

Edward Mosuwe: As a result of the creation of the new Department of Basic Education, the Minister has taken the view that the department must be organised in such a way that it relates to provincial education departments in order to respond to such issues.

There is a national curriculum for grades R–12, but within the department in the past, there were different structures dealing with the various phases, such as GET and FET. There was thus a lack of coordination even at national departmental level. There is now to be a Curriculum Branch to deal with all curriculum matters from grades R–12, and it is hoped that this will increases efficiencies. Having noted the importance and centrality of teachers, the Minister plans to establish a full branch for teachers, including teacher development and training. These steps ought to assist with coordination.

The five-year plan that the task team recommended would be aimed at dealing with deficiencies that had been noted in the system. Investment of the considerable funding available in provincial departments of education as well as the ETDP SETA could begin to show results. The approach is now to have a national plan informed by the realities that all roleplayers seek to address, including universities, NGOs and other stakeholders that are involved in teacher training. There are many examples of successes in the system, but some things could have been done better.

Dr Gillian Arendse (Ithemba LABS): Setting the bar so low for passing matric would not appear to encourage growth and development.

Edward Mosuwe: Growth and development should be at the centre of education; however, it should be remembered that in the previous curriculum (which made provision for learners to study subjects at either the Higher Grade or Standard Grade level), most learners took subjects at SG level. In that system, learners could pass matric on the basis of their aggregate, whereas in the current NCS, the learner has to demonstrate minimum competence in a number of subjects. In the past, a learner could pass matric by getting high marks for only three of the six subjects, provided that the aggregate was high enough.

A bigger question in the current context is whether the schooling system provides for major differentiation. The NCS provides for 29 subjects at FET level (if languages are lumped together) in a number of different streams, including natural sciences, services, agricultural and others. On paper, we show that we are expanding access, but not all the subjects are offered in all areas. This issue is linked to the extent to which career guidance is offered to guide learners on which subject choices to take. The education system could do better in providing career guidance and offering subject choices.

The minimum matric performance requirements represent the bare minimum with respect to achievement in order to deal with candidates at the lower end of achievement, who in the past would have been SG learners. At the same time, the system provides for the top learners to achieve at the upper end of the system. I believe that the demands of the present system in terms of passing matric are higher than the previous system.

Prof. Thapelo Mamiala (North West University): It is common knowledge that language influences learners' understanding of concepts, particularly in mathematics and science. Afrikaans is one of the youngest languages in the world, but Afrikaners have managed to develop their language to the extent that it is used as a language of science and research, and education can be conducted in Afrikaans from grade 1 up to PhD level. To what extent can we dream of the day when African languages are not just taught as additional languages but are sufficiently developed to be used as languages of research and science? We still seem to be anchored in using English as the medium of teaching.

Dr Humphrey Sithebe (Element 6 Advanced Materials): The language used in secondary schools is important. When we talk about mathematics and science, we cannot do so without also talking about language. We need to introduce English early.

Another recommendation is to consider paying mathematics and science teachers to teach learners from disadvantaged schools over the weekend and during holidays.

We must find a solution in the long term to having separate classes for grades 1–5 rather than multigrade classes.

Edward Mosuwe: On the issue of developing African languages to become languages of learning, teaching and research, the DBE has found it difficult to find writers in some of the African languages when there has been call for textbooks or setwork books. The department believes that mother tongue instruction is important, and with the assistance of the Pan South African Language Board (PanSALB) is trying to determine the extent to which certain of the African languages can be resuscitated, but this is proving to be a difficult task.

Basic school functionality is the best predictor of the performance of its learners, rather than the language of instruction.

With respect to the suggested incentives for mathematics and science teachers, the education system is grappling with teacher demand and supply, and the international literature provides some evidence that incentives can work. When incentives are introduced into an organised labour environment, however, the matter becomes a bargaining issue.

In the past, young people tended not to want to go into teaching. However, young Afrikaans girls are increasingly opting for careers in teaching (including subjects such as mathematics and science) to a greater extent than other demographic groups. The DBE is trying to establish what motivates them and to learn from this in order to use the knowledge to redirect policy so as to encourage others.

It was found that many of the underperforming high schools, with matric pass rates of less than 20%, had enrolled small numbers of grade 12 learners. This makes for inefficiency in the system.

I propose that we consider a situation in which certain schools in a region focus on offering tuition in a particular grade for the whole region. This approach could also be used to eliminate multigrade classrooms.

With respect to infrastructure planning, the backlog is currently R265 billion according to the National Education Infrastructure Management System

Michael Ellis (MTN Sciencentre): In 2003, South Africa participated in the Trends in International Mathematics and Science Study (TIMSS) and the Progress in International Reading Literacy Study (PIRLS). South Africa was not involved in the 2007 TIMSS study, which is to be repeated in 2011. Would the DBE consider South African participation in such studies again as a means of assessing the system as a whole, specifically mathematics, science and literacy?

Ms Nokwanda Siyengo (University of Stellenbosch): The comment was made that performance in the matric mathematics literacy paper 2 might be considered as an entrance requirement to certain university programmes. In the bridging programme that we run at the University of Stellenbosch, we have to assist learners that have been given that information, and might even have achieved a distinction in mathematics literacy, but cannot be considered for science or engineering courses. We have to assist these disillusioned learners to pass matric mathematics.

