

Women in Science – a Royal Society Overview

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This paper is a response to the questionnaire from the Inter Academy Council regarding Women for Sciences Project to Academies.

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This IAC response was compiled by Kathleen Logan during January 2005, with support of the Academy Council's Executive Officer, Gill Sutherland. If there are questions about details in this report, please contact Dr Logan, for additional specific information please contact Mrs Sutherland.

3. Academy actions

Introduction

The Royal Society of New Zealand (RSNZ) is both an 'Academy of Sciences' for New Zealand and a 'Purchase Agent', for the government, of research. That is, it runs several competitive funds on behalf of the government.

The RSNZ activities as an 'academy of sciences' include: the development and promotion of a code of professional ethics for researchers, promotional activities in the public, school and parliamentary arenas, and programmes in schools such as an annual national science fair and awards for school science projects mentored by professional researchers (CREST). There are other programmes, which are described in our strategic plan.

The RSNZ acts as a 'purchase agent' for government by administering several competitive funds to support researchers in science (including social sciences) and technology (S&T). These include: research grants (Marsden fund, James Cook Research Fellowships), international travel grants, one-year teacher fellowships in S&T organisations, and a S&T promotion fund.

Activities to Promote Women in Science

There are no Academy activities designed specifically to encourage women to get in to the physical, mathematical and life sciences and engineering that are currently being run. In certain science subject areas from secondary education through to post-doctoral level, e.g. biological sciences and health, recent figures show a higher proportion of women than men partaking. See the details under 'tertiary education enrolments' later in this paper.

Nominations for Fellowship of the RSNZ (FRSNZ) are particularly invited for women, and these nominations are considered by the Academy Council President's Panel, in addition to the Academy Council Selection Committee which considers and shortlists nominations according to disciplines. In 2004, for example, the only woman elected to the Fellowship was recommended to the Academy's Selection Committee by the President's Panel, while the others had been recommended by the discipline Selection Panel. This same double selection process also applies to nominations in the area of applied science and technology who are generally men. In this way, we try to ensure that nominations of women are given special attention, although they are judged by the same criteria as all nominees, so that Fellowships are conferred on the basis of merit only, without quota for women or subject area. Details on RSNZ

membership and Fellows are given later in this paper under the heading 'membership of the RSNZ'.

There are programmes run by the Institute of Professional Engineers of New Zealand, to encourage women to enrol in engineering degrees, but these do not come under the control of, or association with, the RSNZ.

Activities to Promote Minority Groups in Science

New Zealand is comprised of a majority ethnic population of European settlers who mainly arrived in the past 170 years, with minor populations of Asians and Pacific Island settlers who settled mainly in the past 140 and 50 years, respectively. The recognised indigenous people –the Tangata Whenua –are Māori, who settled in this country approximately 800 years ago. The European and Asian populations are well represented in higher education (staff and students), both women and men, but few Pacific Islanders and Māori are involved in S&T research or practice.

The RSNZ as well as the NZ government have recently set in place policies aimed at improving the responsiveness of Māori to S&T, and to encourage the indigenous people of New Zealand to take more control of, and responsibility for, the research that underpins the environmental, social and economic wellbeing of our nation. In New Zealand, discrimination based on ethnicity is not generally acceptable, and very few programmes are delivered according to gender or ethnicity¹. The main ways to encourage these groups in to S&T are 1) to advertise programmes among communities of disadvantaged peoples, 2) to remove barriers that exist among specific groups of people, e.g. the poor, and 3) to adjust the culture of S&T promotion to be inclusive of all cultures and genders.

Membership of the RSNZ

The membership of the Royal Society represents the applied, biological, earth, engineering, information, medical, physical and social sciences, mathematics, and technology. There are about 1400 members, 365 Fellows and Honorary Fellows, 18 Companions, 52 constituent organisations, 9 branches, and 10 affiliate organisations.

At present we do not cater for either academics, practitioners or researchers in the humanities.

Currently there are 25 women who are Fellows and 2 women who are Honorary Fellows. Fellowship of the Royal Society of New Zealand is an honour conferred for distinction in research and/or the advancement of science. The criteria for Honorary Fellowship are similar to those for

Fellowship and consideration is also given to a candidate's association with New Zealand.

Despite specific gender information not being requested in applications for general membership of the Royal Society, we know of at least 300 women members, but we do not know the accurate figure. It is likely to be up to 25% higher than this number, which was obtained using titles (e.g. Ms, Mrs etc) and name recognition.

