

## Sex Differences in Performance Attributions, Self-Efficacy, and Achievement in Mathematics: If I'm So Smart, Why Don't I Know It?

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In this study, we tested the claim that sex differences in mathematics achievement are related to boys' and girls' differing achievement-related beliefs. We compared the mathematics report card grades, 2001 Foundation Skills Assessment (FSA) Numeracy subtest scores, performance attributions, and self-efficacy of 161 British Columbian public school students' (62 fourth-graders, 99 seventh-graders). Findings indicated that girls' mathematics achievement met or exceeded that of boys and that girls' attribution patterns were more self-enhancing than those found in previous studies. However, girls were more apt to display under-confidence relative to their actual mathematics achievement and to attribute mathematics failure to a lack of teachers' help than were boys.

Keywords: sex, gender, achievement, mathematics, self-efficacy, attributions

Les auteurs ont étudié l'affirmation selon laquelle les différences dans le rendement scolaire en mathématiques chez les garçons et les filles sont liées à leurs croyances différentes au sujet du rendement. Ils ont comparé les notes en mathématiques sur les bulletins scolaires, les résultats de 2001 des sous-tests de calcul de la *Foundation Skills Assessment* (FSA), l'attribution des facteurs contribuant au rendement et l'autoefficacité chez 161 élèves d'écoles publiques de la Colombie-Britannique (62 en 4<sup>e</sup> année et 99 en 7<sup>e</sup> année). Les résultats indiquent que le rendement en mathématiques des filles est identique ou supérieur à celui des garçons et, par rapport aux résultats d'études antérieures, les filles attribuent davantage leur rendement à elles-mêmes. Par contre, les filles ont plus tendance à avoir moins confiance en elles quant à leur rendement en mathématiques et à davantage attribuer leurs échecs en mathématiques à un manque d'aide de la part des enseignants que les garçons.

Mots clés : genre, rendement, mathématiques, autoefficacité, attribution.

Sex differences in academic achievement have been the subject of extensive investigation over the past two decades (Fan & Chen, 1997; Kianian, 1996). Traditionally, studies have shown that boys' mathematics achievement is superior to that of girls (e.g., Maccoby & Jacklin, 1974). One explanation offered for this achievement gap is that there are sex differences in students' mathematics-related beliefs (Bandura, 1997; Stipek & Gralinski, 1991) and that, more specifically, boys' attribution patterns and levels of self-efficacy are more self-enhancing than those of girls.

In the past decade, there has been a closing in this mathematics achievement gap. In British Columbia, for example, data from a recent Foundation Skills Assessment (FSA) show only negligible sex differences in performance on the Numeracy subtest (British Columbia Ministry of Education, 2002).

In our study, we posited that, if achievement differences are indeed related to students' self-efficacy and attributions, then boys' and girls' achievement-related beliefs should be the same when their academic achievement is also the same. Therefore, we designed this study to determine if the recent academic gains of girls in mathematics have been met with heightened perceptions of self-efficacy and more self-enhancing performance attributions.

We argue that, as a practical matter, achievement gains are insufficient unless the self-beliefs of girls have changed correspondingly. According to Pajares (1996), an underestimation of mathematics capability, not lack of skill, is responsible for students' avoidance of mathematics courses and careers, and that this is more likely to be the case with females than with males.

Now, more than ever before, mathematics competency is essential for advancement into a breadth of post-secondary programs and careers (Sukthankar, 1999). Furthermore, Eccles (1987) found that persons employed in mathematics- or science-related careers tend to gain more autonomy, higher prestige, and higher pay than do persons in other career domains. As such, research focussed on understanding to a fuller extent students' performance in and beliefs about mathematics is timely and vital.

*Attributions*

The inferences that individuals make about the causes of their successes and failures are called attributions (Graham, 1991; Weiner, 1986). When asked to give the subjective reasons for their academic performance, whether good or bad, students tend to pinpoint factors within themselves (e.g., ability, effort, traits, and dispositions) or factors outside of themselves (e.g., luck, ease or difficulty of the task, and help from teacher). An attribution pattern in which a student internalises success and externalises failure has long been thought to be beneficial academically and important in explaining success (Schunk & Gunn, 1986). Although ability and effort are both internal attributions, it is better for an individual to attribute success to ability, rather than to effort, because ability attributions are more strongly related to motivation, self-efficacy, and skill development than are effort attributions (Schunk & Gunn, 1986). Similarly, Graham (1991) suggests that students benefit more from attributing academic failure to a lack of effort rather than to a lack of ability.

