Mathematics Performance and Future Occupation: Are They (Still) Related?

Gilah C Leder
Monash University
<Gilah.Leder@monash.edu>

At the first MERGA conference, I presented a paper in which I explored possible links between students' mathematics performance at school and their intended occupations. Whether such connections differed for boys and girls was also examined. Diverse sets of evidence are provided to illustrate that, 40 years later, these issues are still relevant and continue to attract research and community attention.

Introduction

Attendance at the first MERGA conference served for many Australian mathematics educators as a powerful initiator into academia. For me, it provided an opportunity to present, and receive feedback, on one of the components explored in my doctoral thesis. A strong recognition that not only cognitive but also affective factors influence students' learning of mathematics permeated the content of the presentation.

My First MERGA Paper

Whether performance in mathematics seemed linked to students' career intentions was the core issue explored. The sample involved 133 boys and 114 girls in Grades 10 and 11. Performance data were gathered through the administration of the grade-level appropriate ACER Tests of Reasoning in Mathematics (TRIM; Australian Council for Educational Research, 1971). These results were checked for each class against the ranking of students by their mathematics teacher. Three questions were used to elicit students' occupational intentions: (1) Do you intend to continue with your studies after you leave school?, (2) If NO, what do you expect to do after school?, and (3) What sort of work do you expect to be doing 15 years from now? The occupational intentions offered by the students were classified in three different ways: by social status, in terms of the "sexiness" or masculinity ratio of the job, and by the occupation's mundaneness ratio. In brief, the "sexiness" of the intended occupation was calculated by finding, using the then most recent available Census data (1971), the proportion of the total workforce engaged in that occupation who were males. The mundaneness ratio was defined, separately for males and females, as the proportion of, respectively, the male or female workforce engaged in that particular occupation. Further explanations of the three measures are found in Leder (1977) and Leder and White (1980). The key findings can be summarised as follows:

- For the boys in both Grades 10 and 11, statistically significant correlations were found between the TRIM score and the intended occupation measures
- For the girls in Grade 10, but not for those in Grade 11, statistically significant correlations were found between the TRIM score and the intended occupation.

This grade related difference between the measure of mathematics achievement and intended occupation led to a further question: *Could the difference in findings for boys and girls in Grade 11 be attributed to differences in social pressures felt by the older students who had to make subject (and eventual career) choices at the end of Grade 10?*

(2017). In A. Downton, S. Livy, & J. Hall (Eds.), *40 years on: We are still learning! Proceedings of the 40th Annual Conference of the Mathematics Education Research Group of Australasia* (pp. 51–54). Melbourne: MERGA.

To test this eventuality, students were also asked to respond to three further items in which a character of the same sex as the respondent was portrayed as successful in three different settings, for example: "Anne/John came top of her/his mathematics/English class last term. Describe Anne/John". By analysing the responses to these cues each student was assigned an M_{-s} score. Reactions of particular interest included references to interpersonal engagement, to the presence or absence of instrumental activity, and to contingent and non-contingent negative consequences. The M_{-s} or "fear of the consequences of success" concept (often unhelpfully shortened to "fear of success", or simply FS) falls within the framework of the expectancy-value theory of achievement motivation. It is considered particularly relevant to high-ability, high-achievement oriented females who are capable of, and aspire to success, but are at the same time concerned about the negative consequences that may accompany this success. For further details of this measure, see Leder (1982).

The findings for this further component revealed that:

- For boys at both grade levels there was no statistically significant correlation between the M_{-s} and the social status, masculinity, or mundaneness job measures
- For the girls, and particularly for those in Grade 11, relatively high correlations were found (effect size around 0.5 for Grade 11 girls) between M_{-s} and the occupational measures.

Although keenly aware that correlational relationships do not necessarily imply causal relationships, I nevertheless hypothesized that:

> An increasing realization that attainment of an ambitious goal may be a mixed blessing and may have negative personal consequences may well lead to a lowering of personal goals. Alternately, this growing anxiety about the consequences of attaining an ambitious goal may act as an impediment on performance (Leder, 1977, pp. 186-187).

