Young Pedestrians’ Gendering of Mathematics: Australia and Spain

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People aged 20-39 were stopped in the streets of Victoria (Australia) and Madrid (Spain) to gauge their views on the gendering of mathematics. The findings suggested that for respondents from both countries, if stereotyped beliefs are held they were more strongly associated with the traditional male stereotype, that is, that males are considered more suited to pursuits in mathematics. However, in general, the Spanish respondents held stronger views than the Australians that mathematics was gender neutral, that is, that it, and related fields, are equally suited to males and females.

Introduction

A glance at recent headlines in the media as well as various websites reveals that gender issues and stereotyping remain topical and in the public eye (e.g., Goldstein, 2012; Topsfield, 2011). The makers of Lego, for example, have pitched their new “Friends” range to girls, the other half of the population (Smith, 2011). Mattel have also developed a “Computer Engineer Barbie doll” (Barbie Doll as Computer Engineer (Geek), n.d.) aimed at encouraging girls to consider this career option.

In the USA, it has been argued that “[D]emocracies are built on public opinion” (The power of public opinion, 2008). For mathematics education, the *Maths multiplies your options* advertising campaign run in Victoria, Australia in the 1980s was aimed at raising parents’ awareness of the importance of mathematics for their daughters. Its success highlighted the positive impact of public exposure on a perturbing, inequitable issue (McAnalley, 1991). Yet in the mathematics education research community scant attention has been paid to the views of the general public on issues associated with mathematics learning. With respect to gender differences in mathematics learning outcomes, explanatory models for these differences typically encompass, among a range of contributing factors, attitudes and beliefs of critical others and societal expectations.

In this paper we build on previously reported findings from surveys of the general public on the gendering of mathematics conducted by Leder and Forgasz (2010, 2011). Data from an expanded Australian sample as well as data gathered in the streets of Madrid, Spain are included. The focus is on findings from participants aged 20-39. This age group formed the largest sub-sample of all participants in both countries, and is of particular interest as they are representative of both Generations X (born 1965 to 1979) and Y (born 1980 to 1994) (McCrindle Research, n.d.), span those who are early in their working lives and those reaching their mid-career, and represent those completing the Organisation for Economic Co-operation and Development’s [OECD] Programme for International Student Assessment [PISA] testing programs in 2000, 2003, and 2006 (but not 2009). In earlier work, Leder and Forgasz (2011) reported that those in the younger age group (under 40) of their sample appeared to hold more traditional gender stereotyped views on mathematics than those aged over 40.

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Background Contexts

A sample from Spain, a non-English speaking, but Western country, was included in the present study for several reasons. When PISA results are examined, Australian students' mean scores are typically above the OECD average, while for Spanish students they are typically below the OECD average. Yet gender differences in favour of males are found in both countries. A summary of the mean PISA (2000, 2003, 2006, and 2009) scores for mathematical literacy in both countries is found in Table 1.

Table 1
PISA Results in Mathematical Literacy for Australia and Spain, 2000, 2003, 2006, & 2009

Year	Mean scores: OECD (Participating countries)	Mean scores and stat. sig. gender diffs.: Australia				Mean scores and stat. sig. gender diffs.: Spain			
		All	F	M	Sig.	All	F	M	Sig.
2000	500 (32)	533	527	539	No	479	469	487	Yes
2003	500 (41)	524	522	527	No	485	481	490	Yes
2006	498 (57)	520	513	527	Yes	480	476	484	Yes
2009	493 (65)	514	509	519	Yes	483	474	493	Yes

