

**Critical Issues in School
Mathematics & Science: Pathways
to Progress**

Academy of Science of South
Africa Forum

01 October 2009

ASSAf Forum: Background

- School science & maths:
 - a ‘national crisis’
 - ‘fare poorly in comparative tests’
 - 2009 cohort has gone through post-Apartheid schooling with “OBE as chosen philosophy” to enable each South African child to achieve his or her full potential
- National Senior Certificate:
 - succeeded in releasing what was a considerable blockage to entry into HE
 - concerns about the ‘capabilities of school-leavers’ as compared with those of a decade ago
 - Early indications: overall student performance in science-based programmes at HEIs is below that of previous years

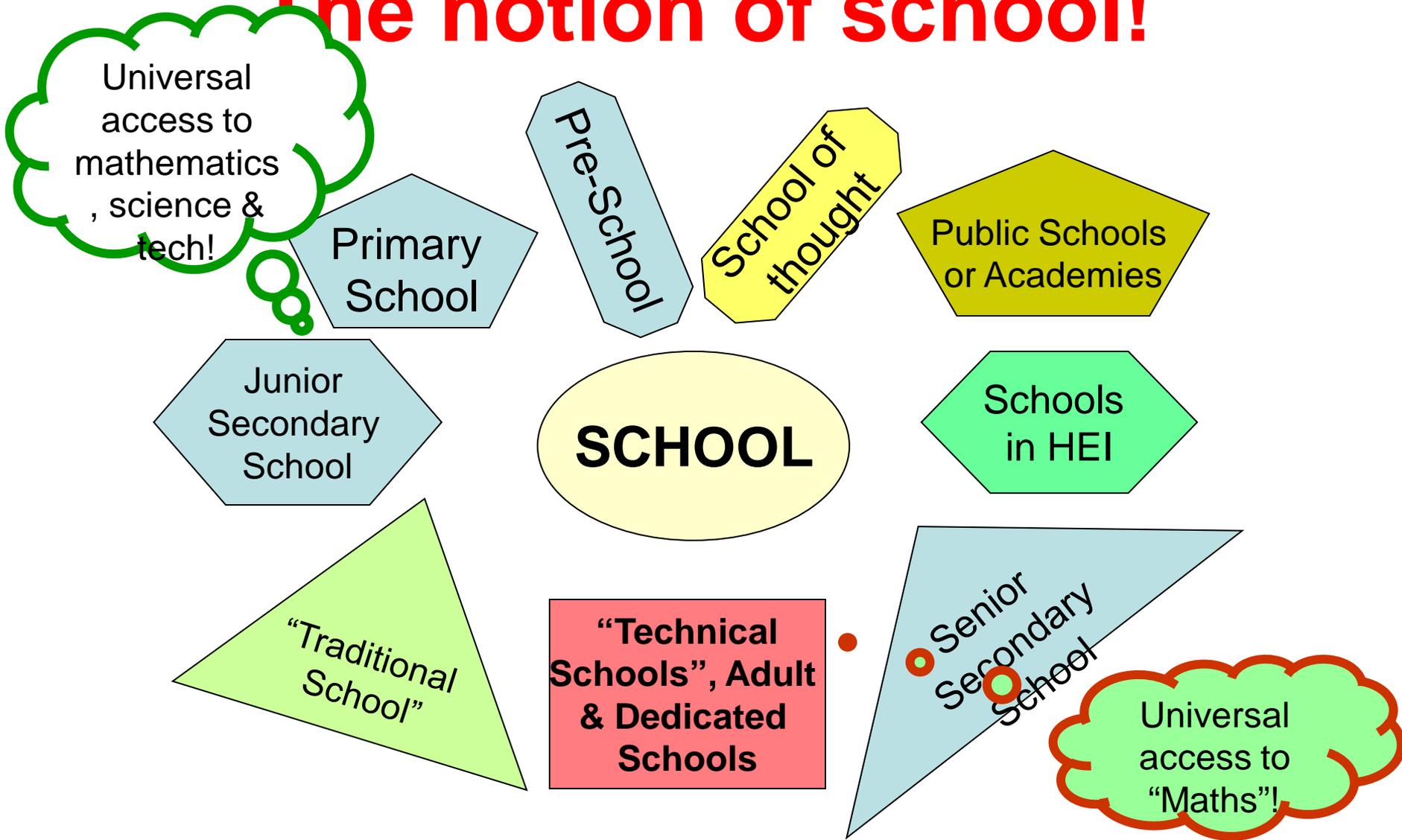
ASSAf Forum: Background

- Pool of future potential scientists, engineers and health practitioners, as well as future teachers of mathematics and science, is severely limited
- This limits ability to be internationally competitive
- Issues related to transformation, equity and social justice?

