

FACING THE FACTS 2019

Women's participation in science, engineering and technology



Women's Participation in Science, Engineering and Technology



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FOREWORD BY THE CHAIRPERSON

With South Africa's history of social exclusion, the government's focus remains on the transformation of the country and its systems. An enabling environment to address the inequalities in our society and its systems has been of paramount importance to our government, and it has invested in many policies, strategies and programmes to address social injustice.

The national system of innovation (NSI) is playing its part in this process. The role of the National Advisory Council on Innovation (NACI) is to advise the Minister responsible for science, technology and innovation (STI) on the role and contribution of STI in promoting and achieving national objectives. One of these is the development of human resources. NACI has been monitoring progress in STI using several instruments in order to produce evidence-based advice, with the indicators being namely, the STI Indicators and Facing the Facts reports. The annual STI Indicators Report highlights positive and negative trends in respect of selected indicators, while this report specifically monitors trends in respect of human resources.

Pleasingly, this report shows us that the participation of women in SET is increasing and, in certain areas, there is gender parity. It also shows that we are on track to meet some of the STI indicators in the National Development Plan. I can confidently say that the STI system is making progress towards achieving gender equality, but the pace is too slow and the transformation process needs to be accelerated.

As always, the NACI Council hopes that this report will serve as a resource to policymakers, researchers, civil society, students and every other stakeholder in the NSI.

Dr Shadrack Moephuli NACI Chairperson

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PREFACE

The National Advisory Council on Innovation is pleased to release the 2019 Facing the Facts report which monitors progress made in women's participation in science, engineering and technology (SET) between 2009 and 2019. This report shows the extent to which women have benefited from investments in SET, and looks at the progress made in achieving the indicators collected in the 2004 and 2009 Facing the Facts reports.

It is important to note that eradication of gender inequality is a cross-cutting issue, and progress differs across the various sectors of the economy. In terms of SET human resources, improvements in the representation of both gender and race can be observed.

Our previous Facing the Facts reports highlighted that, despite the improved participation of women in SET, they tended to be younger and less qualified than men, received a significantly smaller share of the rewards and recognition on offer, and were clustered mainly in particular scientific domains. Our current report shows women's participation in SET degree enrolment has increased by 45%, from 106 941 in 2009 to 154 631 in 2019. Women no longer make up the majority of students enrolling for SET degrees, as was the case in 2009, but from 2016 to 2019, women made up the majority of graduates. African women are in the majority in enrolment and graduation throughout the reporting years.

There are improvements in women's enrolment and graduation at postgraduate level. Enrolments grew from 17 720 in 2009 to 30 161 in 2019 and graduations from 5 513 in 2009 to 14 102 in 2019. Women make up the majority of Master's level students at upper postgraduate levels, however they are still in the minority at Doctoral level. Our report shows that in essential fields like engineering, physics, mathematical sciences and computer sciences, women are in the minority and are under-represented in engineering and physics at Doctoral level.

A contrasting picture is observed in other studies, for example, trends in the annual National Survey on Research and Experimental Development Survey show that women participating in research and development make up 46% of the total in 2018/19 financial year. White researchers are still in the majority, although their share is declining, which translates to a decreasing share in research outputs (36% of journal articles) in 2019.

Improvements in transformation are observed at public higher education institutions, where women were in the majority at 54% in 2019. However, they were still mostly in the lower ranks, as found previously. Women were in the majority at levels below senior lecturer and their representation decreased as their age increased. More needs to be done to develop academic staff at lecturer level, which is where the majority of academic staff is found, as a mere 20% have a PhD and only 51% have a Master's degree.

Improvements are also seen in the proportion of women with National Research Foundation (NRF) ratings, which indicates that government interventions to increase representation could be yielding results. We see that the NRF funding for Africans increased from 69% to 83%; the representation of women student increased from 54% in 2015 to 59 in 2019. Furthermore, the nationality of NRF-funded postgraduate students met the Ministerial Guidelines of 87% South Africans. In 2019, 88% of NRF-funded postgraduate students were citizens and 12% were from other countries. However, more needs to be done in this area too, as the majority of rated researchers are still men and white.

The 2004 and 2009 Facing the Facts reports were developed by the NACI SET4Women Committee, assisted by the NACI Secretariat. This time, the report was developed by the NACI Secretariat with the support of NACI Transformation Committee. I would like to thank the team for their efforts and the NACI Committee on Transformation for its support. NACI welcomes comments and suggestions. Please submit any comments on this report to naci@dst.gov.za.

Dr Mlungisi Cele NACI Acting CEO

1. INTRODUCTION

The history of South Africa is one of social exclusion for the majority of its citizens. Social inequalities were embedded and reflected in all spheres of social life, as a product of the systemic exclusion of black people under colonialism and apartheid as well as the subjugation of women over centuries. As a result, socio-economic discrimination and class, race, gender, institutional and spatial inequalities profoundly shaped, and continue to shape, South Africa today.

To redress this exclusion, democratic South Africa undertook to transform the country and its systems through various interventions. In terms of the science, technology and innovation (STI) system, policies, strategies and plans were put in place to create an enabling environment for transformation. The following are highlighted as key policies that drive human capital development and transformation through the Department of Science and Innovation: The White Paper on Science and Technology (1996), the National Research and Development Strategy (2002), the Ten-Year Innovation Plan (2008-2018) and the White Paper on STI (2019).

The 1996 White Paper on Science and Technology called for a redress of racial and gender discrimination in human capital development for the national system of innovation (NSI). The National Research and Development Strategy (NRDS) rested on three pillars, one of which was "SET human resources and transformation". The strategy highlighted that the human resources in SET were not being adequately developed and renewed. Black and women scientists, technologists and engineers were not entering the academic ranks, and the overwhelmingly white, male and aging scientific population was not being replaced by younger groupings more representative of South Africa's demographics.

The Ten-Year Innovation Plan (TYIP) was clear that South Africa needed to make more rapid progress in critically related areas of societal transformation. This made it necessary to expand the numbers of black and women scientists, engineers and technology experts and, more broadly, to use government investments in science and technology to help eliminate poverty (DST, 2008). Human capital development was cited as one of the pillars that would drive progress towards a knowledge-based economy and outcome targets were set.

In the 2019 White Paper on STI, there is a policy intent, "Transform the profile of the researcher base", with emphasis on the development of black and women researchers at emerging researcher level (with a specific focus on black women). The White Paper also states the need to address racial and gender transformation to unlock the full potential of South African society.

The NACI review of the NRDS and the TYIP showed that the STI initiatives identified and referenced in both documents were adopted and implemented, and the government has, in broad terms, delivered the enabling mechanisms and programmes that needed to be put in place to strengthen and transform the STI system, and thus, by extension, achieve the objectives of the 1996 White Paper on Science and Technology (NACI, 2020). Significant investments were also made in strengthening the knowledge production and human resources development capacity of South African universities through the funding of 16 centres of excellence and more than 200 research chairs.

Furthermore, trends transforming the demographics of STI human resources, especially race, are now well-established. However, the gender picture is slightly more complicated, as women's participation has increased significantly in some areas, but less in other areas, such as contributions to scholarly publications. To address the challenges that still exist, the review recommended the development and implementation of an integrated and updated human resources strategy for science and technology, and an in-depth scoping and impact assessment study of existing human capital interventions for science and technology.

This report is meant to contribute to the monitoring of the progress made in transforming STI human resources in South Africa, focusing on the participation of women in SET. It also highlights the extent to which some of the National Development Plan 2030 targets for increasing and developing SET skills are likely to be met. The report examines the indicators reported on in the 2009 Facing the Facts report. Section 1 covers student enrolment and graduation, and Section 2 looks into other aspects of human resources for SET. Section 3 reports on publication output, and Section 4 on funding allocations. Section 5 looks at the National Research Foundation's scientific rating system.