To what extent the findings of the study reported 40 years ago warrant contemporary attention is discussed in the next section.

The Current Context: Some Exhibits

Both within and beyond Australia there is widespread acceptance that mathematics often serves as a gate keeper to further studies and career choices. More recently such debate has also turned to participation and achievement in STEM (Science, Technology, Engineering, and Mathematics), with mathematics considered an integral part of the STEM cluster.

According to Rickard and Crowther's (2015) collation of the *2015 Survey of Women in the STEM Professions*, "respondents reported that the three greatest barriers to advancement in their working lives were balancing their work/life responsibilities, work place culture and the lack of access to senior roles for women" (p. 8). Many (40.2 %) "did not believe they received equal compensation for work of equal value compared to their male professional colleagues" (p. 4). The Office of the Chief Scientist (2016) furthermore reported: "Across all (occupational) fields a higher percentage of those with University qualifications had an income in the highest bracket compared to those with VET qualifications. The increase was larger for those with STEM qualifications than Non-STEM qualifications" (p. 30). Differences between males and females were also reported, with "almost three times the percentage of male STEM graduates in the highest income

bracket ($104 000 or above) compared to female STEM graduates" (p. 36). This disparity was not a function of a higher proportion of females who work part-time.

Recently Helen Forgasz and I conducted a survey about schooling, careers, and STEM pathways, which attracted well over 1,000 responses (see Forgasz & Leder, in press; Leder & Forgasz, in press, for some preliminary findings). Since space constraints allow only a few, but certainly instructive, snippets to be reported here, the focus is on two of the younger respondents, both aged between 21 and 30.

Participant A, a mining engineer, wrote in response to the item "Who or what served as barriers to your career path(s)/goal(s)?":

> None of my friends went into STEM fields after school (most did law/arts including the males), and it took me a long time to find friends studying similar subjects as me. The general attitude towards me studying STEM was 'wow, that's unusual' or 'wow, you must be really smart' - this was meant as a compliment but for me it just highlights my non-conformance to society's expectations of me".

In response to the survey item, "To promote a boy's/girl's interest in STEM-related studies would you recommend a single-sex school/a co-educational school/could be either, depending on the child", participant B, a speech pathologist, explained that for a boy, the school setting was not important: "I've seen male relatives achieve well in both settings". However, for a girl, she would recommend a single-sex school:

> Social pressures of having males around are not as much of an issue in single sex schools for females. In my experience I've seen females being picked on by males if they are "too smart" or "nerdy" therefore they will dumb themselves down to avoid this and get male attention. However when you take the males out of the equation they can be themselves academically and don't have the social pressures of the male population. This is purely from my experience in a single sex school. I also found girls were less distracted in general without the boys around.

Participant B was not unique in the different recommendations she made for the optimum school setting for boys and girls. In our full sample (see Leder & Forgasz, in press), with respect to the recommendation for boys, 14% recommended a single-sex school, 10% a co-educational school, and 76% responded: "depends on the child". However, for the item that referred to the optimum school setting for girls to promote an interest in STEM-related studies, 43% recommended a single-sex school, 8% a co-educational school, and 49% checked the "depends on the child" option.

Collectively, the material included in this section reveals not only that there appears to be a continuing link between mathematical background and occupational outcomes, but also that, at least among relatively young and well-educated women, differences in societal expectations for males and females persist.

What about the Future?

