Gender, Attribution and Success in Tertiary Mathematics

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Attitudes towards success in mathematics, and attributions for such success, among tertiary mathematics students, were investigated using a semi-structured writing task. A large majority reported no expectation of internal conflict about success or of deliberately lowered future performance, but a majority, significantly larger among males, did expect problems with peers. Students most frequently attributed success to effort. Problems with peers tended to be seen as resolved if this attribution was made. Females reported resolution significantly more frequently than did males.

Early work on attitudes to success (Horner, 1972) claimed that females attitudes tended to be ambivalent, because of sex role stereotyping, which portrayed success as appropriate only for males. Horner used a projective instrument that asked for stories about a person who had been highly successful academically. Responses were counted as showing ambivalent attitudes to success if they referred to an experience of conflict about success, negative social consequences of success, or denial of the fact of success. Horner concluded that ambivalent attitudes tended to motivate women to lower their achievement. Criticisms of this conclusion were multiple, and cumulatively convincing. Evidence was given that the restriction to women was inappropriate (Tresemer (1976), Ishiyama and Chabassol, 1985), and that gender role compatibility rather than general success was a more likely operative factor (Romberg & Shore, 1986). Continuing problems in separating Horner's proposed construct from related achievement anxieties caused a decline in research directly concerned with its validation (see, for example, Piedmont, 1995, p. 140).

But in connection with success in studying mathematics, gender appropriateness and culture are not side issues. Early large scale studies of secondary mathematics students (Fennema & Sherman, 1977, 1978; Armstrong, 1981), in America, tended not to find gender-related differences in students' attitudes to success in mathematics, but did find links between these attitudes and the students' achievement and enrolment in mathematics courses. Leder (1982), in Australia, found that, among high achieving secondary mathematics students, females showed more ambivalence about their success than males did. More recent work, such as that of Norton and Rennie (1998), did not find gender differences in attitudes to success, but did find that a single-sex school environment was associated with more favourable attitudes. Yoder and Schleicher (1996), dealing with training fields that are stereotyped in their perceived gender-appropriateness, found that success in gender-incongruent fields was often seen as entailing personal costs for the individual. Forgasz, Leder and Barkatsas (1998) found that perceptions of mathematics as a male domain are changing, as revealed by updated instruments, but further work by the same group (1999) also found evidence for the influence of cultural background. In addition, the studies by Forgasz and Leder (1996) and Norton and Rennie (1998) indicated that there were still strong differences between the levels to which females and males stereotyped mathematics as a male domain, which indicates a cultural contrast still plausibly involved in students' educational choices.

The group studied in the present project consisted of mathematics students in a large Australian university. These students are survivors as mathematics students, and include many who had made an implicitly strong commitment to studies that are still less traditional for females. It follows that many of the qualifications described above about general success are not an issue, but the research about older and more able students is relevant. The previous research results are compatible with two predictions about university mathematics students. First, it is possible that those students who choose mathematics at university would tend to be those who do not expect adverse consequences of success in the subject. Second, even allowing for the preceding possibility, it is still possible that the attitudes of female students are more ambivalent than those of the males. Hence investigation of both questions is relevant.

There is also an Australian cultural tradition that seems important, and which, *a priori*, should not have different effects for females and males. This is the tendency to deprecate success, a tradition of cutting down tall poppies of either gender. For example, the work of Feather, Volkmer and McKee (1991) found mixed positive and negative attitudes to people successful in Australian public life. This background indicates that survival mechanisms for all successful students are likely to be needed especially strongly in an Australian context. A later study in the same area (Feather, 1992) found that an Australian sample showed less resentment of high socio-economic status if it was attributed to hard work rather than inheritance or luck. This is compatible with Paludis (1984) earlier finding that attitudes to success were less ambivalent when task instructions suggested attribution of success to effort. In educational settings, in any case, it is clear that students' attribution of success or failure to different causes is a plausible putative influence on their choices and intentions. Weiner (1986) presents a considerable amount of evidence in support of his theory that attributions for success and failure are the structures that underlie important areas of motivation and choice. In addition, he gives evidence that attributions can be characterized in terms of a small set of factors, of which stability, locus, and controllability, are the best established, which strongly and predictably influence the effect of the attribution. There is considerable evidence that it is the stability of a perceived cause that is related to changes in expectations of results, and that striving for achievement has as prerequisite a reasonable expectation of success. For students, the least functional belief system is attribution of success to uncontrollable favourable factors and failure to stable unfavourable factors.