2. SET STUDENT ENROLMENT AND GRADUATION

The transformation of the SET human resources in the economy depends on student enrolment and graduation in the education sector. The Department of Higher Education and Training (DHET) monitors the country's trends in human capital development using the Higher Education Management Information System (HEMIS) database, among other instruments. The HEMIS database is a critical tool for monitoring progress with transformation in SET degrees.

2.1 Student enrolment and graduation for SET degrees

In 2019, 323 286 students enrolled for SET degrees, which translates to an increase of 36%, from 237 055 in 2009. There was an increase of 56% in the number of SET students graduating in 2019, with 64 683 SET graduations, up from 41 511 in 2009 (see Figure 1). SET students constituted 30% of total higher education enrolment and 29% of higher education graduations.



Figure 1: Higher education SET enrolment and graduations between 2009 and 2019

In terms of enrolment and graduation at postgraduate level, there were significant increases. Enrolment at undergraduate level increased from 200 633 in 2009 to 266 282 in 2019, and enrolment at postgraduate level increased from 36 422 in 2009 to 57 004 in 2019 (see Table 1). Similarly, SET graduations increased from 30 999 in 2009 to 48 088 in 2019. At postgraduate level, SET graduates increased from 10 512 in 2009 to 16 595 in 2019 (see Table 2).

Table 1: Higher education sector enrolment by level

Year	Undergraduate	Postgraduate	Total	Undergraduate %	Postgraduate %
2009	200 633	36 422	237 055	85%	15%
2010	211 581	39 753	251 334	84%	16%
2011	222 446	42 001	264 447	84%	16%
2012	228 623	44 660	273 282	84%	16%
2013	236 925	46 698	283 622	84%	16%
2014	238 736	48 485	287 221	83%	17%
2015	244 947	49 988	294 935	83%	17%
2016	243 867	51 515	295 383	83%	17%
2017	256 262	53 853	310 115	83%	17%
2018	264 796	55 874	320 671	83%	17%
2019	266 282	57 004	323 286	82%	18%

Table 2: Higher education sector graduation by level

Year	Undergraduate	Undergraduate Postgraduate		Undergraduate	Postgraduate
				%	%
2009	30 999	10 512	41 511	75%	25%
2010	31 259	11 501	42 760	73%	27%
2011	33 652	12 447	46 099	73%	27%
2012	35 586	13 263	48 849	73%	27%
2013	39 134	14 043	53 176	74%	26%
2014	40 853	14 722	55 574	74%	26%
2015	43 020	15 070	58 090	74%	26%
2016	43 574	15 551	59 125	74%	26%
2017	45 478	16 104	61 581	74%	26%
2018	48 392	16 819	65 211	74%	26%
2019	48 088	16 595	64 683	74%	26%

2.2 Gender of students enrolling and graduating in SET degrees

The DHET HEMIS database shows that women were in the minority in SET enrolments and graduations in 2009 and 2019. However, the number of women enrolling in SET degrees is increasing, from 106 941 in 2009 to 154 631 in 2019, an increase of 45% (see Figure 2).



Figure 2: Percentage of SET enrolments by gender (2009-2019)

Furthermore, women graduating with SET degrees increased from 20 531 in 2009 to 33 855 in 2019, an increase of 65% (see Figures 3).



Figure 3: Percentage of SET graduates by gender (2009-2019)

2.3 Race of students enrolling and graduating in SET degrees

The DHET database shows that Africans were in the majority in terms of SET enrolments and graduations in 2009 and 2019, except in Doctoral enrolments in 2009 (see Figure 4). The enrolment of Africans increased 43%, from 148 537 in 2009 to 212 524 in 2019. Similarly, graduations increased 95%, from 22 354 in 2009 to 43 566 in 2019 (see Figure 5).







Figure 5: Percentage of SET graduation by race (2009 and 2019)

Figures 4 and 5 also show a decline in white and Indian enrolments in SET between 2009 and 2019. The number of Indian students enrolling decreased by 1%, from 15 980 in 2009 to 15 852 in 2019. White enrolments decreased 18%, from 57 760 in 2009 to 47 117 in 2019. In respect of graduations, white graduations decreased 6%, from 13 288 in 2009 to 12 553 in 2019. Although, as shown in Figure 5, the proportional representation of coloured and Indian graduates has decreased, the actual numbers for these groups increased 30% and 39%, respectively.

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Looking at women, in 2019, 74% of graduates were African women, followed by white women at 15%, and then Indian and coloured women at about 6% each. Between 2009 and 2019, the number of white, Indian and coloured women enrolled in SET degrees decreased (see Figure 6). A similar picture is observed in SET graduation (see Figure 7). A significant decrease in white men was also observed – 22% in enrolment and 10% in graduation.



Figure 6: Female SET enrolment by race 2009 to 2019



Figure 7: Female SET graduate by race 2009 to 2019

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2.4 SET postgraduate enrolment and graduation by gender

Enrolment and graduation in SET at postgraduate level has improved. In enrolment, an increase of 57% in SET postgraduates was observed, from 36 422 in 2009 to 57 004 in 2019 (see Figure 8). An increase of 156% in SET graduations was observed, from 10 434 in 2009 to 26 677 in 2019 (see Figure 8).



Figure 8: SET enrolment and graduation (2009 and 2019)

Women's enrolment and graduation at postgraduate level also improved significantly. There was an increase of 70% in SET postgraduate enrolments, from 17 720 in 2009 to 30 161 in 2019. There was also an increase of 156% in graduations, from 5 513 in 2009 to 14 102 in 2019 (see Figure 9).



Figure 9: Women enrolment and graduation at postgraduate level (2009 and 2019)



The representation of women at Master's level has improved in both enrolment and graduation. Women were still in the majority in lower postgraduate (postgraduate diplomas and degrees, including Honours degrees) level (see Tables 3 and 4). In 2019, they also made up the majority at Master's level. However, they were still in the minority at Doctoral level (see Tables 3 and 4).

43%

45%

41%

57%

55%

59%

55%

51%

46%

45%

49%

54%

	20	09	2019		
	Female	Male	Female	Male	
Postgraduate Diploma Level	72%	28%	82%	18%	
Postgraduate Bachelor Level	83%	17%	91%	9%	

Table 3: Gender representation at postgraduate-level enrolment between 2009 and 2019

Table 4: Gender representation at postgraduate-level graduation between 2009 and 2019

	20	09	2019		
	Female	Male	Female	Male	
Postgraduate Diploma Level	72%	28%	51%	49%	
Postgraduate Bachelor Level	71%	29%	92%	8%	
Honours Level	44%	56%	57%	43%	
Master's Level	44%	56%	52%	48%	
Doctorate Level	49%	51%	44%	56%	

Honours Level

Master's Level

Doctorate Level

2.5 SET postgraduate enrolment and graduation by race

In 2019, Africans made up 64% of those that enrolled for postgraduate qualifications, followed by white students at 23%, and then Indian and coloured people at 7% at 6%, respectively (see Figure 10). Similarly, 52% of postgraduate graduates were Africans, followed by whites at 30%, Indians at 9% and coloured people at 8% (Figure 11).



Figure 10: Postgraduate enrolment by race between 2009 and 2019

This is an improvement on statistics for 2009, when white people made up the majority of postgraduate graduations at 43%, followed by Africans at 42% (see Figure 11).



Figure 11: Postgraduate graduation by race between 2009 and 2019

2.6 Women SET enrolment and graduation by field of study

Since 2009, women remained in the minority in enrolments for SET degrees in most fields, except in health care and health sciences, life sciences and physical sciences, and social science and social studies (see Table 5). It is important to note that women are under-represented in engineering and engineering technology.

