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The meaning and utility of TIMSS data for systemic and school change

12 April 2013, University of the Free State, Bloemfontein, Master Class

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* Delivery of presentation

Highlights from TIMSS 2011: South Africa

Towards Equity and Excellence

Presentation – three foci

- Methodological:
  - Describing the kind of data collected (instruments & sample)
  - Describing how the data got collected (procedures)
- Empirical:
  - A brief overview of key findings (learner achievement and background; also trends since 1995)
- Policy relevance:
  - Utility of data for planning & programme interventions

Note: Initial analysis was univariate; further analysis will focus with more rigour on factors impacting educational performance based on multivariate modelling

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Rationale behind TIMSS participation

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Trends in International Mathematics and Science Study (TIMSS 2011)

- TIMSS is an opportunity to assess and benchmark South African mathematics and science performance in an international study. TIMSS has been conducted every four years since 1995. In TIMSS 2011, 45 countries participated at the Grade 8/9 level.
- It is important to measure learner achievement through national, regional and international measures. These studies provide information about the well-being of our educational system; so that we could better manage and improve it.
- In August 2011, the HSRC administered the TIMSS 2011 mathematics and science instruments in 285 schools to 11 969 Grade 9 learners.
- We had conducted previous TIMSS in 1995, 1999 and 2002 and have comparable data to monitor system-level trends in a global context.

Rationale, and its relevance for policy

- 2011 saw the introduction of new policy-relevant questionnaire scales (worldwide)
- Striving to collect information about background issues that are increasingly linked in research and the literature to enhanced learner achievement – so that countries can know where they stand and plan how they rectify non-conducive circumstances
- Instruments comprised learner, teacher and school background questionnaires
- Items within these cover home support and school environment for teaching and learning
- Robust learner assessment covers pre-agreed consensus curriculum to close the "theory-of-change" circle

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TIMSS methodology

Making sense / meaning of the data:

– instruments and sampling

Sheer effort of the undertaking:

– research procedures

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Methodology - General

- TIMSS is led by the International Association for the Evaluation of Educational Achievement (IEA)
- Technical data management and processing (requirements and implementation) are supervised by the Data Processing Centre (DPC) in Hamburg
- Stats Canada is responsible for all sampling on the basis of sample frames provided by countries well in advance
- All country participants have to follow very strict guidelines to ensure that samples are nationally representative
- Consensus and collaboration characterise incremental development of aspects of methodology, instruments, curriculum coverage, etc

Methodology - sampling

- The general aims of the TIMSS sampling design are:
  - To ensure that the data provides accurate and efficient estimates of the South African Grade 9 school population;
  - To provide accurate measures of change in the student achievement from cycle to cycle.
- Hence TIMSS follows a 2-stage stratified cluster sampling design. With schools sampled at the first stage and intact classes at the second stage of sampling.
- Variables used for stratification in 2002 and 2011 were:
  - Province
  - Language of instruction in a school
  - School type (Public, Independent and Dinaledi)

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Methodology - Instruments

- Instruments follow a matrix design:
  - Items are spread over 14 unique booklets
  - Structured as 14 blocks of items, each appearing twice
  - Each item block has 10 to 14 items
  - Two Maths and two Science blocks appear per booklet
- The above ensures enough items to cover the curriculum
- Assessment frameworks drive item development (between administrations) and curriculum coverage
- Content and cognitive domains are both accounted for
- The latter covers knowing, applying and reasoning
- Item Response Theory is used for weighting items (for comparability between countries & over years)

Methodology - Procedures

- Country research teams have an **enormous** task:
  - Securing school permission / participation
  - Obtaining lists of classes and class lists
  - Generating the country data structure (through unique participant ID and linkage numbers)
  - Developing administration and record forms
  - Assigning booklets and questionnaires uniquely per learner
  - Adjusting & translating materials for the country (← verified)
  - Laying out and producing booklets, questionnaires, forms
  - Managing all logistics of data collection
  - Scoring the items; capturing and cleaning the data
- Infrastructure needs (calls, boxes and records)

Key empirical findings from TIMSS

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Key messages from TIMSS 2011

- South African mathematics and science national average scores, although still low, have improved from 2002
- The difference between the highest and lowest scores in 2002 to 2011 has decreased
- The greatest improvements in scores are observed at the lowest end, from the lowest performing schools and provinces, and in schools formerly designated for Africans
- The top end has not shown any major improvements and the former House of Assembly/ Model C and Independent schools perform at similar levels, but lower than the middle (Centrepoint) score

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1. Distribution of Mathematics and Science achievement in participating countries

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Exhibit 1.2: Distribution of Mathematics Achievement