Studies of the question of gender differences in attributions of success in mathematics and computing tend to have varying results. Early work by Fennema, Wolleat and Pedro (1979) found that attributions to ability were given by males for success in mathematics, and by females for failure, while females attributed success to effort. Parsons (1982) came to opposing conclusions, but results showing differences continue to appear. For example, Ryckman and Peckham (1987), and DAmico, Baron and Sissons (1995) found significant gender differences in attributions. Forgasz and Leder (1996) found gender differences in attributions for success in the two frequently stereotyped subjects, mathematics and English. One should also note that Kloosterman (1991) found that students' causal beliefs were strongly related to achievement in mathematics. Kloosterman (1993) concluded that females' attributions for mathematics achievement are markedly less functional than those of males.

The present study can have nothing to say about attitudinal patterns over a whole population. Instead, it was undertaken to investigate attitudes to success in mathematics in a clearly successful group of students, though not necessarily successful at an exceptionally high level. Both previous success and the expectation of continuing adequate performance are clearly indicated by the students' enrolment in university mathematics classes, but all levels within such a group are included. The purpose of the study was to elicit information about how such students saw the likely consequences of success in mathematics, and what reasons they gave for success, without any suggestions in the task instructions.

Method

Sample. The sample consisted of 48 females and 58 males in first year mathematics classes at a large Australian university. Sample members were selected in two stages. Class lists were stratified into cells, by degree course, and half-yearly achievement, split at the median. A sample of about 50 of each gender was then taken by randomly selecting a number in each cell proportional to the cell size. The slightly larger group of males resulted from greater variation in degree courses among males (for example, extremely small numbers of women were in engineering courses other than electrical and chemical). Sample members were contacted and asked if they would come to a brief writing session. None of those invited refused.

Task. Students were told that two fictional students, Ann and John, had tied for first place in Higher Mathematics I (a difficult subject, in which first place indicated very high academic success). They were asked to write a short paragraph about each success figure, specifying how they and their friends reacted, most likely reasons for success (the attributional component), and, deliberately vaguely stated, what happened next. Responses were classified by criteria similar to those used by Horner (1972). Attributions of success were grouped using Weiner's (1986) main factors.

Results

Conflict. Table 1 contains the numbers of students who reported any problems experienced by either success figure. The three rows of numbers give independent scores from three different sections of the writing task. Only a minority saw any conflict in the success figures' own reactions, or adverse effects on future performance. Conflicts in the success figures' own reactions were not often severe, with only three extreme cases. One student (female) said, about Ann, that the result was such a shock to her that she became very withdrawn and paranoid, and two (one female, one male) said that being singled out was bad for the success figure of their own gender. One (male) said John was pleased, but "was a good guy really". The rest gave only implicit excuses, such as emphasizing surprise. Responses about futures sometimes expected a decline in performance, but never suggested a deliberate lowering of achievement.

But friends are seen as presenting some problem, more to the same-gender figure, more markedly for females. Females mainly stated that Ann's friends were envious, or that real friends were pleased but others saw her as a freak. In nine cases, they said that male friends resented Ann's success more strongly. Females saw John's friends as less envious. Males

mainly mentioned envy and mockery among friends, for both Ann and John. Three said male friends resented Ann more, and one mentioned freaks, with reference to John. Differences between males and females, and between male and female success figures, are minimal, except for the two cases (friends and futures) where females appear to see successful males as having fewer difficulties.

Table 1
Numbers of Students Who Mentioned Problems Associated With Success

	Females (N = 48)		Males (N = 58)	
Reference	Ann	John	Ann	John
Self	12	11	12	11
Friends	33	24	38	43
Futures	11	6	14	15

Tests. Although the writing task was chosen to give qualitative information about how students thought, and the actual wording of responses was considered very important, quantitative comparisons were also used to assess the relative importance of differences involving broad classifications of responses. Chi-square tests were applied to a set of tables that defined comparisons between females and males, and between the female success-figure and the male. Results are presented in Tables 2, 3 and 4.