Australia's legislative history on gender equity dates back to the 1970s. In 1972, it was agreed that the concept of equal pay would be fully implemented by June 30, 1975; Elizabeth Reid's appointment as adviser to the Prime Minister on women's issues in 1973 was the first position of this kind internationally; and the Federal Parliament passed the Sex Discrimination Act in 1984 (Equal Opportunity for Women in the Workplace Agency, n.d.). Similarly, in Spain, gender equity legislation stems from the 1970s when laws were enacted to recognise equal rights and achieve a gender equitable education system to phase out the female social stereotype. The Equal Treatment Directive (Directive 76/207/CEE of Conseil, 9/2/1976) established the principle of equality of treatment for men and women for access to employment, vocational training, promotion, and working conditions. Since 1985, one particular focus has been on equality of educational opportunity. More recently, Spain increased its commitment to gender equity. New legislation was introduced in 2004 and 2008 to promote principles of gender equity in the spheres of private and public life, and to combat gender-based violence (see, for example, http://www.eurofound.europa.eu /eiro/2006/02/feature/es0602106f.htm). With respect to schooling, milestone legislation was passed in 2006 to enshrine the concept of co-education into educational policies. This is seen as an important step towards achieving a school model based on gender equity to challenge discrimination, gender stereotypes, and gender hierarchies.

As mathematics is a formal prerequisite for many post school educational and employment options, a high proportion of Australian students study mathematics in their final year of schooling. Ainley, Kos, and Nicholas (2008) estimated that at least 80% of students do so; the situation in Spain is similar in this regard.

With respect to women in tertiary education and in employment, there are remarkable similarities for Australia and Spain. In Australia in 2006, women comprised 54.8% of all tertiary students, and 58% of all Australian women were in the workforce in January, 2008 (Department of Foreign Affairs, n.d.). In 2005-6 in Spain, women reached 54.3% of university enrolments. At 51.9%, women's workforce participation rates have risen sharply in recent years (Cacace, 2009; OECD, 2007). However, in Australia and in Spain males predominate in tertiary enrolments in mathematics dependent courses, such as engineering and related technologies, and information technology (Department of FaHCSIA, n.d.; Sanchez de Madariaga et al., 2011; UMYC-Unidad de Mujeres y Ciencia, 2008). In Spain, the percentage of women enrolled in Science and Mathematics is 35.1% and in Engineering, 30.4% compared to 76.4 % enrolled in Education (Sanchez de Madariaga et al., 2011).

Theoretical Models Informing the Study

As noted above, many of the early explanatory models for gender differences in mathematics learning outcomes included societal influences and the views of significant others among the contributing factors. There were common elements in these models:

> … the emphasis on the social environment, the influence of other significant people in that environment, students' reactions to the cultural and more immediate context in which learning takes place, the cultural and personal values placed on that learning and the inclusion of learner-related affective, as well as cognitive, variables. (Leder, 1992, p. 609)

In addition, when Weiner's (1974) attribution theory for success and failure was applied to mathematics, gender differences were widely reported (see Leder, 1992). More recently, Halpern et al. (2007) concluded that reasons for the overlap and differences in the performance of males and females were multifaceted but that "[e]arly experience, biological constraints, educational policy, and cultural context" (p. 41) might all be involved. Some years ago, Baker and Jones (1993) argued that females may consider mathematics less important for their futures, being "told so in a number of ways by teachers, parents, and friends" (p. 92).

Wigfield and Eccles' (2000) model of achievement motivation, and implicitly of academic success, highlighted the influence that learner-related variables as well as the attitudes of "critical others" at home, at school, and in society at large had on students' learning and behaviour. An early version of this model was described by Eccles et al. (1985), and it continues to be widely used to explain gender differences in achievement and career choice with respect to the STEM fields – science, technology, engineering, and mathematics. The elements of the model also continue to be refined (e.g., Eccles, 2005).

The items included in the administered survey instrument are consistent with the elements of the explanatory models about individuals' social milieus.

The Study

Aims and Methods

The aim of this study was to determine whether 20-39 year olds in the general public hold gender stereotyped views of mathematics and its relevance to career suitability. We were also interested to know if Australians and Spaniards held similar or different views.

