Background information for the blog post 'When science gets tough …'

Kathleen Taylor, January 2013

The hierarchy of sciences

In 2011, Daniele Fanelli published an article in PLoS One which was titled *'Positive' results increase down the hierarchy of the sciences*. Fanelli argued that if the old – and highly influential – idea of a hierarchy of sciences were correct, subjects like physics (near the top) would be more rigorous, and so less likely to report positive outcomes in studies which tested a hypothesis, while subjects like psychology (near the bottom) would report more positive results. Fanelli's paper classified subjects by:

- Category: biological, physical, social
- Life: life science or not
- Applied: pure or applied science
- Social: social science or not

Fanelli ranked subjects by the odds of reporting a positive result, and found that these rankings can be thought of as reflecting the degree to which a subject could be considered 'hard science': its place in the hierarchy. At the top were space science and the geosciences; at the bottom were materials science and psychiatry/psychology.

UCAS data

The UK's Universities and Colleges Admissions Service (UCAS) holds information about the numbers of applications and acceptances for higher education courses. Data are available by year, subject and gender.

Fanelli classified subjects into groups derived from the Essential Science Indicators. These can then be matched to the list of UCAS subjects, with any non-matches discarded (such as arts subjects). Thus the UCAS subject 'Ceramics and Glass' is matched with the Fanelli group 'Materials Science'.

Fanelli groups can themselves be grouped into four overarching subject types:

- **Physical** (e.g. physics, chemistry)
- **Biological** (e.g. biology, genetics; Fanelli's 'Life' but not 'Social' sciences)
- **Biological and Social** (e.g. psychology, social studies; Fanelli's 'Life' + 'Social' sciences)
- **Social** (e.g. business studies, economics; Fanelli's 'Social' but not 'Life' sciences)

The result: 73 UCAS subjects, with Fanelli rankings (FR) ranging from 2-20 (space science, which ranked highest with FR=1, is not among UCAS's options).

The Fanelli groups and FR values used were: agricultural sciences (6), biology & biochemistry (16), chemistry (10), clinical medicine (17), computer science (5), economics & business (15), engineering (13), geosciences (2), molecular biology & genetics (14), materials science (19), plant & animal sciences (4), physics (7),

psychiatry/psychology (20), pharmacology & toxicology (18), social sciences, general (11).

The 73 UCAS courses, listed by Fanelli group, were:

Fanelli Group	UCAS Course Name and Code
agricultural sciences	Agricultural Sciences (D7)
agricultural sciences	Agriculture (D4)
biology & biochemistry	Anatomy,Physiology and Pathology (B1)
biology & biochemistry	Biological Sciences: any area of study (C0)
biology & biochemistry	Biology (C1)
biology & biochemistry	Combinations within Biological Sciences (CC)
biology & biochemistry	Nutrition (B4)
biology & biochemistry	Ophthalmics (B5)
biology & biochemistry	Others in Biological Sciences (C9)
biology & biochemistry	Sports Science (C6)
chemistry	Chemistry (F1)
clinical medicine	Combinations within Subjects allied to Medicine (BB)
clinical medicine	Medical Technology (B8)
clinical medicine	Nursing (B7)
clinical medicine	Others in Medicine and Dentistry (A9)
clinical medicine	Others in Subjects allied to Medicine (B9)
clinical medicine	Pre-clinical Dentistry (A2)
clinical medicine	Pre-clinical Medicine (A1)
computer science	Artificial Intelligence (G7)
computer science	Combinations within Mathematical & Computer Sci (GG)
computer science	Computer Science (G4)
computer science	Mathematical & Comp Sci: any area (G0)
computer science	Others in Mathematical & Computer Sci (G9)
computer science	Software Engineering (G6)
economics & business	Business & Admin studies: any area (N0)
economics & business	Business studies (N1)
economics & business	Combinations within Business & Admin Studies (NN)
economics & business	Economics (L1)
economics & business	Finance (N3)
economics & business	Human Resource Management (N6)
economics & business	Management studies (N2)
economics & business	Marketing (N5)
economics & business	Others in Business & Admin Studies (N9)
engineering	Civil Engineering (H2)
engineering	Combinations within Engineering (HH)
engineering	Electronic and Electrical Engineering (H6)
engineering	Engineering: any area of study (H0)
engineering	General Engineering (H1)
engineering	Mechanical Engineering (H3)
engineering	Others in Engineering (H9)
engineering	Production and Manufacturing Engineering (H7)
geosciences	Geology (F6)
geosciences	Physical Geographical Sciences (F8)

geosciences	Science of Aquatic and Terrestrial Environments (F7)
molecular biology & genetics	Biotechnology (J7)
molecular biology & genetics	Genetics (C4)
molecular biology & genetics	Microbiology (C5)
molecular biology & genetics	Molecular Biology,Biophysics & Biochem (C7)
materials science	Ceramics and Glass (J3)
materials science	Materials Science (F2)
materials science	Materials Technology not otherwise spec (J5)
materials science	Metallurgy (J2)
materials science	Minerals Technology (J1)
materials science	Polymers and Textiles (J4)
plant & animal sciences	Animal Science (D3)
plant & animal sciences	Botany (C2)
plant & animal sciences	Forestry (D5)
plant & animal sciences	Pre-clinical Veterinary Medicine (D1)
plant & animal sciences	Zoology (C3)
physics	Astronomy (F5)
physics	Combinations within Physical Sciences (FF)
physics	Others in Physical Sciences (F9)
physics	Physical Sciences: any area of study (F0)
physics	Physics (F3)
psychiatry/psychology	Psychology (C8)
pharmacology & toxicology	Pharmacology,Toxicology and Pharmacy (B2)
social sciences, general	Combinations within Social Studies (LL)
social sciences, general	Media studies (P3)
social sciences, general	Others in Social Studies (L9)
social sciences, general	Social Policy (L4)
social sciences, general	Social Studies: any area of study (L0)
social sciences, general	Social Work (L5)
social sciences, general	Sociology (L3)

