Gender Differences in Science-Related Attitudes and Interests Among Middle School and High School Students

Abstract

A survey of 6th-12th grade students was conducted to measure their science-related attitudes and interests. Significant gender differences were found among these students. Females reported more anxiety about science as well as less motivation in and enjoyment of science than males. In spite of their unfavorable attitudes toward science, a large percentage of females expected to pursue a college major and subsequent career in the health sciences. We discuss reasons for the disconnect between female students' attitudes and their choice of college major and career.

Introduction

Leaders in STEM education, business, and industry have expressed concern that interest in science and science-related careers among U.S. students is failing to keep pace with the expected demand for a scientifically-literate workforce (National Academy of Sciences, 2007). Several explanations have been suggested for this lack of interest in science, among them the development of negative attitudes toward science that originate during the elementary school years (Haladyna & Shaughnessy, 1982) and persist through the secondary and postsecondary years (Desy, Peterson, & Brockman, 2009; George, 2006; Hofstein & Welch, 1984; Simpson & Oliver, 1985).

Although a number of variables may affect students' attitudes toward science, the two most influential appear to be gender and the quality of science instruction students experience early in their academic lives (Ebenezer & Zoller, 1993; Osborne, Simon, & Collins, 2003; Schibeci & Riley, 1986). Past studies (American Association of University Women [AAUW], 1991; George, 2006; Haladyna & Shaughnessy, 1982; Weinburgh, 1995) have shown that girls tend to exhibit more negative attitudes towards science classes and a career in science than do boys. In addition, girls' interest in science steadily declines from middle school to the high school years (AAUW, 1991; Hofstein & Welch, 1984). The lack of interest in science among female high school students does not appear to be explained by low ability or achievement (Miller, Blessing, & Schwartz, 2006; Weinburgh, 1995). In fact, girls are earning high school math and science credits at the same rate as boys and are earning slightly higher grades in these classes (U.S. Department of Education, 2007).

Several researchers (Gogolin & Swartz, 1992; Weinburgh, 1995) have suggested that positive attitudes are essential precursors for students to develop an interest in science. Farenga and Joyce (1998) found that positive feelings and perceptions of science among elementary-aged girls in particular led to their greater interest in science classes. Consequently, positive attitudes in science have been heavily promoted by science educators for the past two decades in a concerted effort to encourage more students to take STEM courses and consider careers in STEM fields (National Science Foundation, 2003).

The purpose of this study was to measure attitudes and interests in science among middle school and high school students from rural, southwest Minnesota. Our primary goals were to: 1) compare the science-related attitudes of middle school and high school students; 2) determine whether gender differences in science-related attitudes exist for these students and what factors may be responsible for any observed differences; and 3) examine the types of college majors and careers that current 6th-12th grade rural students are considering.

Keywords: science attitudes, gender differences, middle school, high school

Method

Participants.

The participants in this study consisted of 1299 students in middle school (grades 6-8) and high school (grades 9-12) taking science classes at six different school districts in southwest Minnesota during the spring semester of 2007. The middle school sample consisted of 316 males, 307 females, and 3 students who did not report their genders. The high school sample consisted of 326 males and 338 females. Another 9 students (2 males, 1 female, 6 unspecified gender) completed the survey but did not report their grade levels. Middle school science classes surveyed included 6th grade science, earth science, and life science; high school science classes surveyed included physical science, biology, environmental science, and anatomy & physiology. Seventy-one percent of those surveyed were in classes related to the biological sciences rather than earth or physical science. The majority of respondents were either in the middle school grades (45.5%) or 9th and 10th grades (43.7%). The most commonly reported ethnicities were White (87.5%), Hispanic/Latino (4.3%), and American Indian (1.7%).

Instrumentation.

A 50-item survey instrument was developed for this study. The first section of this instrument measured attitudes toward science using 24 items requiring Likert-style responses (*strongly agree*=5, *agree*=4, *neither agree nor disagree*=3, *disagree*=2, *strongly disagree*=1). Scale items were derived from the *Attitudes Toward Science Inventory* (ATSI) developed by Gogolin and Swartz (1992), and Germann's (1988) *Attitude Toward Science in School Assessment* (ATSSA). A total of 18 items were selected from the ATSI, those three items from each of the six subscales with highest item-to-scale correlations (see Gogolin & Swartz, 1992; the original ATSI instrument has 8 items per scale). Another 7 items were selected from the ATSSA; all had loadings greater than .70 on a factor assumed by Germann to be measuring a general attitude toward science in school (see Germann, 1988; the original ATSSA scale has 14 items). Although a total of 25 items was selected from the two instruments, one of the items (When I hear the word "science," I have a feeling of dislike) was duplicated among the selections, as it appeared on (and was one of the items selected from) both the ATSI and ATSSA. This item appeared only once on our survey, but was included in two different scales for analysis purposes. Our 24 attitude items were organized across seven scales as shown in Table 1.

