Centre for Research on Science and Technology

A MONITORING AND EVALUATION FRAMEWORK TO BENCHMARK THE PERFORMANCE OF WOMEN IN THE NSI

FINAL REPORT TO THE SET4W REFERENCE GROUP

VOLUME I

MAIN REPORT

Project Leaders: Jaamiah Galant and Johann Mouton

Research team: Nelius Boshoff, Jennifer de Beer, Simone Esau,

Heidi Prozesky and Lynn Lorenzen

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The research team

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ABBREVIATIONS AND ACRONYMS

CESM	Classification of Educational Study Matter
CREST	Centre for Research on Science and Technology (Stellenbosch University)
CWTS	Centre of Science and Technology Studies (Leiden University)
DACST	Department of Arts, Culture, Science and Technology
DoE	Department of Education
DoH	Department of Health
DST	Department of Science and Technology
DTI	Department of Trade and Industry
EMIS	Education Management Information System
FRD	Foundation for Research Development
FTE	Full-time equivalent
HEMIS	Higher Education Management Information System
HSRC	Human Sciences Research Council
IF	Innovation Fund
LFS	Labour Force Survey
KPI	Key Performance Indicator
NACI	National Advisory Council for Innovation
NRF	National Research Foundation
NSI	National System of Innovation
NSFAS	National Student Financial Aid Scheme
MRC	Medical Research Council
R&D	Research and development
SAPSE	South African Post-Secondary Education
SET	Science, engineering and technology
SETI	Science, engineering and technology institution
SET4W	Science, Engineering and Technology for Women
THRIP	Technology and Human Resources for Industry Programme
USPTO	United States Patent and Trademark Office

PART I

INTRODUCTION AND CONTEXT TO THE PROJECT

Part I of this report provides a detailed background to this study, describes the scope and focus of the research, and presents a model for understanding the monitoring and evaluation framework. **SECTION A** begins by outlining the brief of the research and locating the study within national and global contexts. It goes on to describe the project activities and outputs. The section concludes with an outline of the structure of the report. **SECTION B** describes a model for understanding monitoring and evaluation.

SECTION A

INTRODUCTION

Background and brief

This study was commissioned by the Science, Engineering and Technology for Women (SET4W) Reference Group1, a sub-committee of the National Advisory Council on Innovation (NACI) in the Ministry of Science and Technology. The research brief for this project was formulated as follows in the Terms of Reference document:

> *The South African Reference Group on Women in Science and Technology (SET4W) invites submissions for the preparation of a mixed methods research study to design a suitable monitoring and evaluation framework to enable SET4W and NACI to regularly evaluate the performance of women in and the contribution of the respective genders to the input and output of the NSI, [ ] and to use this as a basis to advise the Minister of Science and Technology* (p.3).

The establishment of SET4W was originally proposed in the National Research and Development (R&D) Strategy (2002:36) as a group of local and international "stakeholders and representatives of organisations with interest in the progress of women in science, to monitor and advise the Department of Science and Technology on relevant issues." The key objectives of SET4W include:

- To assist NACI to promote a research agenda, including influencing funding that will improve the quality of life of women
- To assist NACI to promote innovation that will allow women to make a greater contribution to wealth generation in South Africa
- To provide advice on developing mechanisms that will increase the participation and contribution of women in science and technology
- To highlight role models that promote women's entry and advancement in science and technology, and
- To play a monitoring role in tracking institutional impact.

The design of a monitoring and evaluation framework to benchmark the performance of women in the NSI has to be read against the background of the most recent study on women in science, which was undertaken by the Centre for Research on Science and Technology

[1] Previously known as the South African Reference Group (SARG) on Women in SET.

(CREST) and released by NACI in 2004 as *Facing the Facts*: *Women's Participation in Science, Engineering and Technology* (NACI/SET4W, 2004).

Facing the Facts is the first study in South Africa that provides a comprehensive picture of the participation and performance of women in SET. Relying only on available data sources in the system, the study includes:

- a detailed profile of the gender distribution of postgraduate enrolments and graduations in the higher education system
- a detailed profile of the gender distribution of the human resources in the higher education sector and within government science, engineering and technology institutions (SETIs), including the science councils, national research facilities and selected national laboratories
- a detailed overview of the sex differences in publication output
- an overview of the sex distribution in the funding of studies in higher education or for research, as well as in the rating of scientists by the National Research Foundation (NRF)

As such, *Facing the Facts* already provides some baseline data and indicators against which the ongoing participation and performance of women in the NSI can be monitored. The *Facing the Facts* study was undertaken within a particular national and global context that remains pertinent to the endeavour to design a monitoring and evaluation framework for evaluating the performance of women in the NSI. These broader contexts are again described below[2] to serve as a useful backdrop against which to read the monitoring and evaluation framework developed in this study.

The national policy context

Gender equality is one of the core ideals enshrined in the Bill of Rights of the South African Constitution (1993). The government has attempted to give expression to this ideal in both policy and practice. In terms of practice, and following international trends, the government has adopted the approach of 'mainstreaming gender' in dealing with gender equality issues. In brief, 'gender mainstreaming' refers to the "integration of gender equality concerns into the analyses and formulation of all policies, programmes and projects"[3]. As such, the government has established 'gender desks' or 'gender focal points' within each government

[2] See Bailey (ed) 2004: 21 – 26 Women in Science, Engineering and Technology, Main Report, Volume 1

[3] Notes on defining mainstreaming prepared by Prof Amanda Gouws, Department of Political Science, University of Stellenbosch (2003).

department, whose responsibility it is to ensure the integration of a gender perspective into all policy and implementation activities.

The government has also developed policy and legislation that earmarks women as a specific group. The Employment Equity legislation, for example, aims to ensure that women and people from other previously disadvantaged groups are given equal opportunities in terms of participation in the job market.

The goal of gender equality has also permeated all policy development since 1994, including the two policy domains which are particularly pertinent to a study focusing on women in science, namely science and technology, and higher education. The relevant policy documents and associated strategies or plans of action include the White Paper on Science and Technology (Department of Arts, Culture, Science and Technology, DACST 1997) and its associated National R&D Strategy (DST 2002); and, the White Paper on Higher Education (Department of Education, DoE 1997) and its associated National Plan for Higher Education (DoE 2001).

Increasing and diversifying women's participation in SET

A strong feature of the focus on women and gender in these documents is the emphasis on the under-representation of women in the science and technology human resource base. For example, one of the key weaknesses in the existing science and technology system identified in the R&D Strategy is the "frozen demographics" of the human resource base. Based on recent research undertaken by CREST (see, for example, Mouton 2003), the R&D Strategy (DST 2002:21) notes that the scientific workforce in South Africa is shrinking and growing older insofar as "black and women scientists, technologists and engineers are not entering the academic publishing ranks and that the key research infrastructure is composed of people who will soon retire." Furthermore, women tend to publish considerably less than their male counterparts, with the publication outputs of women in the 1990s comprising about one fifth of the total.

Similarly, the White Paper on higher education (DoE 1997:8) highlighted a range of weaknesses and key challenges in the existing higher education system. Among these are "an inequitable distribution of access and opportunity for students and staff along lines of race, gender, class and geography" and "a shortage of highly trained graduates in fields such as science, engineering, technology and commerce" which it ascribes to the discriminatory practices of the past that "limited the access of black and women students."

Four years later, the National Plan (DoE 2001:40) indicated that while gender equity had been achieved in universities, it remained "a problem in the technikons." It also pointed to the uneven gender distribution across programmes and fields of study, "with female students

clustered in the humanities and under-represented in science, engineering and technology, business and commerce, and in postgraduate programmes." At the staff level, the National Plan (DoE 2001:40) notes that "black people and women remain under-represented in academic and professional positions, especially at senior levels."

Strategies to address these persistent inequities are put forward in the R&D Strategy and the National Plan. For example, one of the key objectives of the R&D Strategy is to identify the ways in which this human resource base can be expanded, and in particular, with regard to women and black population groups. In this regard, the R&D Strategy (DST 2002:36) proposed the establishment of the South African Reference Group for women in SET, now called SET4W (described above). According to the R&D Strategy (DST 2002:56), the reference group

> *"... will strengthen women-led initiatives in all phases of participation in science and technology, from school to career achievement. This reference group, which will report to the Deputy Minister of Arts, Culture, Science and Technology, will complement and strengthen the activities of the National Advisory Council on Innovation with respect to gender issues in our national system of innovation."*

The R&D Strategy (DST 2002:55) also outlines the basic requirements for a human resource development approach for SET that includes a clear gender dimension. These requirements include:

- A clear definition of what such a 'gender perspective' involves
- Disaggregated statistics on women in the science system
- Programmes which encourage previously marginalized groups (including women) to participate in science
- A strong gender-inclusive policy in Centres of Excellence
- The consolidation of current policies for women into a programme of empowerment for women, and
- The development of policy for women in science that is not punitive in respect of career development.

The National Plan focuses on the human resource issue from the supply side. One of the expected outcomes in the National Plan (DoE 2001:28) is the broadening of the social base of students. This means increasing the participation rate of 'non-traditional' students, "i.e. workers, mature learners, in particular women, and the disabled." One of the strategies

adopted by the Ministry to achieve these ends is the requirement that institutions indicate in their three-year rolling plans the strategies, including specific timeframes and targets, that they have developed to increase the enrolments among these categories of learners (DoE 2001:28,33). In addition, institutions are required to demonstrate how they intend to "redress the imbalances in the enrolments of students in different programmes, fields of specialisation or qualifications, in particular, postgraduate programmes" (DoE 2001:48).

In terms of staff equity, the National Plan (DoE 2001:48) states that the Ministry will, amongst others, "Consider providing postgraduate scholarships targeted at black, women and disabled students" and that institutions will have to outline the "development and implementation of employment equity plans" in their three-year rolling plans. The National Plan (DoE 2001:40) observes that

> *"... institutional plans place far less emphasis on gender equity than on race equity. This is evident from the fact that, while attempts are being made to develop strategies and interventions to address issues of race equity, there are few, if any, strategies or interventions in place to address issues of gender equity."*

This suggests that, relatively speaking, race has been effectively mainstreamed over the past nine years, while there are still significant gender imbalances in the system but little evidence of strategies to address these.

Ensuring that SET benefits women

The issue of gender equity within the science system is only one aspect of the gender perspective expressed in the White Paper on S&T and the R&D Strategy. These documents also emphasise the importance of harnessing science and technology towards meeting national goals which are broadly defined as economic growth and wealth creation, and improving the quality of life of ordinary South Africans. Since women, and perhaps especially rural women, were excluded and marginalised in the past, part of the concern expressed in these documents can be interpreted as including how research (in the public domain) should impact positively on the lives of women. For example, the White Paper on S&T (DACST 1996:51) argues that

> *"Recent history has demonstrated the potential of technology to improve the quality of people's lives. Yet disadvantaged populations in general and women in particular, especially those in rural areas, have little access to information about these technologies. To date, a combination of factors have prevented them from gaining equitable access to the information they need and have thus limited their ability to participate more fully in the transformation process in South Africa."*

Similarly, the R&D Strategy (DST 2002:44) indicates that "the mission to reduce the impact of poverty needs to deal with the causes of poverty and the impact of poverty on women and the disabled, since they carry the greater burden. Innovative technologies need to be harnessed to positively impact on their daily lives."

The global context

> *On a worldwide scale, science – and even more technology – is still a man's business. This situation is no longer acceptable. It is economically unacceptable because of the waste of human resources that it entails; it is humanly unacceptable since it prevents half the population from taking part in building the world; it is intellectually unacceptable as it deprives scientific and technological research of ideas and methods, in a word, of creativity. Furthermore, it mortgages the future since is nullifies any prospect of a general mobilization in support of science in the service of a lasting peace and sustainable development.*
>
> – Federico Mayor (1999)

Concerns about the participation of women in science and the beneficial impact of science on the lives of ordinary women are not only a South African preoccupation. A review of recent literature and the web sites of various initiatives relating to women in SET suggest that these concerns are being discussed and addressed in many countries around the world. According to McGregor and Bazi (2001:16), the first real focus on issues relating to women in SET emerged in the 1980s. For example, in 1983 the United Nations Commission on Science and Technology (UNCSTD), which had only recently been established, "designated gender as one of its three themes." More recently, the UNESCO World Conference on Science held in Budapest in 1999 dedicated a theme to women in SET and, in February of the same year, the European Commission's "action plan to integrate the gender dimension in research policy" was approved and accepted (Dewandre 1999).

At the national level, some governments, such as those in the United Kingdom, Canada and the United States, have taken a lead in compiling information on and assessing the situation of women in SET. These initiatives have been driven by the recognition that in order for a nation to develop its human resources and its scientific and technological capabilities to the full, it needs to ensure that the whole population is given equal access to education and training, employment opportunities and career-pathing and promotion. As McGregor and Bazi (2001:16) argue,

"Increasingly, as economies reposition themselves to compete in the new knowledge-based global economy, the gender gap in entry, promotion, decision-making and attrition in fields of study and remunerated endeavour in science and technology has caught the attention of planners."

The government of the United Kingdom, for example, has established the Promoting Women in SET Unit within its Office of Science and Technology. In 1994, the UK government also produced a White Paper entitled *The Rising Tide: A report on women in science, engineering and technology*, which outlines a range of opportunities and barriers for women to participate in SET. The UK Department of Trade and Industry also focused its attention on the role of women in SET through two major reports, namely *Breaking the Mould: An Assessment of Successful Strategies for Attracting Girls into Science, Engineering and Technology* (1997) and *Making the Most – Women in Science, Engineering and Technology – Building a Workforce for Sustained Competitiveness*, (Dept of Trade and Industry, and Opportunity 2000, 1995). In the United States, the under-representation of women in SET was first addressed at a national level with the publication of the White House Report, *Changing America: The New Face of Science and Technology* in 1989 (Link & Link 1999:438). This was followed by the establishment of the Committee on Women in Science and Engineering in 1991.

In addition to compiling information on the status of women in SET, these governments have also devised "special mechanisms for recruiting, retaining and mentoring top female talent" (McGregor & Bazi 2001:16), such as the Chairs on Women in Engineering in Universities established by the National Science and Engineering Research Council in Canada. (The database of initiatives for women in SET internationally, which is described in SECTION I of this report, contains a number of other examples of initiatives of this kind.)

But what are the 'issues' relating to women in SET? Interestingly, while there are clearly issues that are country- or institution-specific, there do appear to be a range of issues that are common to women in SET in many countries around the world. For instance, the *Report on the thematic meeting on mainstreaming women in science* of the UNESCO World Conference on Science, which summarises the main features of six regional meeting reports[4] and over 30 speakers, indicates that, context-specific features aside, all participating countries faced the same basic challenges with regard to women in SET (Oldham 2000).

In the first place, in many countries, but especially in less developed countries, fewer girls than boys have access to primary education and even fewer participate in science (Oldham 2000:346). The gap between males and females, especially in the sciences, is widened

[4] From Latin America, Europe, Asia-Pacific, Africa, the Mediterranean, and selected Arab countries.

considerably at the secondary and tertiary levels (Helbing, Verhoef & Wellington 1998:255; Oldham 2000:346). In the more industrialised countries, there have been significant increases in the enrolment of women for higher education degrees, but there remain large disparities between women and men enrolled in the natural sciences and engineering (see, for example, Link & Link 1999:437). Nancy Lane (1999) reports that in the United Kingdom, the gap between men and women in terms of student enrolments in the physical, mathematical and computer sciences is already evident at the undergraduate level, but it becomes a glaring disparity at the postgraduate level.

Men are also more likely to pursue careers in science and technology. More importantly, however, even when women do enter careers in these fields, they are far less likely to occupy senior positions (Ebeling 1999; Etzkowitz *et al* 2000:1; Helbing *et al* 1998:255; Kornhauser 2000:340; Lane 1999; Oldham 2000:346). In most countries, even the most industrially advanced, less than 10% of senior leadership positions are occupied by women. According to Nicole Dewandre (1999), the most significant aspect of the under-representation of women in SET in Europe is the "vertical segregation": "Although the proportion of women gaining scientific degrees has increased significantly in recent decades, the proportion of women reaching the very top of the scientific hierarchy remains stubbornly low." Fox (1998:201) also argues that although more women are pursuing higher degrees in the natural sciences and engineering than ever before, they still "...lag behind men in the number of doctoral degrees attained, and even more so, in levels of professional participation, position, productivity, and recognition ..." In less developed countries in Africa, Latin America and the Middle East, the situation is even worse.

To a large extent, the limited number of women in senior positions is attributed to continued discrimination in the workplace, which often manifests in less funding for women and fewer tenured positions (Kornhauser 2000:340; Lane 1999). However, discrimination is not the only problem for women in their professional careers. Much of the literature points to the challenges women face if they take a break in their career, either to have children or to look after family. Returning to the world of S&T can be difficult. According to Lane (1999):

> *"... time away from the lab leads to unfamiliarity with novel technologies and current 'state-of-the-art' equipment. Retraining is an expensive and time-consuming affair, and finding the necessary financial support and laboratory facilities can prove difficult."*

One of the consequences of the lack of women in senior leadership positions is that women are unable to make an input into decision-making which impacts on them, whether it be in relation to the allocation of funding, or policy guidelines relating to the practice of science (Kornhauser 2000:340; Makhubu 1999). Oldham (2000:346), for instance, notes that

development interventions or programmes tend to bias their activities towards men's activities and needs.

Finally, a problem that many countries – including South Africa – seem to share is the lack of reliable, comprehensive and comparable sex-disaggregated data which is critical in enabling policy-makers and planners to assess the status and profile of women in SET (Oldham 2000:346).

The initiative to design and develop a monitoring and evaluation framework to benchmark the performance of women in the South African NSI can thus be seen as an attempt to provide some mechanism whereby this country can respond to some of the national and global concerns mentioned above. It is only through a monitoring and evaluation system that insists on sex-disaggregated data that this country will be able to measure the performance of women in the NSI, compared to men, and compared to women in other countries.