Edward Mosuwe: On the issue of TIMMS and PIRLS, the Foundations for Learning Campaign and the annual national external assessment are intended to get South Africa to the point where it can re-enter the international assessments. However, the view had been expressed in education circles that the way in which the PIRLS questions were phrased would make it difficult for average children in South Africa to do well in the assessment, because they might not have been exposed to some of the scenarios covered in the assessment (for example, deep-sea diving). Minister Pandor put a stop to South Africa's participation in the international benchmarking assessments, because it was considered that there was first a need for interventions, after which meaningful participation in the assessment would establish whether the intervention had been successful.

There seems to have been some miscommunication of the purpose of mathematics literacy, and some have mistakenly interpreted it as equivalent to standard grade mathematics in the previous curriculum, which did provide entry into certain higher education courses. Another issue is that HESA placed some subjects on the designated list and others not. All these issues point to the need for informed guidance of learners with respect to their subject choice in grade 10. The ministerial task team on mathematics matric results, established in 2009 to investigate the 2008 results, found many learners who had performed well in mathematics literacy. Such learners should instead have been encouraged to take mathematics as a subject.

Dr Kenneth Zimba (Vaal University of Technology): Since there are so many potential topics for discussion, I suggest that in such a situation, the NSTF should narrow down the particular topics for discussion at the workshops.

I trust that the DBE listens to this consultation and takes the issues raised into account when policy is formulated.

On the issue of the gaps in the knowledge of first-year university students (as documented by HESA), I believe that higher education institutions should take the National Curriculum Statement into account in developing their courses, and that they should have been consulted with respect to the matric curriculum.

I also believe that educators should have been consulted before the DBE and the Minister made statements that OBE was out of date so that agreement could have been reached and the parties could have understood one another.

Dr Kosie Smit (University of Stellenbosch): I agree that teachers are tired of attending training courses and workshops. I believe that the Advanced Certificate in Education (ACE) is a focused way of training teachers in the expertise required to teach specific subjects. There are two main problems with the ACE: (1) in the past, there were doubts about the role and value of the ACE, and it was therefore unpopular; (2) according to the draft statement on the structuring of teacher training, it seems that the ACE is to be replaced by an advanced diploma, but such a diploma represents the end of the road in training and is not part of a learning trajectory. It is important to be able to offer teachers a learning trajectory.

Edward Mosuwe: On the issue of policy formulation and who is involved in consultation, government policy formulation is increasingly informed by evidence. An example from the DBE is that the department has consulted with AMESA and SAMF on whether Euclidean geometry should be included in mathematics paper 2 or 3, but there is no consensus on the matter between AMESA and SAMF. In the situation where there is a lack of consensus between groups of stakeholders that are consulted (or even a lack of consensus between experts), the policy-maker has to take policy decisions that are for the greater good.

There is confusion as to whether OBE is dead. We cannot say OBE is dead unless we look at the values, principles and processes that informed the development of the curriculum. I would say that OBE is dead in terms of a narrow interpretation of the curriculum. My view is that we are beginning to redefine what we mean by OBE, since it addressed the fundamental concern that children should be able to read and write. OBE is not informed only by the DBE but is entrenched in the National Qualifications Framework.

With respect to the value of ACE programmes, it should be acknowledged that the ACE programmes have been problematic: some were good, but many were not. The DBE acknowledges the fundamental need to provide for the subject content knowledge of teachers. The system is fraught with difficulties, which the department is addressing. The good elements of the existing system will be taken forward. Minister Pandor insisted that the department should not allow anyone without a university qualification to teach. However, university faculties of science and of education are often not well coordinated in order to complement each other in providing training to teachers. These types of tensions need to be addressed in moving forward, and there are no simple solutions.

The challenge of inadequate achievement and underachievement in mathematics: Focus on a meta-approach (Prof. Kobus Maree, University of Pretoria)

Note: The bibliography for the presentation by Prof. Kobus Maree can be found in Appendix C.

Introduction

Inadequate achievement and underachievement in mathematics impacts both on tertiary study and the national economy (Simkins, Rule & Bernstein, 2007). The negative effect on the economy is practically incalculable.

South African educational institutions are reduced to ongoing reflection about their nature and objectives in an attempt to prepare learners adequately for a changing world. Close to 40% of all first-year students fail their first year of study (especially learners from traditionally disadvantaged communities (Mkhabela, 2004; Pandor, 2004).

Problem statement

Finding a silver bullet: How can the challenge of inadequate achievement and underachievement in mathematics be handled in South Africa, particularly since more adequate

mathematics achievement will in itself contribute to an increase in the number of admissions to sought-after study fields, facilitate better job opportunities, assist individuals in designing meaningful lives and moderate the current restricted national growth?

The following questions emerge from the problem statement:

- Does part of the solution perhaps lie in mathematics teachers being remunerated considerably better than other teachers? (But what about, for example, language teachers, who feel that their contribution is equally vital?)
- Should we recruit retired teachers or those who have left the profession?
- Are the massive amounts invested in Dinaledi schools a good idea? Or should support rather be given to traditionally 'advantaged' ('elite') schools with a demonstrated achievement record to take in more learners from across the diversity spectrum and assist them to perform better in mathematics (Simkins, Rule & Bernstein, 2007)?

A solution-focused approach seems essential. Mere discussion and analysis of the numerous problems is counterproductive.

Some reasons why improved mathematics achievement is non-negotiable

Economic change

- Education, training and re-training will play an important role in respect of the knowledge, skills and attitudes required for a rapidly changing situation.
- Improved mathematics achievement is essential in this regard (Kahn, 2003).
- People that have not completed schooling earn less than R1100 per month; matriculants earn R1600 per month, diplomates R3200, degreed people R5500 (Cloete, 2009).