Sufficient evidence has now been presented to indicate that the topics considered in that first MERGA paper are still "live" issues. Not surprisingly, research foregrounding the expectancy-value theory of motivation continues to appear. A quick Google scholar search conducted in mid-March of this year with the words expectancy-value theory of motivation yielded about 2,300 results since 2016 and 300 since 2017. Restricting the search by adding the words fear of success yielded about 650 results since 2016, and adding instead motive to avoid success generated 750 results since 2016. In my early discussion of the M_{-s} /FS concept (Leder, 1982), I noted the terminological confusion found in extant reviews of the literature, and the range of personal and situational variables invoked in research on this construct. Under related headings such as stereotype threat, motivational differences, attribution theory, self-efficacy, and autonomous learning, research on gender differences

in a range of settings and endeavours is pursued seemingly unabated. Does such a plethora of apparently different perspectives stimulate or obstruct a systematic study of the field?

Those familiar with research on gender and mathematics education are well aware that the terms *sex differences* and *gender differences* are both readily found in the literature. Originally, the term sex differences was used uniquely and consistently. In more recent times, sex has more commonly been used to denote biologically-based differences. The use of *gender* evolved following debates on whether all differences could or should be attributed to biology alone. Gender, as a term, was consequently often used to describe differences between males and females that are not attributable to biology. Recently, the sufficiency of the male-female binary distinction has, however, been challenged:

> In the April [2016] issue of *AERA Highlights*, AERA announced that members would soon have the option to select from an expanded list of gender identity categories when renewing their membership or joining the association… (A) two-step approach to collecting data on gender: the first being the collecting of data on the biological sex assigned at birth, and the second asking members how they describe their gender…. (Levine, 2016)

How, or whether, these new categorizations will impinge on research on gender/sex differences in mathematics learning still remains to be seen.

Finally, to my predictions for the future. I draw on the views of a theoretical physicist from my country of birth (the Netherlands), Hendrik Anthony Kramers, who tantalizingly argued: "In the world of human thought generally, and in physical science particularly, the most important and fruitful concepts are those to which it is impossible to attach a well-defined meaning" (n.d.). Acceptance of this scenario offers a strong incentive to refine our terminology and embrace a common language as we strive to understand better the most complex aspects of human behaviour.

References

Australian Council for Educational Research. (1971). *ACER tests of reasoning in mathematics.* Hawthorn, VIC: ACER.

Forgasz, H. J., & Leder, G. C. (in press). Mathematics enrolments: Single-sex and co-ed. *Proceedings of the 41st Annual Conference of the International Group for the Psychology of Mathematics Education.*

Kramers, H. A. (n.d.). *Science quotes*. Retrieved from http://www.quotes.net/authors/H. A. Kramers

Leder, G. (1977). Mathematics performance and future occupations: Are they related? In M. A. Clements & J. M. Foyster (Eds.), *Research in mathematics education*: *Proceedings of the 1st Annual Conference of the Mathematics Education Research Group of Australia* (Vol. 1, pp. 215-222). Melbourne: MERGA.

Leder, G. C. (1982). Mathematics achievement and fear of success. *Journal for Research in Mathematics Education*, *13*, 124-135.

Leder, G. C., & Forgasz, H. J. (in press). STEM and single-sex schools: What counts? *Proceedings of the 40th annual conference of the Mathematics Education Research Group of Australasia.*

Leder, G. C., & White, R. T. (1980). Three aspects of the occupational aspirations of boys and girls. *Australian and New Zealand Journal of Sociology*, *16*, 90-93.

Levine, F. J. (2016). *From the desk of the executive director: AERA to further refine gender demographic categories*. Retrieved from http://www.aera.net/Newsroom/AERA-Highlights-E-newsletter/AERA-Highlights-May-2016/From-the-Desk-of-the-Executive-DirectorAERA-to-Further-Refine-Gender-Demographic-Categories

Office of the Chief Scientist. (2016). *Australia's STEM workforce: Science, Technology, Engineering and Mathematics*. Canberra: Government of Australia. Retrieved from www.chiefscientist.gov.au

Rickard, K., & Crowther, A. (2015). *The slower track: Women in the STEM professions survey report*. Retrieved from http://hdl.voced.edu.au/10707/388390