Project conceptualisation and design

In conceptualising a monitoring and evaluation framework for regularly measuring the performance of women in the NSI, it was felt that such a framework needs to be as comprehensive as possible and not be constrained by what data is (currently) available in the system. In other words, our brief in designing a monitoring and evaluation framework was to include indicators that would enable all aspects of women's participation and performance in the NSI to be monitored and evaluated. Where no data in the system existed for such monitoring to occur, our brief was to make recommendations for the ongoing and systematic collection of such data. It is against this background that we embarked on designing an 'ideal' monitoring and evaluation framework for women in SET that would support planning and resourcing of the NSI and allow for international benchmarking in selected areas.

The Centre for Research on Science and Technology (CREST) undertook this study and conceptualised it in terms of three phases. The descriptions below include the main activities, outcomes and outputs in each phase.

Phase 1: Identifying indicators, mechanisms and approaches for monitoring and measuring gender impact on the NSI

This phase included the following activities:

- Review of literature and other monitoring and evaluation systems that measure gender impact
- Elaborating on the 'scoreboard' proposed in *Facing the Facts*: *Women's Participation in Science, Engineering and Technology* (NACI/SET4W, 2004)

- Analysis of the contents of available data sources in the system
- Engaging with women scientists through a series of consultative workshops

At the end of this phase we were able to compile a first crude list of possible indicators to be included in the framework. We were also able to establish what data fields were available from existing data sources, and what data would need to be collected in the system. The results of Phase 1 were reported in the First Progress Report to SET4W in June 2005.

Phase 2: Designing a M&E Framework for monitoring and measuring gender impact on the NSI

This phase constituted the core focus of the study and included the following activities:

- Designing and developing a (first version of the) framework that draws on the literature and inputs from Phase 1
- Circulating the framework to a range of stakeholders for comments
- Engaging with women scientists in a second round of consultative workshops around the framework

During this phase we concentrated on refining the indicators, based on inputs from Phase 1, and organising them around core constructs that would form a conceptual framework for monitoring and evaluating the performance of women in the NSI. While the conceptual framework had not yet been properly articulated, we were able to produce a first version of the monitoring and evaluation framework. At the end of this phase we were also beginning to develop insights into the constraints of implementing the framework due to the lack of readily available data in the system. We therefore made no attempt at this point to populate the framework. The results from Phase 2 were reported on in the Second Progress Report to SET4W in August 2005.

Phase 3: Finalising and implementing the M&E Framework

The results of this phase are reflected in this final report and included the following activities:

- Refining and finalising the constructs and indicators
- Describing the conceptual framework
- Making recommendations for data collection and data sources
- Describing different scenarios for applying the framework

Structure of the final report

The final report comprises two separate documents:

- The main body of the report (Volume 1)
- The appendices to the report (Volume 11)

Volume I is divided into three Parts, which in turn, comprise one or more Sections. These are described below.

Part I: Introduction and Context. Part I has two sections. Section A provides a detailed background to this study and describes the scope and focus of the M&E framework. Section B presents a model for understanding monitoring and evaluation.

Part II: Conceptual Framework. This part describes the core constructs around which the indicators are organised in the framework and provides a rationale for the inclusion of the indicators.

Part III: Application of the M&E Framework. This part has two sections. Section A describes the data sources and data availability and makes recommendations for data collection. Section B describes different scenarios for the application of the framework.

Volume II comprises two main appendices:

Appendix 1: Overview of Monitoring and Evaluation Framework to Benchmark the Performance of Women in the South African NSI. This appendix is an abridged version of the framework that provides a quick overview of the constructs and indicator main categories and sub-categories.

Appendix 2: Expanded Monitoring and Evaluation Framework: Constructs, Indicator categories, sub-categories, data tables and indicators. This appendix contains the full list of indicators for each indicator category and sub-category within each construct. In addition, it includes data tables that recommend forms of data collection and reporting.

SECTION B

UNDERSTANDING MONITORING AND EVALUATION

THE BRIEF: The South African Reference Group on Women in Science and Technology (SET4W) invites submissions for the preparation of a mixed methods research study to design a suitable monitoring and evaluation framework to enable SET4W and NACI to regularly evaluate the performance of women in and the contribution of the respective genders to the input and output of the NSI, [ ] and to use this as a basis to advise the Minister of Science and Technology (p.3).

Matters of definition

The brief for this study explicitly states that the key deliverable should be a "monitoring" and "evaluation" framework that would enable various stakeholders to "regularly evaluate" the performance of women. This distinction between monitoring and evaluation activities is a standard distinction in the evaluation literature, although this does not of course mean that the application and use of these terms are not without problems. Before defining each of these terms, as well as the notion of "performance monitoring or evaluation", it is important to distinguish between two other key terms - evaluation (research) and (programme) evaluation – which are often used interchangeably and incorrectly so.

Part of the differences in usage of these terms – if not confusion – arises from the fact that the field of M&E is both an established interdisciplinary academic field of teaching and study as well as a burgeoning domain of practice. So, on the one hand, we find that evaluation researchers and scholars use these terms in a peculiar way, whereas M&E practitioners (and their immediate stakeholders such as donor and aid agencies, government departments, gnu's) use these same terms in somewhat different ways.

Evaluation research and (programme) evaluation

Freeman and Rossi (1993: 5) define evaluation research as

the systematic application of social research procedures for assessing the conceptualization, design, implementation and utility of social intervention programmes.

According to Patton the term “evaluation research” does in fact refer more aptly to the scholarly or academic activities of evaluation researchers. In this sense “evaluation research” is seen as a form of scientific research, albeit an applied and problem-solving kind of research. It is first and foremost defined in typical academic terms. The term “evaluation” on the other hand, refers to the very practical endeavour of evaluating and assessing programmes, policies and other forms of (human) interventions.

According to Michael Scriven evaluation is special because it takes us beyond all the classical types of investigation and research. He writes:

The historian, the detective, the psychologist and the epidemiologist are searching for causes, the meteorologist and the sociologist seek better data and theories, the palaeontologist and botanist look for refinements in their classification schemas - all of these activities are seeking to find out things about the world, and improve our understanding of it. But the evaluator, who needs much of that work as a foundation, goes on beyond it, to answer other questions. In the context of evaluating a new program, to take one example, these further questions might be: how valuable is the result, is it the best available, was it worth what it cost, should we replicate it elsewhere, is it so important a result that we should publish it and publish about it? In thinking about evaluation, it's sometimes useful to keep in mind the following slogan (although it's oversimplified): The scientist answers the question, "What's so?" and the evaluator answers the question, "So what?"

According to Carol Weiss, “evaluation is the systematic assessment of the operation and/or outcomes of a program or policy, compared to a set of explicit or implicit standards, as a means of contributing to the improvement of the program or policy (1998, p4)”. The OECD defines programme evaluation as follows:

The systematic and objective assessment of an on-going or completed project, programme or policy, its design, implementation and results. The aim is to determine the relevance and fulfilment of objectives, development efficiency, effectiveness, impact and sustainability. An evaluation should provide information that is credible and useful, enabling the incorporation of lessons learned into the decision– making process of both recipients and donors. Evaluation also refers to the process of determining the worth or significance of an activity, policy or program. An assessment, as systematic and objective as possible, of a planned, on-going, or completed development intervention. Note: Evaluation in some instances involves the definition of appropriate

standards, the examination of performance against those standards, an assessment of actual and expected results and the identification of relevant lessons. (OECD)

The key notions that are salient in these definitions can be summarised as follows:

- Evaluation is a process that is usually aimed at establishing the worth or merit of an intervention such as a policy or programme.
- Programme evaluations are specifically aimed at assessing the worth or merit of programmes.
- Terms that signify related or similar activities are "assessments" or "reviews". It is more common to apply the term "assessment" to the evaluation of individuals (as in performance assessment or appraisal) and the term "review" to more institutional and systemic level interventions (as in systems reviews, SETI reviews, and institutional reviews).
- As is already indicated in the definitions above, the purposes of evaluations often differ depending also on whether the focus is on the implementation of programmes or on the immediate outcomes or longer-term impact and sustainability.

(Programme) monitoring

The everyday usage of the term "monitoring" already gives a good indication of what it means. We are all familiar with equipment that monitors our health, such as a heartbeat monitor. In economics, analysts use different kinds of measures, such as the consumer price index to measure and monitor the state of the economic system of a country. These examples already point to some of the key features of monitoring activities – regular and standardized measuring of a certain state of affairs.

Programme monitoring is defined as "the continuous process of examining the delivery of programme outputs to intended beneficiaries, which is carried out during the execution of a programme with the intention of immediately correcting any deviation from operational objectives". This definition highlights two characteristics of monitoring activities:

- Monitoring is per definition a regular activity. One cannot talk of one-off monitoring studies.
- Monitoring is primarily a descriptive – as opposed to an evaluative – activity or process.

Monitoring requires regular and continuous measurement. In fact, one implication of regular monitoring is the use of standard measures (or indicators) in order to increase the reliability of monitoring data. What counts as "regular" depends entirely on the programme or system that is being monitored. Heartbeat monitors measure heartbeat every second. The consumer price index measures inflation rates every month. The more complex the phenomenon that is being monitored (as the Eurobarometer of values), the more likely it is that the monitoring activity happens at greater time intervals.

Monitoring is primarily descriptive because its aim is to pick up (small) changes in the natural course of events and in doing so to provide timeous feedback to whoever requires the information. Where monitoring occurs against some standard or benchmark, the notion of "performance monitoring" becomes relevant. In fact, benchmarking a company's performance or a system's performance in some area (e.g. expenditure on R&D as % of GDP) against some standard or goal (1% of GDP), is of course a form of performance monitoring. Using regular R&D surveys to gather information on the performance of the national system of innovation, then allows one to establish whether the system is performing well (above this benchmark) or not.

In summary then, the difference between programme evaluation and programme monitoring is at two levels:

- Programme monitoring - especially when viewed as part of project management - often becomes a routine activity. Programme evaluation, on the other hand, can be a one off assessment or form part of a comprehensive evaluation initiative.
- Programme monitoring is essentially descriptive in nature – it records things as they happen or states of affair as they occur. Monitoring systems consists of sets of indicators that measure processes, output and outcomes but do not necessarily involve value judgments on the worth or merit of programmes. Programme evaluation – as the word suggests – involves some value judgment. Programme evaluations typically result in various kinds of value judgment, e.g. judgments of the effectiveness, success, efficiency and sustainability of programmes or other forms of interventions (such as policies).

THE DIFFERENT PURPOSES OF EVALUATION

Evaluations are commissioned and undertaken to meet very different purposes. The wide range of evaluation purposes attests to the many possible interests and values that evaluation studies are seen to serve. An evaluation might address a number of different

purposes at the same time in which case it will affect the complexity of the design and the duration of the study. We distinguish between two main types of evaluation purposes.

Judgement-oriented evaluations aim to establish whether a programme had delivered on its promises; has it produced value for money. Such evaluations are invariably retrospective or ex post facto-evaluation – they are conducted once the programme has run its course. They are very often commissioned by governing bodies and funders who have to account for the investment in the programme (accountability perspective) and are therefore also usually summative in nature. This means that such evaluations often have to provide an assessment or judgment on the continuation of the programme.

Improvement-oriented (or development-oriented) evaluations aim to provide input to programme staff and other stakeholders on ways in which a programme or policy can be improved and strengthened. Such evaluations are best done concurrently with the implementation of the programme. They are invariably formative in nature and are often conducted in close collaboration with programme staff who share the interest in improving and refining the programme.

SUMMARY COMMENTS

The M&E framework that is presented and elaborated upon in this report takes the distinction between monitoring and evaluation seriously. In Part III of this report, we present FOUR different application scenarios of this framework. The first three scenarios are three different forms of monitoring activity: systems monitoring, sectoral monitoring and international benchmarking. The fourth scenario makes the case for a more in-depth evaluation of the national system of innovation as far as gender impact is concerned – the systems review scenario. These different scenarios also presuppose that monitoring and evaluation activities have different purposes and different stakeholders, which co-define the value of such M&E activities.

PART II

CONCEPTUAL FRAMEWORK

This part describes the core constructs around which the indicators are organised in the framework and provides a rationale for the inclusion of the indicators.

Introduction

In order to inform the rationale and development of our monitoring and evaluation framework, we reviewed and compared how the reports emanating from international initiatives on science and technology indicators have designed their frameworks using broad constructs or organising themes, and clustered indicators within these constructs or themes. Below we provide a summary and brief description of the European Commission and National Science Foundation frameworks, which are the only two frameworks that provide gender analyses of science and technology indicators[5]:

Report	Organising themes (constructs)	Description
1. European Commission, *Women and Science Statistics and Indicators*, *She Figures 2003*	1. How many? (The "critical mass")	This set of indicators provides an overview of gender patterns for the "critical mass" of scientists and researchers studying and working in Europe. Indicators included here measure the gender balance of the graduate population as well as gender patterns in scientific employment. With respect to the latter, gender patterns are examined separately for R&D workers on one hand, and Scientists and Engineers on the other hand.
	2. Horizontal segregation	This set of indicators measures gender differences across scientific fields among women and men graduates as well as women and men researchers in different sectors.
	3. Vertical segregation	These indicators measure the hierarchical distributions of the sexes within academia and R&D occupations. Included in this set of indicators is a measure of gender patterns in scientific performance and output.
	4. Pay Gap	Here one indicator is used to measure the dissimilarity in salary by sex for different occupational grades.
	5. Fairness and Success rates	This set of indicators measures the sex breakdown of applicants and beneficiaries of research funds and the sex composition of scientific boards, editorial boards and scientific review panels.
2. National Science Foundation, *Women, Minorities and Persons with Disabilities in Science and Engineering:*	1. Undergraduate Enrolments	Indicators are clustered to measure sex and race differences in high school completion rates and undergraduate enrolments in different institutional types. In addition, sex and race differences in enrolments by field of study, with a special focus on engineering, are also examined.
	2. Undergraduate Degrees	This set of indicators measures sex and race differences in first bachelor degrees across science and engineering fields of study.

[5] Gender analyses of S&T indicators can have both quantitative and qualitative dimensions. Quantitative gender analyses involve the analysis of sex-disaggregated data, while qualitative gender analyses focus on the historical, political, economic and socio-cultural factors which give rise to these different experiences and impacts (McGregor & Bazi 2001:101).

2000	3. Graduate enrolments	This set of indicators measures sex and race differences in graduate enrolments at different institutional types and across science and engineering fields of study. It also includes indicators that measure sex and race differences in enrolment status (i.e. full- versus part-time).
	4. Graduate Degrees	This set of indicators measures sex and race differences in Masters and Doctorate Degrees across science and engineering fields of study. It also includes indicators that measure sex differences in post-doctoral fellowships across science and engineering fields of study
	5. Science and Engineering employment	This set of indicators measures the sex and race distribution of scientists and engineers in different occupations and sectors, and compares their age, educational attainment and salaries within these occupations. In addition, it includes indicators that measure sex and race differences in unemployment rates of scientists and engineers in different occupations. Within the education sector, indicators are included that measure sex and race differences in type of institution employed at, rank within institutions and qualification levels.

Inspection of the indicators in these two frameworks and comparison with the framework being developed in our study did not reveal any major conceptual gaps, at the construct level, nor at the operational level (at the indicator category and indicator level).

Conceptual Framework

Drawing on our review of international sources on science and technology indicators and our brief to develop a monitoring and evaluation framework for women in SET that should support planning and resourcing of the National System of Innovation, we have developed a framework that has been designed around the following nine core constructs that reflect broad policy concerns and that have planning and resourcing implications. The nine constructs are listed below with brief descriptors of what each construct addresses:

1. SET Potential
    - Leakages in the pipeline
    - Distribution across broad study fields
    - Size and potential of SET and R&D pool
2. SET Labour Force
    - SET human resource capacity
    - Horizontal distribution across SET occupations
    - Absorption of SET graduates
3. R&D Workforce

- R&D human resource capacity
- Horizontal distribution across sectors
- Absorption of SET graduates

4. Fairness and success in funding
    - Access to funding
    - Distribution of funds
    - Funding amounts
5. Rank and Employment
    - Vertical distribution within sectors
    - Permanent appointments and promotions
6. Scientific Agenda Setting
    - Distribution of executive and senior managers across sectors
    - Representation on scientific boards and councils
7. Scientific Recognition
    - Recognition by peers
    - Distribution of reviewers for scientific journals and funding agencies
    - Membership profiles of science academies
    - Citation ratings
8. Scientific Output
    - Authorships and publications
9. Scientific Collaboration and Networking
    - Co-authorships
    - Collaborative research projects
    - Conferences and sabbaticals

The selection and sequencing of these constructs, with their clusters of indicators, have been designed to provide a comprehensive national profile of women in SET in South Africa, that will tell us, for example, how many women are potentially available to participate in the NSI; how women are distributed horizontally and vertically within the NSI; how women are

supported to participate in the NSI, what recognition women get as scientists and what women's contributions are to scientific output.

Below we provide a more detailed description of each construct that highlights the value of the construct and reflects on what its indicators are meant to measure as well as some policy concerns that may be addressed by each construct. Each description ends with the indicator categories associated with the construct. An overview of the constructs, indicator main categories and sub-categories are provided in APPENDIX 1 (Volume II). The detailed breakdown of these categories and sub-categories by individual indicator is provided in APPENDIX 2 (Volume II). Issues relating to data sources and data collection for each construct are discussed in Section A of Part III.