My Mandate

- STEM and National Senior Certificate
 - What was the purpose of the National Senior Certificate (NSC) when it was first proposed?
 - Has it changed?
 - What unintended consequences have resulted from the way in which the NSC has been implemented?
 - What should be done differently in the future and how do we do it?
 - What should the purpose of the NSC be in future?
 - What are the issues around mathematics and mathematics literacy in terms of content and making them compulsory?
 - Should there also be an equivalent compulsory subject for the sciences, science literacy (as was originally proposed)?
- make concrete proposals on how the situation can be improved

The notion of school!



The notions of school science & maths?

What about: Technology (GET)
“Engineering subjects” (FET),
“Computer subjects” (FET),
Compu-typing (FET)

**Mathematics
(GET and FET)
Mathematics or
Mathematical
Literacy (FET)**

**Maths
& Science: LAs &
Subjects?**

Natural Sciences (GET)
Physical Sciences (FET),
Agricultural Sciences (FET)
& Life Sciences (FET)
Science Literacy or
Integrated Science??

What about other sciences?
Economic and Management Sciences (GET),
Human and Social Sciences (GET),
Actuarial Sciences (HET)
[Christian Science Church]

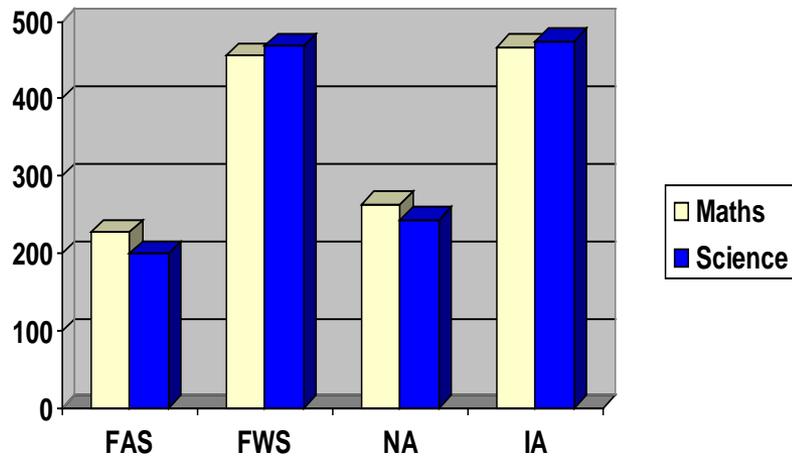
Do we use broadened understandings of mathematics and science? Are we using the right lenses? Do we only pay lip service to Engineering & Technology? Will this forum also debate the role of STEM in innovation.?

BUT SES
remains most
determining
factor

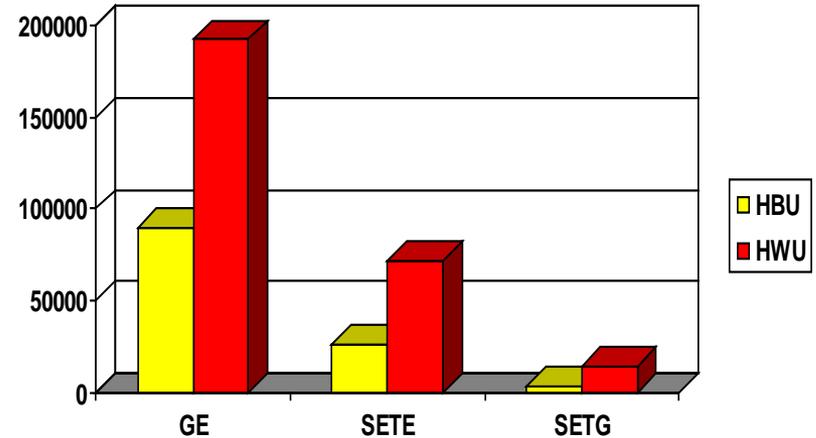
**Universal access to education in general
and ST(E)M education in particular,
improving (DoE, 2006)**