Number of Fellows	321	7.8% women	25 women
Number of Honorary Fellows	44	4.5% women	2 women
Number of Members	1380	% unknown	number unknown

Recipients of Contestable Funds

The 'purchase agent' activities of the RSNZ are listed below. We provide proportions and numbers relating to women in the summary table, and we describe efforts to improve representation of women for each fund/activity.

Marsden Fund

The most prestigious research fund in New Zealand, the Marsden Fund, is administered by the RSNZ and supports research in science (including social science) and technology, as well as humanities. Data presented here for the Marsden Fund awards either include or exclude humanities and social sciences. Please take note, for comparison with other academies of sciences, whether the figures relate only to the physical, mathematical and life sciences and engineering (as requested in the AIC WfS questionnaire) or whether they also include the social sciences and humanities.

The Terms of Reference for Marsden grants specifically state that the only criterion for these awards is excellence of the research proposal. There is no positive discrimination or quota management of particular genders (or ethnicities). There are no special considerations to encourage specifically women to apply, nor are funding breaks mentioned, e.g. for people who need to take time off to have children. Considerations such as leave provisions for researchers are the remit of the employer of the researcher, rather than the purchase agent.

Marsden standard awards

The standard awards provide for full projects for up to 3 years, including additional staff, equipment, and full costs of overheads. (A very few projects are sometimes funded for up to 5 years, subject to a 3-year review.) Because the size of the fund makes up only 5% of New Zealand's contestable funding pool, and it is the only fund available for investigator-led and independent research (or 'blue skies research'), it is a strongly contested fund. Marsden Fund applications undergo a two-stage process with short, preliminary, applications and then full applications. All full applications are subjected to rigorous international peer review, with anonymous reviewers and known applicants. Usually, only the top 7 to 10% of all applications receive grants, which are mainly awarded to principal investigators who have achieved highly in their field, and have proven their research capabilities. They are mainly men, as shown in the following table.

Full Standard Marsden Contracts awarded in 2004:
mathematical and life sciences and engineering
and *excluding the social sciences and humanities*:

Principal investigators	78 total	18 % female	14 females	
Associate investigators	75 total	12 % female	9 females	
All researchers named on projects	160 total	15 % female	24 females	

Marsden Fast Start Awards

These awards are specifically for people within 7 years of their PhD (or who have less than 7 years' research experience), who have permanent jobs but who need funds to undertake independent research (i.e. they are not 'post-doctoral scholarships'). They do not provide the full costs of a full-time salary, but contribute to the costs of research and a significant proportion of a person's salary for up to 2 years. Each grant is given to one person, in contrast to the standard Marsden grants which are given to one or more Principal Investigators, supported by a team of people.

Like the standard Marsden awards, the Marsden fast start grants are provided in a two stage application process. First, a preliminary round, with short applications, followed by a full application for those successful in the first round, which are peer reviewed internationally.

Fast-Start Marsden Contracts awarded in 2004: mathematical and life sciences and engineering and <i>including</i> the social sciences and humanities:				
Preliminary applicants	228 total	37.3 % female	85 females	
Full applicants	49 total	46.9 % female	23 females	
Final awards (contracts)	25 total	52.0 % female	13 females	

Fast-Start Marsden Contracts awarded in 2004: mathematical and life sciences and engineering and <i>excluding</i> the social sciences and humanities:				
Final awards (contracts)	17 total	35.3 % female	6 females	

(This means that 7 of the 8 researchers receiving grants in social sciences and humanities were females.)

It is interesting to note that there were a significantly larger proportion of women *achieving* Fast Start grants than those *applying* ($P = 0.0388$; Chi square test). However, the small number of grants awarded means that a difference of only one person would make this insignificant. Future years will be analysed to determine any bias towards women in awarding these grants.

James Cook Research Fellowships

The James Cook Research Fellowships are for eminent scientists who have a proven track record and usually a senior post, and who wish to take a break from teaching and administrative duties, to enable a two year period of intensive research and publication. These fellowships are strongly contested and only applicants of the highest calibre attain awards.

Generally, these fellowships are awarded in each of 6 subject areas approximately every two years. (That is, 2 or 3 fellowships are granted each year). The subject areas are: Biological sciences (including biotechnology); Engineering sciences and technologies; health sciences; physical sciences (including chemical, geosciences, mathematical and information sciences); research of relevance to peoples of New Zealand and/or the South-west Pacific; and social sciences. In each year there must be at least one fellow in the social sciences.