Description of constructs

1. SET Potential

SET potential refers to the future SET capacity in a particular system of innovation. In this case, the construct focuses on the gender and race balance of the tertiary student population as an indication of the size and potential of the pool from which the future SET and R&D labour force will be drawn. Monitoring student trends in terms of enrolments and graduations, disaggregated by sex, will provide an ongoing picture of women's participation in Higher Education, especially SET studies, compared to that of men. This will contribute directly to monitoring one of the policy objectives stated in the National Plan for Higher Education (2001), namely, to increase the participation and graduation rates of black and female students.

Policy concerns:

How do the gender and race profiles of students compare at each level of study?

Are there differences between men and women students in "drop-out" level? If so, are these differences related to qualification level?

Are there significant gender differences in enrolments and graduations at the undergraduate and postgraduate levels?

The indicators of this construct are meant to show the 'leakages' in the pipeline as female students progress from school through to postgraduate studies. The indicators consider every level of study from matriculation through to PhD, including certificates and diplomas, so that each level is regarded as a potential exit point, and gender and race imbalances at each level can then be easily identified. Different qualification levels obviously serve as entry qualifications for different SET and R&D occupation levels, ranging from technical support staff through to technicians and researchers. Hence the gender and race profile at each qualification level will give an indication of the potential capacity within the system to increase and diversify participation at all levels of the SET and R&D labour force.

In addition to measuring attrition in numbers, the indicators are also meant to measure gender patterns in progressing along this pipeline over time, by comparing age. Policy concerns here are that age might inhibit participation in advanced higher education studies, and that age differences, especially at the start and completion of postgraduate studies, may have a negative impact on the potential of older students to access postgraduate funding and to find employment. For example, if the average age of female students is found to be higher at postgraduate levels, then they may be unfairly disadvantaged in competing with younger males for access to postgraduate funds, which often have age restrictions, and employment.

Policy concern:

Are women students starting and completing postgraduate studies at a later age than men?

Indicators of this construct are also meant to show the gender and race distribution of students across three broad fields of study. This horizontal distribution will reveal whether there are gender and race imbalances in particular fields. The policy concern here refers particularly to the participation of women students in the Natural Sciences and Engineering, because this affects the number of potential female recruits into related SET and R&D occupations. If this pool is found to be too small then it could have a negative impact on the capacity of the system to increase the participation of women in SET related occupations.

Policy concerns:

How do the gender and race profiles of students compare across broad fields of study?

Are women students overly clustered in broad fields of study and under-represented in others?

Finally, the indicators of this construct expand the gender and race profile of the student population to include nationality. The primary aim is to compare the distribution of South African students to other African students and non-African students studying at South African Higher Education institutions, across levels of qualification and fields of study. One compelling reason for this comparison is to be able to assess the extent to which other African students are being trained in South Africa and in which fields. Another reason would be to assess what proportion of the student population, especially at postgraduate levels, are foreign students. The latter will give an indication of the

Policy concerns:

Are there certain fields of study that attract more foreign students than others?

What proportion of postgraduate students in SET are not South African students ?

extent to which the potential pool for the recruitment of the SET and R&D labour force in South Africa is reduced when excluding foreign students.

Construct 1: SET Potential

Indicator categories[6]

1. Matriculants performing in Maths, by gender and race

2. Matriculants performing in Science, by gender and race

3. Matriculants performing in Technology, by gender and race

4. Students enrolled for a certificate/higher certificate, by gender, race, science field, nationality and age

5. Students receiving a certificate/higher certificate, by gender, race, science field, nationality and age

6. Students enrolled for a diploma/higher diploma, by gender, race, science field, nationality and age

7. Students receiving a diploma/higher diploma, by gender, race, science field, nationality and age

8. Students enrolled for a first bachelors degree, by gender, race, science field, nationality and age

9. Students graduating with a first bachelors degree, by gender, race, science field, nationality and age

10. Students enrolled for an honours degree or equivalent, by gender, race, science field, nationality and age

11. Students graduating with an honours degree or equivalent, by gender, race, science field, nationality and age

12. Students enrolled for a masters degree or equivalent, by gender, race, science field, nationality and age

13. Students graduating with a masters degree or equivalent, by gender, race, science field, nationality and age

14. Students enrolled for a doctoral degree or equivalent, by gender, race, science field, nationality and age

15. Students graduating with a doctoral degree or equivalent, by gender, race, science field, nationality and age

[6] The indicator category numbers correspond to the indicator category numbers in Appendix 1 and 2.

2. SET Labour Force

The SET labour force refers to the current capacity in the National System of Innovation (NSI) and it includes all science-based workers. This construct is meant to provide a gender and race profile of the SET human resource capacity. Monitoring the SET human resource capacity, disaggregated by sex, will allow the system to pay particular attention to the participation and distribution of women within the NSI, compared to men.

Policy concerns:

What proportion of the total labour force is made up of SET workers?

What proportion of SET workers is female?

Are SET graduates moving into SET occupations?

SET human resource capacity has to be assessed, firstly, in the context of the total labour force. This will give a broad picture of the SET capacity within the system, which can also be compared internationally. Secondly, the SET human resource capacity has to be assessed in the context of the number and profile of SET graduates at different levels of qualification over time (Construct 1). This will give some indication of the absorption of SET graduates into the SET labour force.

In addition, this category of indicators is also meant to show the horizontal distribution of women and men within the SET labour force. This will reflect the gender and race distribution within different occupations. If there are any skewed distributions within specific occupations it will pose a particular policy challenge to increase and diversify participation in these occupations, and hence broaden the potential for a diverse array of role models within SET occupations.

Policy concern:

Are women SET workers overly represented in certain occupations and under-represented in others?

Bearing the latter in mind, we start with the gender profile of Maths and Science secondary school teachers since they are potentially the first role models in SET that students are exposed to. A lack of female representation within this group could negatively influence the number of female students who choose further studies in SET. Similarly in other SET occupations, if women are under-represented, or occupy only low levels of employment, female students will not be easily encouraged to pursue these as career options. At this stage we have not listed other SET occupations in the indicator categories – see the discussion on data sources and data availability under Section A, Part III.

Construct 2: SET Labour Force

Indicator categories [7]

16. School teachers in Maths at secondary level (Grades 8-12), by gender and by race

17. School teachers in Science at secondary level (Grades 8-12), by gender and by race

3. R&D Workforce

The R&D workforce is a subset of the SET labour force that includes those professionals "engaged in the conception or creation of new knowledge, products, processes, methods and systems" (OECD Frascati Manual, 2002). These include researchers, technicians and R&D support staff, as well as post-doctoral fellows. In addition, we have included indicators relating to Masters and Doctoral supervisors under this construct. The R&D workforce thus represents a very specific form of participation in the NSI that is crucial to monitor over time.

Policy concerns:

What proportion of the total labour force is made up of R&D workers?

What proportion of R&D workers are female?

What is the gender and race profile of R&D workers across R&D levels?

What are the absorption rates of SET graduates into the R&D workforce?

Similarly to Construct 2, the indicators in this category are meant to provide not only a gender and race profile of the R&D human resource capacity, but also to show the horizontal distribution of women and men within the R&D workforce. The R&D human resource capacity should also be assessed within the context of the total labour force as well as the number of SET graduates at different levels of qualification (Construct 1). This will tell us what R&D capacity exists in the system, which can be compared internationally, as well as give some indication of the absorption of SET graduates into the R&D workforce.

The horizontal distribution of R&D workers within this construct is compared across sectors at all levels of R&D. This will reflect the gender and race distribution within sectors. If there are any skewed distributions within specific sectors it will pose a particular policy challenge to increase and diversify participation in these sectors at all

Policy concerns:

Are female researchers overly represented in certain sectors and under-represented in others?

Are female technicians overly represented in certain sectors and under-represented in others?

Are certain sectors attracting more foreign R&D workers than others?

[7] The indicator category numbers correspond to the indicator category numbers in Appendix 1 and 2.

levels of R&D. The sectors compared are Higher Education, Government/Science Councils and Business/ Industry.

Finally, the indicators that comprise this construct expand the gender and race profile of the R&D workforce to include nationality. Comparing the proportions of South African R&D workers with other African and non-African R&D workers will give some indication of the extent to which the system relies on a foreign R&D workforce. If there is a high reliance on foreign R&D workers in certain sectors it will have implications for the sustainability of the R&D human resource capacity in those sectors.

Construct 3: R&D Workforce

Indicator categories[8]

18. Researchers by gender, race, qualification, nationality and sector

19. Technicians/technologists by gender, race, qualification, nationality and sector

20. R&D support staff by gender, race, qualification, nationality and sector

21. Post-doctoral fellows by gender, race, nationality and science field

22. Doctoral supervisors by gender, race, nationality and science field

23. Masters supervisors by gender, race, nationality and science field

4. Fairness and success in funding

Funding for research or for higher education studies is a critical feature of the research infrastructure within science. With increasingly dimishing recources in the system, accessing funds has become highly competitive. Funding makes a major contribution to ongoing participation of students in higher education and to the advancement of research careers. Concomittantly, lack of funds can serve as a barrier to participation and research careers.

This construct is meant to measure whether there are gender and race differences in access to funding and success in obtaining funding. Funding sources include the NSFAS for undergraduate study, the NRF for postgraduate study and research grants in Social Sciences & Humanities and Natural Sciences & Engineering, the MRC for postgraduate study and research grants in Health Sciences, and International funding sources. The indicators in this category consider gender and race patterns in the numbers of applications and awards as well as actual monetary value of awards.

[8] The indicator category numbers correspond to the indicator category numbers in Appendix 1 and 2.

In addition to considering gender and race differences, the indicators also include nationality with respect to research grant funding. This will give some indication firstly, of the extent to which national research funds are distributed to non-South African researchers and secondly, will provide some comparison of access to international funds between South African and non-South African researchers.

Policy concerns:

Are there gender and race differences in applying for funding?

Are there gender and race differences in the awarding of funds?

Are there gender and race differences in the monetary value of funds awarded?

Do foreign researchers have differential access to certain funding sources?

Construct 4: Fairness and success in funding

Indicator categories[9]

24. Differences in applying for NSFAS undergraduate funding, by gender and race

25. NSFAS undergraduate funding applicants, by gender and race

26. NSFAS undergraduate funding recipients, by gender and race

27. Successful NSFAS undergraduate funding applications, by gender and race

28. Differences in applying for postgraduate funding (NRF/MRC), by gender, race and science field

29. Postgraduate funding applicants (NRF/MRC), by gender, race and science field

30. Postgraduate funding recipients (NRF/MRC), by gender, race and science field

31. Postgraduate funding amounts (NRF/MRC), by gender, race and science field

32. Successful postgraduate funding applications (NRF/MRC), by gender, race and science field

33. Differences in applying for grant funding (NRF/MRC), by gender, race and science field

34. Grant funding applicants (NRF/MRC), by gender, race, science field and nationality

35. Grant funding recipients (NRF/MRC), by gender, race, science field and nationality

36. Grant funding amounts (NRF/MRC), by gender, race, science field and nationality

37. Successful grant funding applications (NRF/MRC), by gender, race, science field and nationality

38. Academics with international funding, by gender, race, science field and nationality

39. International funding amounts, by gender, race, science field and nationality

[9] The indicator category numbers correspond to the indicator category numbers in Appendix 1 and 2.

5. Rank and employment

While constructs 2 and 3 monitor the overall participation and career choices of women and men in the NSI, construct 5 monitors the vertical or hierarchical distribution of women and men within different sectors. In other words, it monitors the distribution of women and men at different ranks and statuses of employment. This hierachical distribution can be used to highlight differences between the sexes in career opportunities and progression within different sectors.

Policy concerns:

Are there gender and race differences between the lower ranks and higher ranks in Higher Education?

How is gender and race distributed across different scientific fields and between the lower ranks and higher ranks?

Are there gender and race differences in the appointment of permanent researchers across sectors?

Are there gender and race differences in the promotion patterns of researchers across sectors?

Since there are no standard rank categories in the Government/Science Councils, Business/Industry and Not-for-profit sectors, rank is compared only in the Higher Education sector. These indicators should reflect any gender and race differences between the lower ranks (junior lecturer and lecturer) and the higher ranks (senior lecturer, associate professor and professor) in Higher Education across academic fields.

Vertical distribution is also measured by looking at gender and race patterns in the appointments of permanent researchers as well as promotion of researchers, across sectors. Permanent appointments and promotions within any sector have a bearing on the career opportunities and progression paths of research workers. The policy concern here is therefore to see whether women and men researchers benefit equally from permanent appointments and promotions in all sectors.

Construct 5: Rank and employment

Indicator categories[10]

40. Professors by gender, race, science field, nationality and age

41. Associate professors by gender, race, science field, nationality and age

[10] The indicator category numbers correspond to the indicator category numbers in Appendix 1 and 2.

42. Senior lecturers by gender, race, science field, nationality and age

43. Lecturers by gender, race, science field, nationality and age

44. Junior lecturers by gender, race, science field, nationality and age

45. Academics/researchers with permanent appointments by gender, race and science field

46. Academics/researchers promoted by gender, race and science field

6. Scientific Agenda Setting

Scientific agenda setting is demonstrated through and in bodies that set research agendas and make policy decisions that affect the work and performance of scientific institutions. Within institutions, it is the executive and senior managers who usually make policy decisions that affect and often shape the work of researchers and oversee their implementation. It is important that these decision-making bodies and leadership positions within institutions reflect a diversity of voices to avoid any forms of bias in decision making.

Policy concerns:

What is the representation of women on scientific boards and councils?

What proportion of executive and senior managers across sectors are women?

The indicators of this construct set out to measure the gender and race profiles of decision-making bodies such as councils of universities, boards of scientific councils, boards of directors at R&D intensive companies, and boards of professional registration bodies. In addition, the indicators also measure the gender and race profiles of the executive and senior management at universities, science councils and R&D intensive companies.

Construct 6: Scientific Agenda Setting

Indicator categories[11]

47. Share of female executive board members, by gender, race, nationality and sector

48. Share of female executive managers, by gender, race, nationality and sector

49. Share of female senior managers, by gender, race, nationality and sector

50. Members of boards of professional registration bodies, by gender, race and nationality

[11] The indicator category numbers correspond to the indicator category numbers in Appendix 1 and 2.

7. Scientific recognition

Assessing the quality of scientific work is primarily achieved through peer review. Those scientists who are called upon to review and quality assure the work of their peers are the ones who are already recognised by their peers as experts in their fields, and hence are deemed eligible and capable of passing judgement on the work of fellow scientists. These judgements often take place in the context of reviewing the work of peers, either for the purposes of approving funds or for publication. The indicators of this construct set out to measure the gender and race profiles of South African reviewers for national and international funding agencies, and reviewers for national and international journals as well as their editorial boards.

Policy concerns:

What proportion of reviewers for national and international funding agencies are South African women?

What proportion of reviewers for scientific journals are South African women?

National science academies are also institutions which confer scientific recognition on its membership, since membership is usually only obtained through nomination by peers. Hence indicators here also look at the gender and race profile of members of national science academies.

Policy concerns:

What is the representation of women scientists in national academies?

Are there differences in citation ratings for South African researchers by gender and by field?

Finally, scientific recognition can also be measured by citation ratings, that is, the extent to which a scientist's work is cited by other scientists. Scientific recognition in addition contributes greatly to the visibility of scientists.

The policy concern addressed by all these indicators is to see whether women and men scientists benefit equally from these different forms of scientific recognition.

Construct 7: Scientific recognition

Indicator categories[12]

51. South African reviewers for national funding agencies, by gender and race

52. South African reviewers for international funding agencies, by gender and race

[12] The indicator category numbers correspond to the indicator category numbers in Appendix 1 and 2.

53. South African reviewers for national journals, by gender and race

54. South African reviewers for international journals, by gender and race

55. South African national editorial board members, by gender and race

56. South African international editorial board members, by gender and race

57. South African national academy members, by gender and race

58. Gender comparison of average citation ratings normalized by field

59. Gender comparison of average citation ratings normalized by journal

8. Scientific output

Scientific output (publications and patents) is one of the most common measures of the size and robustness of the science system in a country. It is also used as a measure of academic success, given that 'good' publication records are rewarded with funding and are often used as criteria for other recognition systems like scientific rating, promotions or membership of academies. This in turn means that low rates of scientific output can severely hamper career progress.

Policy concerns:

What is the contribution of women scientists to scientific output in the system?

Are there differential patterns of scientific production by field and gender?

The indicators of this construct are meant to map gender and race patterns in scientific output. Scientific outputs as measured in this construct include peer reviewed articles, books and registered patents. Since scientific output is an indication of the contributions of scientists to the scientific production in the system, it can also be used as an indication of efficiency if one compares the number of outputs per scientist in the system.

Construct 8: Scientific output

Indicator categories[13]

60. South African authors of peer-reviewed articles, by gender and by race

61. Peer-reviewed articles authored by South African women and men, by journal category and by science field of journal

62. South African authored books, by gender of author

63. South African invented USPTO patents, by gender of inventor

[13] The indicator category numbers correspond to the indicator category numbers in Appendix 1 and 2.

9. Scientific collaboration and networking

In today's global context, scientific collaboration and networking has become another form of scientific recognition since it reflects the willingness of peers to be associated with each other's work and also to benefit from sharing resources and expertise. As such, scientists seek out opportunities for collaborative work and to network with other scientists.

Policy concerns:

Are there gender and race differences in the undertaking of collaborative research projects?

What is the proportion of female co-authored articles?

What proportion of papers presented at international conferences is by female researchers?

What proportion of academics taking overseas sabbaticals is female?

However, there is also a danger that networks and collaborations can become exclusionary. Hence, the indicators in this construct set out to measure gender and race patterns in scientific collaboration and networking by looking at co-authorships, collaborative research projects, conference attendances and overseas sabbaticals. The latter two are seen particularly as presenting opportunities for researchers to interact with peers and perhaps establish ongoing relationships that can lead to collaborative projects.