In Australia, data were gathered at 12 heavy foot-traffic sites within metropolitan Melbourne, Victorian regional centres, and smaller rural cities. People were stopped in the street and were invited to participate. One morning or afternoon (about four hours) was spent at each location. About 50 surveys were completed at each site. In Spain, participants were drawn from nine sites in the northwest, south, and central areas of Madrid. The percentage of respondents in the northwest was higher than in the other areas. Data collection was conducted one day a week for a two month period; a morning of about three hours was spent at each location.

The Instrument

Leder and Forgasz (2010) described the instrument used in Victoria as follows:

> To ensure maximum cooperation from those we stopped in the street, we limited our survey to 15 questions. In addition, however, we asked details about age (under 20, between 20 and 39, between 40 and 59, and over 60), and noted whether the respondents were male or female. Further, as well as the readily code-able responses such as “yes”, “no”, “don’t know”, “boys”, “girls”, “the same”, respondents were encouraged to elaborate and explain the reason for their answer; the comments were manually recorded by those administering the public survey. (p. 331)

The instrument was translated into Spanish for administration in the streets of Madrid. Fourteen of the original items were retained. Question 1 (Q1) in each version of the instrument was contextually bound. In Victoria, we asked: Did you see the recent *You can do maths* campaign on TV? A similar contextually bound question was asked in Spain. The 14 questions, common to the English and Spanish versions, were:

Q2. When you were at school, did you like learning mathematics?
Q3. Were you good at mathematics?
Q4. Has the teaching of mathematics changed since you were at school?
Q5. Should students study mathematics when it is no longer compulsory?
Q6. Who are better at mathematics, girls or boys?
Q7. Do you think this has changed over time?
Q8. Who do parents believe are better at mathematics, girls or boys?
Q9. Who do teachers believe are better at mathematics, girls or boys?
Q10. Do you think studying mathematics is important for getting a job?
Q11. Is it more important for girls or boys to study mathematics?
Q12. Who are better at using calculators, girls or boys?
Q13. Who are better at using computers, girls or boys?
Q14. Who are more suited to being scientists, girls or boys?
Q15. Who are more suited to working in the computer industry, girls or boys?

In this paper we report findings for all these items except Q4 and Q7.

Samples

As noted above, findings are reported in this paper from those aged 20-39 who completed the survey. The Victorian sample size was 223 (M=109; F=114); there were 387 (M=163; F=224) in the Spanish sample.

Analyses

The frequency distributions of the responses to the items were examined to determine the views of the Victorian and Spanish participants. Pearson chi-square tests were conducted to identify differences in the responses of the participants from the two countries. Effect sizes (φ) for the statistically significant differences were also calculated.

Results and Discussion

Results are reported under two main headings, personal and gender-stereotyped beliefs.

Personal Beliefs

One group of items analysed only dealt with personal beliefs about mathematics. Questions 2 and 3 required participants to respond ‘Yes’, ‘No’, or ‘Average’; the responses to questions 5 and 10 were ‘Yes’, ‘No’, or ‘Don’t know/Depends’. The results revealed that the majority of Australian and Spanish samples:

- liked mathematics when they were at school (Q2: 57.4% Aus [Australians], 73.7% Span [Spaniards]; $p<.001$, $\varphi = .21$)
- believed they were good at mathematics (Q3: 54.7% Aus, 71% Span; $p<.001$, $\varphi = .22$);
- believed that students should continue learning mathematics when it is no longer compulsory (Q5: 63.7% Aus, 56.9% Span; ns); and
- believed that studying mathematics was important for getting a job (Q10: 70.9% Aus, 56.9% Span; $p<.01$, $\varphi = .14$)

The response distributions for Q2, Q3, and Q10 were significantly different by country, with higher proportions of Spaniards than Australians positive about liking mathematics (Q2) and believing they were good at it (Q3), and a higher proportion of Australians than Spaniards believing that mathematics was important for getting a job (Q10).