TIMSS 2011 Mathematics 8th Grade

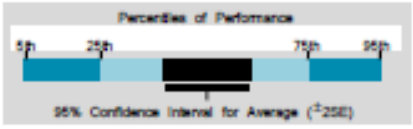
Country	Average Scale Score	Mathematics Achievement Distribution
Korea, Rep. of	613 (2.9)	▲
2 Singapore	611 (3.8)	▲
Chinese Taipei	609 (3.2)	▲
Hong Kong SAR	586 (3.8)	▲
Japan	570 (2.6)	▲
2 Russian Federation	539 (3.6)	▲
3 Israel	516 (4.1)	▲
Finland	514 (2.5)	▲
2 United States	509 (2.6)	▲
‡ England	507 (5.5)	
Hungary	505 (3.5)	
Australia	505 (5.1)	
Slovenia	505 (2.2)	▲
1 Lithuania	502 (2.5)	
TIMSS Scale Centerpoint	**500**	
Italy	498 (2.4)	
New Zealand	488 (5.5)	▼
Kazakhstan	487 (4.0)	▼
Sweden	484 (1.9)	▼
Ukraine	479 (3.9)	▼
Norway	475 (2.4)	▼
Armenia	467 (2.7)	▼
Romania	458 (4.0)	▼
United Arab Emirates	456 (2.1)	▼
Turkey	452 (3.9)	▼
Lebanon	449 (3.7)	▼
Malaysia	440 (5.4)	▼
1 Georgia	431 (3.8)	▼
Thailand	427 (4.3)	▼
Ψ Macedonia, Rep. of	426 (5.2)	▼
Tunisia	425 (2.8)	▼
Chile	416 (2.6)	▼
Ψ Iran, Islamic Rep. of	415 (4.3)	▼
Ψ Qatar	410 (3.1)	▼
Ψ Bahrain	409 (2.0)	▼
Ψ Jordan	406 (3.7)	▼
Ψ Palestinian Nat'l Auth.	404 (3.5)	▼
Ψ Saudi Arabia	394 (4.6)	▼
Ψ Indonesia	386 (4.3)	▼
Ψ Syrian Arab Republic	380 (4.5)	▼
※ Morocco	371 (2.0)	▼
Ψ Oman	366 (2.8)	▼
※ Ghana	331 (4.3)	▼
Ninth Grade Participants		
Ψ Botswana	397 (2.5)	▼
※ South Africa	352 (2.5)	▼
2 ※ Honduras	338 (3.7)	▼

100 200 300 400 500 600 700 800

SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2011

▲ Country average significantly higher than the centerpoint of the TIMSS 8th grade scale

▼ Country average significantly lower than the centerpoint of the TIMSS 8th grade scale



- For mathematics, Asian countries – Korea, Singapore, Chinese Taipei, Hong Kong and Japan - are top performers
- South Africa, Botswana and Honduras conducted the study at Grade 9 level
- South African performance is still at the low end, but has improved since 2002. In 2002 South Africa scored 285 points at the grade 9 level. In 2011 the score was 352.
- The top South African performers approached the average performance of the top performing countries

2. Trends in Mathematics and Science achievement in South Africa: 1995, 1999, 2002 and 2011

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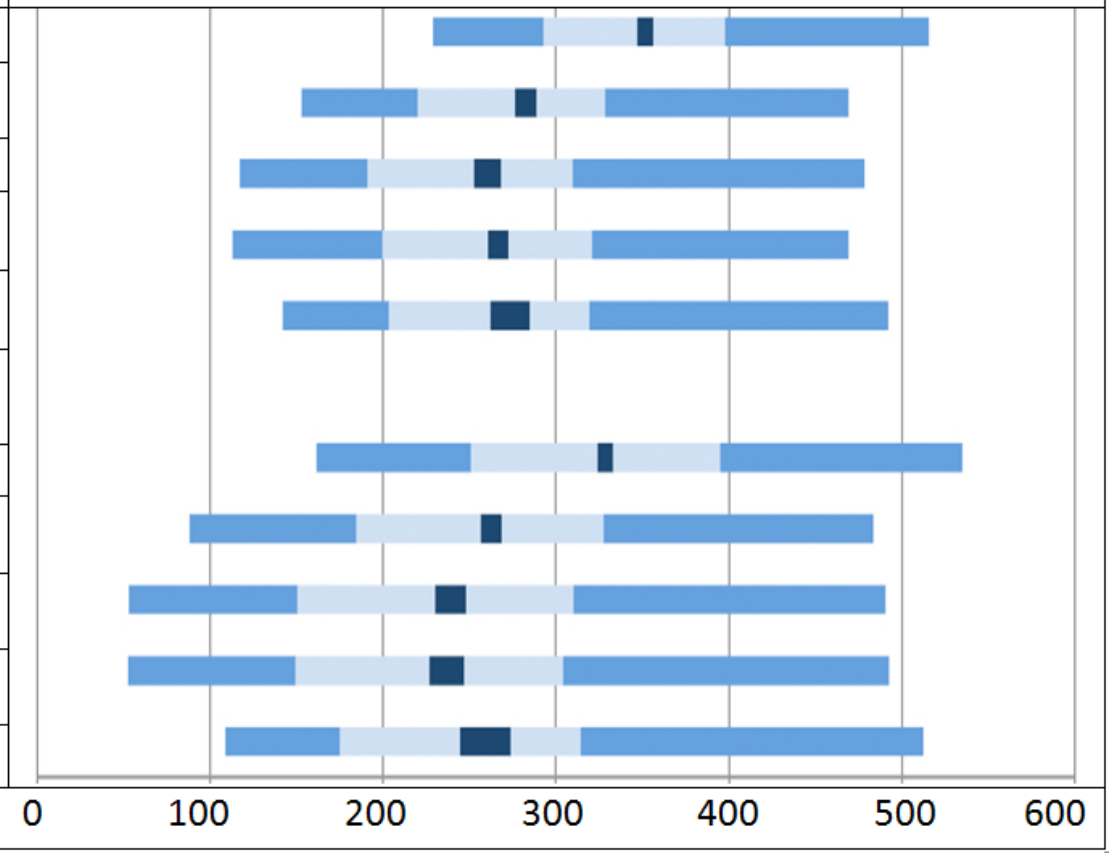
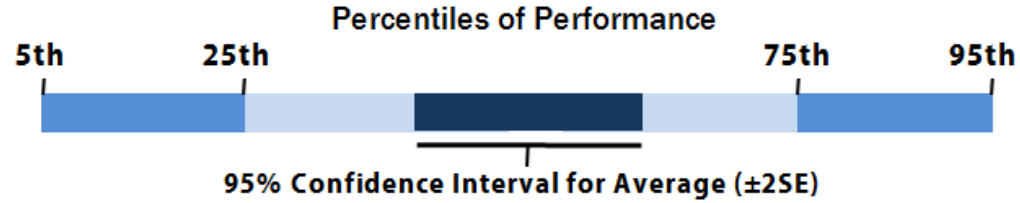
MATHEMATICS	Average scale score	Achievement distribution
Grade 9 TIMSS 2011	352 (2.5)	
Grade 9 TIMSS 2002	285 (4.2)	
Grade 8 TIMSS 2002	264 (5.5)	
Grade 8 TIMSS 1999	275 (6.8)	
Grade 8 TIMSS 1995	276 (6.7)	
SCIENCE		
Grade 9 TIMSS 2011	332 (3.7)	
Grade 9 TIMSS 2002	268 (5.5)	
Grade 8 TIMSS 2002	244 (6.7)	
Grade 8 TIMSS 1999	243 (7.8)	
Grade 8 TIMSS 1995	260 (7.9)	