Construct 9: Scientific collaboration and networking

Indicator categories[14]

64. South African co-authored articles, by author gender and by nature of collaboration

65. South African co-invented USPTO patents, by gender of inventor

66. Students on THRIP projects, by gender, race and nationality

67. Students on Innovation Fund projects, by gender, race and nationality

68. Academics presenting papers at international conferences, by gender, race and science field

69. Academics taking sabbaticals overseas, by gender, race and science field

[14] The indicator category numbers correspond to the indicator category numbers in Appendix 1 and 2.

Conclusion

The M&E Framework organised around these constructs represents an ideal framework for monitoring and evaluating the performance of women in the NSI. The descriptions and policy concerns above provide a rationale for the inclusion and clustering of the indicators. The framework is an ideal framework because it assumes that data for all the listed indicator categories and sub-categories and their associated indicators listed in APPENDIX 1 and 2 are, or can be, routinely collected in the system and hence be readily accessible. This of course is not the case, and in PART III we look at the implications of this for different applications of the framework.

PART III

APPLICATION OF THE M&E FRAMEWORK

This part has two sections. **Section A** describes the data sources and data availability and makes recommendations for data collection. **Section B** describes different scenarios or approaches to the application of the framework that range from annual system monitoring to less regular system reviews.

Introduction

In APPENDIX 2, the full list of constructs and indicators reflects a M&E Framework that is as comprehensive as possible in its coverage of SET indicators that seek to monitor aspects of the NSI where gender and race imbalances have persisted in the past. The framework is an ideal framework because it is premised on an assumption that data for all the listed indicators in APPENDIX 2 are, or can be, routinely collected in the system and hence be readily accessible. This of course is not the case, and hence the application of the framework requires careful consideration.

When applying a M&E framework one needs to consider the following three factors: the **purpose** of monitoring and evaluation, **data availability** and the **audience** to be addressed. Taken together, these three factors influence the selection of indicators to be monitored, the frequency of data collection, and the form of reporting. In other words, when applying the framework decisions have to be made that have time and cost implications. For example, if one's purpose for monitoring is for international benchmarking and comparison then only a small selection of indicators would be necessary to report on and it does not have to be done annually; if one's purpose is to regularly monitor the system to allow for annual reporting, then one has to select indicators which can show annual shifts and for which data is routinely collected and readily accessible; if one wants to report for example to the Minister of Science and Technology, then one would want to select only five or six core indicators that capture the "essence" of possible shifts in the system and so on.

In order to inform the choices that need to be considered in the application of the framework, we have produced four tables (Tables 1 – 4 below) that represent four levels of monitoring and evaluation, namely, national system monitoring, higher education sector monitoring, government/science council sector or SETI monitoring, and business/industry sector or R&D intensive company monitoring. These different levels of monitoring in the system imply different levels of policy or programme interventions. For each table we have mapped a selection of constructs and indicator categories, appropriate to the level of monitoring, against three conditions of data availability. The first condition is data that are routinely collected in the system and are readily available, the second condition is data that are routinely collected in the system but are not readily accessible in the required form, and the third condition is data that are not routinely collected in the system and thus have to be collected with different degrees of effort and investment of time and money.

Section A uses these tables to describe in more detail the data sources and data availability for each construct, and also makes recommendations for data collection. Section B uses these tables to inform four scenarios for the application of the framework.

We recommend that before reading Section A or Section B, the reader becomes familiar with the contents of APPENDIX 1 and APPENDIX 2 in Volume II. For an overview of the constructs, indicator categories and sub-categories consult APPENDIX 1. For a detailed breakdown of these categories and sub-categories by individual indicators consult APPENDIX 2.

TABLE 1: NATIONAL SYSTEM MONITORING

Data Availability	Construct 1 SET potential	Construct 2 SET labour force	Construct 3 R&D workforce	Construct 4 Funding	Construct 5 Rank & employment	Construct 6 Scientific agenda-setting	Construct 7 Scientific recognition	Construct 8 Scientific output	Construct 9 Networking & collaboration
Routinely collected in system and readily available	Students Gender x Race x Qualification x Field		Researchers, Technicians and R&D Support - Gender x Race x Qualification		Academics staff Gender				
Routinely collected in system but not readily accessible	Students - Gender x Nationality x Qualification x Field - Gender x Age x Qualification x Field Matriculants Gender x Race	Teachers Gender x Race		Undergraduate Gender x Race Postgraduate Gender x Race x Field x Amount Grant-holder - Gender x Race x Field x Amount - Gender x Nationality x Field x Amount	Academics staff - Gender x Race x Field - Gender x Nationality x Field - Gender x Age x Field			Articles & Authors Author gender x Author race x Journal category	THRIP students - Gender x Race - Gender x Nationality I Fund Students - Gender Article co-authors Gender x
Can be collected with different degrees of effort/investment		SET Occupations - Gender x Race - Gender x Nationality	Researchers, Technicians and R&D Support Gender x Nationality			Professional Registration Bodies - Gender x Race - Gender x Nationality	National Academy Members Gender x Race	Books & Authors Author gender USPTO patents Gender of SA inventors	sector affiliation of SA authors USPTO co-inventors Gender of SA inventors I Fund Students - Gender x Race - Gender x Nationality

TABLE 2: HIGHER EDUCATION SECTOR MONITORING

Data Availability	Construct 1 SET potential	Construct 3 R&D workforce	Construct 4 Funding	Construct 5 Rank & employment	Construct 6 Scientific agenda-setting	Construct 7 Scientific recognition	Construct 9 Networking & collaboration
Routinely collected in system and readily available	Students Gender x Race x Qualification x Field	Researchers, Technicians and R&D Support Gender x Race x Qualification Post-doctoral Fellows Gender x Race		Academics Gender			
Routinely collected in system but not readily accessible	Students - Gender x Nationality x Qualification x Field - Gender x Age x Qualification x Field		Undergraduate Gender x Race Postgraduate Gender x Race x Field x Amount Grant-holder - Gender x Race x Field x Amount - Gender x Nationality x Field x Amount	Academics - Gender x Race x Field - Gender x Nationality x Field - Gender x Age x Field - Gender x Race x Field x perm/ non-perm status			
Can be collected with different degrees of effort/investment		Researchers, Technicians and R&D Support Gender x Nationality M&D Supervisors - Gender x Race x Field - Gender x Nationality x Field Post-doctoral Fellows - Gender x Race x Field - Gender x Nationality x Field	Academics - Gender x Race x Faculty x International funding amounts - Gender x Nationality x Faculty x International funding amounts	Academics - Gender x Race x Faculty of promoted academics	Council members - Gender x Race - Gender x Nationality Executive managers - Gender x Race - Gender x Nationality Deans - Gender x Race x Faculty - Gender x Nationality x Faculty	Reviewers - Gender x Race x National Funding Agencies - Gender x Race x International Funding Agencies - Gender x Race x National Journals - Gender x Race x International Journals Editorial Boards - Gender x Race x Nat Journals - Gender x Race x International Journals Average citations	Academics - Gender x Race x Faculty of presenters at international conferences - Gender x Race x Faculty of academics taking sabbaticals overseas

	TABLE 3: GOVERNMENT/SCIENCE COUNCIL SECTOR OR SETI MONITORING			TABLE 4: BUSINESS/INDUSTRY SECTOR OR R&D-INTENSIVE COMPANY MONITORING		
Data Availability	**Construct 3** **R&D workforce**	**Construct 5** **Rank & employment**	**Construct 6** **Scientific agenda-setting**	**Construct 3** **R&D workforce**	**Construct 5** **Rank & employment**	**Construct 6** **Scientific agenda-setting**
Routinely collected in system and readily available	Researchers, Technicians and R&D Support Gender x Race x Qualification			Researchers, Technicians and R&D Support Gender x Race x Qualification		
Routinely collected in system but not readily accessible						
Can be collected with different degrees of effort/ investment	Researchers, Technicians and R&D Support Gender x Nationality [FRASCATI]	Researchers - Gender x Race x perm/ non-perm status - Gender x Race of promoted researchers [SETI's]	Executive Boards - Gender x Race - Gender x Nationality Executive managers - Gender x Race - Gender x Nationality Divisional heads - Gender x Race - Gender x Nationality [SETI's]	Researchers, Technicians and R&D Support Gender x Nationality [FRASCATI]	Researchers - Gender x Race x perm/ non-perm status - Gender x Race of promoted researchers [R&D INTENSIVE COMPANIES]	Boards of Directors - Gender x Race - Gender x Nationality Executive managers - Gender x Race - Gender x Nationality Heads of R&D sub-divisions - Gender x Race - Gender x Nationality [R&D INTENSIVE COMPANIES]

SECTION A

DATA SOURCES AND DATA AVAILIBILITY

A. ROUTINELY COLLECTED DATA THAT ARE READILY ACCESSIBLE

The data are either available in the public domain or can easily be obtained from the data collection agency in the desired format.

A.1. Construct 1: SET potential

A.1.1. HEMIS student enrolment and graduation data, available on the DoE website

The National Department of Education (DoE) makes available on its website[15] a selection of the Higher Education Management Information System (HEMIS) data for students at state-subsidised universities. The first year of data reporting is 1986. The last year of reporting is 2003 but data for 2004 are expected to be available soon. By downloading a number of Excel tables (for different gender and race group combinations) from the website and integrating these within a database, one can generate for the total public university sector:

- the headcount of student enrolments, disaggregated by gender, race, CESM category and qualification type (Table 2.12 on DoE website), and
- the headcount of student graduations, disaggregated by gender, race, CESM category and qualification type (Table 2.13 on DoE website).

15 http://education.pwv.gov.za/mainActivities.asp?src=rdoc&xsrc=Higher%20Education%20Management%20Information%20System

The broad classification in terms of science fields (Social Sciences and Humanities, Health Sciences, and Natural Sciences and Humanities) that is required to populate the M&E framework can be obtained by recoding the 22 main CESM categories into three categories. CESM stands for the "Classification of Educational Study Matter" and depicts a major field of study. The 22 CESM categories and their subcategories are listed below.

With regard to qualification type, HEMIS has different classifications for technikons and universities – the differential classification, in all likelihood, will also apply to the 2004 (or even 2005) data. Thus, if any year until 2005 is taken as the first year of reporting in the proposed M&E framework, the technikon and university qualifications would need to be consolidated first. Traditionally the qualifications of technikons and universities have been classified in the following ways:

- Technikons

  National certificate: a qualification which has a grade 12 pass as a minimum entry requirement and which has a minimum duration of 1 year.

  National higher certificate: a qualification which has (a) a minimum duration of 2 years with a grade 12 pass as a minimum entry requirement or (b) a minimum duration of 1 year with a national certificate as a minimum entry requirement.

  National diploma: a qualification which has (a) a minimum duration of 3 years with a grade 12 pass as a minimum entry requirement or (b) a minimum duration of 1 year with a national higher certificate as a minimum entry requirement.

  Post-diploma diploma: a qualification which has a national diploma as a minimum entry requirement and a *minimum duration of 1 year.*

  National higher diploma: a qualification which has (a) a minimum duration of 4 years with a grade 12 pass as a minimum entry requirement or (b) a minimum duration of 1 year with a national diploma as a minimum entry requirement.

  Baccalaureus technologiae degree: a qualification which has (a) a minimum duration of 4 years with a grade 12 pass as a minimum entry requirement or (b) a minimum duration of 1 year with a national diploma as a minimum entry requirement.

  Master's diploma in technology: a qualification which has (a) a minimum duration of 5 years with a grade 12 pass as a minimum entry requirement or (b) a minimum duration of 1 year with a national higher diploma as a minimum entry requirement.

  Magister technologiae degree: a qualification which has a minimum duration of (a) 5 years with a grade 12 pass as a minimum entry requirement or (b) 1 year with a BTech as a minimum entry requirement.

  Laureatus in technology: a qualification which has a minimum duration of (a) 7 years with a grade 12 pass as a minimum entry requirement or (b) 2 years with a master's qualification as a minimum entry requirement.

  Doctor technologiae degree: a qualification which has a minimum duration of (a) 7 years with a grade 12 pass as a minimum entry requirement or (b) 2 years with a master's qualification as a minimum entry requirement.

- Universities

University undergraduate certificate: a qualification which has a minimum duration of less than 3 years and which does not have a bachelor's degree or diploma as an entry requirement

University undergraduate diploma: a qualification which normally has a minimum duration of 3 years and has a grade 12 pass or equivalent as a minimum entry requirement.

General academic first bachelor's degree: a qualification which has a minimum duration of 3 years and which has a grade 12 pass with matriculation exemption as a minimum entry requirement.

Professional first bachelor's degree: a qualification which has a minimum duration of 4 or more years and which has a grade 12 pass with matriculation exemption as a minimum entry requirement.

Post-diploma diploma: a qualification which has either a university or a technikon diploma as a minimum entry requirement and which has a minimum duration of 1 year.

Postgraduate certificate: a qualification which has a bachelor's degree as a minimum entry requirement and which has a minimum duration of 1 year or less.

Postgraduate diploma: a qualification which has a first bachelor's degree as a minimum entry requirement and which has a minimum duration of 1 year.

Postgraduate bachelor's degree: a qualification which has a first bachelor's degree as a minimum entry requirement and has a minimum duration of either 1 or 2 years.

Honours degree: a qualification which has a first bachelor's degree as a minimum entry requirement and has a minimum duration of 1 year.

Master's degree: a qualification which has either a first bachelor's degree or an honours degree as a minimum entry requirement, which is of a level higher than that of an honours degree and which has a minimum duration of 1 year.

Doctoral degree: a qualification which has either an honours or master's degree as a minimum entry requirement, which is of a level higher than a master's degree and which has a minimum duration of 2 years.

Input from the HEMIS staff is required to assist with the merging of the technikon and university classifications into the six-level hierarchy proposed in this M&E framework, i.e. (1) certificate/higher certificate, (2) diploma/higher diploma, (3) first bachelors degree, (4) honours degree or equivalent, (5) masters degree or equivalent, and (6) doctoral degree or equivalent. Liaison with the HEMIS staff will also clarify any DoE developments in establishing a unified reporting system for qualifications at merged higher education institutions[16].

In sum, the following indicator categories and subcategories – pertaining to Construct 1 – can be populated from the HEMIS data available on the DoE website:

<u>Indicator categories for national policy and interventions / higher education sector monitoring and interventions</u>[17]

4	5	6	7	8	9	10	11	12	13	14	15

[16] Merged HEIs have been phased in since 2004. They include universities, comprehensive universities and universities of technology. Technikons have been incorporated into the last two categories.

[17] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

Indicator subcategories (level 1) for national policy and interventions / higher education sector monitoring and interventions

4.1	4.3	5.1	5.3	6.1	6.3	7.1	7.3	8.1	8.3	9.1	9.3
10.1	10.3	11.1	11.3	12.1	12.3	13.1	13.3	14.1	14.3	15.1	15.3

Indicator subcategories (level 2) for national policy and interventions / higher education sector monitoring and interventions

4.1.1	4.1.2	4.1.3	5.1.1	5.1.2	5.1.3	6.1.1	6.1.2	6.1.3	7.1.1	7.1.2	7.1.3
8.1.1	8.1.2	8.1.3	9.1.1	9.1.2	9.1.3	10.1.1	10.1.2	10.1.3	11.1.1	11.1.2	11.1.3
12.1.1	12.1.2	12.1.3	13.1.1	13.1.2	13.1.3	14.1.1	14.1.2	14.1.3	15.1.1	15.1.2	15.1.3

CESM categories in HEMIS

01 Ag. and Renewable Resources
0101 Agricultural Economics
0102 Agricultural Extension
0103 Agricultural Food Technology
0104 Animal Sciences
0105 Horticulture
0106 Plant Sciences
0107 Soil Sciences
0108 Fisheries
0109 Forestry
0110 Outdoor Recreation
0111 Wildlife
0112 Land Reclamation
0113 Renewable Natural Resources
0199 Other Ag. and Renewable Resources
02 Arch. and Env. Design
0201 Environmental Design
0202 Design and Planning Technology
0203 History of Environments
0204 Construction and Design Implementation
0205 Communication in Arch. & Env. Design
0206 Structural Technology
0207 Environmental Technology
0208 Materials of Arch. and Env. Design
0209 Management in Arch. and Env. Design
0210 Prof. Practices of Arch. and Env. Design
0211 Planning
0299 Other Arch. and Env. Design
03 Arts, Visual and Performing
0301 Dance
0302 Film as Art
0303 Music
0304 Theatre Arts
0305 Visual Arts
0306 Related Arts
0307 Arts Therapy
0399 Other Arts, Visual and Performing
04 Business, Commerce & Mgmt. Sc.
0401 Accounting
0402 Administrative and Office Services

0403 Banking and Finance
0404 Business Data Systems
0405 Entrepreneurship
0406 Information Communications
0407 Insurance and Risk Management
0408 International Business
0409 Management
0410 Marketing
0411 Personnel Management and Admin.
0412 Quantitative Methods
0413 Real Estate
0499 Other Business, Commerce & Mgmt. Sc.
05 Communication
0501 Advertising
0502 Code Systems
0503 Communication Methodology
0504 Communication Technology
0505 Cybernetics
0506 Film as Communication
0507 Governmental and State Communication
0508 Innovative Communication
0509 International Communication
0510 Instructional Communication
0511 Interpersonal Communication
0512 Journalism
0513 Mass Communication
0514 Organisational Communication
0515 Print Media
0516 Professional Practices in Communication
0517 Public Relations
0518 Radio
0519 Speech Communication
0520 Special Communication
0521 Television
0599 Other Communication
06 Computer Sc. and Data Proc.
0601 Applications in Computer Sc. & Data Proc
0602 Computer Ops. and Operations Control
0603 Computer Hardware Systems
0604 Computer Hardware

0605 Information and Data Base Systems
0606 Numerical Computations
0607 Programming Languages
0608 Programming Systems
0609 Software Methodology
0610 Theory of Computation
0611 Ed., Societal, & Cultural Considerations
0699 Other Computer Sc. and Data Proc.
07 Education
0701 Foundations of Education
0702 Educational Administration
0703 Systems of Education
0704 Teaching – Subject Matter
0705 Teaching – Programmes
0706 Teacher Training
0707 Counselling and Guidance
0708 Special Education Programmes
0709 Community Service
0710 Educational Development
0711 Educational Evaluation and Research
0712 Educational Technology and Media
0799 Other Education
08 Engineering and Eng. Tech.
0801 Aerospace & Aeronautical Eng. & Tech.
0802 Agricultural Engineering & Technology
0803 Automotive Engineering & Technology
0804 Bio-Engineering and Technology
0805 Chemical Engineering and Technology
0806 Civil Engineering and Technology
0807 Computer Engineering and Technology
0808 Electrical Engineering and Technology
0809 Graphics and Drafting for Eng. & Tech.
0810 Engineering Mechanics
0811 Engineering Science
0812 Environmental Engineering and Tech.
0813 Geological Engineering
0814 Industrial Engineering and Technology
0815 Instrumentation Engineering and Tech.
0816 Manufacturing Engineering and Tech.
0817 Marine Engineering and Naval Arch.