Field of Otrady	2009		2014		2019	
Field of Study	Female	Male	Female	Male	Female	Male
Agriculture and Renewable Resources	44%	56%	51%	49%	55%	45%
Architecture and Environmental Design	38%	62%	38%	62%	42%	58%
Computer Science and Data Processing	39%	61%	36%	64%	37%	63%
Engineering and Engineering Technology	25%	75%	26%	74%	29%	71%
Health Care and Health Sciences	73%	27%	71%	29%	69%	31%
Life Sciences and Physical Science	56%	44%	56%	44%	58%	42%
Mathematical Sciences	47%	53%	41%	59%	40%	60%
Social Sciences and Social Studies	58%	42%	72%	28%	69%	31%

 Table 5: Higher education SET enrolment by field of study (2009, 2014, 2019)

Similarly, in 2009, most graduates in health care and health sciences, life sciences and physical sciences, and social science and social studies were women. However, in 2019, women were also in the majority in agriculture and renewable resources (see Table 6).

Table 6: Higher education SET graduations by field of study (2009, 2014, 2019)

	2009		2014		2019	
	Female	Male	Female	Male	Female	Male
Agriculture and Renewable Resources	45%	55%	52%	48%	56%	44%
Architecture and Environmental Design	38%	62%	41%	59%	44%	56%
Computer Science and Data Processing	37%	63%	40%	60%	39%	61%
Engineering and Engineering Technology	25%	75%	28%	72%	31%	69%
Health Care and Health Sciences	68%	32%	74%	26%	74%	26%
Life Sciences and Physical Science	54%	46%	59%	41%	62%	38%
Mathematical Sciences	44%	56%	44%	56%	43%	57%
Social Sciences and Social Studies	57%	43%	71%	29%	72%	28%

Women were in the minority with regard to enrolment and graduation in SET fields such as computer science, engineering, mathematical sciences and physics (see Table 7 and 8). However, there were improvements in representation. In 2009, women's representation at Doctoral level in engineering increased from 16% to 24%, and from 16% to 28% in physics. In computer science at Doctoral level, women's representation improved from 30% in 2009 to 32% in 2019.

Table 7: Postgraduate enrolment by select fields of study and gender in 2009 and 2019

	2009							
	Honours		Mas	ter's	Doctorate			
	Female	Male	Female	Male	Female	Male		
Computer Sc. and Data Proc.	29%	71%	30%	70%	30%	70%		
Engineering and Eng. Tech.	26%	74%	19%	81%	16%	84%		
Physics	22%	78%	27%	73%	16%	84%		
Mathematical Sciences	38%	62%	35%	65%	28%	72%		
			20	19				
Computer Science and Data Processing	38%	62%	36%	64%	32%	68%		
Engineering and Engineering Technology	34%	66%	30%	70%	24%	76%		
Physics	33%	67%	34%	66%	28%	72%		
Mathematical Sciences	39%	61%	38%	62%	30%	70%		

Table 8: Postgraduate graduation by select fields of study and gender in 2009 and 2019

			20	09		
	Hon	ours	Mas	ter's	Doct	orate
	Female	Male	Female	Male	Female	Male
Computer Sc. and Data Proc.	25%	75%	21%	79%	38%	62%
Engineering and Eng. Tech.	21%	79%	20%	80%	15%	85%
Physics	32%	68%	48%	52%	16%	84%
Mathematical Sciences	35%	65%	35%	65%	22%	78%
			20	19		
Computer Science and Data Processing	34%	66%	44%	56%	37%	63%
Engineering and Engineering Technology	29%	71%	29%	71%	19%	81%
Physics	31%	69%	45%	55%	26%	74%
Mathematical Sciences	42%	58%	38%	62%	27%	73%

In both 2009 and 2019, the majority of students enrolled for Honours and Master's level computer science were African women. In 2009, they made up 64% of Honours enrolments and 57% of Master's, and in 2019 they were even better represented, at 75% for Honours and 77% for Master's. In 2009, African women were under-represented at Doctoral level at 28% and white women were in the majority at 63%, but by 2019 African women were in the majority at 59%, followed by white women at 27%, Indian women at 9% and coloured women at 5%. Increases were also observed in coloured women and Indian women (see Table 9).

Table 9 also shows improvement in the representation of African women in engineering, physics and mathematical sciences, with African women in the majority at Doctoral level in 2019, followed by white women, Indian women and coloured women.

Table 9: Racial representation of women enrolling at postgraduate (Honours, Master's and Doctoral) level by field (2009 and 2019)

		African	1	С	oloure	d		Indian		White		
		2009										
	н	М	D	н	М	D	н	М	D	н	М	D
Computer Sci. and data proc.	64%	57%	28%	5%	5%	4%	10%	9%	6%	21%	29%	63%
Engineering and eng. Tech.	61%	48%	33%	1%	3%	4%	9%	13%	11%	29%	36%	52%
Physics	40%	61%	39%	10%	1%	3%	13%	4%	13%	37%	33%	45%
Mathematical sciences	44%	44%	41%	2%	6%	5%	8%	11%	8%	46%	40%	47%
						20	19					
Computer Science and Data Processing	75%	77%	59%	8%	5%	5%	7%	8%	9%	10%	11%	27%
Engineering and Engineering Technology	72%	71%	61%	3%	4%	5%	5%	8%	9%	20%	17%	25%
Physics	77%	74%	67%	4%	6%	3%	4%	8%	15%	15%	12%	16%
Mathematical Sciences	72%	63%	61%	4%	1%	5%	5%	6%	9%	18%	30%	25%

The graduation picture shows that between 2009 and 2019 African women were in the majority at Honours and Master's levels in computer science (53% of Honours graduates and 54% of Master's), and in 2019 they made up 69% in both categories. However, graduation at Doctoral level shows that African women were under-represented in 2009 at 11% and still in the minority in 2019 at 38% - see Table 10.

At Doctoral level, white women were in the majority at 78%, followed by African women at 38%, then Indian women at 12% and coloured women at 3%. It is important to note the decrease in the representation of coloured women at this level, from 8% in 2009 to 3% in 2019. In 2009, only one of nine women who graduated in computer science was a coloured woman, and in 2019 there was one coloured woman out of 34.

Table 10: Racial representation of graduating women at postgraduate (Honours, Master's and Doctoral) level by field (2009 and 2019)

		African	1	С	oloure	d		Indian		White		
	2009											
	н	М	D	н	М	D	н	М	D	н	М	D
Computer Sc. and Data Proc.	53%	54%	11%	8%	6%	11%	11%	8%	0%	28%	32%	78%
Engineering and Eng. Tech.	52%	41%	13%	2%	5%	0%	12%	14%	7%	35%	40%	80%
Physics	13%	70%	40%	14%	0%	0%	19%	0%	20%	53%	30%	40%
Mathematical Sciences	32%	33%	38%	2%	4%	0%	8%	14%	0%	58%	48%	63%
						20	19					
Computer Science and Data Processing	69%	69%	38%	2%	3%	3%	13%	3%	12%	16%	25%	47%
Engineering and Engineering Technology	59%	71%	56%	3%	6%	0%	8%	8%	12%	30%	16%	32%
Physics	70%	97%	52%	3%	3%	10%	21%	0%	14%	6%	0%	24%
Mathematical Sciences	55%	28%	37%	2%	1%	11%	20%	52%	35%	24%	19%	16%

Table 10 shows increases in African women's representation in engineering, physics and mathematical science. In these fields of study, African women's graduation share improved at Doctoral level from under-representation and minority representation to a majority.