Trends between TIMSS 1999 and TIMSS 2011

- For TIMSS 1995, 1999 and 2002, the average score remained the same – perhaps due to the structural and educational changes in the country since 1994
- Between TIMSS 2002 to 2011, there was an increase in achievement scores
- Score distribution: the scores at the lower end increased
- The IEA estimates that within a 4-year cycle a country could expect up to 40 points improvement –i.e., improve by one grade level
- South African scores improved by around 60 points – a general improvement by 1.5 grade levels between 2002 and 2011

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3. Provinces: Achievement and Change in Achievement between 2002 to 2011

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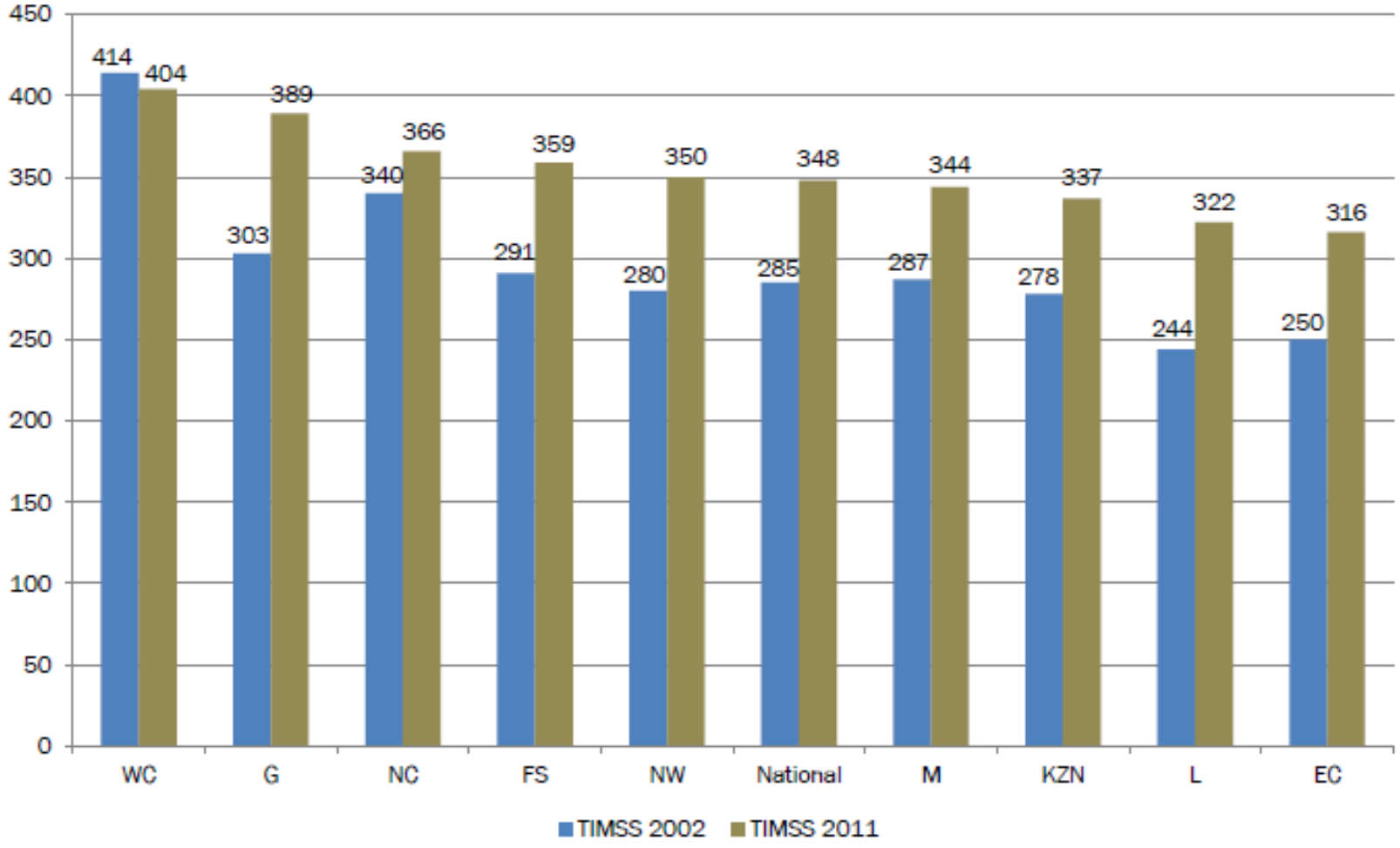
Change in achievement by province between 2002 to 2011