0818 Materials Engineering and Technology
0819 Mechanical Engineering and Tech.
0820 Metallurgical Engineering and Tech.
0821 Mining Engineering and Technology
0822 Nuclear Engineering and Technology
0823 Ocean Engineering
0824 Petroleum Engineering
0825 Surveying and Mapping
0899 Other Engineering and Eng. Tech.
09 Health Care and Health Sciences
0901 Basic Health Care Sciences
0902 Clinical Health Sciences
0903 Rehabilitation and Therapy
0904 Pharmaceutical Science
0905 Emergency Services
0906 Hospital and Health Care Administration
0907 Public Health
0908 Veterinary Health Sciences
0909 General Persp. Health Care & Health Sc.
0999 Other Health Care and Health Sciences
10 Home Economics
1001 Clothing and Textiles
1002 Consumer Education
1003 Food and Nutrition
1004 Home Management
1005 Housing
1006 Human Development and Family Studies
1007 Inst. Housekeeping & Food Service Mgmt.
1099 Other Home Economics
11 Industrial Arts, Trades and Tech.
1101 Construction
1102 Manufacturing
1103 Power Systems
1104 Product Service
1105 Graphic Arts
1106 Transportation
1107 Personal Service
1199 Other Industrial Arts, Trades and Tech.
12 Language, Linguistics, and Lit.
1201 Linguistics

1202 Literary Studies
1203 Study & uses of the Afrikaans Language
1204 Study & uses of the English Language
1205 Arabic
1206 Artificial Languages
1207 Chinese
1208 Dutch
1209 Finnish
1210 French
1211 German
1212 Greek
1213 Hebrew
1214 Italian
1215 Japanese
1216 Latin
1217 Native American
1218 Norwegian
1219 Persian
1220 Portuguese
1221 Russian
1222 Sanskrit
1223 Slavic Languages
1224 South-east Asian Languages
1225 Spanish
1226 Swedish
1227 Yiddish
1228 Herero
1229 Kwangali
1230 Kwanyama
1231 Lozi
1232 Mbukushu
1233 Nama
1234 IsiNdebele
1235 Ndonga
1236 San (Bushman)
1237 Shona
1238 SeSotho
1239 SeSotho Sa Leboa
1240 SiSwati
1241 XiTsonga
1242 SeTswana

1243 TshiVenda
1244 IsiXhosa
1245 IsiZulu
1249 Other African Languages
1250 Gujerati
1251 Hindi
1252 Tamil
1253 Telugu
1254 Urdu
1259 Other South Asian Languages
1260 The Study and uses of Languages
1299 Other Language, Linguistics, and Lit.
13 Law
1301 International Aspects of Law
1302 Perspectives on Law
1303 Mercantile Law
1304 Private Law
1305 Public Law
1306 Formal Law
1307 Law for Black Persons in South Africa
1308 Legal Profession
1399 Other Law
14 Libraries and Museums
1401 Libraries and Museums in Perspective
1402 Physical Records
1403 Information
1404 Library and Museum users
1405 Library & Museum Services & Functions
1406 Administration of Libraries and Museums
1407 Facilities for Libraries and Museums
1408 Equipment for Libraries and Museums
1499 Other Libraries and Museums
15 Life Sciences and Physical Sc.
1501 Astronomy
1502 Atmospheric Sciences
1503 Biological Sciences
1504 Chemistry
1505 Geology
1506 Oceanology
1507 Physics
1508 General Earth-Space Science

1599 Other Life Sciences and Physical Sc.
16 Mathematical Sciences
1601 Mathematical Sc., General Perspective
1602 Logic, sets, and Foundations
1603 Arithmetic and Algebra
1604 Classical Analysis
1605 Functional Analysis
1606 Geometry and Topology
1607 Probability
1608 Statistics
1609 Numerical Analysis & Approx. Theory
1610 Classical Applied Mathematics
1611 Applications of Mathematics
1612 User-oriented Mathematics
1699 Other Mathematical Sciences
17 Military Sciences
1701 Military History
1702 Military Organisation
1703 Military Management and Leadership
1704 National Security and Defence
1705 Military Law
1706 International Military Systems
1707 Military Communications
1708 Field Training, Camps and Cruises
1709 Drill, Commands and Ceremonies
1710 Weaponry and Marksmanship
1711 Military First Aid and Health Education
1712 Air Force
1713 Army
1714 Marine Corps
1715 Navy
1799 Other Military Sciences
18 Philosophy, Religion and Theology
1801 Systematic Philosophy
1802 History of Philosophy
1803 Main Philosophical Currents and Trends
1804 Science of Religion
1805 Buddhism
1806 Christianity
1807 Hinduism
1808 Islam

1809 Judaism
1810 Primal Religions
1899 Other Philosophy, Religion and Theology
19 Phys. Ed., Health Ed. and Leisure
1901 Physical Education
1902 Kinesiology
1903 Sport
1904 Dance
1905 Health Education
1906 Driver and Safety Education
1907 Leisure Studies
1999 Other Phys. Ed., Health Ed. and Leisure
20 Psychology
2001 Foundations of Psychology
2002 Biopsychology
2003 Environmental Psychology
2004 Experimental Psychology
2005 Psychology Applied to Health
2006 Psychology Applied to Education
2007 Psych. applied to Indy., Gov. & other
2008 Psychometrics
2009 Social Psychology
2010 Developmental Psychology
2011 Cognitive Psychology
2099 Other Psychology
21 Public Admin. and Social Services
2101 Public Administration
2102 Public Works
2103 Safety and Correctional Services
2104 Social Work
2105 Public Recreation
2199 Other Public Admin. and Social Services
22 Social Sciences and Social Studies
2201 Anthropology
2202 Economics
2203 Geography
2204 History
2205 Political Science
2206 Sociology
2299 Other Social Sciences and Social Studies

A.2. Construct 3: R&D workforce

A.2.1. R&D survey data, available on the HSRC website and/or through data requests to DST/HSRC

Since the start of the new millennium, South Africa has successfully completed two national research and experimental development (R&D) surveys – respectively for the 2001/02 and 2003/04 financial years. A third R&D survey (for the 2004/05 financial year) is in the process of data collection. DST commissioned the Centre for Science, Technology and Innovation Indicators (CeSTII) at the Human Sciences Research Council (HSRC) to conduct these surveys, based on the international guidelines contained in the Frascati Manual of the Organisation for Economic Co-operation and Development (OECD)

The 2003/04 survey marked the beginning of the *annual* collection of data pertaining to R&D in South Africa. However, given the time, effort and money involved in collecting the data from various R&D performing sectors, it was decided that a detailed survey would be conducted only every second year. During the alternative years a so-called 'soft-touch' survey will be administered. The 2003/04 R&D survey represented the first 'soft-touch' approach, meaning that the current survey (2004/05) is a detailed one.

The difference between the 'soft-touch' and detailed surveys corresponds to a difference in the amount of information requested about the reporting unit. For instance, whereas the detailed survey asks for a breakdown of the three R&D personnel categories (researchers, technicians/technologists, and R&D support staff) by gender, race and highest qualification, the 'soft-touch' survey only requires a breakdown of these personnel categories by gender. This has obvious implications for populating Construct 3 because the gender profiles of the three R&D personnel categories can be disaggregated by race and qualification only every second year.

Below are specific comments relating to three key variables in populating the R&D workforce component of the M&E framework.

- Sector

In cases where the M&E framework serves the purpose of developing national policy priorities and interventions, the required system-level R&D workforce indicators will be based on the sum of headcounts of R&D staff in all four sectors surveyed (i.e. higher education, government/science council, business/industry and not-for-profit sectors). However, where the focus is on sector-specific monitoring and intervention, the not-for-profit sector will be

excluded as this sector accounts for only 2% of R&D performed in the country. The four sectors can be described as follows:

> *Higher education sector*: All public higher education institutions and some private higher education institutions with an R&D component.
> *Government/science council sector*: All government departments with an R&D component, government research institutions and museums. It also includes the eight science councils and the Africa Institute, all established through Acts of Parliament.
> *Business/industry sector*: Large, medium and small enterprises, including state-owned companies.
> *Not-for-profit-sector*: Non-governmental and other organisations registered as not-for-profit organisations.

- R&D personnel

The headcounts of R&D personnel include permanent and non-permanent staff and the three personnel categories are defined as follows in the latest R&D survey:

> *Researchers*: Staff engaged in the conception or creation of new knowledge, products, processes, methods and systems and also in the direct management of the projects concerned. It includes managers and administrators engaged in the planning and management of the scientific and technical aspects of a researcher's work. It excludes managers and directors concerned primarily with budgets and human resources, rather than project management. It also excludes (in higher education) masters and doctoral students and post-doctoral fellows doing part-time work for the institution or receiving a stipend as research assistants.
> *Technicians/technologists*: Persons doing technical tasks in support of R&D, normally under the direction and supervision of a researcher.
> *R&D support staff*: It includes executives and directors concerned primarily with budgets and human resources in support of research, rather than project management. It also includes skilled and unskilled craft workers supporting research, together with secretarial, administrative and clerical personnel working on, or directly associated with, R&D activity.

- Highest qualification

The current R&D survey (2004/05) uses the same qualification categories for the different personnel groupings, namely 'doctorates', 'masters/honours/bachelors or equivalent' and 'diplomas and other qualifications'. In the 2001/02 survey there were five qualification categories for researchers ('doctoral degree or equivalent', 'masters degree or equivalent', 'honours/bachelors degree or equivalent', 'diplomas and higher diplomas' and 'degree/non-formal qualifications'), four categories for technicians/technologists ('all degree qualifications', 'higher diplomas', 'diplomas' and 'other qualifications') and three for R&D support staff ('all degree qualifications', 'diploma/secondary qualifications' and 'other qualifications'). The three-level qualification breakdown of the 2004/05 survey is used in this M&E framework, although the middle category tends to be relatively broad in coverage – it treats both first degrees and postgraduate degrees as being of the same kind.

Lastly, specific to the higher education sector, the R&D survey requests a gender breakdown of post-doctoral fellows in the 'soft-touch' survey and a gender-by-race breakdown in the detailed survey.

The following indicator categories and subcategories of Construct 3 can be populated from figures in the R&D survey reports that are available on the HSRC website[18] and/or through uncomplicated data requests to DST/HSRC:

Indicator categories for national policy and interventions[19]

18	19	20

Indicator subcategories (level 1) for national policy and interventions

18.1	18.2	18.4	19.1	19.2	19.4	20.1	20.2	20.4

Indicator category for higher education sector monitoring and interventions

21

Indicator subcategory (level 1) for higher education sector monitoring and interventions

21.1

Indicator subcategories (level 2) for higher education sector monitoring and interventions

18.1.1	18.2.1	19.1.1	19.2.1	20.1.1	20.2.1

Indicator subcategories (level 2) for government/science council sector monitoring and interventions

18.1.2	18.2.2	19.1.2	19.2.2	20.1.2	20.2.2

Indicator subcategories (level 2) for business/industry sector monitoring and interventions

18.1.3	18.2.3	19.1.3	19.2.3	20.1.3	20.2.3

[18] http://www.hsrc.ac.za/RnDSurvey/index.html

[19] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

A.3. Construct 5: Rank and employment

A.3.1. HEMIS academic staff data, available on the DoE website

DoE provides on its website (see Footnote 7) a selection of the HEMIS data collected on academic staff at state-subsidised universities. As with the student data, the first year of reporting is 1986 and the last 2003. No academic staff data exist for 1999. Data for 2004 have not yet been released.

Apart from a gender breakdown of rank, none of the publicly available HEMIS staff datasets combines gender with any of the other variables required for indicator subcategories 40.1 to 44.4.2. Thus, from the Excel data sheets downloadable from the DoE website (Table 3.5 on the DoE website), one can only calculate the share of female professors, the share of female associate professors, the share of female senior lecturers, etc. The following indicator categories of Construct 5 can therefore be immediately populated without having to submit a special request to DoE:

Indicator categories for national policy and interventions / higher education sector monitoring and interventions[20]

40	41	42	43	44

Two things need to be kept in mind. First, HEMIS uses different rank classifications for university and technikon staff. This is expected to change, since the technikon sector has recently been integrated with the university sector (See Footnote 8).

- Universities

  Professor, Associate professor, Senior lecturer, Lecturer, Junior lecturer, Below junior lecturer, Undesignated

- Technikons

  Vice rector, Director, Associate director, Senior lecturer, Lecturer, Other

Second, the rank classifications only apply to permanent academic staff members. A person is classified as a permanent staff member if contributing to an approved retirement fund of the academic institution. HEMIS defines an academic staff member as an instructional/research

[20] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

professional. The latter is a position in which at least 50% of time is spent on instruction and/or research activities, and the person holds a higher education qualification equivalent to at least 4 years of higher education study.

B. ROUTINELY COLLECTED DATA THAT ARE NOT READILY ACCESSIBLE

Special requests and negotiations are required to solve issues of data ownership and/or to arrange for data permutations as the available data are not in the desired format.

B.1. Construct 1: SET potential

B.1.1. EMIS data on Grade 12 performance in SET-related subjects

The annual *Education Statistics in South Africa at a Glance* reports, published by DoE on the department's website[21], gives a gender breakdown of the senior certificate examination results for selected subjects, including Mathematics HG/SG and Physical Science HG/SG. Thus, the Education Management Information System (EMIS) of DoE includes the end-of-year performances of Grade 12 learners, disaggregated by (at least) gender and subject. However, to meet the data requirements of this M&E framework, a special data request needs to be communicated to DoE, involving data permutations on the side of the EMIS staff. Only Grade 12 learners who obtained at least 60% in each of Mathematics, Physical Science and Technology must be extracted and these three subject-specific subsets of learners must be broken down in terms of gender and race.

The data permutation will allow for the following indicator categories and subcategories of Construct 1 to be populated:

Indicator categories for national policy and interventions[22]

1	2	3

[21] http://www.education.gov.za/EMIS/default.htm

[22] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

Indicator subcategories (level 1) for national policy and interventions

1.1	2.1	3.1

B.1.2. HEMIS student enrolment and graduation data, not available on the DoE website

The HEMIS database captures information about a student's year of birth and nationality but this does not form part of the data that are available on the DoE website (see Section A.1.1). Given that the DoE, has since 1999, collected unit record data (a unit corresponds to an individual student) it is possible for the HEMIS staff to generate a dataset that contains both year of birth (i.e. age) and nationality as variables, together with gender, race, CESM category and type of qualification. This is possible for both student enrolments and student graduations. However, a special request to DoE needs to be formulated in this regard.

On the basis of these newly generated datasets for student enrolments and student graduations, the following indicator categories and subcategories of Construct 1 can be populated:

Indicator subcategories (level 1) for national policy and interventions[23]

4.2	4.4	5.2	5.4	6.2	6.4	7.2	7.4	8.2	8.4	9.2	9.4
10.2	10.4	11.2	11.4	12.2	12.4	13.2	13.4	14.2	14.4	15.2	15.4

Indicator subcategories (level 2) for national policy and interventions

4.2.1	4.2.2	4.2.3	4.4.1	4.4.2	5.2.1	5.2.2	5.2.3	5.4.1	5.4.2	6.2.1	6.2.2
6.2.3	6.4.1	6.4.2	7.2.1	7.2.2	7.2.3	7.4.1	7.4.2	8.2.1	8.2.2	8.2.3	8.4.1
8.4.2	9.2.1	9.2.2	9.2.3	9.4.1	9.4.2	10.2.1	10.2.2	10.2.3	10.4.1	10.4.2	11.2.1
11.2.2	11.2.3	11.4.1	11.4.2	12.2.1	12.2.2	12.2.3	12.4.1	12.4.2	13.2.1	13.2.2	13.2.3
13.4.1	13.4.2	14.2.1	14.2.2	14.2.3	14.4.1	14.4.2	15.2.1	15.2.2	15.2.3	15.4.1	15.4.2

Indicator subcategories (level 3) for national policy and interventions

4.4.1.1	4.4.1.2	4.4.1.3	5.4.1.1	5.4.1.2	5.4.1.3	6.4.1.1	6.4.1.2	6.4.1.3	7.4.1.1	7.4.1.2
7.4.1.3	8.4.1.1	8.4.1.2	8.4.1.3	9.4.1.1	9.4.1.2	9.4.1.3	10.4.1.1	10.4.1.2	10.4.1.3	11.4.1.1
11.4.1.2	11.4.1.3	12.4.1.1	12.4.1.2	12.4.1.3	13.4.1.1	13.4.1.2	13.4.1.3	14.4.1.1	14.4.1.2	14.4.1.3

[23] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

15.4.1.1	15.4.1.2	15.4.1.3

B.2. Construct 2: SET labour force

B.2.1. EMIS data on teachers in SET-related subjects

An inspection of the annual *Education Statistics in South Africa at a Glance* reports, published by DoE (see Footnote 10), shows that EMIS is capable of producing the headcounts of teachers at secondary schools. A special request to DoE needs to be formulated, asking for two subject-specific data tables to be generated. The first must contain the headcounts of secondary school teachers in Mathematics, broken down by gender and by race. The second must contain the gender by race breakdown of secondary school teachers in Physical Science. This will assist in populating the following indicator categories and subcategories of Construct 2:

Indicator categories for national policy and interventions[24]

16	17

Indicator subcategories (level 1) for national policy and interventions

16.1	17.1

B.3. Construct 4: Fairness and success in funding

B.3.1. NSFAS data from HEMIS

The National Student Financial Aid Scheme (NSFAS) is a loan and bursary scheme, established in 1996, that is funded by DoE.[25] To qualify for a NSFAS award, a student must submit evidence of:

- South African citizenship,
- registration at a South African university as an undergraduate student, studying for a first tertiary educational qualification (or a second tertiary qualification, if the latter is necessary to practice in a chosen profession, e.g. LLB or HDE),
- potential for academic success, and

[24] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

[25] https://www.nsfas.org.za/nsfas/downloads/NSFAS_student_guide_2005.pdf

- financial need.

