REFERENCES AND TECHNICAL NOTES FOR DATASHEET 2

Primary school

1. The “two thirds” statistic was obtained in two recent, unrelated studies – a 2012 study in Greece, and a 2009 study in the USA. The two studies used slightly different methods, but found that roughly 65% of children aged between nine and eleven drew male scientists in both Greece and the USA. It should be noted that the USA study also analysed the drawings of Chinese students, who drew male scientists 78% of the time. The information on Chinese students was not incorporated into the infographic due to seemingly large cultural differences. The last major “draw a scientist test” study that included Australian students (although they were a minority) was published in 1983, and reported that 99.4% of students aged five to eleven depicted a scientist as a man.

   Sources: D. Farland-Smith, How does culture shape students’ perceptions of scientists? Cross-national comparative study of American and Chinese Elementary students. *Journal of Elementary Science Education*. **21**(4), 23-42 (2009). G. Samaras, F. Bonoti, V. Christidou, Exploring children’s perceptions of scientists through drawings and interviews. *Procedia – Social and Behavioral Sciences*. **46**, 1541-1546 (2012). D.W. Chambers, Stereotypic images of the scientist: The Draw-a-Scientist Test. *Science Education*. **67**(2), 255-265 (1983).

2. The statistics are for Australian Grade 4 students who participated in the 2011 Trends in International Mathematics and Science Study (TIMSS). TIMSS assesses Year 4 and Year 8 students every four years. It is directed by the International Association for the Evaluation of Educational Achievement: an independent cooperative of national research institutions and government agencies from around the world. To investigate students’ beliefs about their abilities in mathematics, TIMSS created a Student Confidence with Mathematics scale, based on students’ responses to seven statements about their mathematics ability.

   Source: S. Thomson, K. Hillman, N. Wernert, M. Schmid, S. Buckley, “Monitoring Australian Year 4 student achievement internationally: TIMSS and PIRLS 2011” (Australian Council for Educational Research, Melbourne, 2012), pp. 93.

3. The National Assessment Program – Literacy and Numeracy (NAPLAN) is an annual assessment for all Australian students in Years 3, 5, 7 and 9. The numeracy component tests students in number and algebra; measurement and geometry; and statistics and probability. NAPLAN has an achievement scale with ten “bands”, which represent increasing complexity of knowledge and skills. Year 3 students are grouped using Bands 1-6, while Year 7 students are grouped using Bands 3-8. Therefore, the “highest recorded achievement band” is Band 6 for Year 3 students and Band 8 for Year 7 students. It should be noted that, for Years 3 and 5 students, the average male score was slightly higher in each state (except for Year 5 NT students). Performance” is measured by the average score.

   Source: “NAPLAN Achievement in Reading, Persuasive Writing, Language Conventions and Numeracy: National Report for 2015” (ACARA, Sydney, 2015), pp. 47, 111.

Secondary school

4. The statistics are for 15-year old Australian students who did not agree or strongly agree to the statements “mathematics is an important subject for me because I need it for what I want to study later on” and “I will learn many things in mathematics that will help me get a job”. The questions were asked as part of the 2012 OECD Programme for International Student Assessment (PISA). PISA conducts surveys every three years to assess the competencies of 15-year-olds in reading, mathematics and science. Each cycle has a focus on one of these domains. Once a domain has been the focus of a PISA cycle, results for that year can be compared with results for later cycles.

   Source: S. Thomson, L. De Bortoli, S. Buckley, “PISA 2012: How Australia measures up” (Australian Council for Education Research, 2013), pp. 227.

5. In PISA 2012, students were asked whether they were “confident” or “very confident” about having to perform different mathematical tasks. The statistics are for Australian students’ responses to “solving an equation like $3x + 5 = 17$” and for “calculating the petrol consumption rate of a car”. Significantly more males were confident in other specific tasks, including “finding the actual distance between two places on a map with a 1:10 000 scale” (68% vs. 43%), “calculating how many square metres of tiles you need to cover a floor” (80% vs. 65%) and “calculating how much cheaper a TV would be after a 30% discount” (83% vs. 69%). Although there were differences for specific questions, overall, “girls’ and boys’ average mathematics performance [was] similar in each of the quartiles of self-efficacy”.

   Source: S. Thomson, L. De Bortoli, S. Buckley, “PISA 2012: How Australia measures up” (Australian Council for Education Research, 2013), pp. 236.

6. In the maths component of both TIMSS (2011) and PISA (2012), relative gender performance varied between countries. If there was an innate gender difference between boys and girls, then one would expect boys to outperform girls across all countries. The TIMSS data is for “eighth grade” students, and the PISA data is for 15-year olds. The “performance” measure is the average score.

   Sources: S. Thomson, L. De Bortoli, S. Buckley, “PISA 2012: How Australia measures up” (Australian Council for Education Research, 2013), p 28. I.V.S. Mullis, M.O. Martin, P. Foy, A. Arora “TIMSS 2011 International Results in Mathematics” (International Association for the Evaluation of Educational Achievement, Chestnut Hill, MA, 2012), pp. 72.