Much of the attribution literature involves an examination of the relationship between students' attributions and their achievement in mathematics. For example, Georgiou (1999) explored the relationship between sixth-grade students' performance attributions and their achievement in mathematics. He found that children's attributions to effort, to ability, and to other internal factors were related positively to academic achievement, whereas attributions to luck and to external factors were related negatively to achievement. Schunk and Gunn (1986) investigated how task strategies and success attributions during mathematics training were related to students' perceptions of efficacy and to their skills. Participants lacking division skills were given assistance in solving problems. Results revealed that children who attributed their problem-solving success to ability showed enhanced perceptions of self-efficacy. These perceptions of self-efficacy, in turn, related to higher mathematics achievement.

Research suggests that girls tend to attribute their mathematics successes to external factors and to effort and their failures to their own lack of ability (a self-defeating attribution pattern), whereas boys tend to

ascribe the causes of their mathematics successes to internal factors and their failures to external factors (a self-enhancing attribution pattern). These patterns have explained, in part, girls' traditionally poorer mathematics achievement compared to that of boys. For example, Campbell and Hackett (1986) investigated sex differences in mathematics performance attributions and found that successful females rated "being lucky" (an external attribution) as the cause of their performance significantly more often than did males.

#### *Self-Efficacy*

In addition to sex differences in attribution patterns, researchers have related the mathematics achievement gap between the sexes to boys' and girls' differing perceptions of their abilities. Self-efficacy refers to judgements individuals make about their abilities to perform behaviours at a certain level (Bandura, 1997; Schunk, 1984). The perceptions students hold about themselves, and about their academic competence, help to determine what they do with the knowledge and skills they possess (Pajares & Valiante, 1999), and influence their choice of activities, effort expended, task persistence, and task accomplishments (Schunk & Gunn, 1986).

Much of the self-efficacy literature examines specifically the relationship between students' self-efficacy and their achievement in mathematics. Hackett and Betz (1989), for instance, explored the relationship between college students' mathematics achievement and mathematics self-efficacy, their attitudes towards mathematics, and their choice of mathematics-related degree programs. They discovered positive correlations among students' mathematics achievement and their levels of self-efficacy, mathematics attitudes, and their masculine sex-role orientation. Lent, Lopez, and Bieschke (1993) investigated the relationships among students' prior mathematics achievement, mathematics self-efficacy, outcome expectations, and students' interests. Their findings indicated that participants' mathematics self-efficacy related positively to their interest in mathematics and science, to their selection of science-based degree programs and career choices, and to their performance in mathematics. Matsui, Matsui, and Ohnishi (1990)

explored the mechanisms underlying mathematics self-efficacy in Japanese college students. They found that students with high frequencies of mathematics accomplishment also had higher levels of mathematics self-efficacy than did students with fewer accomplishments. They also found that males' mathematics self-efficacy was significantly higher than that of females.

Much of the related literature reveals differences in males' and females' perceptions of mathematics efficacy, suggesting that these different perceptions relate to girls' relatively lower mathematics performance and lower participation rates in mathematics-related careers (Eccles, 1987). For example, Malpass, O'Neil, and Hocevar (1999) investigated the effects of sex and of self-efficacy on mathematics achievement in a sample of gifted high-school students. Results showed that self-efficacy related positively to achievement and that males had enhanced perceptions of mathematics self-efficacy than did females. Junge and Dretzke (1995) examined the relationship between gifted students' self-efficacy and their mathematics behaviours and determined that, generally, boys had more enhanced perceptions of self-efficacy than did girls. Pajares and Miller (1994) explored the role of self-efficacy in mathematical problem solving and found that mathematics self-efficacy was more predictive of problem solving than was mathematics self-concept, perceived usefulness of mathematics, prior experience with mathematics, or students' sex.

## METHOD

### *Participants*

One hundred sixty-one students consented to participate in the study: 62 fourth-graders (37 male, 25 female) and 99 seventh-graders (43 male, 56 female). The mean age of fourth-grade participants was 9.32 years ( $SD = 0.50$ , range 8 to 10 years) and 12.27 years for seventh-graders ( $SD = 0.45$ , range 12 to 13 years). Fourth-grade participants were drawn from five public elementary schools, and seventh-grade participants were drawn from two public middle schools. All schools were situated in one school district in a suburban area of a moderate-sized city in British Columbia.