3. HUMAN RESOURCES FOR SCIENCE, ENGINEERING AND TECHNOLOGY

The Department of Science and Innovation monitors trends in the transformation of research and development (R&D) human resources through the National Research and Experimental Development Survey (R&D Survey), among other instruments. The survey is developed by the Centre for STI Indicators at the Human Sciences Research Council.

3.1 South African R&D personnel

The trends in the R&D Survey shows an increase in R&D human resources/personnel¹, from 59 494 in 2009/10 to 84 036 in 2018/19. This is a 41% increase, most of which is in the higher education sector, which saw an increase of 78% (see Table 11).

	Government	Science council	Higher education	Business	Not-for-profit	Total
2009/10	2 580	5 926	32 392	18 216	380	59 494
2010/11	2 704	4 923	32 571	14 933	400	55 531
2011/12	3 143	4 494	36 157	15 288	405	59 487
2012/13	3 252	5 399	38 205	17 155	906	64 917
2013/14	2 874	5 884	41 464	17 599	1 017	68 838
2014/15	2 893	4 836	44 457	18 743	1 471	72 400
2015/16	2 997	5 162	48 034	17 245	1 493	74 931
2016/17	3 076	4 955	52 384	17 998	1 616	80 029
2017/18	3 027	4 866	57 074	17 554	1 741	84 262
2018/19	2 910	4 514	57799	16 876	1 937	84 036
Growth	13%	-24%	78%	-7%	410%	41%

Table 11: R&D headcount by sector 2009/10 to 2018/19

Adapted from the DSI/HSRC 2018/19 R&D Survey Report

The not-for-profit sector's R&D personnel increased by 410%. This increase could be attributed to the expansion of the sample of participating institutions, therefore, further analysis is needed.

R&D personnel in the science councils and the business sector declined significantly, by 24% and 7%, respectively (see Table 11).

The available data on the gender of R&D personnel starts from the 2013/14 financial year. In this period, a growth of 27% in the representation of women can be observed. In 2013/14, women made up 44% of R&D personnel (30 231) and, in 2018/19, 46% (38 528) (see Figure 12).

¹ All people (irrespective of nationality) employed directly in R&D, as well as those providing direct services such as R&D managers, administrators, and clerical staff. These include emeritus professors, honorary fellows and research fellows (DSI, 2021).



Figure 12: Percentage of R&D personnel by occupation and gender – adapted from DSI/HSRC 2018/19 R&D Survey Report

The R&D Survey trends show that researchers constitute the bulk of R&D personnel. In 2018/19, 74% of R&D personnel were researchers, followed by technicians and other R&D personnel, with both being at 13%. The number of researchers increased from 40 797 in 2009/10 to 62 166 in 2018/19, an increase of 52% (see Table 12).

		Headcour	nt			Percenta	ge	
	Researchers	Technicians	Other	Total	Researchers	Technicians	Other	Total
2009/10	40 797	9443	9254	59 494	69%	16%	16%	100%
2010/11	37 901	8 559	9 071	55 531	68%	15%	16%	100%
2011/12	40 653	9 260	9 574	59 487	68%	16%	16%	100%
2012/13	42 828	10 790	11 299	64 917	66%	17%	17%	100%
2013/14	45 935	10 800	12 103	68 838	67%	16%	18%	100%
2014/15	48 479	12 183	11 738	72 400	67%	17%	16%	100%
2015/16	51 877	11 518	11 536	74 931	69%	15%	15%	100%
2016/17	56 761	11 346	11 922	80 029	71%	14%	15%	100%
2017/18	61 840	11 219	11 203	84 262	73%	13%	13%	100%
2018/19	62 166	10 545	11 325	84 036	74%	13%	13%	100%
Growth					52%	12%	22%	41%

Table 12: R&D personnel by occupation (2009-2019)

Adapted from the DSI/HSRC 2018/19 R&D Survey Report

3.2 South African researchers

In the 2018/19 financial year, the majority of researchers were found in the higher education sector at 82% (51 187). There was a 79% increase, from 28 552 in 2009/10 to 51 187 in 2018/19 (see Table 13). The science councils and business sector experienced a decline in the number of researchers. A decrease of 27% was observed in the science councils, from 2 669 in the 2009/10 financial year to 1 951 in 2018/19. In the business sector, a decrease of 17% was observed, from 8 366 in 2009/10 to 6 942 in the 2018/19 financial year (see Table 13).

Financial year	Government	Science councils	Higher education	Business	Not-for-profit	Total
2009/10	986	2 669	28 552	8 366	224	40 797
2010/11	1 184	1 941	28 154	6 372	250	37 901
2011/12	1 411	1 803	30 993	6 192	254	40 653
2012/13	1 409	1 879	32 955	6 191	394	42 828
2013/14	1 229	1 956	36 133	6 182	435	45 935
2014/15	1 343	1 988	38 381	6 261	506	48 479
2015/16	1 573	2 072	41 639	6 128	465	51 877
2016/17	1 677	2 189	46 028	6 463	404	56 761
2017/18	1 671	2 053	50 549	7 142	425	61 840
2018/19	1 662	1 951	51 187	6 942	424	62 166

Table 13: Researcher headcount by sector adapted from DSI/HSRC 2018/19 R&D Survey Report

Overall, progress was observed in the representation of women researchers², with an increase of 42% between 2009/10 and 2018/19. In 2009/10, women researchers made up 40% of the total (11 641), and in 2018/19 they made up 46% (16 481).

Overall, and in terms of race, white researchers were in the majority in the 2018/19 financial year, at 48%. However, there was a 17% decrease in white researchers from 18 024 in 2009/10 to 14 890 in the 2018/19 financial year. The representation of African researchers, coloured researchers and Indian researchers has substantially increased (see Table 14). In 2018/19, African researchers represented 35% of the total, up 50% from the 2009/10 financial year. Indian researchers increased by 38%, from 2 448 in 2009/10 to 3 370 in the 2018/19 financial year. The number of coloured researchers increased by 33%, from 1 573 in 2009/10 to 2 099 in the 2018/19 financial year.

² Excluding Doctoral students and post-Doctoral fellows.

	African	Coloured	Indian	White	Total	Female	Male	Total
2009/10	7 210	1 573	2 448	18 024	29 255	11 641	17 614	29 255
2010/11	6 756	1 316	2 438	14 789	25 299	10 477	14 823	25 300
2011/12	7 201	1 438	2 202	15 113	25 954	10 889	15 065	25 954
2012/13	8 101	1 591	2 514	15 108	27 314	11 936	15 378	27 314
2013/14	8 024	1 685	2 530	15 775	28 014	12 494	15 520	28 014
2014/15	8 468	1 815	2 522	15 919	28 724	12 899	15 824	28 723
2015/16	9 548	1 881	2 629	15 396	29 454	13 305	16 150	29 455
2016/17	9 968	1 957	2 921	15 151	29 997	15 078	17 957	33 035
2017/18	10 815	2 209	3 352	15 795	32 171	16 433	19 800	36 233
2018/19	10 818	2 099	3 370	14 890	31 177	16 481	19 116	35 597

Table 14: Researcher headcount by gender and race (HSRC, 2021)

3.3 Occupational representation of higher education staff

The DHET database on public higher education institutions shows that the number of higher education institutions staff increased from 16 320 in 2009 to 19 901 (see table 15) in 2019, which is an increase of 22%. The biggest growth was observed at the occupational level of associate professor (35%), followed by lecturer (31%) and those below junior lecturer level (25%).

Overall, the majority of higher education staff were found at lecturer level, followed by senior lecturers, and then associate professors and professors (see Table 15). In 2019, 92% of professors had Doctoral degrees, associate professors followed at 88%, senior lecturers at 60%, lecturers at 20%, and junior lecturer at 6%. Much still needs to be done to increase the number of lecturers with Doctoral degrees (see Figure 13).