Reasons given by participants for their responses to the last two of these items provide insights into why higher proportions of Australians than Spaniards agreed with them. The responses revealed that the Australian sample appeared to place greater emphasis on *the utility of mathematics for everyday life and career* than did the Spanish respondents. Typical examples of the Australian respondents were in relation to two main themes:

1. Mathematics is important/needed for everything:
   - Good discipline - helps with problem solving
   - Every time one needs mathematical skills. Makes the brains faster
   - Vital for lots of stuff - wish I had done it
2. Mathematics is needed in life (e.g., understanding money), for work; some added that it depended on the job while some claimed it is needed in all jobs.
   - I took maths when it was not compulsory but I hated it. Now I need maths. I’m in a management role in hospitality. I need graphs and maths all the time
   - Maths is part of every profession in some way
   - Maths is such a fundamental part of life / relevant to everyday life
   - Must do maths, encompassed in financial literacy

With respect to the first two questions, the participants’ explanations were not helpful in understanding why more Spaniards than Australians liked mathematics or believed they were good at it. Taking into consideration that Australia outperformed Spain in PISA and TIMSS, a possible explanation may be related to the differences in the level of mathematical challenge and content coverage experienced in mathematics classrooms.

Gender-stereotyped Beliefs

The items associated with gender stereotyping are listed in Table 2, together with the response frequencies, Pearson chi-square (by country) results, and effect sizes (φ).

The results in Table 2 reveal two fairly consistent patterns.

1. If participants in either country held gender stereotyped beliefs (ie. responded ‘girls’ or ‘boys’), almost invariably the direction of their beliefs was stronger about ‘boys’ than about ‘girls’. For example, in response to Q12 (Who are better at using calculators?), 6.3% of Australians and 5.1% of the Spaniards said ‘girls’, while 14.8% of Australians

and 9.9% of the Spaniards said ‘boys’. The two exceptions to this finding were for Q2 and Q15; slightly fewer Spaniards said ‘boys’ than said ‘girls’.

That it was only among the Spaniards that more people respond ‘girls’ than ‘boys’ is consistent with the second common pattern identified, described next.

2. With one exception (Q11), higher proportions of Spaniards than Australians provided the response, ‘same’ (ie. that there was no difference between girls and boys).

Table 2
Frequency Distributions and Pearson Chi-square Results (by county) for Questions Tapping Gender Stereotyped Beliefs

Question	Responses	Australia (n, %)	Spain (n, %)	Pearson χ^2, p-level, & φ
6. Who are better at maths, girls or boys?	Girls	25 (11.2%)	53 (13.5%)	43.29
	Boys	58 (26.0%)	47 (12.0%)	p<.001
	Same	103 (46.2%)	268 (68.2%)	.27
	Don’t know	37 (16.6%)	25 (6.4%)	
8. Who do parents believe are better at maths, girls or boys?	Girls	32 (14.3%)	31 (7.9%)	32.18
	Boys	52 (23.3%)	42(10.7%)	p<.001
	Same	61 (27.4%)	117 (45.3%)	.23
	Don’t know	78 (35.0%)	141 (36.1%)	
9. Who do teachers believe are better at maths, girls or boys?	Girls	30 (13.5%)	42 (10.7%)	36.48
	Boys	30 (13.5%)	51 (13.0%)	p<.001
	Same	76 (34.1%)	222 (56.8%)	.24
	Don’t know	87 (39%)	76 (19.4%)	
11. Is it more important for girls or boys to study maths?	Girls	4 (1.8%)	5 (1.3%)	10.59
	Boys	9 (4.0%)	5 (1.3%)	p<.05
	Same	204 (91.5%)	352 (90.0%)	.13
	Don’t know	6 (2.7%)	29 (7.4%)	
12. Who are better at using calculators, girls or boys?	Girls	14 (6.3%)	20 (5.1%)	ns
	Boys	33 (14.8%)	39 (9.9%)	
	Same	144 (64.6%)	290 (73.8%)	
	Don’t know	32 (14.3%)	44 (11.2%)	
13. Who are better at using computers, girls or boys?	Girls	11 (4.9%)	3 (0.8%)	12.83
	Boys	74 (33.2%)	123 (31.3%)	p<.01
	Same	120 (53.8%)	241 (61.3%)	.14
	Don’t know	18 (8.1%)	26 (6.6%)	
14. Who are more suited to being scientists, girls or boys?	Girls	18 (8.1%)	33 (8.4%)	39.71
	Boys	46 (20.6%)	18 (4.6%)	p<.001
	Same	146 (65.5%)	311 (79.1%)	.25
	Don’t know	13 (5.8%)	31 (7.9%)	
15. Who are more suited to working in the computer industry, girls or boys?	Girls	7 (3.1%)	5 (1.3%)	38.11
	Boys	85 (38.1%)	67 (17.1%)	p<.001
	Same	121 (54.3%)	295 (73.5%)	.25
	Don’t know	10 (4.5%)	25 (6.4%)	