*Instruments*

*Foundation Skills Assessment (FSA) Numeracy subtest scores.* Participants' 2001 FSA Numeracy subtest standardised scores served as the first measure of mathematics-related achievement. The BC Ministry of Education's FSA is a three-part annual assessment test designed to measure the reading comprehension, writing, and numeracy skills of fourth-, seventh-, and tenth-grade students<sup>1</sup> throughout British Columbia. The FSA reflects what students learn in the classrooms in two important ways. First, it measures:

foundation skills that are part of the provincial curriculum. FSA represents broad skills that all students are expected to master. FSA only addresses skills that can be tested in a limited amount of time, using a pen-and-paper format. FSA does not measure specific subject knowledge or many of the more complex, integrated areas of learning (British Columbia Ministry of Education, 2001, p. 4, Pull-Out Section).

Second, the FSA tests are designed to measure cumulative learning. When fourth-graders complete the assessment, they are expected to implement skills they have gained from kindergarten to the spring of grade 4; when seventh-grade students complete the version of the FSA, they are expected to use skills gained from kindergarten to grade 7 (British Columbia Ministry of Education, 2001).

According to the British Columbia Ministry of Education (2001) numeracy refers to the "combination of mathematical knowledge, problem solving and communication skills required by all persons to function within our technological world [and] is more than knowing about numbers and number operations" (p. 41). Although numeracy and mathematics are not identical ideas, mathematics is the school subject most closely related to numeracy. The fourth- and seventh-grade versions of the 2001 FSA Numeracy subtest each contained 32 multiple-choice questions, and four constructed response questions worth four points each.

*Mathematics report card grades.* Participants' spring 2001 mathematics report card grades served as the second achievement measure. These grades reflect teachers' assessments of students' performance of the BC Ministry of Education's grade-4 or grade-7 mathematics curriculum.

Teachers and school secretaries provided us with each participant's report card grade in percentage form. The Ministry of Education's descriptions of report card achievement levels are presented in Table 1.

TABLE 1

*Description of the British Columbia Ministry of Education's Report Card Achievement Levels*

Achievement level	Letter grade	Description
86-100%	A	Excellent
73-85%	B	Very good
67-72%	C+	Good
60-66%	C	Satisfactory
50-59%	C-	Minimally acceptable
0-49%	F	Below minimally acceptable

*Attribution scale.* A modification of Stipek's (1993) attribution scale, the first half of our attribution scale contained a list of six attributions given commonly by students in explaining their academic success: three internal attributions ("I studied hard"; "I studied the right things"; and "I am smart") and three external attributions ("the teacher explained things well"; "someone helped me"; and "the work was easy"). The second half of the scale contained six attributions often offered for academic failure: three internal attributions ("I didn't study enough"; "I studied the wrong things"; and "I don't think I am smart") and three external attributions ("the teacher explained things poorly"; "no one helped me"; and "the work was hard"). The same scale was used for

both grades.

*Self-efficacy scale.* We designed two separate versions of the self-efficacy scale: one for fourth-graders and one for seventh-graders. Both were designed according to Bandura's (2001) specifications and included a booklet of nine numeracy questions equivalent in form and difficulty to items on the grade-specific version of 2001 FSA Numeracy subtest. We drew the test items directly from the BC Ministry of Education's web site, which contains sample FSA numeracy items for parents, students, and teachers.<sup>2</sup> We provided students with an answer sheet to report their perceived confidence according to each of the sample FSA items in their respective booklets.

The proportions of self-efficacy scale sample FSA items devoted to each of the four FSA numeracy categories (numbers, patterns and relationships, shape and space, and statistics and probability) were commensurate with the proportions of questions used on the 2001 FSA. We achieved this parity by designing the self-efficacy scales according to the BC Ministry of Education's 2001 FSA Table of Numeracy Specifications, a document that details the proportion of test items devoted to each numeracy category.<sup>3</sup> The sample FSA items included in the self-efficacy scales were not included in the 2001 FSA.

#### *Procedure*

We used approximately 30 minutes of class time to explain and to administer the attribution and self-efficacy scales. Although all grade-appropriate students in the relevant schools were approached for participation in the study, a very small number of students did not return consent forms and/or chose to not participate. Teachers asked these non-participants to read novels or to draw silently at their desks while the participants filled out the questionnaires.

*Attribution scale.* First, we asked participants to read over the list of success attributions and to indicate on a five-point Likert-type scale the degree to which each attribution would explain "strong" mathematics performance (1 = "this is not why I did well"; 3 = "this is kind of why I did well"; 5 = "this is the most important reason why I did well"). Second, participants read over the list of failure attributions and



indicated the degree to which each attribution would explain “poor” mathematics performance, according to a similar scale (1 = “this is not why I did poorly”; 3 = “this is kind of why I did poorly”; 5 = “this is the most important reason why I did poorly”).