There were 9 fellows during 2003/04, all of whom were men.

There were 7 fellows during 2004/05, 2 women and 5 men.

Teacher Fellowships

The RSNZ runs a scheme to place teachers in authentic science and technology research or practise positions for a year, usually in research institutes or industry. These fellowships enable the teacher to refresh, relearn and regain enthusiasm in their field of expertise. There is a lengthy application process, and those who apply are only awarded fellowships based on merit.

In New Zealand, approximately 70 % of school teachers are women, with 65 % of management positions held by women and women make up 41 % of principals.

2004 applications for teacher fellowships:	106 total	50.9 % female	54 females
2004 teacher fellowships awarded:	59 total	64.4 % female	38 females

Contestable fund for S&T promotion

This fund supports people running promotions and events that raise awareness of S&T in the public arena.

2003/04 awards for S&T Promotion	8 total	75 % female	6 females
2004/05 awards for S&T Promotion	9 total	67 % female	6 females

Royal Society of New Zealand Travel Grants

These grants enable postgraduate students who are New Zealand citizens (or permanent residents) to attend their first international conference. A total of 51 awards were granted in 2004 and 51% were women.

2004 March travel awards:	36 total	50 % female	18 females
2004 September travel awards:	15 total	53 % female	8 females

4. Actions by other Organisations

We do not have specific information on activities of other organisations, that promote women in S&T. However, we recommend contacting the Institute of Professional Engineers of New Zealand to discuss programmes in place to increase numbers of women in engineering.

There are mentoring programmes run by some universities and schools, aimed at increasing the retention and pass rates of Māori and Pacific Island children and students. It is interesting to note that to date these programmes have been more successful among girls than boys. However, there has been a lack of evaluation based on gender of such programmes, and it is difficult to point to figures that demonstrate the results for ethnic minority women in schools and universities.

5. Actions that have not worked

We know of no programmes aimed at increasing women in S&T that have failed.

Other Relevant Background Information

Statistics of Total Researcher Numbers in New Zealand, 2002

These tables provide numbers and background information on proportions of women in research and development (R&D) in New Zealand. These figures are from the 2002 national R&D survey, a compulsory survey run by the government of New Zealand. The R&D survey includes all research, and does not distinguish science and technology from humanities and social sciences.

Total number of full-time equivalent staff employed in New Zealand R&D in 2002, including graduate research students, by research position:

Researchers	13,133	
Technicians	2,784	
Support staff	1,850	
Total	17,767	41 % female

Full-time equivalent (FTE) women employees involved in government R&D by qualification (year end June 2002).

Staff highest qualification	% Female FTEs	Total FTEs
PhD	20.4 %	1,136
Bachelor /masters etc	42.8 %	1,455
Technical	33.5 %	325
Trade Certificate	41.9 %	31
Diploma (other post tertiary)	36.6 %	224
Secondary School	47.7 %	373

Other or none	57.4 %	305
Total in government R&D	36.7 %	3,849

Full-time equivalent (FTE) women employees involved in business R&D by qualification (year end June 2002).

Staff highest qualification	% Female FTEs	Total FTEs
PhD	18.7 %	493
Bachelor /masters etc	26.8 %	2,069
Technical	13.5 %	570
Trade	8.7 %	332
Diploma (other post tertiary)	42.9 %	163
Secondary School	50.7 %	286
Other post secondary	47.3 %	239
Total in business R&D	26.0 %	4,152

Full-time-equivalent (FTE) women employees involved in higher education R&D by research position (calendar year-end 2002).

R&D staff research position	% Female FTEs	Total FTEs
Researchers	40.3 %	2,516
Technicians	39.5 %	496
Support staff	80.3 %	615
Research post-graduate students	51.1 %	6,139
Total in higher education R&D	49.6 %	9,766

Crown Research Institutes:

There are nine government-owned research institutes in New Zealand. Manaaki Whenua Landcare Research, which performs research in conservation, agricultural and environmental sciences, has doubled its proportion of women post-graduate staff from 1995 to 2004, which now stands at 32%. In contrast, the Institute of Geological and Nuclear Sciences has less than 14 % of women among its 145 post-graduate qualified staff and women make up just 16.3 % of the total staff of 233. At the National Institute of Water and Atmospheric Research, 28 % of the total 612 staff are female. The Horticultural Research Institute reported an increase of women to 45 % of staff (total about 480) in 2003. The other five research institutes did not report the proportions of women on their staff, but some other information was obtained from annual reports. The NZ Forest Research Institute (ForestResearch) supports a women's group to encourage women scientists in their careers; it provides a school holiday programme preferentially for school-age children of ForestResearch and the local city council staff; and it also offers a ForestResearch Suffrage Scholarship for a girl from any of the town's high schools to proceed to tertiary education in science. At the NZ Institute for Crop & Food Research Ltd, 4 of 7 directors are women. Directors of all national research institutes are appointed by government. The balance of gender and cultural considerations of the board members of state-owned companies is a factor in their appointments. Further information is available at www.ccm.au.govt.nz.

Tertiary Education Student Enrolments in S&T

The following data were obtained from the 2002 education statistics published by the Ministry of Education. More recent figures are not freely available at this time. All figures exclude international students. In total in New Zealand in 2002, 58.4 % of tertiary education enrolments were women.

Qualification level	% Female enrolments	Number of female enrolments
Higher Doctorate	72.4 %	66
Doctor of Philosophy	48.7 %	1,882
Masters	59.3 %	6,991
Bachelors Honours	58.9 %	6,991

Post Graduate Diploma	57.7 %	5,819
Post Graduate Certificate	70.4 %	1,914

Science and technology subjects in tertiary education, including: natural and physical sciences; information technology; engineering and related technologies; architecture and building; agriculture and environmental studies; and health; made up only 34.2 % of all enrolments. Of science and technology enrolments in 2002:

56.5 % were males	43.5 % were females
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The other arts and humanities subjects, (education; management and commerce; society and culture; creative arts; food, hospitality & personal services; and mixed field programmes) made up 65.8 % of 2002 tertiary enrolments. Of these remaining subject enrolments in 2002:

33.9 % were males	66.1 % were females.
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The relative proportion of female and male enrolments at different levels of education is very much subject dependent. For example, nursing makes up one half and one third of degree-level and post-graduate health qualifications respectively, and at both levels, 90% of enrolments are female.

The proportion of S&T enrolments that were female in 2002 by qualification level and subject area are as follows:

Proportion of enrolments that were female	Post-Graduate	Degree	Diploma	Certificate	Total
1. Natural and Physical Sciences	47.5%	46.2%	53.4%	62.8%	48.5%
2. Information Technology	37.7%	26.1%	30.6%	59.3%	49.6%
3. Engineering & Related Technologies	20.7%	23.5%	8.7%	9.7%	12.2%
4. Architecture & Building	34.9%	47.9%	22.3%	24.3%	30.1%

5. Agriculture & Environmental studies	53.0%	40.0%	38.9%	24.8%	28.9%
6. Health	75.2%	81.3%	85.9%	74.4%	79.2%
Total S&T Enrolments that were female:	57.4%	59.1%	58.9%	55.8%	57.5%

Women in Advanced Career Stage

There is a paucity of information relating to numbers of women at different levels of research careers, particularly within national research institutes and private research associations. New Zealand has a strong presence of female staff and students in tertiary institutes. However, at the professorial and senior research levels numbers of women are relatively low.

A few research institutes and universities publish records that have been compiled below:

Otago University 2003 Annual Report:

At Otago University in 2003 there were 18,927 full-time equivalent students, of which 55.8 % were female.

The under-representation of women in the upper echelons of the academic career are demonstrated in the following tables, which show the percentage and numbers of women in academic, general and other staff groups, by career profile:

Academic and Research Staff	General Staff
Vice Chancellor/Senior Managers: 14 % (1 female)	Senior Managers: 17 % (1 female)
Professors 12 % (14 females)	Technicians 59 % (207 females)

Readers /Associate Professors 13 % (12 females)	Librarians & library assistants 81 % (104 females)
Senior Lecturers 31 % (107 females)	Student/community services 67 % (35 females)
Lecturers 46 % (99 females)	General staff 73 % (586 females)
Other teaching staff 49 % (117 females)	General services staff 46 % (118 females)
Research only staff 49 % (141 females)	
Research support staff 66 % (143 females)	
Total academic FTEs 41.6 % (633 females)	Total general staff FTEs 65.9 % (1051 females)

Canterbury University 2003 Annual Report:

Equivalent full-time students:	All staff: 49% female	Executive Positions
Undergraduate 49 % female	Academic staff 28.5 % female	Council 20 % female
Postgraduate 48 % female	Technical staff 16.5 % female	Committees 29.5 % female
	General staff 69.1 % female	Academic Board 17 % female
		Faculties and Board of Studies 31 % female

Factors affecting women in S&T in New Zealand

New Zealand research funding is provided on a highly contestable basis. In particular, state-owned research institutes receive no base-funding (to pay for salaries, buildings etc), and rely completely on contestable funds for their existence. That means that where researchers take time off to have children, it is often not possible to keep their jobs open, because there is no security of funding. Despite this, many of these research institutes offer maternity leave provisions, which are known to enable women to keep their S&T careers. These provisions include:

- 6 or 12 weeks' parental leave on full pay, or 80% pay (usually taken by the mother) [Government legislation does not require any payment from employer to people on parental leave, because the Government offers 13 weeks (in 2005) of a state benefit payment (up to 30% higher than the maximum unemployment benefit) to parents on parental leave who fulfil certain criteria.]
- up to 12 months' extended leave without pay, up until the child is one year old (or until one year after adoption), during which time the position is kept open for the parent
- flexible working arrangements such as hours of work and part-time work

Universities in New Zealand often have convenient, but limited, on-site child care facilities.

Women in New Zealand are under-represented in the hard sciences, such as physics, chemistry, engineering and mathematics, but are strongly represented in biological sciences, health and other sciences such as environmental and social sciences.

New Zealand has a low number of ethnic minorities undertaking S&T qualifications, as well as a reducing proportion of tertiary enrolments across the board, in S&T. The popularity of tertiary education has increased greatly, since certain policies have been instituted in the past 10-15 years; these include: student loans, full-time-equivalent funding, and lower welfare payments to people under the age of 25 years. However, most of the increased interest in tertiary education has been for certificate or short courses, rather than degree courses.

Universities receive funding based on pass rates and encourage students to enrol for subjects they are likely to pass. The government provides more funding per student for subjects that are more expensive to teach, but it is reported by some that the extra funding, (e.g. for biomedical sciences, physics, engineering and chemistry) still does not cover the increased costs associated with teaching these subjects, particularly at

research-degree level. It is unknown what impact this factor is having on women enrolling in these degrees, but it is not supportive of a general increase in teaching these subjects. Some universities have strategies for encouraging people to enrol in degrees for which there is strong demand of graduates.

Although research institutions enable flexible working hours, the option of part-time jobs and maternity leave, the reality of the full-cost contestable funding system is that employees must remain highly competitive to keep their jobs. If one is to compete in science, one has to work very hard, and sometimes long hours. Such work habits are often incompatible with family life, and since women in New Zealand are still the primary carers of children in the home, it is often at, or just before, this family-stage that women opt out of research careers. Other careers such as consulting, teaching, or advising local or national government agencies are some of the options that women take up after having a family. There is a paucity of statistical data that confirm these anecdotes, and it is hoped that a government study of human resources in science and technology in 2005 will gather information on gender representation at various career stages. Strategies could then be developed to increase the numbers of women available for professorial-level careers.

Summary

The Royal Society of New Zealand advances and supports science and technology, and runs contestable funds to provide for research, teaching and promotional activities. Our programmes are run on an equal opportunities basis as much as possible, with particular efforts to advertise to under-represented groups. We also work to remove cultural and economic barriers that stand in the way of these people who would otherwise be interested in S&T.

The Year of Physics, 2005, will see us involved in many educational, promotional and media activities that increase awareness of physics among the public, schools and government. It will be an opportunity to encourage people of both genders and all ethnicities to become interested in physics, which is one of the remaining university subjects with a paucity of women.

To recommend one most important action item for the IAC is difficult. The government and tertiary institutes need to think more about how to match the educational efforts to the industry requirements in each country. Some futures-thinking needs to occur to predict numbers required, e.g. in physics, engineering etc. in 10 years'time, and promote these courses to motivated people, both men and women. Certainly, retaining highly qualified women in mid-career stage (particularly at the post-family-rearing age), is of utmost importance: to maximise the return

on investment in these women; to enable their prosperity and choice in their careers; and to enable the higher echelons of S&T positions to be more populated by women. Retaining women long term in S&T careers would increase the numbers of highly qualified people able to contribute to the economy. Women in advanced career positions also become role models for younger potential scientists and technologists.