In collecting data on students at public sector universities, HEMIS also captures information about NSFAS applications and awards. This happens in the form of a code in a single data column. Any one of four mutually exclusive codes can be captured in the column, respectively indicating that a student (1) has applied for and received an NSFAS award, (2) has applied for, was eligible for but did not receive an NSFAS award, (3) has applied for but was not eligible for an NSFAS award, or (4) did not apply for an NSFAS award or that no information exists about whether or not a NSFAS application was submitted.

HEMIS is in a position to generate a dataset of undergraduate students that contains gender and race as well as the NSFAS variable. This will provide data to populate the following indicator categories and subcategories of Construct 4:

Indicator categories for national policy and interventions / higher education sector monitoring and interventions[26]

24	25	26	27

Indicator subcategories (level 1) for national policy and interventions / higher education sector monitoring and interventions

24.1	25.1	26.1	27.1

B.3.2. Postgraduate and grant-holder data from the NRF and MRC

The National Research Foundation (NRF) is the South African government's national funding agency for research. It was established in 1999 after amalgamation of the former Centre for Science Development (CSD) and Foundation for Research Development (FRD). In 2001 the NRF introduced nine focus areas in an attempt to align individual research activities to national goals more closely. Researchers apply for grants within these focus area programmes, through the NRF's Research and Innovation Support Agency (RISA). Researchers can also apply for grants within a number of development programmes, namely the Institutional Research Development Programme (IRDP – which develops research capacity within approved institutional niche areas) and Thuthuka (which develops research capacity among women, black and entry-level researchers). The overwhelming majority of

[26] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

NRF grant recipients are from the higher education sector. All fields of Social Sciences, Humanities, Natural Sciences and Engineering are represented, with the exclusion of Health Sciences.

The NRF has two modes of postgraduate student support. First, masters and doctoral students can apply directly to the NRF for bursaries and scholarships, in which case the applications are captured onto the NRF data system. However, masters and doctoral students can also be supported in the form of grant-holder linked bursaries and assistantships. In such cases, the students apply via the grant-holders and/or institutions for funding, resulting in the student applications not being captured on the NRF system. Nevertheless, the details of all postgraduate students who receive NRF funding (regardless of the mode of support) are collected by the NRF. The point to be made is that only where students apply directly to the NRF for funding can the number of postgraduate recipients be regarded as a subset of the number of postgraduate applicants.

Three datasets need to be requested from the NRF:

- A dataset of masters and doctoral recipients, comprising nine variables: name, gender, race, institutional affiliation, year, level (masters or doctoral), type of support (free-standing or grant-holder linked), field/subject area, and funding amount.

- A dataset of masters and doctoral applicants, comprising seven variables: name, gender, race, institutional affiliation, year, level (masters or doctoral), and field/subject area. The assumption is that these students all applied for free-standing bursaries and scholarships (i.e. not grant-holder linked).

- A dataset of grant-holders (i.e. grant recipients), comprising nine variables: name, gender, race, nationality, institutional affiliation, year, programme type (focus area or development), field/subject area, and funding amount.

- A dataset of grant applicants, comprising eight variables: name, gender, race, nationality, institutional affiliation, year, programme type (focus area or development), and field/subject area.

The Medical Research Council (MRC) is the second largest funding agency of academic research and scholarship in the country. The agency function of the MRC, as the science council's name implies, is restricted to support in the Health Sciences. There are basically two ways in which the MRC finances research at higher education institutions. The first is through

its university-based research programmes, which involve joint undertakings between the MRC and academic institutions in the form of centres, units, groups or lead programmes that are organised around prominent researchers. The university-based research programmes also allow for self-initiated research projects. Successful applicants for self-initiated project funding can receive support for a maximum period of three years. Researchers who are part of the MRC centres, units, groups or lead programmes are not allowed to apply for funding in this category.

Bursaries and scholarships constitute the second leg of the MRC's research support to higher education institutions. This mode of support is mostly about research capacity building, as it involves funding to postgraduate students and various groups of researchers-in-training. Specifically, the MRC offers masters and doctoral scholarships for students who wish to complete their study at any of the higher education institutions in South Africa. Preference is given to students who plan to do their research with a supervisor that is funded by the MRC.

For the purposes of this M&E framework, 'MRC grants' are taken to mean grants for self-initiated research projects, and 'MRC postgraduate funding' means masters and doctoral scholarships. The issue of grant-holder linked versus free-standing masters and doctoral scholarship discussed above also applies to the MRC. With this in mind, four datasets need to be requested from the MRC:

- A dataset of masters and doctoral recipients, comprising nine variables: name, gender, race, institutional affiliation, year, level (masters or doctoral), type of support (free-standing or grant-holder linked), field/subject area, and funding amount.

- A dataset of masters and doctoral applicants, comprising seven variables: name, gender, race, institutional affiliation, year, level (masters or doctoral), and field/subject area. The assumption is that these students all applied for free-standing scholarships (i.e. not grant-holder linked).

- A dataset of grant-holders (i.e. grant recipients), comprising eight variables: name, gender, race, nationality, institutional affiliation, year, field/subject area, and funding amount.

- A dataset of grant applicants, comprising seven variables: name, gender, race, nationality, institutional affiliation, year, and field/subject area.

Once received, the NRF and MRC data need to be reconciled and integrated within a single database, to populate the following indicator categories and subcategories of Construct 4:

Indicator categories for national policy and interventions / higher education sector monitoring and interventions[27]

29	30	31	32	34	35	36	37

Indicator subcategories (level 1) for national policy and interventions / higher education sector monitoring and interventions

29.1	29.2	30.1	30.2	31.1	31.2	32.1	32.2	34.1	34.2	34.3	35.1
35.2	35.3	36.1	36.2	36.3	37.1	37.2	37.3				

Indicator subcategories (level 2) for national policy and interventions / higher education sector monitoring and interventions

29.1.1	29.1.2	29.1.3	30.1.1	30.1.2	30.1.3	31.1.1	31.1.2	31.1.3	32.1.1	32.1.2	32.1.3
34.1.1	34.1.2	34.1.3	34.2.1	34.2.2	34.2.3	35.1.1	35.1.2	35.1.3	35.2.1	35.2.2	35.2.3
36.1.1	36.1.2	36.1.3	36.2.1	36.2.2	36.2.3	37.1.1	37.1.2	37.1.3	37.2.1	37.2.2	37.2.3

Of the indicator categories and subcategories that deal with postgraduate students, half pertain to students who received free-standing bursaries/scholarships, whereas the other half pertain to students supported through either free-standing bursaries/scholarships or grant-holder linked bursaries/assistantship. The difference is as follows:

- Free-standing bursaries/scholarships only

  Indicator category 29 and subcategories 29.1, 29.1.1, 29.1.2, 29.1.3 and 29.2, which give a breakdown of applicants by gender

  Indicator category 32 and subcategories 32.1, 32.1.1, 32.1.2, 32.1.3 and 32.2, which compare successful applications (i.e. recipients as % of applicants) for women and men

- Free-standing bursaries/scholarships and grant-holder linked bursaries/assistantships

  Indicator category 30 and subcategories 30.1, 30.1.1, 30.1.2, 30.1.3 and 30.2, which give a breakdown of recipients by gender

  Indicator category 31 and subcategories 32.1, 32.1.1, 32.1.2, 32.1.3 and 32.2, which give a breakdown of funding amount by gender

[27] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

Lastly, indicator categories 28 and 33 and their subcategories have been omitted in the above cells because they cannot be produced from the NRF and MRC data alone. They also require student enrolment data and academic staff data from HEMIS – the number of masters and doctoral funding applicants is expressed as a percentage of all masters and doctoral student enrolments, and the grant funding applicants as a percentage of all researchers (academics). Moreover, the possibility remains to exclude indicator categories 28 and 33 from the M&E framework, especially since the postgraduate applicants only involve those who have applied for free-standing bursaries/scholarships.

B.4. Construct 5: Rank and employment

B.4.1. HEMIS academic staff data, not available on the DoE website

As discussed in Section A.3.1, the HEMIS datasets on academic staff that can be downloaded from the DoE website, do not disaggregate the gender profile of each rank by race, science field, age in years, or nationality. This involves a special request to DoE. Thus, it is possible for HEMIS to generate a dataset that includes gender, race, rank, science field, birth year and nationality as variables. The permanent/non-permanent status of an academic can also be included. However, specific data permutations are required because the science field classifications (CESM) of academics are reported not for headcount staff but for full-time equivalent (FTE) staff.

The following indicator categories and subcategories pertaining to Construct 5 can be populated with the requested academic staff data:

Indicator subcategories (level 1) for national policy and interventions / higher education sector monitoring and interventions[28]

40.1	40.2	40.3	40.4	41.1	41.2	41.3	41.4	42.1	42.2	42.3	42.4
43.1	43.2	43.3	43.4	44.1	44.2	44.3	44.4	45.1			

(Subcategory 45.1 only for higher education sector monitoring and interventions)

Indicator subcategories (level 2) for national policy and interventions / higher education sector monitoring and interventions

[28] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

40.1.1	40.1.2	40.1.3	40.2.1	40.2.2	40.2.3	40.4.1	40.4.2	41.1.1	41.1.2	41.1.3	41.2.1
41.2.2	41.2.3	41.4.1	41.4.2	42.1.1	42.1.2	42.1.3	42.2.1	42.2.2	42.2.3	42.4.1	42.4.2
43.1.1	43.1.2	43.1.3	43.2.1	43.2.2	43.2.3	43.4.1	43.4.2	44.1.1	44.1.2	44.1.3	44.2.1
44.2.2	44.2.3	44.4.1	44.4.2	45.1.1	45.1.2						

(Subcategories 45.1.1 and 45.1.2 only for higher education sector monitoring and interventions)

Indicator subcategories (level 3) for national policy and interventions/ higher education sector monitoring and interventions

40.4.1.1	40.4.1.2	40.4.1.3	41.4.1.1	41.4.1.2	41.4.1.3	42.4.1.1	42.4.1.2	42.4.1.3	43.4.1.1	43.4.1.2
43.4.1.3	44.4.1.1	44.4.1.2	44.4.1.3	45.1.1.1	45.1.1.2	45.1.1.3				

(Subcategories 45.1.1.1, 45.1.1.2 and 45.1.1.3 only for higher education sector monitoring and interventions)

B.5. Construct 8: Scientific output

B.5.1. Peer-reviewed article data from SA Knowledgebase at CREST

SA Knowledgebase is a dynamic database of public science in South Africa, developed by the Centre for Research on Science and Technology (CREST) at Stellenbosch University. SA Knowledgebase collects bibliographic information (excluding citations) on articles with South African author addresses, which appeared in journals accredited by the South African Department of Education. Information on the article title, authorship, journal, publishing detail and keywords is captured from a variety of bibliographic indexes, including the ISI Web of Science and the Index of South African Periodicals. SA Knowledgebase aims to deliver a comprehensive, accurate and up to date database of article output from 1990 onwards. At present almost 100 000 articles are included in SA Knowledgebase.

As implied, SA Knowledgebase not only covers articles produced by the South African higher education sector, but also articles by the science councils, national research facilities and government research organisations. The database also provides author-specific information by disaggregating the article output by selected demographic variables (gender, race, year of birth, highest qualification, areas of specialisation and institutional affiliation). The linking of these demographic data to the article authors is an on-going task. Since 1998 CREST has utilised a variety of sources, including its own national surveys, requests for demographic information from South African universities, technikons and science councils, as well as web searches, to add the demographic information of the authors of these articles. The almost 100 000 articles have been produced by more than 50 000 unique individual authors. Of these authors, the database currently contains some demographic information for approximately 45%. Lastly, SA Knowledgebase uses fractional counts to account for multiple

authorships. This means that, for instance, if an article has four authors, each author is allocated 0.25 of an article; in the case of three authors, each receives 0.33 article equivalents.

SA Knowledgebase is a strategic asset of CREST and its contents are not freely available. A contractual arrangement has to be negotiated in order to access the data in SA Knowledgebase. SA Knowledgebase can generate both a dataset of South African authors (broken down by gender, race and publication year) as well as a dataset of articles authored by South African men and women, where the journals are classified according to science fields and other classifications such as local/international. To identify high impact journals, the journal impact factors of the ISI Web of Science (in the journal citation reports) can for instance be used but these figures first need to be integrated with SA Knowledgebase.

The following indicator categories and subcategories of Construct 8 can be populated with data from SA Knowledgebase:

Indicator categories for national policy and interventions[29]

60	61

Indicator subcategories (level 1) for national policy and interventions

60.1	61.1	61.2

In addition, two indicator categories of Construct 9 can also be populated with SA Knowledgebase data:

Indicator category for national policy and interventions

64

Indicator subcategory (level 1) for national policy and interventions

64.1

The focus of indicator categories 64 and 64.1 is on article co-authorship patterns. An analysis of co-authorship patterns is based on the institutional, sector and country affiliations of article

[29] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

authors. This means that, should CREST be contracted to do the analysis, the process of linking the institutional affiliations to the author names would have to be accelerated. To do so, would require access to the current and historic staff records of R&D performing organisations in the public sector, as well as the appointment of additional assistants to perform the linking.

B.6. Construct 9: Networking and collaboration

B.6.1. THRIP student data from the NRF

THRIP refers to the 'Technology and Human Resources for Industry Programme', which is primarily a funding initiative managed by the NRF on behalf of the National Department of Trade and Industry (DTI). It can also be described as a partnership programme that challenges companies to match government funding for human resources and innovative R&D in South Africa. THRIP focuses on projects that specifically promote and facilitate scientific research, technology development and technology diffusion, or any combination of these. All projects funded by THRIP must include a human resource development component but the choice of technological focus is left to the industrial participants and their partners. The industry and DTI share the costs of developing commercial technology on a R2 to R1 basis (industry = R2; DTI = R1). DTI's support may be doubled if a project supports certain THRIP priorities. One of the objectives of THRIP is to promote increased interaction among researchers and technology managers in industry, higher education and SETI's, i.e. public sector-private sector research collaboration.[30]

Although the annual THRIP reports (as from 1996 onwards) give a gender breakdown of the number of students working on THRIP projects, the term 'students' not only includes undergraduate and postgraduate students but also post-doctoral researchers. Post-doctoral researchers need to be excluded from the reported figures, which would require a special request to the NRF. Also, the gender of the students must be disaggregated by race and by nationality.

The requested data will populate the following indicator categories and subcategories of Construct 9:

Indicator category for national policy and interventions[31]

66

Indicator subcategories (level 1) for national policy and interventions

[30] http://www.nrf.ac.za/thrip/about.html

[31] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

66.1	66.2

B.6.2. Innovation Fund student data from the NRF

The Innovation Fund (IF) dates back to 1996. It is a DST initiative, managed by the NRF on behalf of the Innovation Fund Trust. The IF primarily serves to identify technologically innovative and commercially viable 'proof of concept' projects. It spans what has been commonly referred to as the innovation chasm, investing in projects at the most critical stage and facilitating the transfer of promising technologies into the marketplace, thereby contributing towards economic growth and national benefit. Each funded project comprises a consortium of scientists, where the consortium members can represent tertiary institutions, science councils, private companies or SMME's (Small, Medium and Micro Enterprises). Capacity development is not a core focus of the IF but graduate students are trained in the course of the three- to five-year funded projects.[32]

The project leaders must annually submit technical reports. Each report summarises the project-participating masters and doctoral students in terms of selected demographics. A template is provided for this purpose. However, the template does not disaggregate gender by race or by nationality, as can be seen from the example below.

Student Participation								
Name of HEI (1)								
Name of HEI (2)								
Total number of students involved in project	Local				International			
Highest qualification	Masters				PhD			
Breakdown of students per gender type	Male				Female			
Breakdown of South African students per race group	W		C		A		B	
Breakdown of International students per race group	W		C		A		B	
Number of African students (non-South African)								

Thus, from the collected IF project data on students that can be requested from the NRF, the following indicator can be populated:

Indicator category for national policy and interventions[33]

67

[32] http://www.innovationfund.ac.za/pdf/if_arep_2003.pdf

[33] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

C. DATA NOT ROUTINELY COLLECTED

Procedures for collecting this data can be introduced requiring different degrees of effort/investment of time and money.