*Self-efficacy scale.* We gave students 20 seconds to view the first of the self-efficacy scale’s sample FSA items. After the time elapsed, we asked participants to indicate how confident they were that, if asked to actually complete the question, they could determine the correct answer. Participants rated their confidence according to a seven-point Likert-type scale (1 = “not confident at all”; 3 = “not too confident”; 5 = “pretty confident”, 7 = “very confident”). This process continued for each of the nine scale items. We asked students to refrain from actually completing (i.e., formulating an answer for) the sample FSA items included in the self-efficacy scale because, according to Bandura (1986), individuals are more influenced by how they interpret a task, than by their actual achievement, in terms of self-perceptions of competence.

According to Pajares and Kranzler (1995), researchers must administer self-efficacy scales as closely as possible in time to the performance task to which the scale’s responses will be compared. As such, we administered the attribution and self-efficacy scales to participants approximately one to two weeks before the administration of the 2001 FSA and as close as possible to the release of spring report card grades.

*Total self-efficacy and relative self-efficacy.* We calculated two distinct self-efficacy scores for each of the participants: a total self-efficacy score and a relative self-efficacy score. Students’ total self-efficacy score represented the sum of their respective confidence ratings across all the self-efficacy scale items, irrespective of their mathematics achievement.

Because research suggests that boys tend to display over-confidence relative to their actual academic achievement, whereas girls tend to display relative under-confidence (e.g., Hackett & Betz, 1989), we also calculated a relative self-efficacy score for each participant to determine the extent to which a participant’s self-efficacy was incongruent with his or her actual academic achievement.

First, each student’s total self-efficacy score was standardised by subtracting the mean total self-efficacy of all participants in his or her grade from his or her individual total self-efficacy score. We then

divided the difference by the standard deviation of the total self-efficacy scores of all participants in his or her grade. Second, each student's FSA score was standardised by subtracting the mean FSA score of all participants in his or her grade from his or her individual FSA score. We then divided the difference by the standard deviation of the FSA scores of all participants in his or her grade. Finally, we calculated each student's relative self-efficacy by subtracting his or her standardised FSA score from his or her standardised total self-efficacy.

The rationale underlying the creation of the relative self-efficacy score was that: (a) students whose total self-efficacy values were high but whose FSA scores were low would yield relative efficacy values *greater than zero*, thus implying that the students' self-efficacy was high given their actual academic achievement; (b) students whose total self-efficacy values were low but whose FSA scores were high would yield relative efficacy values *less than zero*, suggesting that the students' self-efficacy was low given their actual academic achievement; and (c) students whose total self-efficacy and FSA scores were both high, or whose total self-efficacy and FSA scores were both low, would yield *near-zero* relative efficacy values, thus implying that the students' self-efficacy was commensurate with their actual academic achievement. We chose to use students' FSA scores, rather than their report card grades, when calculating their relative self-efficacy because we considered the former to be a more objective and consistent measure of student achievement than the latter, and we related the students' self-efficacy judgements directly to the sample FSA test items.

## RESULTS

### *Data Anomalies*

Various records were either missing or removed as extreme variables. On the attribution scale, one student failed to indicate how important task difficulty was in explaining poor performance. Because two male seventh-graders' and one male fourth-grader's report card grades were well below the grades of their colleagues, we excluded their records from analysis. Two participants' FSA scores were missing from the BC

Ministry of Education's database, suggesting that the students either missed class during the days of the Numeracy subtest administration or that they moved out of province before the administration of the FSA. One male seventh-grader earned an FSA score of over 1000 [ $M$  (provincial population of seventh-graders) = 500,  $SD$  = 100]. Because the calculation of students' relative self-efficacy was contingent partially upon their FSA scores, relative self-efficacy scores could not be calculated for the last three students mentioned.

#### *Reliabilities*

We calculated Cronbach internal consistency coefficients of .77 and .85 for the fourth and seventh-grade participants' self-efficacy scale responses, respectively. As supplied the BC Ministry of Education, the alphas for the provincial population of fourth- and seventh-grade students' responses on the 2001 FSA Numeracy subtests were .85 and .86, respectively. We could not calculate Cronbach alphas for the current sample's FSA responses because we did not obtain item-level data. We constructed the attribution scale to elicit students' judgements of their most dominant attributions from a list of possible attributions. Given this, one would not expect high internal consistency across items and, as such, Cronbach alphas are not reported for the attribution scale.