Table 15: Higher education staff by occupation (2009-2019)

		Headcount			Percentage	
	2009	2014	2019	2009	2014	2019
Professor	2 048	2 209	2 288	13%	12%	11%
Associate Professor	1 784	1 991	2 407	11%	11%	12%
Vice Rector	0	0	0	0%	0%	0%
Director	65	67	3	0%	0%	0%
Associate Director	125	118	58	1%	1%	0%
Senior Lecturer	4 187	4 682	5 122	26%	26%	26%
Lecturer	6 626	7 977	8 698	41%	44%	44%
Junior Lecturer	906	913	993	6%	5%	5%
Below Junior Lecturer	99	162	124	1%	1%	1%
Undesignated/Other	480	131	208	3%	1%	1%
Total	16 320	18 250	19 901	100%	100%	100%





Figure 13: Percentage of academic staff with a postgraduate degree (Master's and Doctorate)

The majority of staff were in the 35-44 and 45-54 age groups, each representing 29% of higher education staff in 2019. They were followed by those in the 25 to 34 (19%) and 55 to 59 (13%) age groups (see Figure 16). There is a very large increase (185%) in staff over 70 years and above. In 2009, there were only 13 higher education staff in this category, and in 2019 there were 37 (see Table 16).

	Under 25 Years	25 - 34	35 - 44	45 - 54	55 - 59	60 - 62	63 - 65	66 - 69	70 Years and Over
Professor	0%	0%	10%	37%	26%	16%	900%	2%	2%
Associate Professor	0%	3%	28%	38%	17%	8%	5%	0%	0%
Vice Rector	0%	0%	0%	0%	0%	0%	0%	0%	0%
Director	0%	0%	0%	0%	0%	33%	67%	0%	0%
Associate Director	0%	0%	12%	36%	29%	22%	0%	0%	0%
Senior Lecturer	0%	13%	34%	30%	13%	6%	3%	0%	0%
Lecturer	0%	29%	31%	26%	8%	4%	1%	0%	0%
Junior Lecturer	3%	47%	26%	16%	5%	1%	1%	0%	0%
Below Junior Lecturer	2%	31%	32%	22%	6%	4%	3%	0%	0%
Undesignated/Other	0%	28%	21%	19%	13%	4%	7%	6%	1%
Total	0%	19%	29%	29%	13%	6%	3%	0%	0%

Table 16: Higher education staff by occupation and age in 2019

One of the National Development Plan (Vision 2030) targets was to increase the percentage of higher education staff with a PhD qualification from a baseline of 34% in 2010 to 75% in 2030. In 2019, 47% of higher education staff had a Doctoral degree; only a 13% increase from the baseline – see Table 17.

Table 17: Higher Education Staff with Doctoral degree

	Masters	Doctoral	Grand Total	% Masters	% Doctoral
2009	5190	5602	16320	32%	34%
2010	5349	5885	16684	32%	35%
2011	5343	6239	16934	32%	37%
2012	5520	6643	17451	32%	38%
2013	5680	7209	17838	32%	40%
2014	5858	7673	18250	32%	42%
2015	6018	7952	18567	32%	43%
2016	6266	8430	19213	33%	44%
2017	6465	8827	19631	33%	45%
2018	6298	9278	19781	32%	47%
2019	6385	9269	19901	32%	47%

3.4 Gender and racial representation of higher education staff

Women were the majority in higher education throughout the reporting years. In 2009, women represented 53% of higher education personnel and in 2019, 54%. This is an increase of 41%, from 24 732 in 2009 to 34 781 in 2019. Likewise, Africans were in the majority throughout the reporting years. In 2009, 42% of higher education personnel were Africans, and in 2019, 58% were (an increase of 90%). An increase of 46% is also observed in coloured staff, from 5 235 in 2009 to 7 669 in 2019. In contrast, there is a 16% decrease in white academics (see Table 18).

			Ra	ice				Gender	
	White	Coloured	Indian	African	Other	Total	Male	Female	Total
2009	18 231	5 235	3 250	19 600	112	46 428	21 696	24 732	46 428
2010	18 115	5 410	3 360	19 974	285	47 144	22 033	25 111	47 144
2011	17 829	5 710	3 395	20 260	449	47 643	22 290	25 353	47 643
2012	17 872	5 939	3 385	20 893	251	48 340	22 773	25 567	48 340
2013	17 667	6 105	3 387	21 414	312	48 885	22 940	25 945	48885
2014	17614	6 249	3 385	22 320	522	50 090	23 408	26 682	50090
2015	17 321	6 550	3 459	23 582	399	51 311	23 670	27 641	51 311
2016	17033	7 115	3 457	29 125	654	57 384	26 593	30 791	57 384
2017	16 598	7 387	3 504	33 254	499	61 242	28 143	33 099	61 242
2018	15 921	7 560	3 486	34 693	511	62 171	28 387	33 784	62 171
2019	15 325	7 669	3 476	37 150	504	64 124	29 343	34 781	64 124

Table 18: Higher education staff by gender and race (2009-2019)

Women's representation and share decreased as the age category increased, while the representation of men increased as the age category increased (see Figure 14).



Figure 14: Higher education staff by gender and age category in 2019

In 2019 women in higher education were in the minority in occupations at and above senior lecturer level. It is important to note that there were no women at director level, and that the majority of women were at lecturer level and below (see Table 19).

		Headcount		Perce	ntage
	Male	Female	Total	Male	Female
Professors	1 565	723	2 288	68%	32%
Associate professor	1 405	1 002	2 407	58%	42%
Director	3	0	3	100%	0%
Associate director	32	26	58	55%	45%
Senior lecturer	2 661	2 461	5 122	52%	48%
Lecturer	4 018	4 680	8 698	46%	54%
Junior lecturer	469	524	993	47%	53%
Below junior lecturer	69	124	193	36%	64%
Other	106	102	208	51%	49%
Total	10 328	9 642	19 970	52%	48%

Table 19: Higher education staff by occupation and gender in 2019

It is important to note that there has been progress in almost all categories reported on in 2009. The representation of female professors increased from 19% in 2009 to 32% in 2019; the representation of female associate professors increased from 30% in 2005 to 42%; the representation of female senior lectures increased from 40% in 2005 to 48%; the representation of lectures increased from 51% in 2005 to 54%. The representation of female junior lectures decreased from 56% in 2005 to 53%.

4. RESEARCH PUBLICATION OUTPUT

According to *The State of the South African Research Enterprise* report, produced in 2019 by the DSI-NRF Centre of Excellence in Scientometrics and Science, Technology and Innovation Policy (SciSTIP), South Africa's research performance is excellent given the relatively low levels of investment in research and the country's small researcher capacity.

4.1 South Africa's performance in research publication

South Africa's world ranking improved from position number 35 in 2000 to 28 in 2016. Its share of world output more than doubled, from 0,4% in 2000 to 0,91% in 2016. The country's publications in the World of Science increased from 3 668 publications in 2000 to 15 550 in 2016, an average annual growth rate increase of 2,9% (see Figure 15). However, in the engineering fields, South Africa's world ranking dropped from 35 to 38 (SciSTIP, 2021).



Figure 15: Rate of growth in the number of research outputs - Sourced (SciSTIP, 2021)

South Africa has one of the more "well-rounded" science systems in terms of relative field strength. South African scientists and scholars are increasingly collaborating with the rest of the world, including countries outside Africa. Overall, international collaboration increased from 34% in 2000 to 52% in 2016. Also, the citation impact of South African authored papers, as measured by the mean normalised citation score (MNCS), increased steadily from 0.8 in 2000 to 1.1 in 2016 (see Figure 16). The increases are observed in all fields except the humanities (SciSTIP, 2021).