- ECD (246 911: **1.8%** of learners in the public education system)
- Schooling (11 902 316: **85%** of learners in the public education system)
 - Learner: educator = 1:32.8 (public schools)
 - Learner: educator = 1:16.2 (private schools)
 - Female: male: ECD (50.3: 49.7); Found (48.5: 51.5); Inter (48.9: 51.1); Senior (50.3: 49.7) & FET Colleges (53.1: 46.9)
- Higher Education – (737 372: **5.3%** of learners in public higher education system)

The empirical data for both schooling & HE reveals biting impact of our legacy

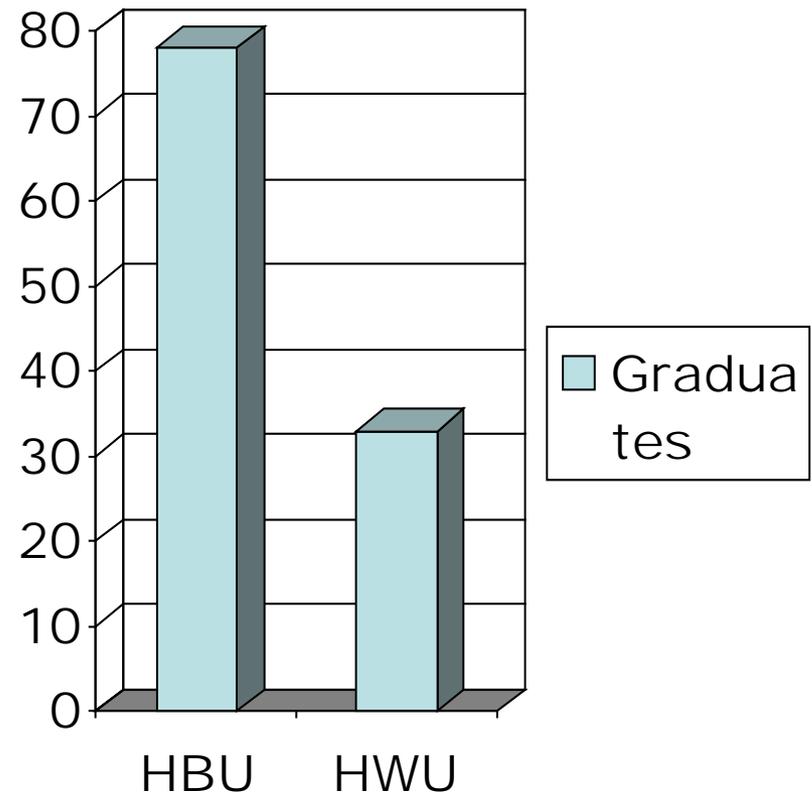
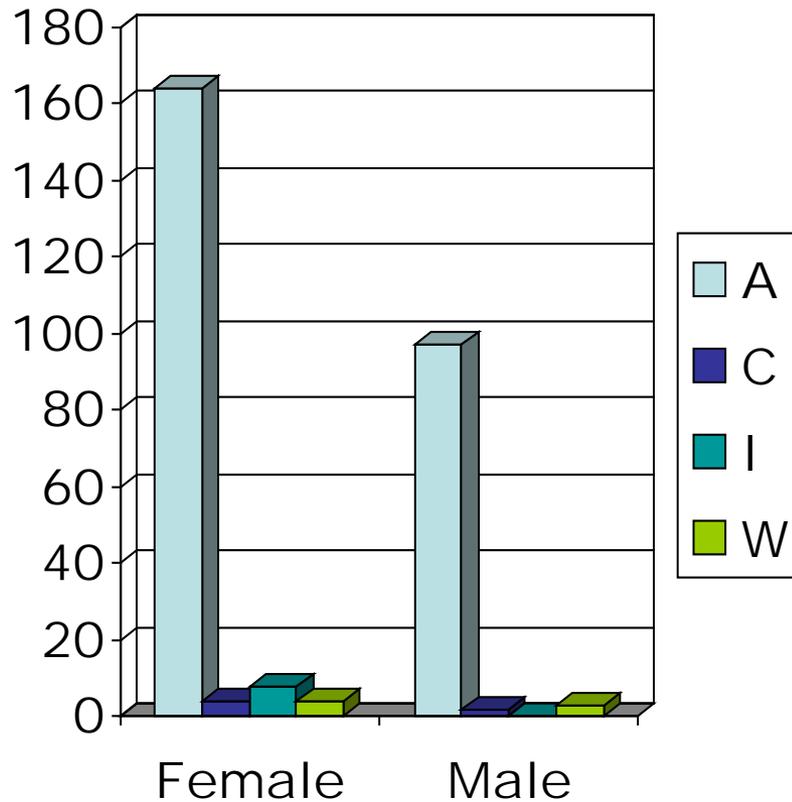