Unemployment

- The official unemployment rate in South Africa currently stands at 32.6%, and unofficially it is estimated to be as high as 50% (Maree, 2002; Mkhize, 2004).
- South Africa is heading for a crisis due to the high population growth and the inability of the economic sector to create enough job opportunities for young work-seekers.
- The statistics are disturbing. While 75% of all white South African matriculants of 2001 have found employment, only 18% of their black counterparts have since found a job. Corresponding figures for coloured and Indian matriculants are 45% and 32% respectively.
- One in every 20 matriculants has given up finding a job (Nielsen, 2004)
- The discrepancies are blamed on unequal achievement in mathematics and physical sciences (far too many black learners still underachieve in grade 12, which has far-reaching negative effects on their chances of gaining access to tertiary institutions and eventually finding a job) (Reddy, Dlamini & Ntshingila-Khoza, 2004).
- In 2000, individuals with tertiary education were twice as likely to be employed as those with less than matric. By 2007, individuals with tertiary education were three times as likely to be employed as those with less than matric. In 2002, white South Africans were twice as likely to get a university education; by 2007 this had increased to 3.5 times.

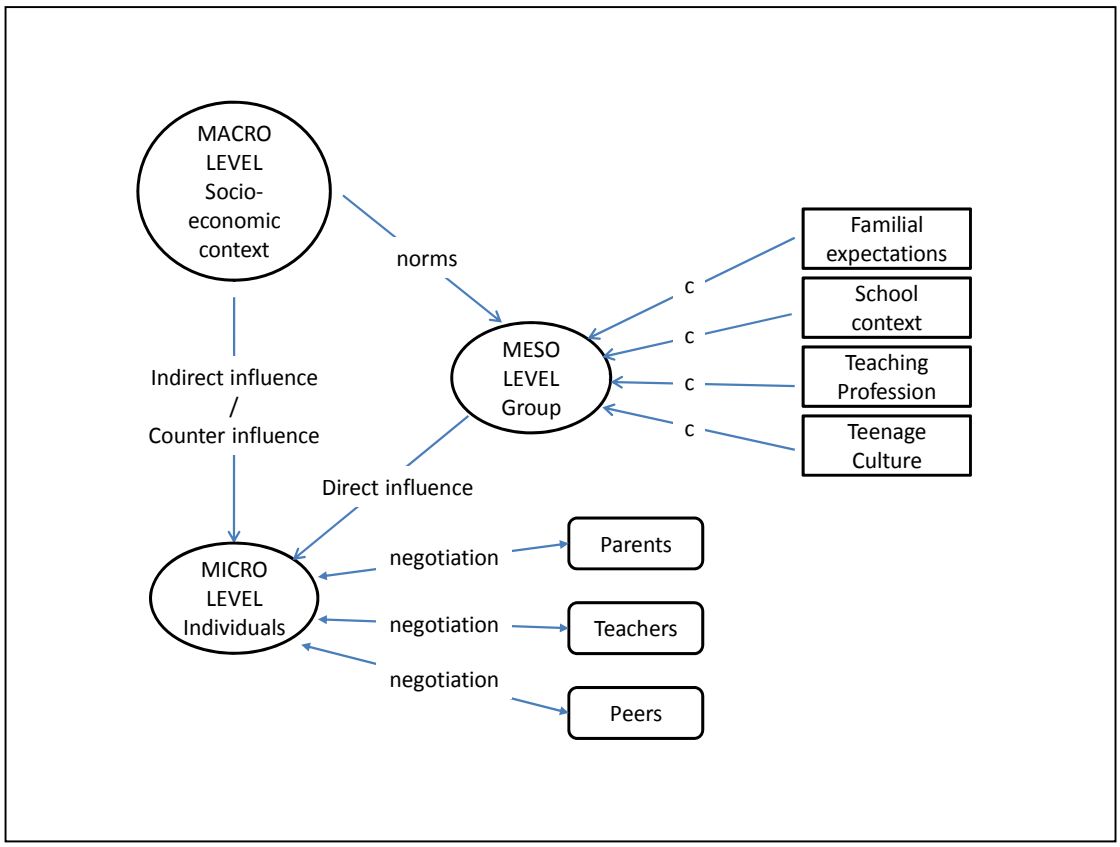
Technological change

- Technological progress one of the largest incentives for change within a community (Smith, in Van Dyk et al. [1995])
- Unless the performance of South African learners in mathematics and physical sciences in particular improves drastically, the country (in essence a developing country with a very strong Third World economic component) runs the risk of falling even further behind.

Re-drawing the contours of the discussion: meta-approach towards the challenge of inadequate achievement and underachievement in mathematics

Prof. Mark Savickas (2008; 2009), undisputed world leader in the field of counselling and career psychology, believes that there is much that South Africans can do to deal with the challenges without necessarily having to re-invent the wheel. Savickas (2009) uses the term 'meta-approach' to indicate that existing approaches can be meaningfully blended to design a newer, more streamlined and pragmatic, functional meta-approach as the basis for dealing with challenges.

Baron and Hourbette (2005) worked on trying to diminish inequalities between gender groups in mathematics (Figure 1). They focused on the macro, meso and micro levels. Their approach is relevant in the South African context of inequality. A possible framework for enhancing mathematics achievement at each of these levels is shown in Figure 3.



Source: Baron and Hourbette (2005: 1)
Figure 1: Categorisation of research on mathematics and gender

Education policy formulation needs to be informed by evidence, including teaching and learning theories and the role of language. It is also critically important to involve parents. Unless all aspects shown in Figure 2 are taken into account, any attempts to address the problems will be incomplete.