#### *Achievement Variables*

After combining the records of all girls and boys (in both grade levels), the mean FSA Numeracy subtest score for the entire sample was 503.56 ( $SD$  = 84.08,  $N$  = 158), with girls achieving a mean FSA score of 510.64 ( $SD$  = 84.24,  $n$  = 81) and boys achieving a mean score of 496.12 ( $SD$  = 83.82,  $n$  = 77). Although the scope of the current study did not include an investigation of grade-level differences in achievement per se, it is worth noting that the mean FSA score for all fourth-grade participants (both boys and girls) was 516.28 ( $SD$  = 81.36,  $n$  = 61), as compared to a mean score of 495.57 ( $SD$  = 85.19,  $n$  = 97) for seventh-graders.

The mean report card percentage for the entire sample was 76.71% ( $SD$  = 15.20,  $N$  = 158) with girls' achieving a mean report card percentage of 79.92% ( $SD$  = 13.07,  $n$  = 81) and boys earning a mean percentage of

73.34% ( $SD = 16.58$ ,  $n = 77$ ). The mean report card percentage for all fourth-grade participants (both boys and girls) was 76.18% ( $SD = 15.85$ ,  $n = 61$ ), whereas seventh-graders earned a mean percentage of 77.05% ( $SD = 14.86$ ,  $n = 97$ ).

We conducted a multivariate analysis of variance (MANOVA) on both achievement variables simultaneously. Students' grade level (grade 4 or 7) was the sole independent variable so that we could investigate the relationship between students' grade level and the composite achievement variable. Results of this MANOVA suggest that there was no significant main effect of students' grade level on the composite achievement variable, Wilks'  $\lambda = .972$ ,  $F(2, 152) = 2.21$ ,  $p > .05$ . Consequently, we collapsed students' grade levels and conducted two independent samples t-tests to determine whether the sexes differed significantly in terms of FSA scores and report card grades, respectively. Results of the first t-test showed that boys' and girls' FSA performance was essentially the same ( $t(156) = 1.09$ ,  $p > .05$ ). Results of the second t-test, however, revealed that girls' report card grades were significantly higher than those of boys ( $t(156) = 2.78$ ,  $p < .01$ ) with a calculated Cohen's  $d$  effect size of 0.43, representing a small/moderate effect size (Cohen, 1988).

#### *Achievement-Related Belief Variables*

The means and standard deviations related to the attribution and self-efficacy scale responses for the entire sample (boys and girls, both grade-levels combined), for girls only (both grade-levels combined), and for boys only (both grade-levels combined) are illustrated in Tables 2, 3, and 4, respectively.

We performed a second MANOVA on the achievement-related belief variables: all six success attributions (effort, strategy, ability, teachers' help, help from others, and task ease, respectively), all six failure attributions (lack of effort, lack of strategy, lack of ability, lack of teachers' help, no help from others, and task difficulty, respectively), total self-efficacy, and relative self-efficacy. Once again, the independent variable was students' grade level. Results of this MANOVA revealed that the composite achievement-related belief variable was related

TABLE 2

*Means and Standard Deviations of All Participants' Achievement-Related Belief Variables*

Variable	<i>M</i>	<i>SD</i>	<i>N</i>
Attributions for success			
Effort	3.15	1.44	161
Strategy	3.10	1.30	161
Ability	3.72	1.23	161
Teachers' help	3.47	1.44	161
Help from others	2.48	1.34	161
Task ease	3.41	1.33	161
Attributions for failure			
Lack of effort	2.87	1.45	161
Lack of strategy	2.35	1.44	161
Lack of ability	1.87	1.37	161
Lack of teachers' help	2.53	1.53	161
Lack of help from others	2.18	1.35	161
Task difficulty	2.84	1.41	160
Total self-efficacy	52.98	8.14	161
Relative self-efficacy	0.00	1.14	158

*Note.* The higher an attribution's mean, the more important the attribution was in explaining students' success or failure.

TABLE 3

*Means and Standard Deviations of Female Participants' Achievement-Related Belief Variables*

Variable	<i>M</i>	<i>SD</i>	<i>n</i>
Attributions for success			
Effort	3.20	1.36	81
Strategy	3.30	1.27	81
Ability	3.80	1.12	81
Teachers' help	3.32	1.47	81
Help from others	2.63	1.26	81
Task ease	3.43	1.22	81
Attributions for failure			
Lack of effort	3.02	1.40	81
Lack of strategy	2.31	1.34	81
Lack of ability	1.89	1.33	81
Lack of teachers' help	2.89	1.57	81
Lack of help from others	2.15	1.17	81
Task difficulty	2.81	1.33	81
Total self-efficacy	52.28	8.34	81
Relative self-efficacy	-0.17	1.10	81

*Note.* The higher an attribution's mean, the more important the attribution was in explaining students' success or failure.