FAS= former African Schools
FWS= former White Schools
NA= National Average
IA= International Average

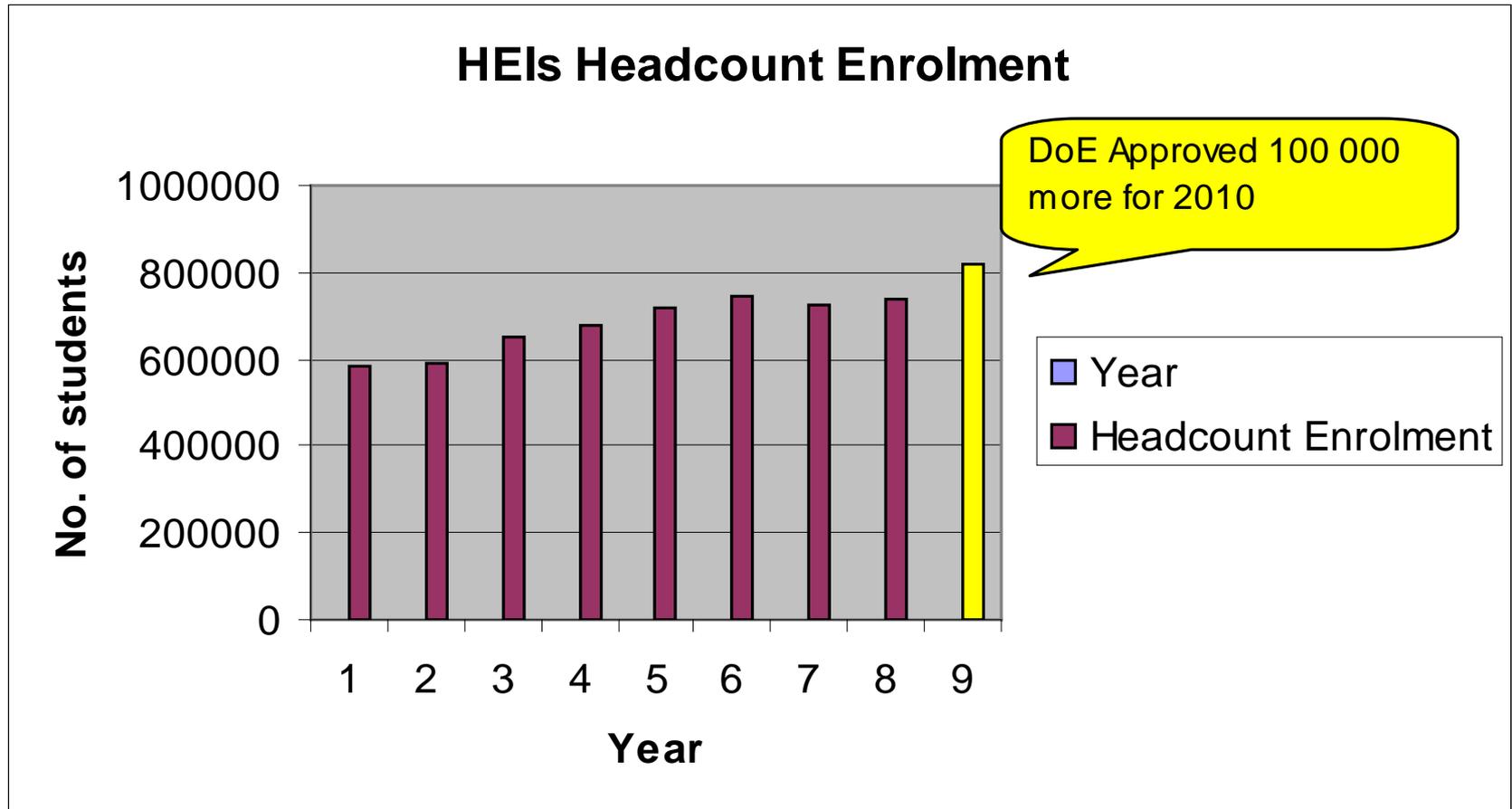


- **GE= General Enrolments**
- **SETE= Science, Engineering and Technology Enrolments**
- **SETG= Science, Engineering and Technology Graduates**
- **HBU= Historically Black Universities**
- **HWU= Historically White Universities**

Unemployed Science & Maths graduates are African, female from Historically Black HEIs