7. The ratio of Australia’s male to female Year 12 students was obtained by compiling the raw enrolment datasets of each state and territory curriculum authority. The datasets were from 2012. In addition to the imbalanced ratios, there has been an overall decline in STEM participation for both genders.

   Source: J. Kennedy, T. Lyons & F. Quinn, The continuing decline of science and mathematics enrolments in Australian high schools. *Teaching Science* **60**(2), 34-46 (2014).

University education

8. All data refers to domestic university graduates. Bachelor completions data includes: Bachelor’s Graduate Entry; Bachelors Honours and Bachelor’s Pass degrees. Postgraduate completions data includes: Doctorate by Coursework; Doctorate by Research; Higher Doctorate; Masters by coursework; Masters by research. The broad and narrow fields of education are taken from the Australian Standard Classification of Education (ASCED). “Engineering” refers to the broad

ASCED field of Engineering and Related Technologies; “Maths” refers to Mathematical Sciences; “Chemistry” refers to Chemical Sciences; “Agriculture and Environment” refers to Agriculture, Environmental and Related Studies; “Biology” refers to Biological Sciences.

Source: Department of Education and Training special data request (2015). Office of the Chief Scientist calculations.

Workforce

In this section, “graduates” refers to people with a university degree, regardless of when they graduated.

9. Australia has a small proportion of women with post-secondary qualifications. Only 29% of STEM university graduates, and 9% of people with STEM VET qualifications (Certificates III or IV) are female. When combining the two different qualification types, just under 16% of Australia’s STEM-qualified (VET and/or university) population is female. It should be noted that, compared with males, the percentage of females who held post-secondary qualifications grew faster across all STEM fields except IT (2006 to 2011).

   Sources: Office of the Chief Scientist, “Australia’s STEM workforce” (Australian Government, Canberra, 2016). Australian Bureau of Statistics, “2011 Census of Population and Housing” (Australian Government, Canberra, 2011).

10. The sector names displayed in the table are shortened from the corresponding ANSZSIC Divisions. “Transport” represents Transport, Postal and Warehousing. “Education” represents Education and Training. “Healthcare” represents Health Care and Social Assistance. The “bottom” sector’s population of STEM graduates has the lowest proportion of females. The “top” sector’s population of STEM graduates has the highest proportion of females.

    Sources: Office of the Chief Scientist, “Australia’s STEM workforce” (Australian Government, Canberra, 2016). Australian Bureau of Statistics, “2011 Census of Population and Housing” (Australian Government, Canberra, 2011).

11. In the 2011 Census, the highest recorded income bracket was $104 000 or above. Compared with males, a smaller percentage of female STEM graduates earned $104 000 or above in every STEM discipline. This overall difference (32% vs. 12%) is comparable to non-STEM graduates (30% vs. 10%). Fewer female STEM graduates earn in the top bracket regardless of age, or whether their highest degree is a bachelor or PhD. This is true for both full-time and part-time workers, and for women with, and without children. The one exception is for over-65 full-time workers with PhDs.

    Counterintuitively, when averaging across all age groups, the proportion of female graduates in the top income bracket is 12% for women with children, and women without children. This is because there is a large number of women aged 20-29 that don’t have children (87% of the age cohort, and 49% of women without kids), and who also earn beneath $104 000 (which is normal for younger people). This drags down the average income of women without children. In the cohort of STEM graduates (bachelor and above) aged over 30, 18.6% of women without children are in the top income bracket, compared with 11.6% of women with children, and 35.4% of men.

    The impact of having children is greater for bachelor graduates, than for PhD holders; but in both cases, gender effects are more significant. Consider, for example, bachelor STEM graduates aged 30+. In this cohort, 17.4% of without children earn over $104 000, compared with 10.1% of women with children, and 34.6% of men. When considering PhD-holders over 30, 20.7% of women without children earn over $104 000, compared with 19.4% of women with children, and 38.6% of men. The effects of motherhood don't explain why, in the 30+ age cohort, nearly twice as many men earn in the top income bracket compared with women without children, regardless of qualification level.

Sources: Office of the Chief Scientist, "Australia's STEM workforce" (Australian Government, Canberra, 2016), pp. 53-57. Australian Bureau of Statistics, "2011 Census of Population and Housing" (Australian Government, Canberra, 2011).

12. Females make up 28% of total (across all levels of seniority) STEM academic and research staff. Level A academics (ranked below Lecturers) have been classified as "junior", and Level E academics (Professors, Heads of School or College Fellows) have been categorised as "senior". The subject fields correspond to the ASCED fields of education. "Agriculture and Environment" refers to Agriculture, Environmental and Related Studies; "Science" corresponds with Natural and Physical Sciences (excluding Mathematical Sciences); "Maths" refers to Mathematical Sciences; "Engineering" refers to Engineering and Related Technologies.

    Source: Department of Education and Training special data request (2014). Office of the Chief Scientist calculations.