Provincial performance

- All provinces, except Western Cape, increased their mathematics and science scores between 2002 and 2011
- The changes in the Western Cape and Northern Cape scores are not statistically significant
- The order of greatest improvement in mathematics scores is: Limpopo (1.33), Gauteng (1.31), Eastern Cape (1.27), NorthWest (1.26), Free State (1.24), KwaZuluNatal (1.23), Mpumalanga (1.2), Northern Cape (1.07), Western Cape (0.99)
- In 2002, the difference between highest and lowest performing province was 170 points. This decreased to 86 in 2011 – moving towards equitable outcomes

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4. School Type: Achievement and change in achievement

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4.1 Public and Independent Schools

- In the study we oversampled the group of independent schools so that we could report on performance in public and independent schools
- Independent schools scored higher than public schools. For mathematics:

Public schools:	348 points
Independent schools:	474 points

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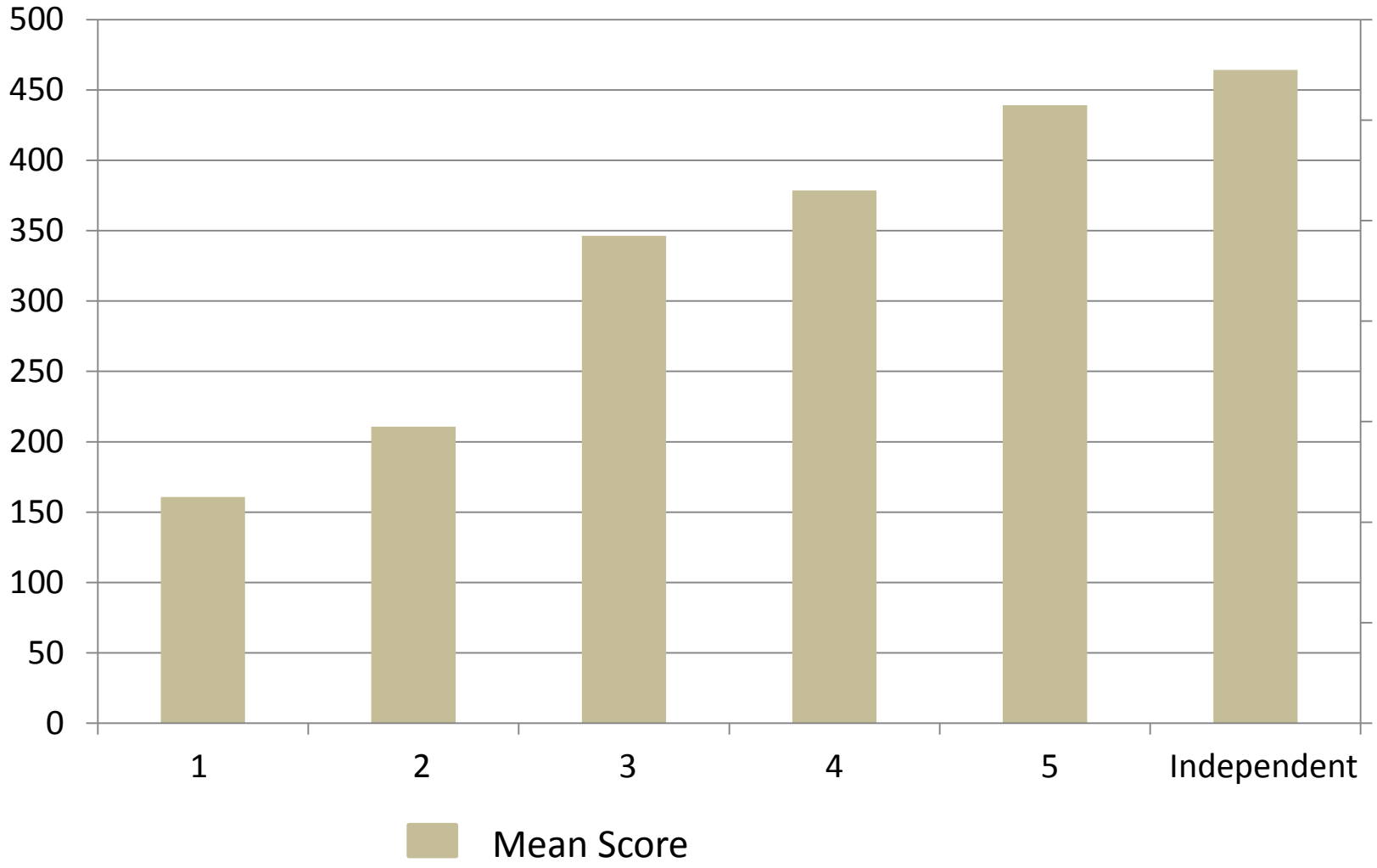
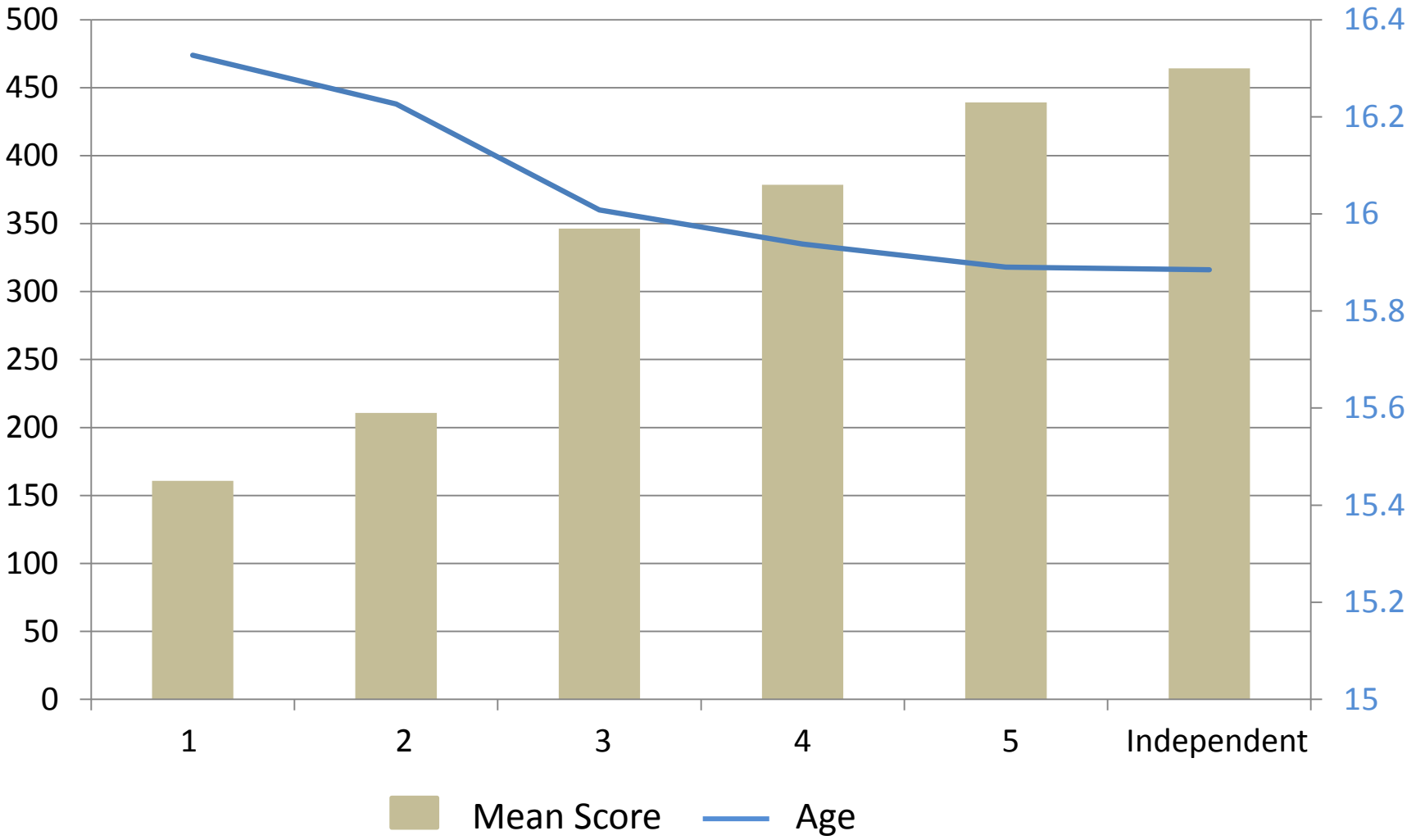
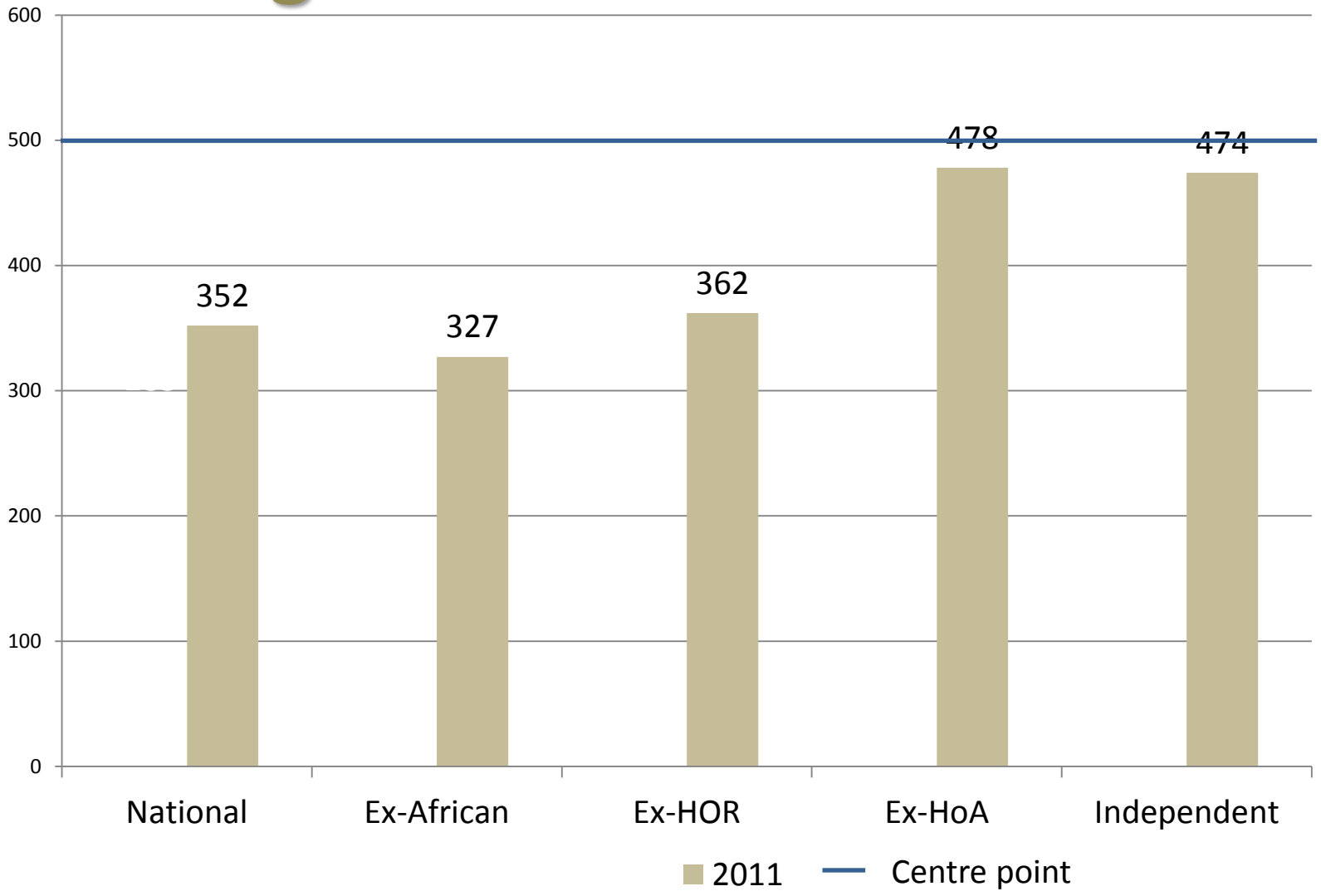
4.2 Performance by the poverty index of schools