TABLE 4

*Means and Standard Deviations of Male Participants' Achievement-Related Belief Variables*

Variable	<i>M</i>	<i>SD</i>	<i>n</i>
Attributions for success			
Effort	3.10	1.51	80
Strategy	2.90	1.32	80
Ability	3.64	1.34	80
Teachers' help	3.63	1.40	80
Help from others	2.33	1.41	80
Task ease	3.38	1.43	80
Attributions for failure			
Lack of effort	2.71	1.50	80
Lack of strategy	2.39	1.54	80
Lack of ability	1.86	1.41	80
Lack of teachers' help	2.17	1.41	80
Lack of help from others	2.21	1.51	80
Task difficulty	2.87	1.50	79
Total self-efficacy	53.69	7.94	80
Relative self-efficacy	0.19	1.15	77

*Note.* The higher an attribution's mean, the more important the attribution was in explaining students' success or failure.

significantly to students' grade level, Wilks'  $\lambda = .795$ ,  $F(14, 142) = 2.61$ ,  $p < .01$ .

Wilks' Lambda represents the variance not accounted for by a linear combination of variables (Tabachnick & Fidell, 1996). For each statistically significant effect, the proportion of variance accounted for by the given combination of variables ( $h^2$ ) is determined by subtracting the Wilks' Lambda value from one. Using this criterion, we determined that we could attribute 20.5% of the composite variable's variability to students' grade level.

Results from the MANOVA suggested that the significant main effect of students' grade level on the composite variable was related to three variables in particular: attributions of effort for success, attributions of teachers' help for success, and total self-efficacy. As such, we did not collapse students' grade levels. Rather, we conducted a  $2 \times 2$  (sex  $\times$  grade level) analysis of variance (ANOVA) on each of the three variables. Results indicated no significant main effect of sex on any variable, nor was there a significant sex  $\times$  grade interaction in any instance. There was, however, a significant main effect of grade level on students' effort attributions for success and attributions of teachers' help for success, respectively,  $F(1, 157) = 11.46$ ,  $p = .001$  and  $F(1, 157) = 9.97$ ,  $p < .01$  (on average, fourth-graders indicated that each of the two aforementioned attributions were more important in explaining their success than did seventh-graders). Although the MANOVA suggested that the main effect of grade level on the composite achievement-related belief variable was related to students' total self-efficacy, the  $2 \times 2$  ANOVA results did not indicate a significant main effect of grade level on students' total self-efficacy,  $F(1, 157) = 3.43$ ,  $p = .066$ . The Cohen's  $d$  effect sizes for effort attributions for success and for attributions of teachers' help for success were 0.52 and 0.53, respectively, both representing medium effect sizes (Cohen, 1988). These results should be interpreted with caution, however, because students' grade levels could not be collapsed in three instances. As a consequence, we grouped students by sex and by grade level simultaneously, resulting in relatively small sample sizes.

We then performed an independent samples t-test on each of the remaining 11 achievement-related belief variables: four success attributions (strategy, ability, help from others, and task ease), all six



failure attributions (lack of effort, lack of strategy, lack of teachers' help, no help from others, and task difficulty), and relative self-efficacy. Results revealed that the sexes differed significantly on only two measures: attributing failure to a lack of teachers' help ( $t(159) = 3.05, p < .01$ ) and relative self-efficacy ( $t(156) = -1.98, p < .05$ ). The Cohen's  $d$  effect sizes were 0.47 (an approximately medium effect size) and 0.31 (a small/medium effect size), respectively (Cohen, 1988).

## DISCUSSION

### *Mathematics Achievement Variables*

Our results support the recent findings that the mathematics achievement gap between the sexes is narrowing: Girls' scores on the Numeracy subtest of the 2001 FSA were on average fourteen points higher than those of boys (although this difference was not significant statistically in the current sample) and students' report card grades indicated that girls' achievement was significantly higher than that of boys.

### *Attributions for Mathematics Success*

Unlike the findings of prior attribution research, results of the current study demonstrate promising gains for girls in terms of their attributions for mathematics success, in that no significant differences between the sexes were discovered for any of the six success attributions. Irrespective of these findings, three success attribution results are worth elucidating: effort, ability, and help from teachers.