Figure 16: MNCS scores in all fields between 2000 and 2016: Sourced (SciSTIP, 2021)

The increase in the citation impact to 1.1 in 2016 brought the average citation impact of South African-authored papers to slightly above the world average for the fields in which South Africa published (SciSTIP, 2021).

4.2 Research publication of South African universities

According to the DHET report on research output by South African universities published in March 2021, research output increased from 9 109,34 units in 2009 to 21 176,45 in 2019 (see Figure 17).



Figure 17: DHET awarded publication subsidy units between 2009 and 2019

Table 18 also shows that in South African universities, journal articles remain the predominant mode of knowledge dissemination across the majority of scientific fields and disciplines through the years. Most journal articles (82% in 2019) are indexed in Scopus and the Web of Science (*these journals appear in both or one of the two indexes*). In terms of scientific fields, social sciences and humanities accounted for the majority of journal articles in 2019 (see Figure 18).

Year	Journal articles	Books and book chapters	Conference proceedings	Total	Journal articles (%)	Books and book chapters (%)	Conference proceedings (%)
2009	8 256,6	376,7	476	3 296,7	91%	4%	5%
2010	8 603,4	401,7	742,8	3 747,5	88%	4%	8%
2011	9 890,9	412,5	887,6	4 096,1	88%	4%	8%
2012	11 035,7	580,8	747,3	4 328,1	89%	5%	6%
2013	11 997,4	774,4	1 236,9	5 645,3	86%	6%	9%
2014	13 135,9	879,7	1 301,3	6 114,0	86%	6%	8%
2015	13 976,4	994,8	1 349,6	6 526,4	86%	6%	8%
2016	15 187,8	2 276,6	1 347,9	8 504,5	81%	12%	7%
2017	15 388,4	2 207,9	1 275,9	8 872,8	82%	12%	7%
2018	15 753,6	2 076,4	1 299,5	9 177,9	82%	11%	7%
2019	17 194,2	2 554,7	1 270,8	10 021,5	82%	12%	6%

Table 20: DHET awarded publication subsidy units between 2009 and 2019



Figure 18: Journal article output by scientific field in 2019 – adapted from DHET (2021) data

DHET gender data on authors of journal articles shows that women's share of journal publications remained low. It was 36% in 2019, an increase of 6% from 2005 (see Figure 19). DHET has indicated that the observed increase in the women's share of journal articles could be attributed to the increase in the proportion of female academic staff at South African universities. Thus, further analysis needs to be conducted and interventions are still required to reach some level of parity (DHET, 2021).



Figure 19: Journal publication by gender (2005-2019) – Adapted from DHET (2021) data

In terms of race, the trend shows the increasing contribution of black African, coloured and Indian/Asian academics to the knowledge production. Publications by black Africans showed a 20% increase from 2005 to 2019 (see Figure 20). Coloured academics showed the lowest increase at 1%, and there was only a 4% increase by Indian/Asian academics (DHET, 2021). These findings are supported by the SciSTIP report, which saw an increase in the proportion of Black Africans authored papers from 16% in 2005 to 31%.



Figure 20: South African publications by race (2005-2019) – Adapted from DHET (2021) data



The DHET data on the age of journal article authors show that publication numbers for younger authors were increasing. In 2005, the majority of publishing authors were between 40 and 49 years old, followed by 50-59 and then 30-39 (see Table 20). In 2019, authors in the 40-49 age bracket were still in the majority, but were followed by those in the 30-39 category. There was also a 3% increase in publications authored by those in the under-30 age category (DHET, 2021).

Age	20	05	20	10	2015		2019	
<30	551	5%	1 418	7%	1 856	5%	3533	8%
30-39	2 168	22%	4 729	23%	8 268	23%	12 330	27%
40-49	3 188	32%	6 269	30%	11 087	30%	12 776	28%
50-59	2 940	29%	5 290	26%	9 185	25%	9 963	22%
60+	1 178	12%	2 992	14%	6 184	17%	6 480	14%
Total	10 025	100%	20 698	100%	36 580	100%	45 082	100%

Table 21: Trends in authors of journal articles by age (2005-2019)

5. FUNDING ALLOCATIONS

5.1 Funding of the science, technology and innovation system

The Department of Science and Innovation (DSI) funds science, technology and innovation (STI) through its entities³ and received a funding allocation of approximately R8 billion in the 2019/20 financial year, 92% (R7,5 billion) of which went on transfers and subsidies. Of the R7,5 billion, 73% (R5,6 billion) went to DSI agencies for the purpose of implementing its policies, strategies, plans and programmes.

5.2 NRF funding allocations

The majority of DSI transfers to its agencies go to the National Research Foundation (NRF), for among other things, investment in the Human Capacity Development and Excellence Pipeline initiative. According to NRF actual performance for the 2009/10 to 2018/19 financial years, most of this funding was invested in the next generation, which primarily includes postgraduate students, followed by strategic investments, including Research Chairs, Centres of Excellence and Science Missions (see Figure 21).



Figure 21: The NRF Human Capacity Development Excellence Pipeline

³ The DSI entities are the Academy of Science of South Africa, the Council for Scientific and Industrial Research, the Human Sciences Research Council, the National Advisory Council on Innovation, the South African Council for Natural Scientific Professions, the South African National Space Agency, and the Technology Innovation Agency.



The South African Research Chairs Initiative (SARChI) received the biggest portion of funding in the strategic investment category (see Figure 22). This initiative has been significant in transforming STI human resources by attracting and retaining talented researchers; increasing the number of Master's and Doctoral students and post-Doctoral researchers; increasing publications in high-impact journals; and developing improved research capacity at host institutions and nodes of excellence at some of the universities.



Figure 22: NRF investment in the next generation of researchers

However, the demographics of SARChI chair holders show a female to male ratio of 46%:54% (2009, 19%:81%). Furthermore, only 30% of chair holders were South African black researchers, consisting of African (12%), coloured (8%) and Indian/Asian (9%) chair holders. The distribution of chairs between the well-endowed and less well-endowed institutions has also shown very little change from 2012 (NRF, 2019).

The largest proportion of funding is allocated for next-generation investments, which are meant to increase and develop the next generation of researchers through the competitive awarding of free-standing scholarships, grant holder-linked bursaries and academic development programmes aimed at Honours, Master's and Doctoral students (see Figure 23). The majority of funding for next generation of researchers went to freestanding scholarships followed by grant holderlinked bursaries.



Figure 23: NRF investment in the next generation of researchers

Established and emerging researchers received the lowest proportion of funding. However, investment in established researchers is essential for enhancing research productivity as well as training and mentoring the next generation of researchers. The majority of funding was invested in incentive funding for rated researchers, but due to changes in the NRF funding approach, there is a considerable decline in the outer year, and this investment will be further reduced in the following years (see Figure 24).



Figure 24: NRF investments in established researchers

5.3 Human Capacity Development and Excellence Pipeline

The NRF targeted grant-funding instruments have assisted tremendously in transforming the system, by focusing on women and black researchers, and fast-tracking black female PhD graduates towards obtaining the NRF rating. The benefits of the programmes can be seen in the section on NRF-rated scientists (see Section 7).

According to the SciSTIP report (2021), the NRF funding of South African academics over the period 2002-2015 became much more inclusive (SciSTIP, 2021). The proportion of female grant holders increased from 20% to 36% over this period and the trend is evident across most subfields, with steep increases recorded for the social sciences, natural sciences and engineering. The smallest increase was in the humanities (from 30% to 34%) (see, Figure 25).



Figure 25: Proportion of female and African NRF grant holders (SciSTIP, 2021)

Furthermore, the proportion of black grant holders also increased substantially, from 13% in 2002 to 31% in 2015. This was a general increase across all fields, with particularly steep increases recorded for the agricultural and engineering sciences (SciSTIP, 2021).