4.2 Performance by age



4.3. Former racial departments: Changes between 2002 to 2011



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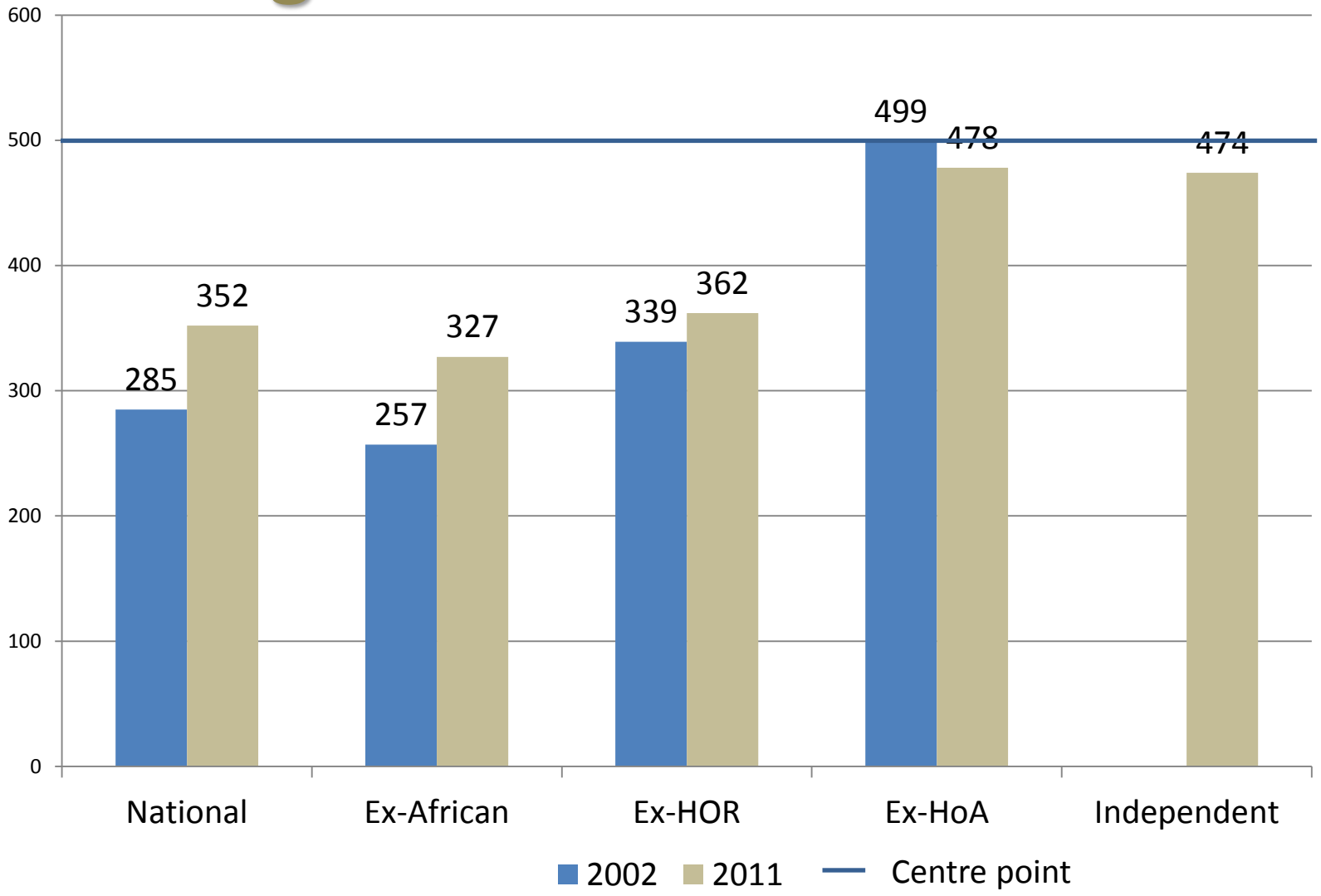

Performance by School Type

- The greatest improvement in average achievement scores, between 2002 and 2011, was in former African schools
- The Independent Schools and former House of Assembly schools perform at similar levels
- Former HoA, Quintile 5 and Independent schools achieve average scores below the Centrepoint/ middle score of 500

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5. Performance at International Benchmarks

Describe what learners know and can do

Helps identify learners that can perform at high skills level

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Performance at scores above 400: access to S&T careers and indicator of quality

	Advanced Benchmark (%) >625	High Benchmark (%) >550	Intermediate Benchmark (%) 475	Low Benchmark (%) >400	Less than 400 points
Gr 8 TIMSS 1995	0.3	2	6.6	13.6	**87%**
Gr 8 TIMSS 1999	0.2	1.5	5.7	13.2	**86.8%**
Gr 9 TIMSS 2002	0.6	1.5	2.8	10.5	**89.5%**
Gr 9 TIMSS 2011	1	3	9	24	**76%**