Analyses of students' effort attributions for success did not corroborate the findings of previous studies that report that girls tend to attribute their academic successes to effort significantly more frequently than boys do. Rather, boys and girls were equally likely to attribute their successes to effort. Although the sexes did not differ in their effort attributions, the study's results revealed that students' effort attributions were related significantly to their grade level. Results also indicated that fourth-graders tended to ascribe the causes of their successes to effort more than seventh-graders. One potential explanation for this finding is

that younger children tend to view effort and ability as being similar (and thus can't make the distinction between effort and ability), whereas older children tend to view effort and ability as being related inversely (Stipek, 1993).

As a result of the large quantity of research that suggests that boys tend to ascribe the cause of their successes to ability more often than girls do, we expected that the sexes would differ significantly in their ability attributions for success. Results did not substantiate this expectation, though, in that boys' and girls' ability attributions for success were approximately the same. On average, ability was the attribution that both boys and girls rated as most important in explaining their successes (however, boys also rated teachers' help as being nearly equally important). Because ability attributions for success have been linked with higher academic achievement and enhanced perceptions of self-efficacy, this finding challenges Stipek and Gralinski's (1991) claim that girls' attribution patterns are more self-defeating than those of boys.

Analysis of students' attributions of help from teachers for their success revealed that the sexes did not differ significantly on this measure. Although students' sex did not have an impact on the importance they gave this attribution in explaining their successes, students' grade level did. More specifically, fourth-graders were significantly more likely than seventh-graders to attribute their successes to help from their teachers. A possible explanation for this finding is that fourth-graders may tend to be less autonomous and to rely on their teachers more than their older counterparts, resulting in fourth-graders' attributing their successes to their teachers' help more frequently than do seventh-graders. Another possibility is that teachers actually play a more "hands-on" role in the learning of fourth-graders than they do for that of seventh-graders.

#### *Attributions for Mathematics Failure*

Unlike the findings of traditional attribution research, results of the current study demonstrate promising gains for girls in terms of their attributions for mathematics failure, given that the sexes differed significantly for only one failure attribution. Three failure attributions

are worth discussing further, however: lack of effort, task difficulty, and lack of teachers' help.

Consistent with the findings of various studies mentioned previously, we expected that boys would attribute their failures to a lack of effort significantly more often than girls. Our results did not support this expectation. Rather, the importance both boys and girls gave to a lack of effort in explaining their failure in mathematics was approximately the same. Girls, on average, reported effort as the most important attribution in explaining their academic failures.

We compared the importance that boys and girls gave task difficulty in explaining their academic failures. Although the sexes did not differ significantly for this measure, on average, task difficulty was the boys' most important reason for mathematics failures.

We compared boys' and girls' use of the "lack of teachers' help" attribution in explaining their academic failure. Results revealed that girls were more apt to attribute their failures to a lack of teachers' help than were boys.

#### *Mathematics Self-Efficacy*

Although analyses of students' total self-efficacy showed no significant difference between the sexes, results suggested that fourth-graders tended to be more efficacious than seventh-graders. The latter findings have been observed elsewhere (Paris & Oka, 1986). Analyses of students' relative self-efficacy revealed that girls tended to be under-confident relative to their actual academic achievement whereas boys tended to be relatively over-confident. This finding suggests that, despite our current study's results that demonstrate relative gains for girls in terms of attributions, and despite the finding that girls' academic achievement met or exceeded that of boys, girls were still under-confident of their abilities in comparison to boys. Inspection of the correlations between students' relative self-efficacy and FSA scores showed that the relationship was negative for the entire sample, between sexes, and between grade levels, respectively, suggesting that students whose self-efficacy is higher or lower relative to their actual achievement show poorer achievement than those students whose self-efficacy is

commensurate with their actual achievement. These correlations imply that, for achievement to be maximised, students' perceived ability should be commensurate with their actual achievement.

#### FUTURE RESEARCH

Researchers interested in replicating the current study should address various limitations. First, only fourth- and seventh-graders participated in the study; the FSA, however, was administered to tenth-graders in that school year, as well. A number of studies have demonstrated that sex differences in students' achievement-related beliefs undergo developmental change from elementary to secondary school (Shell, Colvin, & Bruning, 1995), and are most pronounced during late adolescence. Having only fourth- and seventh-graders in the study may explain why there were relatively few significant differences between girls' and boys' achievement-related beliefs. As a result, researchers should consider including older students in their studies to investigate to a fuller extent the degree to which students' academic achievement and achievement-related beliefs change over time. We note that every effort was made to include tenth-graders in the current study. Only two of the district's schools enrolled grade-10 students: The first school chose to not participate in the study, and the second school yielded an extremely low rate of return of consent forms.