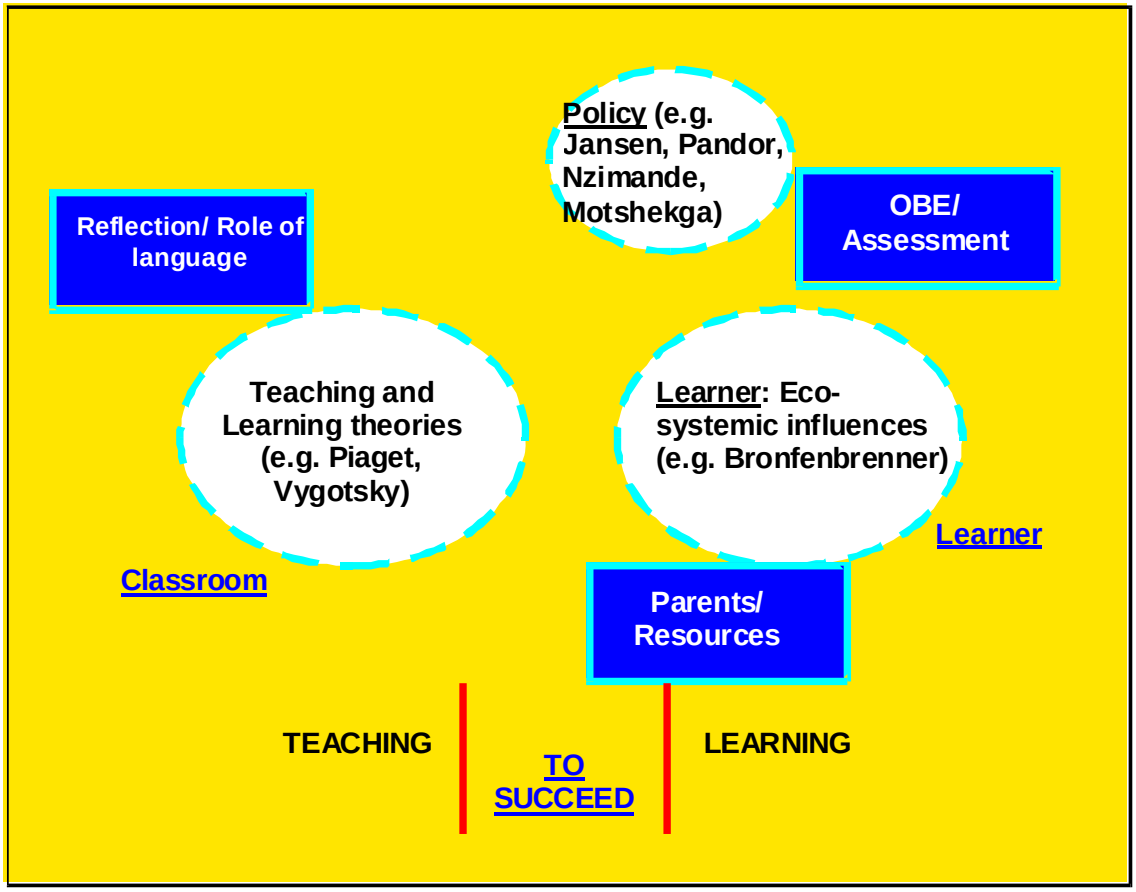
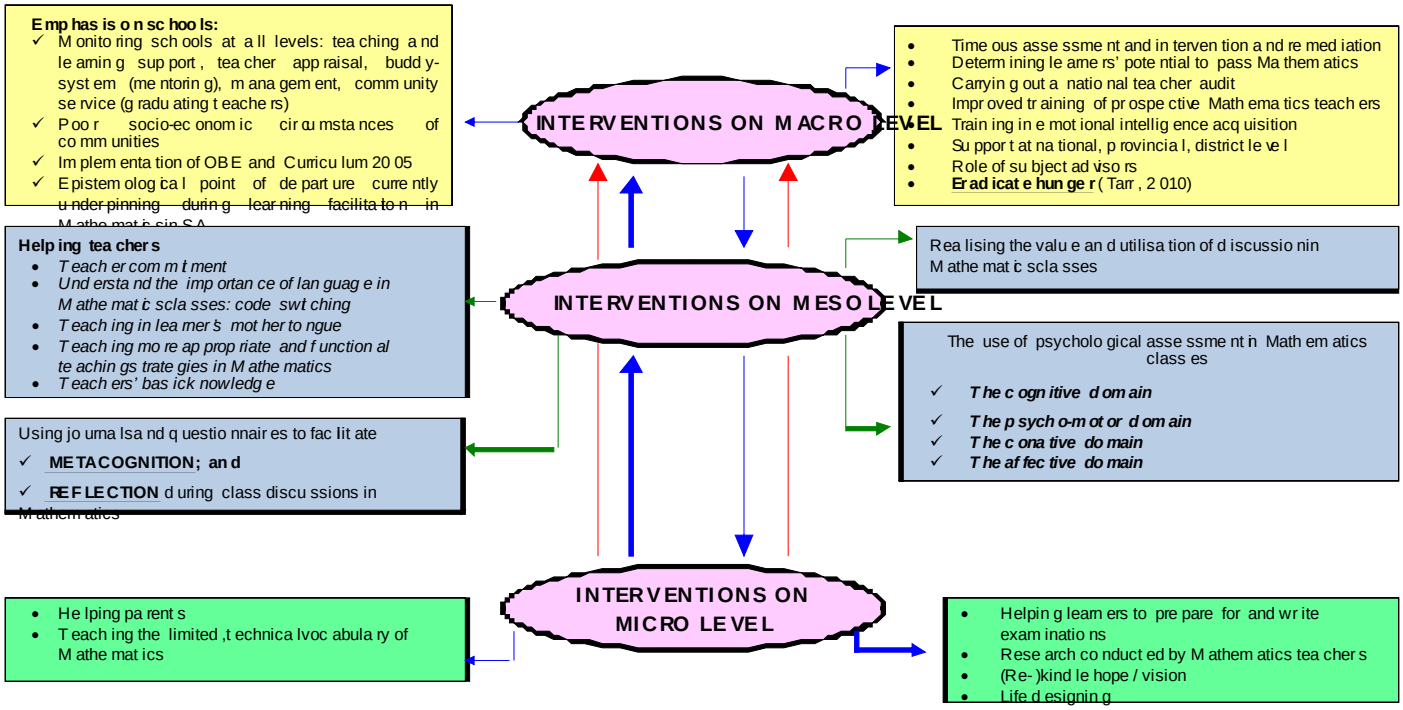