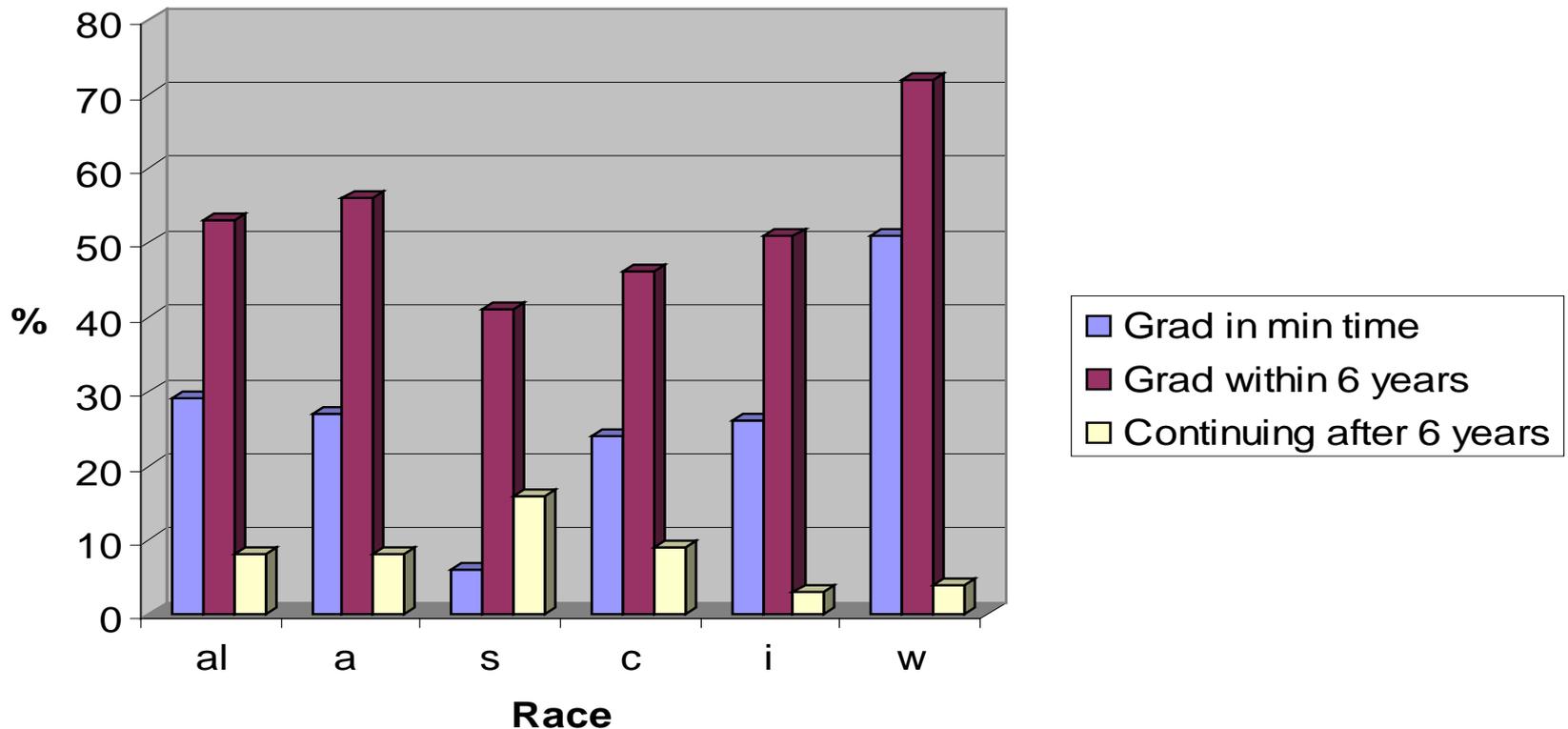


HE Enrolments for 1999-2006 reveals a gradually improving trend

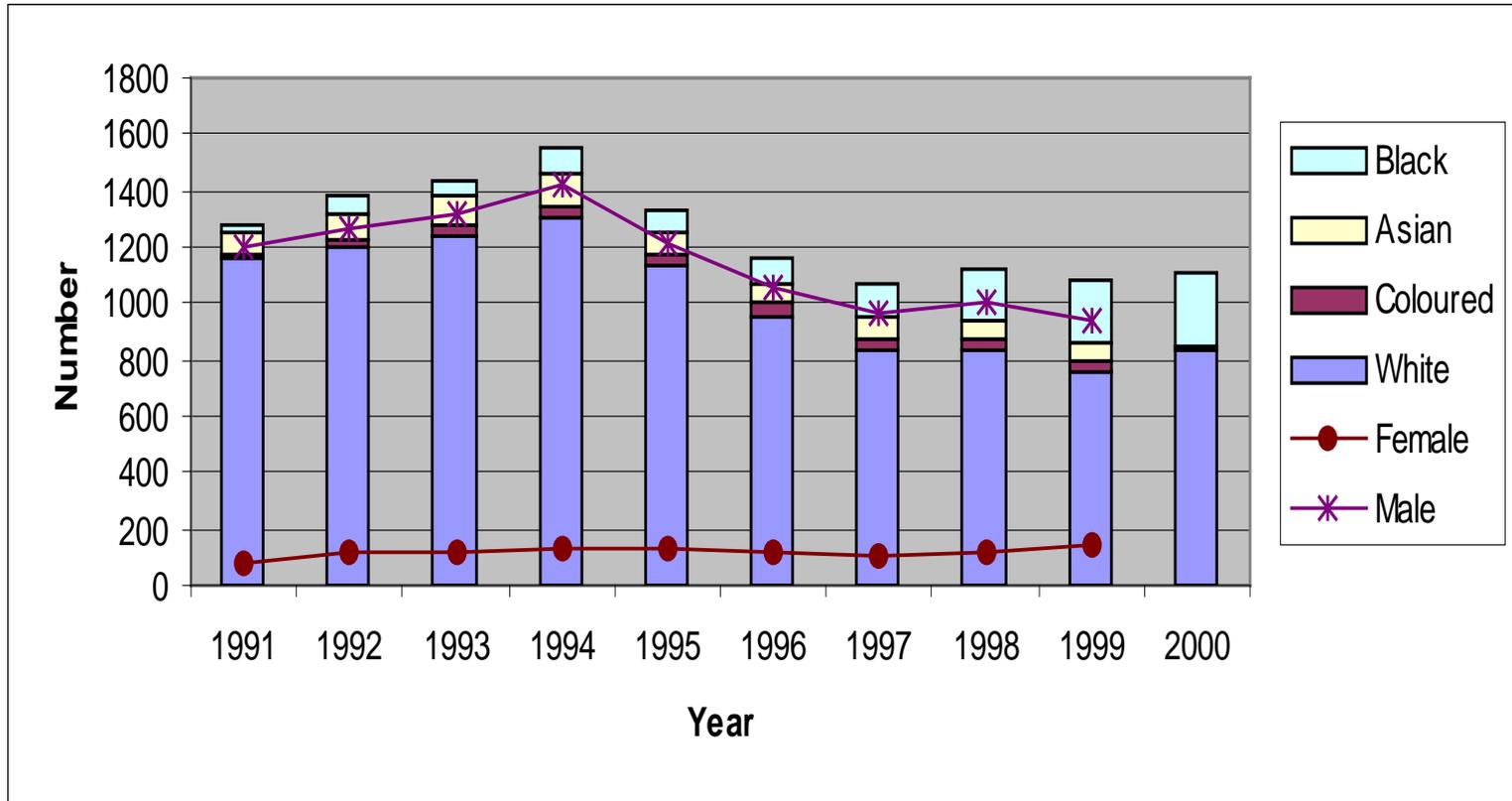


Engineering throughput rates for 6 successive cohorts in one HEI during 1995-2001 reveals impact of legacy