Gender data

For the year 2011, data were collated from UCAS showing the number of female and male applications and acceptances for each of the 73 subjects, so that the percentage of females applying for, and being accepted onto courses could be assessed. (The correlation between applications and acceptances was 0.89, so for simplicity the focus is on acceptances).

Findings

The percentage of women accepted onto a course Spearman-correlates with the subject's Fanelli ranking (FR) at a level which SPSS suggests is significant (0.32, $p = 0.006$). Thus as subjects get softer (and the FR increases), proportionally more women are taking the course.

			% Women Accepted	Fanelli Ranking
Spearman's rho	% Women Accepted	Correlation Coefficient	1.000	.318[**]
		Significance (2-tailed)	.	.006
		Number of cases	73	73
	Fanelli Ranking	Correlation Coefficient	.318[**]	1.000
		Sig. (2-tailed)	.006	.
		N	73	73

A partial correlation remains significant (just) when controlling for the variables Category, Life, Social and Applied. Given how small this dataset is, the numbers should be taken with quantities of salt.

The grouping of subjects into physical, biological and social showed, unsurprisingly, that fewer women, proportionally, were accepted onto physical than nonphysical science courses. Perhaps the obvious outlier, Forestry, is too physical in another sense?
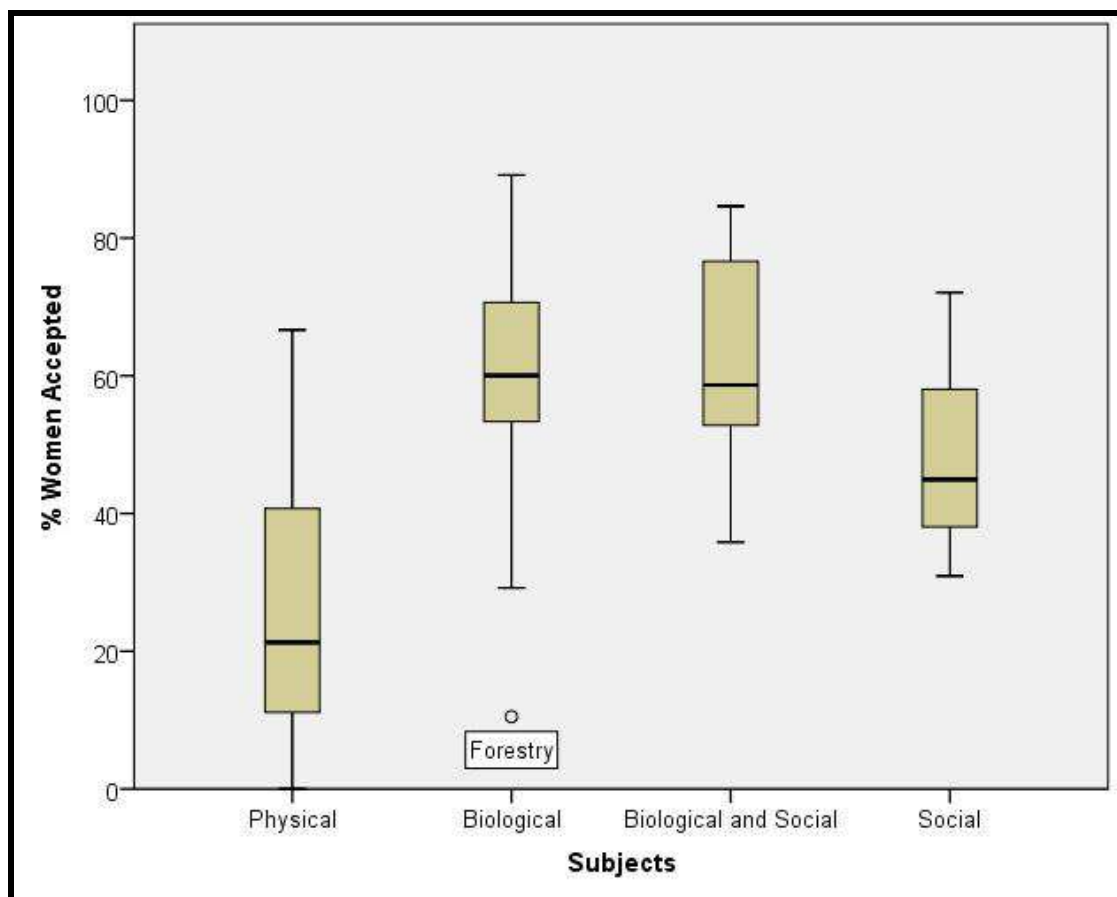
When data were grouped by Life vs non-Life and Social vs. non-Social science subjects, the results again suggest that, in general, women are more interested in people, or at least organisms. In the life sciences, similar proportions do social and

nonsocial subjects; outside the life sciences, the proportions of women are lower, and those doing non-social subjects particularly low.

.