A second limitation pertains to the attribution scale. The scale required that students indicate the degree to which each of six attributions was important in explaining their academic successes or failures, respectively. Although the scale was comprised of some of the most common attributions given by children in explaining their academic performance, it is possible that the particular attribution a student rated as being "most important" on the scale may not have been indeed his or her true and dominant attribution. In one instance, a participant informed us that his dominant reason for failure in mathematics was that he tended to rush and make "stupid mistakes" (an attribution that was not included in the scale). For this reason, researchers should consider including a greater variety of attributions on the scale.

Third, we classified each attribution as being either internal or external only. According to Weiner (1983), attributions may vary according to three “dimensions of causality”: locus, stability, and controllability. Locus refers to whether the location of the cause is within the person (internal) or outside the individual (external). Stability refers to whether the cause of a behaviour is viewed to be relatively enduring or variable across situations or from moment to moment. Controllability refers to whether or not an individual can exert choices over a cause. Ultimately, the classification of students’ attributions on the basis of their locus of causality alone provides only limited information about the attribution patterns of girls and boys. Nonetheless, future studies should compare students on the basis of all three of Weiner’s dimensions.

A fourth limitation pertains to the format of the numeracy questions included in the 2001 FSA. Numeracy questions included in the assessment are typically posed with a great deal of accompanying text. According to Maccoby and Jacklin (1974), when mathematics-related questions are posed in such a manner, it may be that the test is assessing verbal skills, rather than mathematical skills exclusively. This may have a negative impact on the performance of boys, whose reading and writing achievement has typically been surpassed by that of girls (Wentzel, 1988). Future research should examine this issue more closely.

Finally, given the relatively low sample sizes included in the current study, we caution readers against making strict generalisations about the sexes based on the findings. Findings should be interpreted as trends, rather than as definitive generalisations.

## CONCLUSIONS

Overall, results of the current study are promising in terms of girls’ mathematics performance for several reasons. First, results showed that girls’ achievement in mathematics met or exceeded that of boys. Second, it seems that there have been relative gains for girls in terms of attributions. More specifically, it appears that girls’ success and failure attributions tended to be more self-enhancing than reported in traditional attribution research. Boys’ success and failure attributions were also relatively self-enhancing. These results seem to challenge those

of previous studies that claim that girls espouse more self-defeating attribution styles than boys. According to Hill and Augoustinos (1997), less emphasis should be placed on the findings of these early studies because attribution patterns may change over time. Results of the current study seem to support this view.

Despite gains for girls in terms of their attributions, educators, parents, and researchers alike should be concerned about the finding that girls tend to be under-confident of their mathematics ability relative to their actual achievement, whereas boys tend toward over-confidence: Even though girls' mathematics achievement was commensurate with that of boys, this study suggests that girls do not yet know how able they are in mathematics. In a sense, they are good at mathematics, but do not know it. According to Shell et al. (1995), perceptions of ability become more accurate with students' increasing age, so it may be that the relative efficacy findings are related significantly to the age of the children. Nonetheless, for girls' and boys' academic potentials to be maximised, it is imperative that students' achievement-related beliefs are commensurate with their actual academic achievement. Future studies should investigate the specific reasons underlying girls' under-confidence and boys' over-confidence relative to their actual mathematics achievement.

#### ACKNOWLEDGEMENTS

We thank the British Columbia Ministry of Education for supporting this research project. We also thank Drs. John O. Anderson and Leslee Francis-Pelton of the University of Victoria, and Dr. Nancy L. Galambos of the University of Alberta, for their comments on an earlier draft of this paper.

#### NOTES

<sup>1</sup> Effective the 2003-2004 school year, tenth-grade students no longer participate in Foundation Skills Assessment program.

<sup>2</sup> Readers wishing to view sample FSA test items visit the following Ministry of Education web site: [http://www.bced.gov.bc.ca/assessment/fsa/sample\\_tests.htm](http://www.bced.gov.bc.ca/assessment/fsa/sample_tests.htm)

<sup>3</sup> We did not have information about the numeracy category to which each

sample FSA question belonged. As such, we had to determine the number and proportion of sample FSA questions to include in the self-efficacy scales ourselves, by comparing each question against the description of each numeracy category provided in the Table of Specifications.

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