Table 1: *Attitudes toward science scale items*

Scale	Items
Perception of the science teacher	Science teachers make science interesting to me.
	Science teachers present materials in a way that I understand.
	Science teachers are willing to give me individual help.
Anxiety toward science	When I hear the word "science," I have a feeling of dislike.[a]
	It makes me nervous to even think about doing science.
	I have a good feeling toward science.
Value of science in society	Science is helpful in understanding today's world.
	Science is of great importance to a country's development.
	There is little need for science in most of today's jobs.
Self-concept in science	No matter how hard I try, I cannot understand science.
	I do not do very well in science.
	Science is easy for me.
Enjoyment of science	Science is something that I enjoy very much.
	I enjoy talking to other people about science.
	Science is one of my favorite subjects.
Motivation in science	I would like to do some extra or un-assigned readings in science.
	The only reason I am taking science is because I have to.
	I have a real desire to learn science.
Attitude toward science in school	When I hear the word "science," I have a feeling of dislike.[a]
	During science class, I usually am interested.
	I would like to learn more about science.
	Science makes me uncomfortable, restless, irritable, and impatient.
	Science is fascinating and fun.
	I feel a definite positive reaction to science.
	Science is boring.

Note: The first six scales were derived from Gogolin and Swartz (1992); the 'Attitude toward science in school' scale was derived from Germann (1988). Reverse coding was used to quantify responses on negatively worded items.

[a] Item appears only once on survey but included in two scales for analysis purposes.

The remaining 26 items on the survey consisted of questions related to students' interest in science, encouragement they received from adults, participation in science, their personal connections to science, perceived opportunities in science for rural students, and demographic characteristics (e.g., gender, ethnicity). Participants were also asked to report their favorite and least favorite subjects in school, expected major in college, and career interests. These 26 items were analyzed individually.

Reliability of the seven attitude scales was examined separately for middle school and high school participants using Cronbach's alpha. All alpha coefficients were greater than .60 (range .61 to .93), the criterion recommended by Aron and Aron (2003).

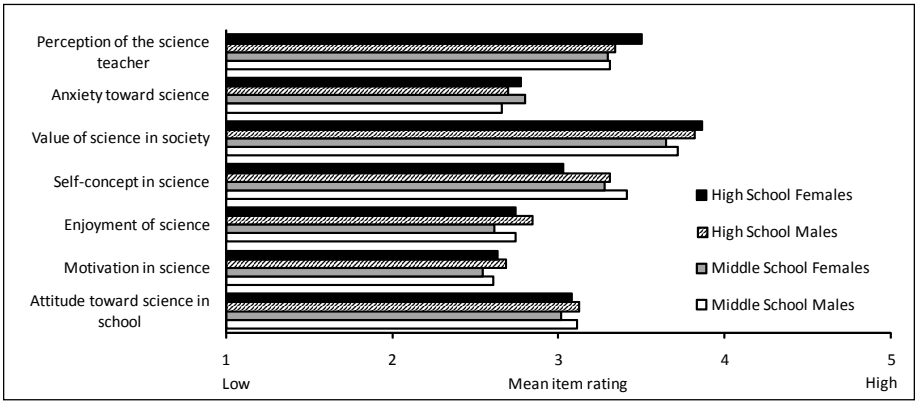
Results

Science attitudes.

Scores on the seven attitude scales were computed for each participant by averaging the ratings for the items within each scale. Higher scores represent a more positive perception of the science teacher, more anxiety toward science, a higher value of science in society, a more positive self-concept in science, more enjoyment of science, greater motivation in science, and a more positive attitude toward science in school, respectively. Mean scores were computed for males and females at each school level and are shown in Figure 1.

Multivariate analysis of variance was used to examine the overall gender differences in attitudes toward science for both middle school and high school students. For each analysis, the independent variable was gender and the dependent variables were the scores on the seven attitude scales. The multivariate effect did not reach statistical significance for middle school students, Pillai's Trace = .014, $F(7, 613) = 1.21$, $p = .297$. Although follow-up univariate analysis is not warranted for the middle school data due to lack of a multivariate effect, the data suggest a somewhat more favorable attitude toward science for male

Figure 1. Attitudes toward science among middle school and high school students.



students than female students. Females reported a noticeably higher level of anxiety toward science than males, while males scored higher than females on all other scales (see Table 2).