Figure 2: Meta-theoretical overview: merging policy perspectives, eco-systemic influences, and teaching and learning approaches

A possible framework for enhancing mathematics achievement at each of the macro, meso and micro levels is shown in Figure 3. Commitment is one of the most decisive factors for success in education, and this cannot be taught at university. A corps of committee teachers is essential. Some of the top-achieving schools engage in reflective thinking about their teaching practice to help teachers become more committed. This type of practice should be replicated everywhere, not only in a few schools that are already performing well.

At some stage it is necessary to assess the success of interventions and to remediate.



Source: Maree (2002)
Figure 3: Possible framework for enhancing mathematics achievement

Basic, time-honoured teaching and learning principles

The following basic time-honoured teaching and learning principles are fundamental to successful learning:

- **Play:** Learning should be fun.
- **Discussion:** The limited, technical vocabulary of mathematics has to be acquired. Between grades 8 and 12, learners need master no more than 500 new words in mathematics.
- **Example:** Not everything can or needs to be discovered. This element seems to have been overlooked in OBE. Much can be discovered, but not everything; the notion that learners have to find everything out for themselves is not well informed.
- **Instruction:** Learners need to be guided and nudged – extremely carefully, professionally and empathetically – from the known to the unknown; building on prior knowledge and small successes (Elias, 2008).

Some research results

The following research results relate to studies of predictors for success in mathematics:

- **Steyn & Maree (2003), University of Pretoria:** Information processing, problem-solving and mathematics confidence contribute significantly to achievement in mathematics.

- **Maree, Pretorius & Eiselen (2003), University of Johannesburg:** Calculations, study attitude and mathematics anxiety affect mathematics performance.
- **Maree, Hislop-Esterhuizen, Fraser, Swanepoel & Van der Linde (2009), University of Pretoria:** In a study in primary schools, mathematics anxiety, study attitude and study habits were shown to be significant predictors of performance in mathematics.
- A research project by the University of Pretoria on the career choices of student teachers compared the merit scores of male and female students enrolling for teaching courses in order to go into teaching as a prospective career. Very few males enroll, and the females that enroll have far higher academic achievement in matric.
- **Maree, Fletcher, Sommerville & Lombard (Current/ Ongoing), University of Pretoria:** Emotional intelligence (with its five subfields of intrapersonal relations, interpersonal relations, stress management, adaptability and general mood) is not a strong predictor of academic success at school. Language is definitely a predictor of success, reading ability probably, calculations definitely, and there is a definite and clear trend with respect to study habits, attitudes and anxiety. This is the start of a provisional model that could be used to identify people capable of achieving success at university.

Interventions

Interventions at the macro level

For our purpose, the macro level refers primarily to the contribution by the national government. First and foremost: 'Fighting "education poverty" is key to progress' (All Global Monitoring Report [Unesco, 2010]). "Being born into a poor household significantly raises the risk of deprivation" (All Global Monitoring Report [Unesco, 2010]).

The adjustment of the school funding model is essential, with a focus on the allocation of available resources to poorer schools.

A task team report had been released on the implementation of OBE and Curriculum 2005. The report recommends that syllabi should be 'streamlined' to a greater extent and that teachers should be given more time to do what they are supposed to do, namely to teach (Motshekga in Rademeyer, 2009; Vinjevoldt, 2009). The need for explicit mastery of particular facts is recommended (Pandor, 2008b:1): "Facts and knowledge are important, and learners need support from competent and knowledgeable learners." Gaps have been found in learners' mastery of mathematics content when they arrive at university, and consideration needs to be given to how best to address this situation.

The epistemological point of departure currently receives priority during learning facilitation in mathematics. It is a 'non-question' whether OBE is better or worse than any other education system, and this question should never be asked because it is difficult to formulate comparative/evaluative criteria from among the different approaches, or to attempt to provide a framework within which both the newer approach and the traditional and other approaches can be assessed and compared. They have different sets of outcomes in mind and depart from different epistemological approaches. Government is working on amending the approach, and teachers must work with the system as it is and adapt to changes as they are implemented.

As regards the epistemological point of departure that currently receives priority during learning facilitation in mathematics, the current reflection upon mathematics teaching must be borne in mind:

- To learn by oneself is extremely meaningful.
- The ability to master mathematics is not genetically inherited, but is carried forward from one generation to the next.
- Children do not learn completely on their own.
- Learning is infinitely more than mere coaching.