In addition to the SciSTIP report, the NRF performance information revealed that the number of female researchers supported have further increased from 36% in 2015 to 45% in 2019, while the number of black researchers supported have increased from 31% in 2015 to 48% in 2019.

5.4 NRF postgraduate funding

The pipeline for research human capacity begins with postgraduate students. The DSI/NRF postgraduate investments have targets to enable the transformation of the research pipeline. Black students funded through the NRF increased from 69% in 2015 to 83% in 2019. The representation of female students increased from 54% in 2015 to 59% in 2019. Furthermore, over the period 2015 to 2019, the nationality of NRF-funded postgraduate students met the Ministerial Guidelines target of 87% of supported students to be South African (including permanent residents). In 2019, 88% of funded students were South African citizens or permanent residents. The remaining 12% comprised 5% from the SADC, 4% from the rest of Africa and 3% from the rest of the world (see Figure 26).



Figure 26: NRF-funded postgraduates in 2019

According to the NRF's 2021/22-2023/24 annual performance plans, the race and gender composition of NRF-funded Honours students has not translated into representative support at Master's and Doctoral levels, and has not led to the transformation of the researcher cohort in the way anticipated (NRF, 2021). The NRF has therefore began implementing a new Postgraduate Student Funding Policy in 2020/21, which makes provision for postgraduate funding allocations to be underpinned by the principles of equity of opportunity, representivity and prioritisation.

6. SCIENTIFIC RATING

6.1 National Research Foundation Rating System

In South Africa, the NRF established a rating system in 1984, as a recognition and reward system for individual researchers. According to the NRF website⁴, the NRF rating system is a key driver in the NRF's bid to build a globally competitive science system in South Africa. It is a valuable tool for benchmarking the quality of our researchers against the best in the world. NRF ratings are allocated based on a researcher's recent research outputs and impact as perceived by international peer reviewers.

The rating system encourages researchers to publish high quality outputs in high impact journals/outlets. Rated researchers as supervisors will impart cutting-edge skills to the next generation of researchers. Currently, the system comprises five rating categories, namely, rating A (Leading International Researchers), B (Internationally Acclaimed Researchers), C (Established Researchers), P (Prestigious Awards) and Y (Promising Young Researchers).

6.2 South African NRF-rated scientists



The number of rated researchers have inversed from 1 923 in 2009, to 3 971 in 2019 (see Figure 27)

Figure 27: NRF-rated scientists 2009 to 2019 (NRF Research and Development Information Platform data)

Although there was an increase in the number of rated researchers within all rating categories, the rate of increase in the C and Y categories were more significant, while the L category was phased out (see Figure 28).

⁴ https://www.nrf.ac.za/rating

FACING THE FACTS



Figure 28: Headcount of NRF rated scientist by rating (2009 – 2019)

In 2019, C-rated researchers constituted 59.2% of rated researchers, followed by B-rated researchers at 19.5%, then Y-rated researchers at 17.8%. The higher rate of increase in the number of C and Y rated researchers has resulted in a decline in the proportion of A and B rated researchers (see Figure 29).



Figure 29: Proportion of NRF-rated researchers per rating category (NRF Research and Development Information Platform data)

Although the majority of rated researchers were men, there is a constant increase in the proportion of women rated researchers, climbing from 26% in 2009 to 34% in 2019 (see Figure 30). This significant increase in the proportion of women rated researchers is evident across the A, B, C, and Y rating categories, while the trend is less obvious in the P category which represented only 19 researchers in 2019 (see Figure 29).

When considering the race breakdown of women rated researchers, evidence demonstrates the following (see Figure 30):

- South African White women still constitutes the majority of the rated women researchers, but their representation reduced from 84% in 2009 to 72% in 2019 (see Figure 32).
- The proportion of South African, African women researchers has increased from 4% in 2009 to 9% in 2019. The South African Indian women researchers figure has increased from 4% in 2009 to 7% in 2019, while for South African coloured women researchers it has increased from 2% in 2009 to 5% in 2019 (see Figure 32).
- The proportion Non-South African women researchers has remained constant at 7%.
- Women are underrepresented in A and B rating and are generally in the minority in the C, Y and P ratings (see Figure 31).











Figure 32: Race representation of NRF-rated women researchers (2009-2019)

Overall, most rated researchers were South African White researchers, but the proportion of South African White rated researchers has decreased from 75% in 2009 to 61% in 2019. During the period from 2009 to 2019, the proportion of South African Black African researchers has increased from 7% to 16%, and Indian researchers from 4% to 7%. During the same period, the proportion of South African Coloured rated researchers remained constant at 4% while the proportion of Non-South African rated researchers remained constant at 12% (see Figure 33).



Figure 33: Demographics of NRF-rated scientists (sourced from the NRF Research and Development Information Platform)

As reflected by the previous Facing the Facts report (2009), the majority of NRF-rated researchers were still concentrated in the Natural Sciences but it is worth noting that the proportion of researchers in Natural Sciences has decreased from 49% to 39%. During the period 2009 to 2019, the proportion of rated researchers in Social Sciences has increased from 16% to 20%, Humanities as well as Health and Medical Sciences has increased from 12% to 15%, while the proportion of rated researchers in Engineering remained constant at 8% (see Figure 34).



Figure 34: NRF-rated researchers by scientific domain (2009-2019)

When analysing the scientific domain and gender representivity of the rated researchers over the period 2009 to 2019, it is evident that there is a slight increase in the representation of women in Engineering, Health and Medical Sciences, as well as Humanities. The proportion of women in Social Sciences has increased from 5% in 2009 to almost 9% in 2019. The decline in the proportion of rated men in the Natural Sciences needs to be noted (see Figure 35).

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35,0%										.		
30,0%										Hillin.		
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15,0%												
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0,0%	Formolo	Mala	Fomolo	Mala	Formolo	Mala	Fomolo	Mala	Formolo	Mala	Formolo	Mala
	remaie	wale	Female	iviale	remaie	wate	remale	wate	remale	wate	remaie	wale
	Engine	eerina	Мес	lical	Huma	nities	Inter-d	omain	Nat	ural	Soc	cial
		g	Scier	nces					Scie	nces	Sciei	nces
2009	0,8%	8,1%	5,5%	6,9%	4,0%	8,1%	0,6%	1,0%	9,8%	39,3%	5,0%	10,9%
2010	0,8%	7,3%	5,6%	7,4%	4,2%	8,8%	0,9%	1,1%	9,6%	37,9%	5,6%	10,8%
■2011	1,0%	6,9%	5,6%	6,9%	4,5%	9,2%	1,0%	1,2%	9,6%	37,1%	5,9%	11,1%
2012	1,0%	6,7%	5,6%	7,2%	5,3%	9,4%	1,2%	1,3%	9,6%	35,2%	6,3%	11,1%
2013	0,9%	6,7%	5,8%	7,4%	5,1%	9,2%	1,4%	1,5%	9,9%	34,7%	6,4%	11,0%
2014	1,0%	6,6%	5,8%	7,7%	5,2%	9,2%	1,4%	1,6%	9,7%	33,6%	7,0%	11,4%
2015	1,0%	6,7%	6,1%	7,9%	5,2%	9,1%	1,5%	1,7%	9,0%	31,9%	7,6%	12,3%
2016	1,0%	6,7%	6,6%	7,9%	5,4%	9,4%	1,4%	1,7%	9,0%	30,8%	8,0%	12,1%
■2017	1,0%	6,8%	6,9%	7,7%	5,3%	9,7%	1,5%	1,8%	9,1%	29,9%	8,2%	12,2%
2018	1,1%	6,5%	7,3%	7,2%	5,4%	9,9%	1,5%	1,8%	9,2%	29,2%	8,6%	12,2%
2019	1,2%	7,0%	7,9%	7,3%	5,3%	9,6%	1,5%	1,7%	9,6%	29,0%	8,7%	11,2%

Figure 35: NRF-rated researchers by scientific domain and gender (2009-2019)

When considering the racial distribution of the rated researchers within the various science domains it becomes clear that, although continued transformation is still required, notable progress is evident. The representation of African rated researchers increased within all domains but special mention needs to be made of the increase in Engineering surging from 8.2% in 2009 to 24% in 2019. The representation of White rated researchers has also reduced across all domains (see Table 21).