C.1. Construct 2: SET labour force

C.1.1. SET occupations by gender, race and nationality

From 1987 to 1995 the (then) Central Statistical Service annually conducted a National Manpower Survey. These surveys covered public and private enterprises in the formal non-agricultural sector –the agricultural, hunting and fishing industry was excluded, as well as private households and informal businesses. Unemployed workers were also excluded.[34] The Manpower Survey collected headcounts of workers (by gender and by race) within literally hundreds of occupations. The results of the Manpower Survey formed the basis for reporting on the SET workforce and SET occupations in the country (e.g. the report on *SA Science and Technology Indicators*, released in 1996 by the Foundation for Research Development). In 1996, the name of the Manpower Survey changed to the Occupational Survey, where after it was discontinued.

In 2000, Statistics SA introduced the Labour Force Survey (LFS), which is a biennial rotated panel survey. The survey's overall objective is to provide insight into the dynamics of employment and unemployment in the country. It does so by measuring a variety of issues relating to the labour market, such as the unemployment rate and the industrial structure of the economy.[35] The LFS also produces the headcounts of workers (per 1 000 of the population) within 10 occupation groupings, namely:

- Legislators, senior officials and managers
- Professionals
- Technical and associate professionals
- Clerks
- Service workers and shop and market sales workers
- Skilled agricultural and fishery workers
- Craft and related trades workers
- Plant and machine operators and assemblers

[34] http://www.statssa.gov.za/publications/Report-02-01-01/Report-02-01-011995.pdf

[35] http://www.statssa.gov.za/publications/P0210/P0210March2005.pdf

- Elementary occupation
- Domestic workers

These occupation groupings follow *the International Standard Classification of Occupations* (ISCO) of the International Labour Office. It is basically the categories of 'legislators, senior officials and managers', 'professionals' and 'technical and associated professionals' that comprise the SET workforce. However, the LFS lacks a finer breakdown of these three categories in terms of individual occupations (e.g. engineers, doctors). The feasibility of unpacking the categories to include individual SET occupations (disaggregated by the gender, race and nationality of workers) needs to be explored. It goes without saying that Statistics SA should be a stakeholder in such an exercise.

The Canberra Manual[36], which is the OECD guideline to measure human resources devoted to S&T, proposes a tentative occupational breakdown for the three occupation groupings in which SET workers are assumed to be concentrated. These occupational breakdowns, together with the individual occupations used in the Manpower Survey, as well as current international practice and South Africa's own monitoring and development needs, should inform the design of an appropriate list of SET occupations for inclusion in the LFS.

Lastly, the possibility also remains to introduce a dedicated national survey of South African HRST (human resources in S&T). In other words, the introduction of a survey that is separate from the LFS and which follows the guidelines of the OECD's Canberra Manual.

C.2. Construct 3: R&D workforce

C.2.1. R&D workers by gender and nationality

Only the 2001/02 R&D survey included a breakdown of R&D personnel (researchers, technicians & R&D support staff) by gender, race and nationality. The inclusion of nationality was a special case in time because the R&D survey coincided with a national study on the mobility of R&D workers. Questions on mobility (requiring the nationality of R&D workers) were 'piggy backed' on the R&D survey. The benefits of repeating this exercise (i.e. disaggregating the R&D personnel categories by gender and nationality) in future R&D surveys need to be weighed against the concomitant costs. If feasible it would result in the following indicator categories and subcategories of Construct 3 being populated:

[36] http://www.oecd.org/dataoecd/34/0/2096025.pdf

Indicator subcategories (level 1) for national policy and interventions[37]

18.3	19.3	20.3

Indicator subcategories (level 2) for higher education sector monitoring and interventions

18.3.1	19.3.1	20.3.1

Indicator subcategories (level 2) for government/science council sector monitoring and interventions

18.3.2	19.3.2	20.3.2

Indicator subcategories (level 2) for business/industry sector monitoring and interventions

18.3.3	19.3.3	20.3.3

C.2.2. Masters and doctoral supervisors by gender, race, field and nationality

Information about masters and doctoral supervisors would need to be collected from the individual universities. The ideal is to collect the information from the heads of departments. Each departmental head must specify:

- the headcount of academics in her/his department who are supervisors or co-supervisors for masters students at the home university or any other South African university (the headcount must be disaggregated by gender, race and nationality, together with the faculty affiliation of the head of the department); and
- the headcount of academics in her/his department who are supervisors or co-supervisors for doctoral students at the home university or any other South African university (the headcount must be disaggregated by gender, race and nationality, together with the faculty affiliation of the head of the department).

The same academic, if both a masters and doctoral supervisor, will appear in each of the two lists. Any academic, however, can appear only once in each list. Moreover, although it could be argued that the collected headcounts are not "fixed" because students can change

[37] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

supervisors during the course of their study, a set time of data collection (e.g. as at 30 June) would solve the problem.

The faculty affiliations can be used to determine the scientific field of the supervisors. In this regard, the proposed M&E framework combines the Natural Sciences and Engineering and Health Sciences into one broad field. This is because departments in the Faculty of Health at universities with medical schools can often also be found in the Faculty of Science at universities without medical schools. An example is Pharmacology. Thus, unless each university department is systematically classified as belonging to a certain science field, the dual classification of Social Sciences versus Natural Sciences would need to suffice. Of course, one can choose to ignore these institutional differences in faculty composition and aggregate the data for more or less similar faculties to create three broad science fields.

The following indicator categories and subcategories of Construct 3 can be populated if data on masters and doctoral supervisors are to be collected:

Indicator categories for higher education sector monitoring and interventions[38]

22	23

Indicator subcategories (level 1) for higher education sector monitoring and interventions

22.1	22.2	22.3	23.1	23.2	23.3

Indicator subcategories (level 2) for higher education sector monitoring and interventions

22.1.1	22.1.2	22.2.1	22.2.2	23.1.1	23.1.2	23.2.1	23.2.2

C.2.3. Post-doctoral fellows by gender, race, field and nationality

As indicated in Section A.2.1, the R&D survey asks in both the 'soft-touch' and detailed applications for a breakdown of post-doctoral fellows by gender, and only in the detailed survey for a breakdown by gender and race. The gender category is never disaggregated by nationality, nor is information collected on the science field classification of post-doctoral fellows.

[38] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

The suggestion is that universities should be surveyed to collect the demographic breakdowns. The data most probably lie at different management levels at the various universities, e.g. at the University Research Office, at the offices of the faculty deans and at the offices of the heads of departments. Heads of departments are the shared entity and will provide the most accurate data. Hence, it is recommended that the heads of departments be surveyed. Each must specify:

- the headcount of post-doctoral fellows in the department, disaggregated by gender, race and nationality, together with the faculty affiliation of the department.

The post-doctoral data from the individual universities will populate the following indicator categories and subcategories of Construct 3:

Indicator subcategories (level 1) for higher education sector monitoring and interventions[39]

21.2	21.3

Indicator subcategories (level 2) for higher education sector monitoring and interventions

21.1.1	21.1.2	21.2.1	21.2.2

The data from the universities will also populate indicator category 21 and subcategory 21.1, which already can be populated with the R&D survey data.

C.3. Construct 4: Fairness and success in funding

C.3.1. Academics by gender, race, faculty, nationality and international funding amounts

International funding for academics can be of two broad types – first, money received in exchange for S&T work conducted for international organisations and, second, money received from international funding bodies. The first case implies contract work, where the contracting agency can be an overseas firm, university, government body, etc. In the second instance, applications to international funding agencies and foundations (e.g. the National

[39] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

Institutes of Health, Ford Foundation) are implied. Here financial support is dependent on a process of peer-review and ranking of applications.

Thus, clarity is first required about the operational definition of the concept of 'international funding'. Should it include both types of funding or only the second? Often the boundaries are blurred. Consider the scenario where a consortium of international organisations (including a South African university) receives financial support from an international foundation, based on a collective grant application. An overseas consortium member acts as the overall project co-ordinator, which means that the money is deposited into that organisation's account. However, part of the money is channelled to the South African university team for specific R&D tasks performed. Is this an example of international contract funding or of international agency funding?

Only once consensus has been reached on the operationalisation of international funding, can the details of surveying be decided upon. One suggestion is to collect the headcounts and international funding amounts from academic staff members. The obtained data will populate the following indicator categories and subcategories of Construct 4:

Indicator categories for higher education sector monitoring and interventions[40]

38	39

Indicator subcategories (level 1) for higher education sector monitoring and interventions

38.1	38.2	38.3	39.1	39.2	39.3

Indicator subcategories (level 2) for higher education sector monitoring and interventions

38.1.1	38.1.2	38.1.3	38.2.1	38.2.2	38.2.3	39.1.1	39.1.2	39.1.3	39.2.1	39.2.2	39.2.3

C.4. Construct 5: Rank and employment

C.4.1. Researchers in SETI's and R&D-intensive companies by gender, race and permanent/non-permanent appointment

[40] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

Only with a national R&D survey can a comprehensive survey of researchers be conducted, covering all R&D performing sectors (i.e. higher education, government/science councils, business/industry and not-for-profit). However, since the inclusion of a question on type of appointment (permanent versus non-permanent, disaggregated by the required demographics) would overburden the already 'packed' R&D survey, the suggestion is to rather use other means of data collection. In Section B.4.1 it is explained that a breakdown of academic staff at public universities – by gender, race and permanent/non-permanent status – can be requested from HEMIS. It is therefore proposed that such breakdowns also be requested (by means of surveys) from institutions in the non-university sector.

With regard to those organisations that the R&D survey classifies as belonging to the government/science council sector, it is proposed that only the 9 public SETI's be surveyed (SETI's = Science, Engineering and Technology Institutions). These are the eight science councils and the Africa Institute of South Africa. These organisations routinely submit Key Performance Indicator (KPI) reports to DST, which means that in-house mechanisms ought to be in place for the collection, storage and retrieval of researcher-related data. Some science councils (e.g. the CSIR in its 2003/04 KPI report) already produce a breakdown of employees in terms of permanent/non-permanent appointments, for each gender and race grouping. However, the definitions of 'researcher' and 'permanent versus non-permanent employee' need to be standardised across SETI's, and a shared template for reporting be developed.

Moreover, since surveying all R&D performing companies in South Africa would imply significant manpower and financial costs, it is proposed that only R&D-intensive companies be targeted. The definition of R&D-intensive companies is based on R&D expenditure, which means that data from the national R&D surveys need to be used to classify a company as R&D intensive or not.

The following indicator categories and subcategories of Construct 5 can be populated on the basis of data obtained from SETI's and R&D-intensive companies:

Indicator subcategories (level 1) for SETI / R&D-intensive company monitoring and interventions[41]

45.2	45.3

[41] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

Indicator subcategories (level 2) for SETI / R&D-intensive company monitoring and interventions

45.2.1	45.3.1

A systems-level indicator (i.e. the aggregate of the sectors' figures on permanence – indicator category 45) cannot be computed – first, because the units of reporting are not the same (academics for universities and researchers for SETI's and R&D-intensive companies) and, second, because not all R&D performing organisations in government and industry are covered.

C.4.2. Promoted academics/researchers by gender, race and faculty

Data on the promotion of researchers are not currently collected or reported on within the South African SET system. Thus, specific measures need to be introduced to generate a sector-specific definition of promotion and to obtain the required data from individual organisation within the R&D performing sectors. Again, it is suggested that a narrow delineation of sectors be used, consisting only of public universities, SETI's and R&D-intensive companies. The questions on promotion can be combined with the questions of Section C.4.1 in a single survey.

Data on research promotions will result in the following indicator categories and subcategories of Construct 5 being populated:

Indicator subcategories (level 1) for university / SETI / R&D-intensive company monitoring and interventions[42]

46.1	46.2	46.3

Indicator subcategories (level 2) for university / SETI / R&D-intensive company monitoring and interventions

46.1.1	46.1.2	46.2.1	46.3.1

Indicator subcategories (level 3) for university monitoring and interventions

[42] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

46.1.1.1	46.1.1.2

Again, a system level indicator (indicator 46) cannot be computed.

C.5. Construct 6: Scientific agenda-setting

C.5.1. Members of professional registration bodies by gender, race and nationality

The data must be requested directly from the professional registration bodies in the country. The two main bodies are the Engineering Council of South Africa (ECSA) and the Health Professions Council of South Africa (HPCSA). It is unknown whether the data on members' demographics are collected and captured in such a way that a gender by race and nationality breakdown can easily be generated. The data from these two registration bodies (and others deemed necessary) also need to be integrated in a single database, where after the following indicator category and subcategories of Construct 6 can be populated:

Indicator category for national policy and interventions[43]

50

Indicator subcategories (level 1) for national policy and interventions

50.1	50.2

C.5.2. Council members, executive managers and deans at universities, by gender, race and nationality (and faculty in the case of deans)

Universities must be surveyed in order to obtain the headcounts and demographics of their top and senior management. Whereas the categories of 'council members' and 'deans' are self-explanatory, the category of 'executive management' needs to be unpacked. It includes the vice-chancellor, deputy vice-chancellors, executive directors and senior directors. The university survey will populate the following indicator categories and subcategories of Construct 6:

Indicator subcategories (level 1) for university monitoring and interventions[44]

[43] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

47.1	48.1	49.1

Indicator subcategories (level 2) for university monitoring and interventions

47.1.1	47.1.4	48.1.1	48.1.4	49.1.1	49.1.4

Indicator subcategories (level 3) for university monitoring and interventions

49.1.1.1	49.1.1.2

C.5.3. Executive board members, executive managers and divisional heads at SETI's, by gender, race and nationality

SETI's must be surveyed in order to populate the following indicator categories and subcategories of Construct 6:

Indicator subcategories (level 1) for SETI monitoring and interventions[45]

47.1	48.1	49.1

Indicator subcategories (level 2) for SETI monitoring and interventions

47.1.2	47.1.5	48.1.2	48.1.5	49.1.2	49.1.5

C.5.4. Board of directors, executive managers and heads of R&D subdivisions at R&D-intensive companies, by gender, race and nationality

R&D-intensive companies must be surveyed in order to populate the following indicator categories and subcategories of Construct 6:

Indicator subcategories (level 1) for SETI monitoring and interventions[46]

47.1	48.1	49.1

[44] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

[45] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

[46] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

Indicator subcategories (level 2) for SETI monitoring and interventions

47.1.3	47.1.6	48.1.3	48.1.6	49.1.3	49.1.6

Note: The data to be obtained in Sections C.5.2, C.5.3 and C.5.4 cannot be aggregated to produce a systems-level indicator (i.e. indicators 47, 48 and 49 cannot be computed). It is because the units of reporting differ across the three sectors (academics for universities, and researchers for SETI's and R&D-intensive companies) and because not all R&D performing organisations in government and industry are included in the proposed surveys.

C.6. Construct 7: Scientific recognition

C.6.1. Members of national academies by gender and race

The membership data need to be requested from the three science academies in South Africa, namely the (1) Academy of Science of South Africa (ASSAf), (2) the Royal Society of South Africa and the (3) *Suid-Afrikaanse Akademie vir Wetenskap en Kuns*. It is not known to what extent each academy collects the gender and race of its members, and if it is the case, whether the data are available electronically and can easily be cross-tabulated. Also, the data from the three academies need to be integrated within a single database to populate the following indicator category and subcategory of Construct 7:

Indicator category for national policy and interventions[47]

57

Indicator subcategories (level 1) for national policy and interventions

57.1

C.6.2. South African reviewers for national funding agencies, by gender and race

The data need to be requested from the NRF and MRC. On the basis of NRF reports, it seems that a breakdown of reviewers by institutional affiliation is possible[48]. However, it is unknown to what extent the NRF and MRC also collect and capture information on the gender and race

[47] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

[48] http://www.nrf.ac.za/evaluation/Content/Documents/Rating/Facts&figures_Support_Dataset.doc

of local reviewers. Special efforts may be required to obtain the data, which will populate the following indicator category and subcategory pertaining to Construct 7:

Indicator category for higher education sector monitoring and interventions

51

Indicator subcategory (level 1) for higher education sector monitoring and interventions

51.1

C.6.3. South African reviewers for international funding agencies, by gender and race

The headcounts and demographics of reviewers for international funding agencies are required only for university researchers. The data can be collected in one of two ways: by surveying academics at universities or by identifying a selection of international funding agencies (based on certain criteria) and to ask these agencies for the data. However, it is imagined that international funding agencies – at best – would only collect data on the institutional affiliation and expertise of South African reviewers. The option of surveying academics is therefore preferred.

The data will populate the following indicator category and subcategory of Construct 7:

Indicator category for higher education sector monitoring and interventions[49]

52

Indicator subcategory (level 1) for higher education sector monitoring and interventions

52.1

C.6.4. South African reviewers for national journals, by gender and race

The data can be obtained from the editors of the about 250 South African journals that are accredited by DoE, depending on whether the journals have records of the gender and race

[49] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

of their reviewers. Alternatively, the data can be collected by means of a survey of academics. This will populate the following indicator category and subcategory of Construct 7:

Indicator category for higher education sector monitoring and interventions[50]

53

Indicator subcategory (level 1) for higher education sector monitoring and interventions

53.1

C.6.5. South African reviewers for international journals, by gender and race

The data can either be collected by surveying academics at universities or by identifying a selection of international journals (based on certain criteria, e.g. the journal impact factors of the ISI Web of Science) and requesting the data from the journal editors. However, it is highly unlikely that international editors would record the race classifications of South African reviewers. A survey of academics therefore seems more advantageous.