Performance at scores above 400: access to S&T careers and indicator of quality

	Advanced Benchmark (%) >625	High Benchmark (%) >550	Intermediate Benchmark (%) 475	Low Benchmark (%) >400	Less than 400 points
Gr 8 TIMSS 1995	0.3	2	6.6	13.6	**87%**
Gr 8 TIMSS 1999	0.2	1.5	5.7	13.2	**86.8%**
Gr 9 TIMSS 2002	0.6	1.5	2.8	10.5	**89.5%**
Gr 9 TIMSS 2011	1	3	9	24	**76%**
BOTSWANA	0	2	15	50	**50%**

6. CONTEXTUAL INFORMATION : Using Learner, Teacher, School & Curriculum Questionnaires

Provide insights into factors that are positively related to academic success

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6.1 Curriculum and Teachers

- For the period 2002 to 2011, the Revised National Curriculum Statement guided classroom instruction
- There is over 90% overlap between RNCS & the TIMSS curriculum
- 60% of mathematics learners and 53% of science learners were taught by teachers with a degree. Internationally close to 90% of teachers have a degree qualification.
- Around 40% of teachers indicated they were 'satisfied with their profession'
  Internationally 47% of teachers were 'satisfied with their profession'

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6.2. School Climate and Classroom Resources

- School safety is an issue of concern:
  - 41% of learners attended schools where Principals identified discipline and safety as a moderate problem. Internationally this was 18%.
  - 75% of South African learners reported some sort of bullying compared to 41% internationally
- Resources to schools have been improving – with around 10% of Mathematics and Science learners being affected 'a lot' by lack of resources

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6.3 Home: parental education & language

- There is a strong relationship between achievement and parental education:
  - TIMSS 2011, 19% of parents completed a university degree
  - In 2002, 11% of parents completed a university degree
  - Internationally one third (32%) of learners have one parent with a university education
- In TIMSS 2011, 26% (a quarter) of learners reported they 'always or almost always' spoke the language of test at home and 9% 'never' did
  - Internationally 79% of learners reported they 'always or almost always' spoke the language of the test at home

Utility of the study and policy

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Some implications related to context

School and home resources

- Higher levels of resources are linked to better educational outcomes
- Learning is more difficult in learning environments where discipline, absenteeism, safety/fear of injury or loss of personal property is a problem
- In EC, MP, NC, NW all learners attended schools with discipline and safety problems. Three in every four learners (75%) in SA experience bullying weekly/monthly – the international figure is 41% of learners

Curriculum

- There was curriculum stability for the trend period (10 yrs)
- Schools / teachers should know and adhere to national curriculum – curriculum challenges continue
- Curriculum coverage and learner achievement do not necessarily overlap

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Curriculum coverage in percentages

	IEA TCMA intended	SA Intended	SA reported implemented
Mathematics	100	94	72
Science	100	90	62

Task: to ensure optimal alignment between country & international assessment frameworks and curriculum models

The latter (for IEA) concerns: (i) intended → (ii) implemented → (iii) attained

(i) National, social and educational context
(ii) School, teacher and classroom context
(iii) Student outcomes and characteristics

Source: TIMSS 2007 Assessment Frameworks, p.5

Some implications related to context

Teachers

- Findings indicative rather than representative of SA teachers; learners remain the unit of analysis
- South African TIMSS 2011 teachers are: older, experienced, well-qualified, well-prepared, confident, satisfied
- Audit of teacher qualifications: at national level, or for a representative sample, is required
- Emphasise combination of subject & subj. pedagogy/didactics training

Importance of language for achievement

- (See next three slides)

THE IMPORTANCE OF LANGUAGE

- Assumptions:
  - Learners move from "learning to read" to "reading to learn"
  - Text-rich, language-dependent background and activity enhance conceptual, cognitive and academic proficiency among learners
- TIMSS data allow for analysis of the association between learner achievement and contextual language factors/conditions closely related to writing, reading and speaking (within the three categories shown in the 2nd table to come)