FACING THE **FACTS**

Table 22: NRF-rated scientists by race and science domain (2009-2019)

	Engineering	Health and Medical Sciences	Humanities	Inter-domain	Natural Sciences	Social Sciences
2009						
Black African	8.2%	7.6%	5.2%	3.2%	7.0%	5.6%
Coloured	0.6%	4.2%	3.0%	6.5%	4.1%	3.3%
Indian/Asian	3.5%	10.1%	2.6%	0.0%	4.2%	2.9%
White	78.8%	71.4%	83.6%	80.6%	70.6%	79.7%
Non-SA Citizen	8.8%	6.7%	5.6%	9.7%	14.1%	8.5%
2009 Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
2014						
Black African	17.3%	10.3%	6.1%	4.6%	10.1%	10.5%
Coloured	1.8%	4.0%	3.1%	4.6%	3.5%	3.9%
Indian/Asian	5.8%	9.8%	4.7%	1.1%	4.5%	6.8%
White	60.4%	68.2%	78.1%	78.2%	65.0%	68.7%
Non-SA Citizen	14.7%	7.8%	8.0%	11.5%	16.9%	10.1%
2014 Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
2019						
Black African	24.4%	12.4%	13.6%	15.3%	16.8%	14.1%
Coloured	3.4%	7.1%	2.9%	2.4%	3.8%	4.4%
Indian/Asian	7.7%	11.1%	4.4%	6.5%	5.6%	6.8%
White	50.6%	62.5%	68.6%	65.3%	58.7%	64.1%
Non-SA Citizen	13.9%	6.8%	10.6%	10.5%	15.1%	10.6%
2019 Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

7. CONCLUSION

In conclusion, the 2019 Facing the Facts measures progress made in women's participation in SET since the 2009 report. The report captures progress in five key areas, namely, (i) the participation of women in SET enrolment and graduation, (ii) research and development personnel, (iii) research publication, (iv) NRF funding allocations and (v) NRF scientific ratings. The report provides statistics on the progress of women's SET participation, not an interpretation of the trends.

7.1 SET enrolment and graduation

The findings of the report show improvement in the participation of women in SET enrolment and graduation. The number of women enrolling and graduating in SET has increased. Participation in enrolment increased from 106 941 in 2009 to 154 631 in 2019. Participation in graduation increased from 20 531 in 2009 to 33 855 in 2019. Although the trends show increases in women participating in SET enrolment, they remained a minority throughout the reporting years (2009-2019). This trend has reversed from the previous (2009) report, which showed that women participating in SET enrolment and graduation. In respect of graduation, the trends show that women were in the minority from 2009 to 2014 and in the majority from 2015 onward.

The intersection between race and gender shows that African women were in the majority of women enrolling for SET degrees throughout the reporting years, followed by white women, Indian women and coloured women. At postgraduate level, women's enrolment and graduation have also improved. In respect of enrolment, the number of women increased from 17 720 in 2009 to 30 161 in 2019, and in respect of graduation, women increased from 5 513 in 2009 to 14 102 in 2019. Despite the observed improvements, while women were in the majority at lower postgraduate level, they were in the minority at upper postgraduate level. It is also important to note the improvements at Master's level, where women were in the majority in 2019.

African women drive the growth observed in women's participation, with an increase of 121% in enrolment and 235% in graduation. They are followed by coloured women (40% and 196% increase in enrolment and graduation, respectively) and then Indian women (38% and 112% increase enrolment and graduation). However, there was a 2% decrease in the enrolment of white women and a 27% increase in graduation.

In terms of enrolment by field of study, the findings show that in 2009, women were in the majority in healthcare and health sciences at 73%, followed by social science and social studies at 58%, and life science and physical sciences at 56%. However, in 2019, women's representation dropped to 69% in healthcare and health sciences, while increasing to 69% in social science and social studies, and to 58% in life sciences and physical sciences. Importantly, women were in the majority in agriculture and renewable resources in 2019, at 55%. The graduation picture is similar to that for enrolment.

As for enrolment at postgraduate level in fields that are essential for jobs of the future, such as engineering, physics, mathematical sciences and computer science, women are in the minority and under-represented in engineering and physics at Doctoral level. Women graduating at postgraduate level in the same fields were also in the minority or under-represented at Doctoral level in engineering and physics. While there have been improvements between 2009 and 2019, more still needs to be done.

The intersection between gender and race shows improvement in the representation of African women. African women were in the minority in the selected fields for jobs of the future in 2009, but by 2019 they were in the majority. For example, in 2009 African women enrolling at Doctoral level were under-represented at 28%, and in 2019 they made up 59% of enrolments. In respect of graduation in the same fields, while African women were under-represented at Doctoral level in 2009 at 11%, by 2019, although still in the minority, they were at 38%.

7.2 Human resources for SET

The trends in the National Survey on Research and Experimental Development show improvements in the representation of women, although they are still in the minority. Most of the women in research are white, but a decline is observed, and the representation of African, coloured and Indian researchers has grown. Between 2009/10 and 2018/19, the number of African women grew 50%, 33% and 38% for African, coloured and Indian researchers, respectively.

Looking at occupations in higher education institutions, women are in the majority throughout the reporting years. They made up 53% of staff in 2009, and 54% in 2019. Likewise, African staff are in the majority throughout the reporting years. In 2009, 42% of staff were African and, by 2019, this figure had gone up to 58%. The representation of women decreases with age; for men, it increases. In addition, the representation of women decreases as the rank level increases. Overall, there are improvements in women's representation throughout the reporting years.

7.3 Research publications

In research outputs, the share of women authors in journal articles has remained low. In 2019, women's representation was at 36%, an increase of 6% from 2005. There were improvements in the journal publication figures for black African, coloured and Indian scientists, and journal article authors were younger.

7.4 NRF funding allocations and ratings

The demographics of funding allocations to SARChI chair holders shows that women were in the minority at 46% and only 30% of chair holders were black researchers, which consist of African at 12%, coloured at 8%, Indian/Asian at 9%. The distribution of chairs between the well-endowed and less well-endowed institutions has shown little progress. The proportion of women grant-holders increased from 20% to 36% over the reporting period and the trend is evident across most subfields, with steep increases recorded for the social sciences, natural sciences and engineering. The smallest increase was in the humanities (from 30% to 34%). The funding of Africans increased from 69% to 83%, and the fund met the Ministerial Guidelines of 88% citizens and 12% from other countries.

The majority of rated researchers were men; there is a constant increase in the proportion of women rated researchers from 26% in 2009 to 34% in 2019. When considering the race breakdown of women rated researchers, there's evidence that South African White women still constitute the majority of the rated women researchers, but their representation reduced from 84% in 2009 to 72% in 2019.

The proportion of South African, African women researchers has increased from 4% in 2009 to 9% in 2019. South African Indian women researchers has increased from 4% in 2009 to 7% in 2019, while South African coloured women researchers has increased from 2% in 2009 to 5% in 2019. The proportion Non-South African women researchers has remained constant at 7%, and women are underrepresented in A and B rating and are generally in the minority in the C, Y and P ratings.

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