The data will populate the following indicator category and subcategory of Construct 7:

Indicator category for higher education sector monitoring and interventions[51]

54

Indicator subcategory (level 1) for higher education sector monitoring and interventions

54.1

C.6.6. South African editorial board members of national journals, by gender and race

[50] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

[51] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

The data collection considerations in Section C.6.4 also apply to the collection of data on academics who serve on the editorial boards of national journals. The data will populate the following indicator category and subcategory of Construct 7:

Indicator category for higher education sector monitoring and interventions[52]

55

Indicator subcategory (level 1) for higher education sector monitoring and interventions

55.1

C.6.7. South African editorial board members of international journals, by gender and race

The considerations in collecting the demographics of editorial board members of international journals are similar to the considerations mentioned in Section C.6.5. The relevant indicator category and subcategory are:

Indicator category for higher education sector monitoring and interventions[53]

56

Indicator subcategory (level 1) for higher education sector monitoring and interventions

56.1

C.6.8. Citation impact rates

It is recommended that this component be contracted out to the Center of Science and Technology Studies (CWTS) at Leiden University in the Netherlands. CWTS is an international centre of excellence in the field of bibliometrics, and also a research partner of CREST at Stellenbosch University. CWTS holds a worldwide license from Thomson Scientific in the USA, which allows CWTS to use the detailed article records of Thomson Scientific's *Citation Indexes*

[52] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

[53] The indicator category and sub-category numbers correspond to the numbers in Appendix 1 and 2.

for scientific research and for commercial applications. Thus, CWTS can generate the following citation impact scores:

- Journal-normalised citation impact score

  Citation impact rate of a unit's publications compared to the weighted average citation rate of the set of journals in which the unit has published. A score above 1 indicates a citation impact rate above journal average.

- Field-normalised citation impact scores

  Citation impact rate of a unit's publications compared to the weighted average citation rate of the set of fields in which the unit has published. A score above 1 indicates a citation impact rate above field average.

The involvement of CWTS will result in the following indicator categories of Construct 7 being populated:

Indicator categories for higher education sector monitoring and interventions

58	59

C.7. Construct 8: Scientific output

C.7.1. South African authors of books by gender

The indicators here concern the percentage of books authored respectively by South African women and men. To generate these indicators, two issues need to be clarified: first, what counts as a book and second, where to find a list of books (as defined) with known author genders. One possibility is to use the books listed by universities and science councils in their research and annual reports. The names of the book authors can then be linked to the article author data in SA Knowledgebase, which do include gender. This will populate one indicator category of Construct 8:

Indicator categories for national policy and interventions

62

C.7.2. South African USPTO inventors by gender

Details of patents with South African inventors can be downloaded from the website of the United States Patent and Trademark Office (USPTO)[54]. The inventor-specific information includes the full names and organisational affiliations of inventors (from 1976 up to the present). In most cases, the gender of the inventor can be guessed with 100% accuracy, as it is implicit in the name. In the remainder of cases the gender can be obtained by establishing data links with SA Knowledgebase and/or by asking the inventors themselves.

The dataset created will have a patent as the unit of observation. For each patent it will be indicated whether there is at least one South African female inventor. Similarly, it will be indicated whether a patent has at least one South African male inventor. The dataset will populate a single indicator category of Construct 8:

Indicator categories for national policy and interventions

63

C.8. Construct 9: Networking & collaboration

C.8.1. Innovation Fund student data, by gender, race and nationality

As discussed in Section B.5.2, the template used by the NRF to collect the demographics of Innovation Fund project students, does not disaggregate gender by race or by nationality. In order to obtain the required breakdowns, the template (that project leaders complete as part of their annual reporting) would need to be changed. This will result in the following indicator subcategories of Construct 9 being populated:

Indicator subcategories for national policy and interventions

67.1	67.2

C.8.2. USPTO co-inventors

The underlying dataset will be a subset of the USPTO patent dataset described in Section C.7.2. It will include only patents with two or more inventors, i.e. co-invented patents. This will populate one indicator category of Construct 9:

[54] http://www.uspto.gov/patft/index.html

Indicator category for national policy and interventions

65

C.8.3. Academics presenting at international conferences, by gender, race and faculty

The data is non-existent, which means that academics need to be surveyed in order to populate the following indicator categories and subcategories of Construct 9:

Indicator category for higher education sector monitoring and interventions

68

Indicator subcategories (level 1) for higher education sector monitoring and interventions

68.1	68.2

Indicator subcategories (level 2) for higher education sector monitoring and interventions

68.1.1	68.1.2

C.8.4. Academics taking sabbaticals overseas, by gender, race and faculty

The data also need to be obtained from academics by means of a university survey. This will populate the following indicator categories and subcategories of Construct 9:

Indicator category for higher education sector monitoring and interventions

69

Indicator subcategories (level 1) for higher education sector monitoring and interventions

69.1	69.2

Indicator subcategories (level 2) for higher education sector monitoring and interventions

69.1.1	69.1.2

Conclusion

The discussion of data sources and data availability in this section highlights the complexity of populating the M&E framework. Even for condition A, where the data are routinely collected and readily available in the system, the ease of populating the framework will depend on considerations such as the first year of comparison used. For example, if it is decided that 2000 should be the first year of comparison, additional work is required to reconcile the different qualification classifications for universities and technikons.

However, data for the majority of indicator categories and sub-categories have to be obtained with varying degrees of effort either through special requests to data collection agencies (condition B above) or through specially commissioned surveys (condition C above). For condition B, where data are routinely collected in the system, the degree of effort required to meet the special requests will vary. In some cases it might simply be a case of extracting additional fields (e.g. HEMIS student data not available on the DoE website) whereas in other cases more challenging data permutations might be involved (e.g. NRF and MRC funding data).

For condition C, where data are not routinely collected, the degree of effort to obtain the required data will vary depending on whether the data are collected in any form at all. If they are collected, recommendations for the form and frequency of collection need to be negotiated with the relevant organisations and implemented. An example is the data on membership of national professional registration bodies – negotiations are required with regard to data collection templates, the categories of membership to include, the date of data submission, etc.

However, the greatest effort and investment is required to obtain data that are not at all currently collected in the system. Here recommendations have been made for special surveys to be administered at different levels in the same institutions. A large number of these surveys are targeted at public sector universities, such as the surveying of heads of departments (e.g. to obtain data on supervisors and post-doctoral fellows), academics (e.g. to obtain data on promotion, international funding and membership of international journals) and HRD departments (e.g. to obtain data about top and senior managers). For these proposed surveys to be implemented negotiations have to be undertaken with the institutions around who will administer the surveys and what the time and cost implications are.

To complicate the issue of populating the M&E framework even further, the next section (Section B) considers the purposes of the monitoring exercise in addition to the data availability and proposes four scenarios for the application of the framework.

SECTION B

APPLICATION SCENARIOS

Introduction

In considering the application of the framework this section proposes four application scenarios that take into account the purpose of the monitoring exercise, the audience, and the cost and time implications of data collection and reporting. The application scenarios described in this section are not mutually exclusive scenarios – on the contrary, they represent complimentary schemes in a six-year cycle of monitoring and evaluation activities. During this six-year cycle, annual monitoring of the system for reporting to the Minister (Scenario A) is proposed, as well as, a three-year cycle of sector monitoring and reporting (Scenario B) and international comparison (Scenario C), and six-yearly comprehensive reviews that evaluate the impact of new or ongoing interventions in the system (Scenario D).

In the discussion below, the purpose and the audience for each application scenario is described, in addition to providing a rationale for the selection of constructs and indicator categories and for frequency of reporting. The reader is reminded to again refer to Tables 1 – 4 (pages 38, 39 & 40) to follow the discussion below.

Scenario A: System monitoring scenario

This scenario is geared towards producing annual reports on the system to the Minister. Monitoring in this scenario is thus at a national level (Table 1) and while it would be ideal to be able to report regularly on all the constructs, the conditions of data availability do not make this possible. Given the frequency of expected reporting, this scenario ideally has to be limited to routinely collected data in the system (row 1 and row 2 in Table 1). Routinely collected data that are not readily accessible (row 2) will require some effort to make special requests to the data source agencies[55]. Once the requests have been formulated, the requests themselves can become routine, hence making annual reporting possible.

[55] See Section A (B1 – B6) for the nature of these requests.

Based on data availability within this scenario, data on the following can be collected and reported **annually**:

- Construct 1: (i) Students: Gender x Race x Qualification x Field; Gender x Nationality x Qualification x Field; Gender x Age x Qualification x Field; (ii) Matriculants: Gender x Race;
- Construct 2: Teachers: Gender x Race
- Construct 3: Researchers, Technicians and R&D Support Staff: Gender x Race x Qualification
- Construct 4: (i) Undergraduate funding: Gender x Race; (ii) Postgraduate funding: Gender x Race x Field x Amount; (iii) Grant holder funding: Gender x Race x Field x Amount; Gender x Nationality x Field x Amount
- Construct 5: Academics: Rank x Gender x Race x Field; Rank x Gender x Nationality x Field; Rank x Gender x Age x Field
- Construct 8: Articles and Authors: Author gender x Author race x Journal category
- Construct 9: (i) THRIP students: Gender x Race; Gender x Nationality; (ii) I Fund students: Gender

While it would be possible to report annually on all of the above data, the purpose and audience of such a report will ultimately determine the selection of indicator categories and sub-categories. For example, a glossy annual report on "Women in SET at a glance" might include only the main indicator categories for Constructs 1, 3, 5 and 8.

Based on data availability, Construct 2 includes only the indicator category related to secondary teachers, which represents a very small proportion of the SET Labour Force. We propose therefore that data on SET occupations also be collected and reported on in this scenario, even though it might require some effort initially and collaboration with other data agencies[56] to obtain this data. This is a data category that if applied once, data can become routinely collected in the system.

In this system monitoring scenario one may be concerned that Constructs 6 & 7 are not addressed at all. The indicator categories for these constructs include gender and race profiles of members of professional registration bodies and of national science academies. While data for these indicator categories are not routinely collected, they can be obtained

[56] See Section A (C.1) for further discussion of this.

with very little effort. However, because these numbers are quite small and also usually entail less regular shifts and changes in composition, monitoring them annually will not really add value to the system monitoring scenario. Instead, they are suggested for inclusion in Scenario D.

Scenario B: Sector monitoring scenario

For Scenario B we have clustered constructs and indicator categories into three sectors. In this scenario the purpose of monitoring is to inform sector level policies and interventions. It is important to note that when developing and designing the M&E framework we were considering only system level applications of the framework. However, as the framework developed it became apparent that certain indicator categories were more pertinent for sector monitoring, especially those categories that could not be aggregated to the system level[57]. Those categories that could be aggregated to the system level, or deemed appropriate at that level, have been included in Scenario A.

Table 2 shows the selection of constructs and indicator categories pertaining to Higher Education sector monitoring; Table 3 shows the selection of constructs and indicator categories pertaining to Government/Science Council sector or SETI monitoring; and Table 4 shows the selection of constructs and indicator categories pertaining to Business/Industry sector or R&D intensive company monitoring.

We propose that the sector monitoring scenario follow a **three-year cycle** in which one sector report is produced per year, giving each sector three years for collecting data before the next sector report. This will allow each sector to invest some time and resources to indicator categories for which data is not routinely collected in the system (row 3 in Tables 1 - 4).

Within this scenario, the following data can be collected and reported on in each sector every three years:

1. Higher Education sector

- Construct 1: Students: Gender x Race x Qualification x Field; Gender x Nationality x Qualification x Field; Gender x Age x Qualification x Field;

- Construct 3: (i) Researchers, Technicians and R&D Support Staff: Gender x Race x Qualification; Gender x Nationality; (ii) Post-doctoral fellows: Gender x Race; Gender

[57] See comments in Section A (C.4.1 and C.4.2)

x Race x Field; Gender x Nationality x Field; (iii) M&D Supervisors: Gender x Race x Field; Gender x Nationality x Field;

- Construct 4: (i) Undergraduate funding: Gender x Race; (ii) Postgraduate funding: Gender x Race x Field x Amount; (iii) Grant holder funding: Gender x Race x Field x National funding amounts; Gender x Nationality x Field x National funding amounts; Gender x Race x Faculty x International Funding amounts; Gender x Nationality x Faculty x International Funding amounts

- Construct 5: Academics: Rank x Gender x Race x Field; Rank x Gender x Nationality x Field; Rank x Gender x Age x Field; Gender x Race x Field x perm/non-perm status; Gender x Race x Field x promoted academics

- Construct 6: (i) Council members: Gender x Race; Gender x Nationality; (ii) Executive managers: Gender x Race; Gender x Nationality; (iii) Deans: Gender x Race x Faculty; Gender x Nationality x Faculty

- Construct 7: (i) Reviewers: Gender x Race x National Funding Agencies; Gender x Race x International Funding Agencies; Gender x Race x National Journals; Gender x Race x International Journals; (ii) Editorial Boards: Gender x Race x Nat Journals; Gender x Race x International Journals; (iii) Average citations: (Leiden University)

- Construct 9: Academics: Gender x Race x Faculty of presenters at international conferences; Gender x Race x Faculty of academics taking sabbaticals overseas

2. Government/Science Council sector or SETIs

- Construct 3: Researchers, Technicians and R&D Support Staff: Gender x Race x Qualification; Gender x Nationality

- Construct 5: Researchers: Gender x Race x perm/non-perm status; Gender x Race of promoted researchers

- Construct 6: (i) Executive Boards: Gender x Race; Gender x Nationality; (ii) Executive managers: Gender x Race; Gender x Nationality; (iii) Divisional heads: Gender x Race; Gender x Nationality

3. Business/Industry sector or R&D intensive company

- Construct 3: Researchers, Technicians and R&D Support Staff: Gender x Race x Qualification; Gender x Nationality

- Construct 5: Researchers: Gender x Race x perm/non-perm status; Gender x Race of promoted researchers
- Construct 6: (i) Boards of Directors: Gender x Race; Gender x Nationality; (ii) Executive managers: Gender x Race; Gender x Nationality; (iii) Heads of R&D sub-divisions: Gender x Race; Gender x Nationality

The indicator categories and sub-categories proposed in Scenario B are not exhaustive of all the indicator categories or sub-categories that can be included for each sector. In addition, further levels of disaggregation not reflected in the current framework, may be included in the sector reports if desirable. For example, in a Higher Education sector report, reporting by field may be disaggregated to report by CESM categories rather than only broad fields of study. Decisions in this regard should be made in consultation with the different sectors. Attempts should also be made to align the form and frequency of the sector reports with other sector monitoring and reporting activities like for example, HE Audits and SETI reviews.

Scenario C: International benchmarking scenario

Monitoring and reporting in this scenario is geared towards international comparisons which we propose is done **every third year**. In this scenario indicator categories are selected on the basis of currently available international data. Drawing on the statistics and indicators available from the *European Commission* (Women and Science Statistics and Indicators, She Figures 2003) and the *National Science Foundation* (Women, Minorities and Persons with Disabilities in Science and Engineering: 2000), a selection of the following indicator categories may be compared internationally:

- Construct 1: Students: Gender x Race x Qualification x Field
- Construct 2: SET occupations: Gender x Race x SET occupation x total labour force
- Construct 3: Researchers, Technicians and R&D Support Staff: Gender x Race x Sector
- Construct 4: Grant-holder funding: Gender x Applications and Awards
- Construct 5: Academics: Rank x Gender x Race x Field
- Construct 6: (i) Professional Registration Bodies: Gender; (ii) University Councils: Gender; (iii) Science Councils' Executive Boards: Gender
- Construct 7: (i) National Academies: Gender

There are at least two further indicator categories that are used in the European comparative studies that are not included in this framework. The first is gender x field distribution of researchers across sectors, and the second is the pay gap between men and women in the same SET occupations and as researchers in the same sectors. The time and cost implications of including these indicator categories in the framework need to be considered.

Scenario D: System review scenario

This scenario represents a comprehensive review of the system. We propose that this review be undertaken **every six years**, which would mark the end of two three-year cycles of sector reports and international comparisons. The purpose of this review will be to inform all stakeholders in the system of all aspects of the NSI. A review of this type can be used for example by the SET4W Reference Group to make policy or research recommendations to the Minister. By implication, a comprehensive review of the system must include qualitative and quantitative components. The scenario described here reflects only the quantitative component of such a review. In this scenario attempts will be made to include all constructs and data categories, especially those that require great effort or investment of time and money to collect the data. Again, for a system review not all the indicator sub-categories will be appropriate.

If Scenarios A to C are implemented as suggested above, then Scenario D will include all of the already collected data plus data on the following:

- Construct 2: SET occupations: Gender x Nationality x SET occupation
- Construct 3: Researchers, Technicians and R&D Support Staff: Gender x Nationality x Sector
- Construct 6: Professional Registration Bodies: Gender x Nationality
- Construct 8: (i) Books and Authors: Author gender; (ii) USPTO patents: Gender of SA inventors
- Construct 9: (i) Article co-authors: Gender x sector affiliation of SA authors; (ii) USPTO co-inventors: Gender of SA inventors (iii) I Fund students: Gender x Race; Gender x Nationality

Conclusion

The different levels and cycles of the application scenarios imply that the M&E framework is a dynamic measuring instrument that expands or contracts in terms of constructs, indicator categories and indicators, depending on the purpose it is to serve. While this section proposes the four application scenarios as complimentary activities, the implementation of these scenarios would have to be based on careful consideration of time and resources (financial and human).

Section A and Section B highlight the many decisions that have to be made and negotiations that have to be entered into, in order to apply and populate the M&E framework. These decisions and negotiations have to involve a range of stakeholders and they all have time and cost implications. It is for this reason that we have refrained from any attempts to populate the framework at this point. Furthermore, if we were to attempt to populate the framework with only readily accessible routinely collected data (data availability condition A), the framework would be so sparsely populated as to render it unproductive.

In conclusion, the application of the four scenarios in a six-year cycle may be represented as follows:

	YEAR 1	**YEAR 2**	**YEAR 3**	**YEAR 4**	**YEAR 5**	**YEAR 6**
Scenario A	System monitoring	System monitoring	System monitoring	System monitoring	System monitoring	System monitoring
Scenario B	HE Sector monitoring	Govt Sector monitoring	Industry Sector monitoring	HE Sector monitoring	Govt Sector monitoring	Industry Sector monitoring
Scenario C			International benchmarking			International benchmarking
Scenario D						System review