Seven of the eight items shown in Table 2 had statistically significant differences in response frequencies by country. Effect sizes for these items were all small (φ between 0.1 and 0.3). The differences in the response frequencies among the Australians and the Spaniards for all of these items generally reveal that the Spanish participants were more likely than the Australians to respond “same”, and that higher proportions of Australians than Spanish participants responded ‘boys’ to the item.

The quantitative findings reveal that, compared to the Spaniards, 20-39 year old Australians generally held stronger traditionally gender-stereotyped beliefs about mathematics learning (ie. that males are considered better than females at mathematics and more suited to careers in mathematics-related fields). Yet in Spain, as in Australia, males continue to dominate in tertiary mathematics studies, and hence in areas requiring such studies as a prerequisite. The media campaign waged in Australia in the 1980s saw a heightened awareness of the importance of mathematics and an increase in the number of females taking mathematics. The recent emphasis in Spain, in 2008, to promote gender equity in all spheres of society may similarly be encouraging a *perception* that females, too, can do mathematics – perceived by many of the respondents as an easy subject and in which they also claimed to have performed well.

In both groups, not all of those who selected either boys or girls for the items shown in Table 2 gave reasons for their answers. The pool of comments was, arguably, too limited to explain with confidence why this is so. Explanations of those who did comment included:

1. Social factors:
   - Girls – from my experience
   - Girls use maths in more practical ways, e.g., shopping
   - Boys – in my experience
   - People have higher expectations of boys
2. Effort
   - Girls work harder (no comparable statement for boys)
3. Innate factors
   - Girls are just smarter
   - Boys – they have a more analytically and mathematically inclined brain
   - Boys are more intelligent.

The comments parallel the factors typically included in explanatory models of gender differences in mathematics learning, and echo the elements in Weiner's (1974) attribution theory of success and failure.

Final Words

Based on the data gathered from the 20-39 year old citizens of Victoria (Australia) and Madrid (Spain) in this study, the traditional male stereotype is apparently still prevalent. For the majority of items for which gender stereotyped views were held, higher proportions of participants responded that "males" were more suited to studies in mathematics and/or related careers than were "females". At the same time, more Spaniards than Australians considered there to be no difference between males and females with respect to suitability to study mathematics or work in related fields. Participants' qualitative comments to explain their response choices highlighted factors consistent with early explanatory models for gender differences in mathematics learning outcomes: social/environmental factors, and innate characteristics. The nature-nurture debate, it seems, lives on in the realm of gender issues and mathematics education.

The findings suggest that factors in the social milieu shape individuals' beliefs. Social context cannot be divorced from research on affective factors. Further work in different countries is needed to clarify more precisely which social factors are the more significant contributors to the persistent gendering of mathematics as a male domain.

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