- Problem-solving, problem-centred learning, (social) constructivism and learner involvement is but one path to mathematical 'truth', which should be used in conjunction with other approaches.
- Discovery or creation in the mathematics classroom need not/should not occur in a logical-deductive manner only. Classroom discussions (including in a group context), own activity, (class) discussions and independent work can only contribute to the construction of new mathematics (Maree, 1995).

Prof. Mark Savickas's approach of career construction counselling for life designing has gained much respect throughout the world over the past two decades. Savickas combined several approaches into this single meta-theory. His view is that we stand on the shoulders of great people, benefiting from research done in the past. We therefore need to learn from others.

The facilitation of mathematics learning at the tertiary level

- Feedback from colleagues implies that there is considerable disjuncture between teaching and learning styles at school level and at university levels. Greater alignment between the two learning environments is essential.

Timely assessment and intervention

- The problem of inadequate achievement and underachievement in mathematics stems from early in learners' career. The focus should be on early assessment and intervention

Determining learners' potential for passing mathematics

- There is much uncertainty about matters such as how learners' potential for achieving in mathematics can be determined. Mathematics teachers often interpret test results in an unscientific and isolated way. Aptitude tests provide more information about the learning that the learner has already acquired than about what the learner can achieve. Intelligence is defined in the national IQ test as "acquired academic potential".
- Purposeful attention should be given to the design of remedial strategies for 'recovering' those learners who have lost their way in mathematics but still have the potential to catch up. It borders on tragedy that so many learners who might have been able to pass mathematics are lost to the discipline every year. Needless to say, in most cases these learners never manage to fulfil their true potential.

Conducting a national teacher audit

- It is hoped that a national teacher audit will be conducted soon, as conceived by Simkins, Rule & Bernstein (2007).

Improved training of prospective mathematics teachers

- The disjuncture between faculties of science and education seems to be improving at universities.
- South Africa has to find ways of recruiting more mathematics and science teachers.
- Educational psychologists and teachers who have just completed their training should be compelled to do community service, especially by teaching, for example, in remote rural schools, township school or disadvantaged urban schools.
- All teachers should be able to pass examinations set for learners (Task team report, 2009).
- Teachers working in remote schools should receive emotional, psychological and financial encouragement, and the necessary steps should be taken to ensure their safety.

Training in respect of emotional intelligence (EI)

- As a researcher, I have over the past number of years repeatedly been confronted with the following situation:
  - Schools welcome research into any facet of mathematics. However, they are extremely reluctant to give time to programmes of emotional intelligence (the standard excuse being that in overcrowded syllabi there is no room for facilitating the 'softer' skills). Research

has time and again proved that school achievement, aptitude and IQ predict only about 9% of learners' future success, while EI predicts between 36% and 40% of future success (Bar-On, 2006).
    - Teachers should be trained suitably in respect of ways of facilitating emotional intelligence in the classroom. One of the aspects of emotional intelligence is social responsibility, which should be impressed upon every teacher and learner.
    - Emotional intelligence is related to performance in mathematics. Research shows that the higher the stress levels, the low the cognitive achievements.

Interventions at the meso level

Assistance to teachers

- Top schools should buddy with underachieving schools.
- We need to learn from others; some schools achieve despite difficulty.
- We must realise the importance of language in the mathematics class. Code switching (switching from one language to another in the course of the teaching situation) is often indispensable for the smooth progress of mathematics tuition. Teachers' own language skills are also important.
- We should build on small learning successes to boost the confidence of learners (as stressed by Maurice Elias of Rutgers University, author of *Promoting Social and Emotional Learning: Guidelines to Educators*).
- It is imperative for teachers to make learning fun.

Instruction in the learner's mother tongue

- Research has repeatedly shown the link between learners' achievement in mathematics and the language of instruction. Those that receive instruction in their mother tongue perform consistently better.
- In addition, learners should receive instruction in English for twice the number of hours as at present.

Realising the value and use of discussion in the mathematics class

Using psychological tests in mathematics classes

- Teachers should make optimal use of strategies and techniques by means of which learners' personal strong and weak points in respect of the cognitive, psychomotor, conative as well as affective areas may be identified in order that these may be applied in the timely facilitation of intervention:
    - **The cognitive area:** Far too many teachers do not have even the most basic knowledge about the interpretation of IQ and aptitude scores, such as that a low IQ or general aptitude does not necessarily predict poor achievement in mathematics (and vice versa). Teachers should be well aware of the criteria for referral. There is much ignorance even in some of the top schools about such things as tutoring and how to apply for extra time in examinations for learners (in terms of how to assess learners and which ones qualify).
    - **Psychomotor:** Teachers are sometimes unaware of the physical challenges of learners (who might not be able to see the board or hear the teacher properly, but may be relegated to the back of the classroom).
    - **The conative area:** If a learner's conative base (involving the will and resolve) is not intact, problems in mathematics are virtually a given.
    - **The affective area:** The importance of a strong affective base as an essential supporting structure for adequate cognitive achievement in mathematics cannot be overestimated. A strong self image is very important for performance. Teachers are in a hypnotherapeutic relationship with their learners. If a teacher tells a learner that he/she cannot do the work, this has a profound impact on the learner. Teachers need to be made aware of their level of influence over learners.

Using journals and questionnaires to facilitate meta-cognition and reflection during class discussions in mathematics

- Reflection and adequate communication in the mathematics class are vital if a teacher wants learners to achieve. Reflection should take place after every lesson so that the teacher can assess whether he/she has got the message across effectively and whether the learners understand.
- There should be a change in focus from ability to effort.