Table 2
Comparisons between Females and Males

		Reference		
	Success figure	Self	Friends	Futures
Chi-square	Ann	0.28	0.12	0.02
	John	0.02	6.58*	2.95

Note. df = 1 (N=106) throughout
*p<0.05

The only significant difference involved peers' reactions to the male success figure, in which area the females envisaged fewer problems than the males did.

Table 3
Comparisons between Female and Male Success Figures

			Reference		
		N	Self	Friends	Futures
Chi-square	Females	48	0.06	3.50	1.78
	Males	58	0.02	1.02	0.05

Note. df = 1 throughout

Here no results were significant, but the comparison for females, referring to friends, where fewer problems for the male success figure were expected, came close to significance ($p < 0.1$).

Table 4
Comparisons between Expectations for the Success Figure of the Same Gender as the Respondent and that of Opposite Gender.

	Reference		
	Self	Friends	Futures
Chi-square	0.24	4.06*	1.00

Note. df=1 (N=106) throughout.
*p<0.05.

In this set too, the only significant result was in the area of friends' reactions. All students tended to envisage fewer problems for a success figure of gender opposite to their own. Thus it was only the peer group that was associated with any significant differences. Females saw males' position as less troubled than males did, and females also tended to see the male success figure as having fewer difficulties than the female.

Attributions. The overwhelming majority of students attributed success to effort. Frequencies are in Table 5.

Table 5
Attribution of Success to Effort

Attribution	Females		Males		All	
	Ann	John	Ann	John	Ann	John
Effort	30	29	36	38	66	67
All other causes	18	19	22	20	40	39
Total	48	48	58	58	106	106

Peers and attributions. The responses indicated that attributions for success tended to be involved in peers' perceived reaction to success. The thesis was most clearly stated by an engineering student, who said

> If you worked, and you got a mark because you deserved it, if they were a ... friend, they wouldn't hassle you about it, but if you were the sort of guy who got good marks anyway, they might feel It is a bit unfair.

In writing about friends, the idea that a mark was deserved by hard work was presented repeatedly, implicitly or explicitly, as a reason for the peer group not to resent high achievement, so that social difficulties would not arise. Both females and males expressed the idea, in similar terms. It was decided to examine the effect of placing responses in which problems with peers were seen as resolved in this way in the same category as those in which such problems were not mentioned. Frequencies for reclassified responses are in Table 6, and results of comparisons are in Table 7.

The number of females who saw conflict unresolved after attribution to effort is markedly lower than the number who originally mentioned conflict arising. For males, the number who saw conflict unresolved is somewhat lower than the corresponding original number, but the difference is smaller than that for females.

Table 6
Peers: Resolved Conflict Grouped with Absent Conflict: Frequencies

Conflict involving peers	Females		Males	
	Ann	John	Ann	John
Resolved or not mentioned	32	36	26	24
Unresolved	16	12	32	34

Table 7
Peers: Resolved Conflict Grouped with Absent Conflict: Comparisons

	Females versus males		Ann versus John		Same gender versus opposite
	Ann	John	Females	Males	
Chi-square	5.06*	12.08**	0.81	0.14	0.69
N	106	106	58	48	106

Note. *df* =1 throughout
*p <0.05. **p<0.01

Scores for females and males were compared, using a chi square test, which gave a significant result. Comparisons between scores for Ann and John did not have significant results. Thus, if one accepts responses in the unified category as reflecting lower conflict, the significant result indicates lower conflict among females.

Discussion

It is clear that attribution of success to effort is the dominant orientation for the whole group. If this results in greater diligence, then it is a practical survival factor. But it seems that the attribution has additional importance as a means of defusing the issue of social consequences of success, whether the reasons given are totally believed or not. Such a conclusion is based on the frequency of responses that mentioned reduction of unfavourable peer reactions when success was attributed to effort. It is important here that the attribution to effort was not suggested in the task instructions.

Resolution of conflict, in this sense, was stronger among females, and more so in connection with females success. The evidence is compatible with the females group being to some extent better equipped to deal with success, in that they more frequently describe the reduction of social difficulties associated with success when an attribution to effort is made. The same pattern is found in the males' responses, but less frequently, which is compatible with the interpretation that they see success as more socially disruptive than

the females do. It is, however, also of interest that both females and males saw the social position of students of the opposite gender as easier.

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