Engineering students throughput rates



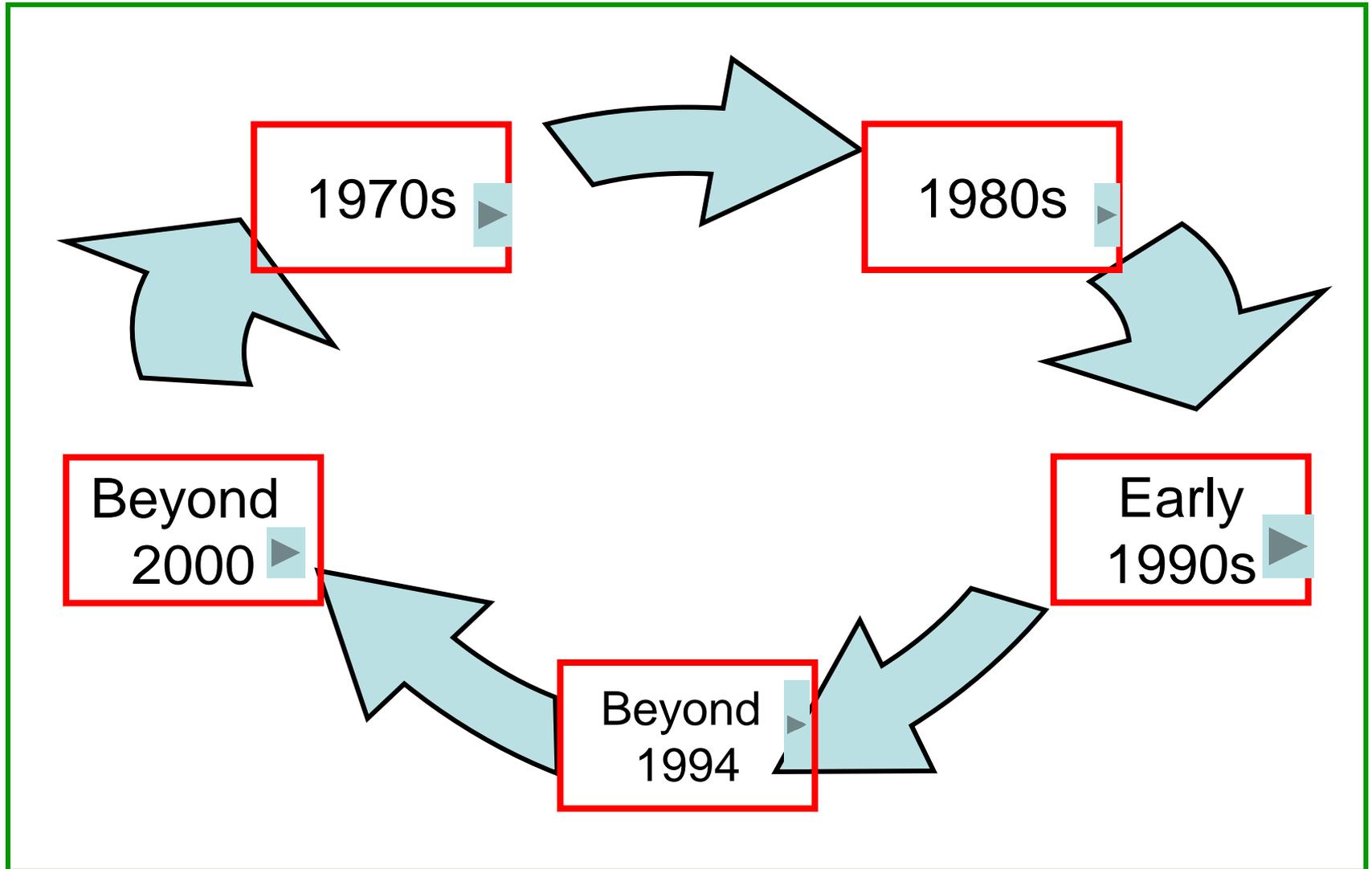
Disaggregation of B. Engineering Graduates i.t.o. Gender and Race





Personal development, national South African identity built on constitutional values, lifelong learner who is confident, independent, literate, numerate, multi-skilled, compassionate with respect to environment and able to participate in society as a critical and active citizen

Evolution of 'National Senior Certificate'



In the 1970s



- Differentiation in former British colonies in Southern, West and East Africa influenced by post-war Ordinary and Advanced Level differentiation in the UK.
- The system of differentiation (i.t.o. *National Education Policy Act of 1972*) was implemented **WITHOUT ANY EMPIRICAL RESEARCH**. HG (400 marks = 40%) had to be 15% 'more difficult' than SG (300 marks = 33.3%), and LG should be 15% 'less difficult' than SG. (*Department of Education, 1994*).
- Differentiation policies commenced with Standard 8 in 1973, Standard 9 in 1974 and Standard 10 in 1975. (*Lötter, 2003*). 1975 final year of Standards 6 as an external certificate resulted in bigger classes of Standard 6 in 1976
- In SA, streaming included ten “academic” subjects in academic stream, (A Stream) and “lower level subject equivalents” existed for school-leaving purposes in non-academic (B Stream). (*Lötter, 2003; Malherbe, 1977*)
- Level of difficulty and topics varied across subjects. (*Department of Education, 1994*)
- Subjects applicable to university entrance combinations were placed in six subject groupings and subject fields. [viz. 2 (a) official languages, (b) mathematics, (c) natural sciences, (d) other languages, (e) social sciences, (f) applied science and practical subjects] (*Department of Education, 2001*); *Committee of Principals, 2002*)
- Specified vocational subjects were under Group F.