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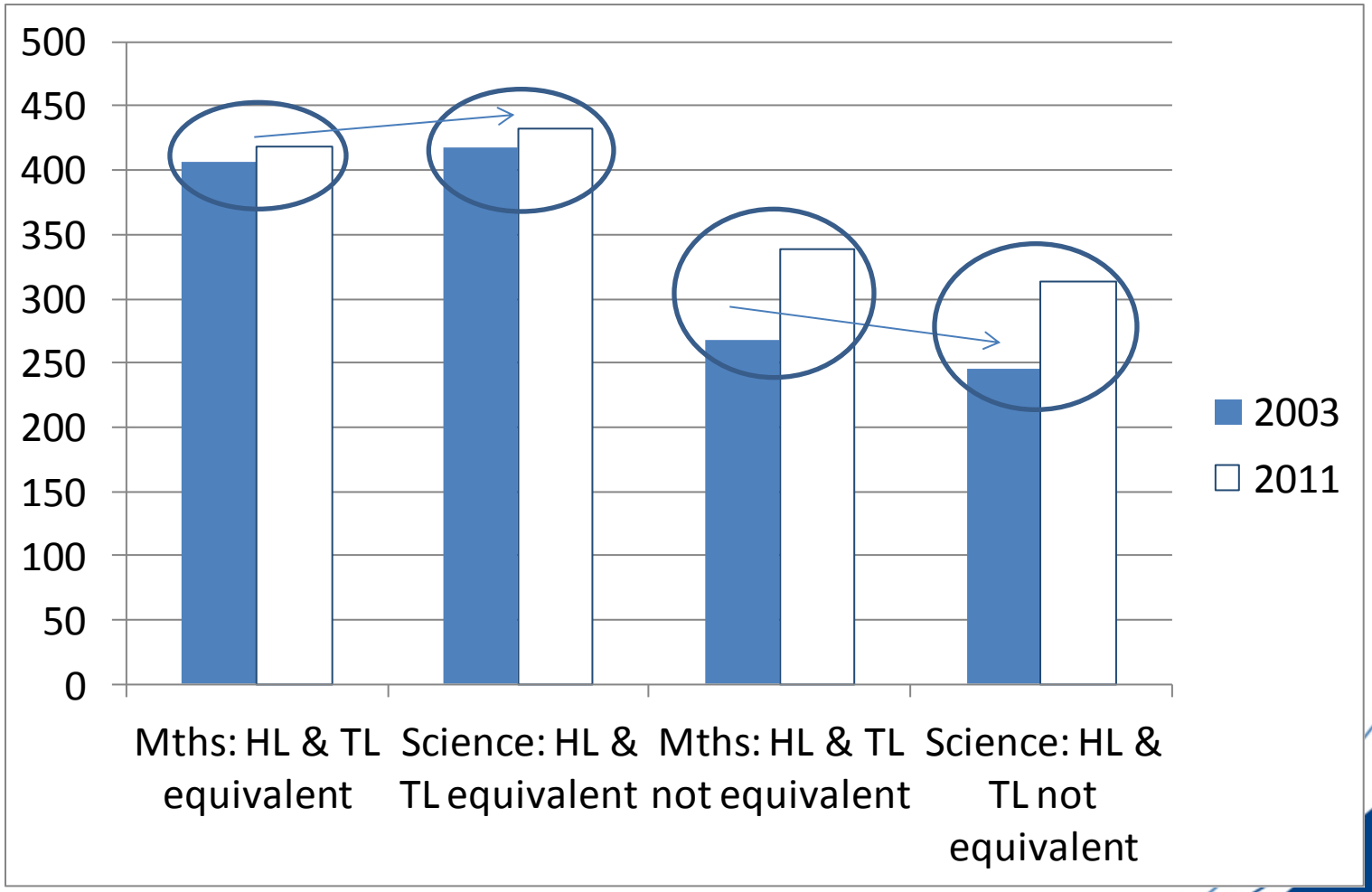
Home / test language equivalence



… Language vulnerability of Science

Factor affecting lo-hi score differences in the next column/s	Maths	Science
I. Demographic and structural conditions		
Home and instructional/test language equivalence	80	120
Perceived learner difficulty understanding spoken school lang.	65	65
Female & male parent/caregiver qualification level	85 & 90	118 & 122
II. Access to language opportunities and support		
Schools sending extra learning materials home	37	45
Exposure to writing through homework (frequency ; volume) (3+ times per week; 16-30 to 31-60 minutes in volume)	35 (teachers) 40 (learners)	Erratic
Frequency of speaking the test language at home	84	141
Number of books at home	46	61
III. Resource constraints and limitations		
Effect of textbook/learning material shortages on instruction	107	135
Resources: - software use in class - computers, Internet, TV#, dictionaries* at home	40 46 (39*)	57 66 (76#)

7. Towards Equity & Excellence

- Continue investment in schools and households for the poorest and continue to increase these scores so that we move to a narrower distribution of scores
- Need to challenge and support traditionally more resourced schools, and we need to re-affirm the agenda for excellence and high skills & high performance
- As one aspect of a national assessment regime (ANA, National Senior Certificate, ongoing, etc) all the complementary information enables comprehensive investigation and improvement

Benefits of participation

- Knowing if we're improving as country over time, or not
- Knowing where we stand compared to international best practice, but also similarly resourced countries – indicators of the well-being of our schooling system
- High confidence in rigour of procedures and techniques, and data reliability / validity (state of the art; independent view)
- Nuanced data/findings by province, test language, type of school, item, content and cognitive domains of each item
- Continuous pool of released items / examplars
- Greater understanding of contributing contextual factors
- Opportunity for critical look at ourselves
- More engagement with findings towards remedies

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Disadvantages related to participation

- Not having individual school, teacher or learner information as an "assessment for learning" outcome (who struggles, and what they are struggling with)
- Some lack of overlap of intended curriculum for Science
- Not all countries serve as good comparisons for S.A. (size of system, resources, curriculum overlap*)
- Few officials and researchers access & benefit from data

*Note: IEA sophistication enables comparisons between countries should we have done the same item pools

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In closing (1)

- Historically, human and social science research focused strongly on quantitative techniques and the development of sophisticated statistical skills (e.g., in psychometrics; at universities and science councils) [1960s to 1990]
- That got eroded during recent shift towards qualitative techniques, and diminished large-scale studies, data collection and modelling [1990 to 2010]
- Only to be revived lately – with return of strong need for rebuilding the lost proficiencies [2010→]

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In closing (2)

- The foregoing strongly calls upon post-graduate students to step forward and undertake such training and work
- Dissemination and engagement with the study, its items and findings should be used to leverage accountability, especially through parent- and community-driven action
- Findings on poor achievement per content and cognitive domains call for enhanced curriculum coverage and teacher training (subject pedagogy in addition to subject content)
- National Development Plan sets achievement targets:
  - TIMSS 2023: 420 (up from 264) (Ch 9; p 276)
  - by 2030: 500 (up 10 places in rank)

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8. Future.....?

- Participation in TIMSS 2015
- Work towards improvement of both lower and top end of performance
- With the effort and commitment of schools, teachers and learners and support from the educational departments we should set the target for an improvement by **30 points p.a. to reach a score of 382 in 2015 with 40% of learners scoring above 400 points**

Projected scores

YEAR	Grade 9 Mathematics scores
2023	**442**
2019	**412**
2015	**382**
2011	**352**
2002	**285**
1999	**296 (extrapolated)**
1995	**294 (extrapolated)**

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