Interventions at the micro level

Giving help to parents

- Parents in particular should be empowered to become involved at all levels. Unless the solution to problems in education involves parents, it will address only 70% of the issues.
- The physical environment of many learners is inadequate for learning and is marked by housing need, overcrowded dwellings, poverty, malnutrition, as well as other health problems.
- This situation causes great concern. “Children from families with low incomes, low levels of parental education, and single parents often have less mathematical knowledge when they begin school than do children from more advantaged backgrounds. This tends to hinder their learning for years to come” (National Mathematics Advisory Panel, 2008).
- It is important to educate parents to have realistic expectations with regard to their children’s achievement in mathematics. The issue of realistic expectations needs more discussion. Some parents whose children are doing well in mathematics literacy expect their children to be able to continue to a career as an engineer or doctor. Parents need to understand clearly that mathematics literacy will not provide entry to tertiary studies in science or engineering, however well the learner performs. Such ignorance exists at a high level throughout the country and needs to be addressed.

Teaching the particular technical vocabulary of mathematics

- The limited, technical vocabulary of mathematics has to be acquired. Between grade 8 and 12, learners need master no more than 500 new words in mathematics.

Helping learners study and write examinations

Research conducted by teachers

- After every examination or test, lecturers/teachers should analyse learners’ marks carefully with the aid of diagnostic questionnaires and determine the questions and subsections of questions in which learners did particularly well or poorly.
- Apart from the above, it is vital that a number of basic statistical calculations be made, such as the mean score for the questionnaire as a whole as well as per question, the mode, the median, the standard deviation and learners’ standard scores (the basic scores). Compiling frequency tables and drawing basic graphs are equally necessary to help to create a visual representation of achievements
- Basic tests will reveal quickly whether, for example, boys in grade 11 perform significantly better or poorer than girls in (say) trigonometry.

Prof. Maree proposed that the DoBE launch a journal of teaching in South Africa in which teachers could publish their results. Teachers could be rewarded for the publication of their (peer-reviewed) articles as an incentive, in the same way that researchers in higher education are rewarded for their publications.

Third paper in mathematics

There seems to be general consensus that the third mathematics paper is an excellent idea. However, it is not compulsory for any field of study (at this stage at least). The main challenges are:

- To make this 'facility' available to all learners; at present, mathematics paper 3 is elitist
- To ensure that a sufficient number of teachers are available and able to teach this paper
- Not to create the impression that certain groups of learners (remote rural, township, poor inner city) are being marginalised (through being excluded or denied the opportunity to take this subject and succeed in it).

Contextual issues

Figure 4 shows the disproportionately low numbers of black professionals. Some more detailed statistics illustrate this situation even more clearly:

- Twelve of a total of 497 actuaries are black (Shan, 2003).
- There are 94 female and 231 male chartered accountants out of a total of 3695 female and 17 255 male chartered accountants.
- There is a shortage of mathematics and physical sciences teachers.
- In 2003, not one African student registered for primary school education training in the Western Cape
- Yet, many teachers cannot find employment (suggesting low demand for their qualifications).

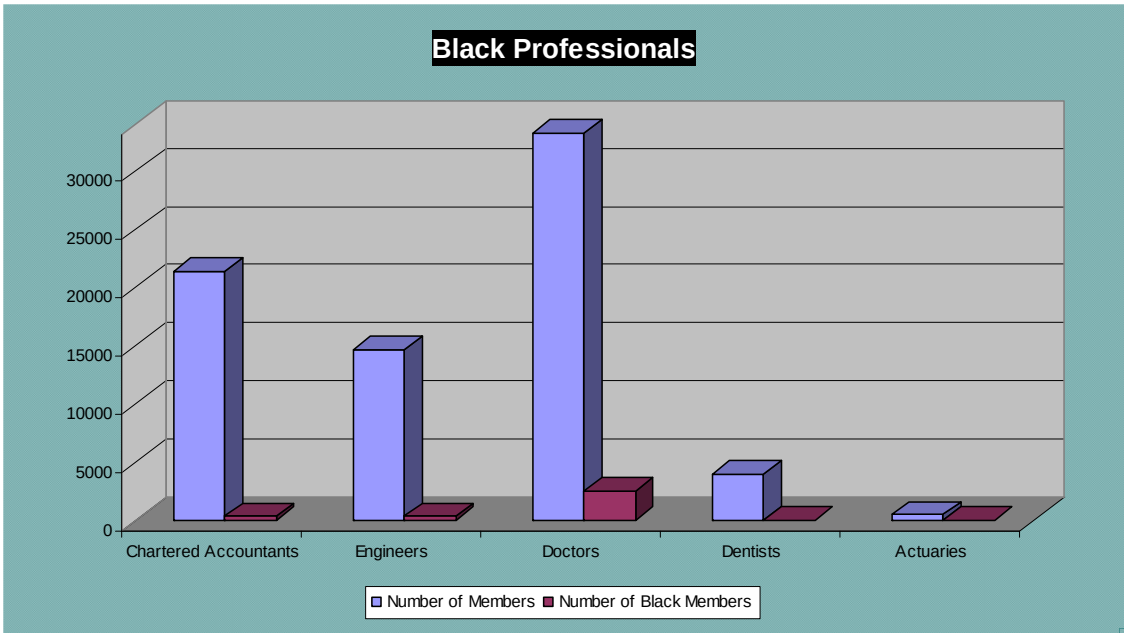


Figure 4: Numbers of black professionals

Focusing on the 'bigger picture': the need for a holistic approach

A vast array of factors predict success in mathematics. Learner achievement in mathematics is not merely linearly a function of teacher efficiency and quality. There is a need to focus on the quintet of T's: teacher (training), teachee (learner), teaching, parent, textbooks and teaching time. ("Teachers must Teach; Learners must Learn"). There is potential value in introducing a continuous professional development (CPD) system. The overriding value in education must be

the ethics of basic respect. Teachers must have respect for every learner. Other values to be instilled include punctuality, self-discipline, motivation, dedication, creativity, innovation and commitment.