In the 1980s



- In the early 1980s conversion level for Higher Grade subjects was raised from between 25% and 39% to between 30% and 39%;
- HG failures between 25% and 39% were converted to SG pass marks
- Introduction of Standard 10 Practical, which was neither accepted by employers nor by the public in general
- Lower Grade (LG) syllabuses were introduced

In the early 1990s



- In 1994 Empirical Investigation into Differentiated Teaching and Examination.
- The Working Committee report accepted as
 - “...educational principle that a curriculum for pre-tertiary education should make provision for differentiation in terms of learners’ interests, aptitudes and competencies...” but “...that vertical differentiation does not always achieve its aim”. (July 1994, CHED).
- The CHED proposed an investigation into the feasibility of introducing a common graded examination;
- In 1994 Lower Grade subject offerings in the school stream except for learners with disabilities were abolished. Regardless of the abolition of the offering of Lower Grade subjects in 1996 (*Department of Education, 2001; Lötter 2003*) Lower Grade conversion level for Standard Grade was retained
- Post-1994: Senior Certificate examination at end of Grade 12 with ~1500 question papers set

Beyond 1994



- A “once off” ‘high stakes’ Senior Certificate examination under controlled conditions continued
- It did not accurately measure learner’s achievement over the twelve year period.
- It did not assess ability to apply knowledge
- Senior Certificate is the first examination of standard confronting learners after 12 years of schooling
- There were no national benchmarks at Grades 10 and 11
- Educators have tended to rely mostly on written tests and examinations
- A term/year mark, where it was done, comprised mainly continuous testing
- It was also deficient in its formative role

Beyond 2000



- National Curriculum Statements = learning areas and subject statements (assessment sections) & the qualifications (GET & FET) and assessment framework. Assessment is an integral part of curriculum.
- Complicated conversion system has been done away with
- Grade-specific assessment standards throughout the schooling system
- “GETC” and “NSC” ‘have’ theoretical, oral and practical components
- Fewer number of subjects and examination papers improve manageability of assessment systems
- High-stakes examination will not necessarily disappear overnight (75:25 external: continuous assessment is policy with exception of Life Orientation) and vice versa in the GET band
- If assessor capacity is not developed at classroom, school and district levels, public confidence in the assessment system will remain low
- Curriculum change in schooling system adopted an evolutionary approach characterised by incremental introduction of new elements of assessment while maintaining some old elements
- To allow individual learners to succeed necessitates individualized methods of assessment, and, therefore, individualized instruments. This poses challenges of validity and reliability (e.g. language to be used)

Access to HEIs remains varied. What role should All Schools play?

Responses to the Questions

1. What is the purpose of NSC?
2. Has it changed?
3. What unintended consequences resulted from NSC implementation?
4. What should be done differently in future and how do we do it?
5. What should the purpose of NSC be in the future?
6. Issues around maths & maths literacy i.t.o. content and mandatory
7. What about equivalent mandatory subject for the sciences?

1. Broader purpose (assessment is an integral part of curriculum)
2. It is systemically evolving
3. We need at least 5 years of policy implementation to analyse results
4. Acknowledge & build on successes, adopt more systemic, incremental approach to change (evidence-based)
5. Lower & parallel qualifications could reduce its once-off high stakes status – its broader purpose will continue to be monitored and interrogated
6. See SAMF reports in last three years
7. All learners are exposed to one form of science – more interactive exposure in other social spaces

Proposals for Improvement: Path to Progress

- Problematise concepts and roles more – especially within the contexts of a developmental State and African century
- Also look at the (wo)man in the mirror
- Interrogate the roles of STEM in promoting innovation
- Consider pursuing the debate of 3rd tier schools
- Support implementation of multi-year plans
 - SEE PRESIDENCY’S (a) PME PLAN, (b) MTSF (Medium Term Strategic Framework) & (c)
[HRDSA..\..\Palama\Presidency\Improving Government Performance.pdf](#)
 - [..\..\Palama\Curriculum Chief Directorate\Strategies\2009-2014 Government Strategy.pdf](#)
 - [..\..\Palama\Curriculum Chief Directorate\Strategies\HRDS for SA.doc](#)

Final Word

Not everything that counts can be counted
and not everything that counts can be
counted (Einstein)

I THANK YOU