Discussion

Unknown speaker: Parents recycle to their children their own anxiety about mathematics.

Unknown speaker (University of KwaZulu-Natal): Why has it been proposed that the learning areas in the Intermediate phase be reduced from eight to six, with technology being incorporated into the science curriculum? UKZN has made considerable efforts to upgrade its technology education programme over the last few years and has an honours and a masters programme in this field.

Jansie Niehaus: Mr Mosuwe indicated that decisions had not yet been taken and that the DBE was still looking at the Intermediate phase. There were good reasons for introducing technology as a subject and those issues will have to be taken into account in restructuring the curriculum. The amount of time for technology should not be reduced. There are only two hours a week for natural science, which is already tight, and it would be difficult to incorporate technology into this time as well. To do so would be to risk technology simply becoming book learning, rather than taking the hands-on approach that is intended for technology teaching. The views on technology will be forwarded to the DBE.

CLOSURE

Ms Niehaus closed the workshop at 13:15 and invited delegates to lunch at the Cattle Baron restaurant.

APPENDIX A: ATTENDEES

Present:

Beyond 2000 Publishers	Marie Ainslie
Department of Basic Education	Mr Edward Mosuwe (Speaker)
DFPT	Richard Hurndall
Durban University of Technology	Prof. Darren Lortan
E6 Advanced Materials	Humphrey Samkelo Sithebe
Eskom	Nicolene Boyes
Eskom Expo for Young Scientists	Priscilla Moodley
iThemba LABS	Dr Gillian Arendse
Kraus Consulting and Engineering CC	Ing. Manfred Kraus
MTN Sciencentre	M. Jacobs
MTN Sciencentre	John Crossland
MTN Sciencentre	Detlef Basel
MTN Sciencentre	Michael Ellis
Nelson Mandela Metropolitan University	Prof. WA Olivier
Nelson Mandela Metropolitan University	Dr VG Govender
Nelson Mandela Metropolitan University	Dr L King
North West University	Prof. Thapelo Mamiala
NRF	Sive Stofile
NSTF	Ms Jansie Niehaus (Chairperson)
NSTF	Ms Thabo Mphahlele
NSTF	Ms Wilna Eksteen
NSTF	Ms Dipolelo Thobane
SACNASP (Eskom)	Carmel Bester
SANHARP	Zethu Maseko
SANHARP	Nolubabalo Nomangola
Somerset Education	Malcolm Beech
Somerset Education	Brian Samuels
Stellenbosch University	Dr Mdu Ndlovu
Stellenbosch University	Ms Nokwanda Siyengo
Stellenbosch University	Dr Kosie Smit
Tshwane University of Technology	Dr Ina Louw
University of Cape Town	Rene Toerien
University of Kwazulu-Natal	Dr N Govender
University of Kwazulu-Natal	Dr D Brijlall
University of Kwazulu-Natal	Dr BP Alant
University of Pretoria	Prof. Kobus Maree (Speaker)
Vaal University of Technology	Dr Kenneth Zimba
Western Cape Education Department	Phumla Satyo
Write Connection	Ms Robyn Arnold (Scribe)

Apologies:

Brombacher and Associates cc	Aarnout Brombacher
Human Sciences Research Council	Dr Vijay Reddy
NSTF Chairperson	Prof. Brenda Wingfield
NSTF Deputy Chairperson	Prof. Stephanie Burton

APPENDIX B: ACRONYMS

ACE	Advanced Certificate in Education
AMESA	Association for Mathematics Education of South Africa
CPD	Continuous professional development
CTA	Common Task Assessment
DGG	Deputy Director General
DBE	Department of Basic Education
DoE	Department of Education (prior to April 2009)
DST	Department of Science and Technology
DYFTP	Denel Youth Foundation Training Programme
EI	Emotional intelligence
ETDP SETA	Education, Training and Development Practices Sector Education and Training Authority
FET	General Education and Training Phase
GET	General Education and Training Phase
HESA	Higher Education South Africa
HOD	Head of Department (provincial government)
HSRC	Human Sciences Research Council
IQ	Intelligence quotient
LTSM	Learning teaching support materials
NAPTOSA	National Professional Teachers' Organisation of South Africa
NGO	Non-governmental organisation
NSTF	National Science and Technology Forum
OBE	Outcomes-based Education
SAMF	South African Mathematics Foundation
SETI	Science, engineering, technology and innovation
STEM	Science, technology, engineering and mathematics
UKZN	University of KwaZulu-Natal

APPENDIX C: BIBLIOGRAPHY FOR PRESENTATION BY PROF. KOBUS MAREE (UNIVERSITY OF PRETORIA): THE CHALLENGE OF INADEQUATE ACHIEVEMENT AND UNDERACHIEVEMENT IN MATHEMATICS: FOCUS ON A META-APPROACH

Bagley, T. & Gallenberger, C. (1992). Assessing students' dispositions: Using journals to improve students' performance. *The Mathematics Teacher*, 85(8):660-663.

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