A significant multivariate effect was detected for the high school students, Pillai's Trace = .057, $F(7, 656) = 5.68$, $p < .001$, indicating that there were significant gender differences among the scales. Follow-up univariate t-tests comparing male and female high school students revealed significant differences in perception of the science teacher and self-concept in science. Females reported a significantly higher perception of the science teacher, whereas males reported a significantly higher self-concept in science. Although other differences were not statistically significant, males reported greater enjoyment of science, greater motivation in science, and slightly more positive attitudes toward science in school. Females reported greater anxiety toward science and a slightly higher value of science in society (see Table 2).

Further analysis was conducted to examine the relationship between attitudes toward science and self-reported academic achievement. One of our survey items asked students to rate the statement: "I consider myself a(n) _____ student" using a 5-point Likert-style response (5=*excellent*, 4=*very good*, 3=*good*, 2=*fair*, 1=*poor*). Females rated themselves as better students in both middle school (female, $M = 3.63$; male, $M = 3.46$) and high school (female, $M = 3.62$; male, $M = 3.49$). This gender difference was significant among the middle school students ($p < .05$) and nearly significant among high school students ($p = .069$). Pearson correlation coefficients were computed to measure the relationship between this measure of academic achievement and the scores on the various attitude scales (see Table 3).

As shown in Table 3, all correlations were found to be significant for both the middle and high school students. Students with more positive attitudes toward science and less anxiety toward science tended to rate themselves as better students. Follow-up analysis revealed a similar pattern of correlations for both male and female students.

Table 2: *Attitudes toward science among middle school and high school students*

	Male		Female			
Scale	Mean	SD	Mean	SD	t	p
			Middle School			
Perception of the science teacher	3.31	0.89	3.30	0.79	0.22	.828
Anxiety toward science	2.66	0.92	2.80	0.85	-2.04*	.042
Value of science in society	3.72	0.74	3.65	0.69	1.19	.235
Self-concept in science	3.41	1.01	3.28	1.00	1.69	.093
Enjoyment of science	2.74	1.04	2.62	0.90	1.63	.103
Motivation in science	2.61	0.98	2.55	0.85	0.84	.400
Attitude toward science in school	3.11	0.98	3.01	0.86	1.59	.113
			High School			
Perception of the science teacher	3.34	0.83	3.50	0.69	-2.72**	.007
Anxiety toward science	2.70	0.91	2.77	0.86	-1.12	.263
Value of science in society	3.82	0.78	3.86	0.66	-0.77	.444
Self-concept in science	3.31	1.02	3.03	1.01	3.53**	.000
Enjoyment of science	2.84	1.05	2.74	0.98	1.29	.197
Motivation in science	2.69	0.96	2.64	0.91	0.72	.473
Attitude toward science in school	3.12	0.93	3.08	0.86	0.59	.554

*$p < .05$, 2-tailed. **$p < .01$, 2-tailed.

Interest in science.

Students rated their and their friends' level of interest in science using a 5-point Likert scale (1=*very low*, 2=*low*, 3=*medium*, 4=*high*, 5=*very high*). No significant gender differences were found in these ratings among middle school students or high school students. However, students rated their own level of interest in science significantly higher than their friends' level of interest in both middle school (own, $M = 2.98$; friends', $M = 2.59$; $t = 8.84$, $p < .001$) and high school (own, $M = 3.05$; friends', $M = 2.57$; $t = 12.56$, $p < .001$).

Interest in science was also evaluated by examining students' reported favorite and least favorite subjects in school, as well as their anticipated college majors and career interests. Favorite and least favorite subjects reported by middle and high school students are shown in Table 4. Favorite subjects among middle school students were math, gym, and science. Math and science seem to be equally liked by both male and female students, whereas gym was mentioned much more often by males than females. Interestingly, science and math were

Table 3: *Correlations between academic self rating and attitudes toward science*

Scale	Middle School	High School
Perception of the science teacher	.18	.20
Anxiety toward science	-.26	-.31
Value of science in society	.18	.20
Self-concept in science	.49	.41
Enjoyment of science	.19	.30
Motivation in science	.22	.33
Attitude toward science in school	.25	.32

Note: All correlations are significant at $p < .01$, 2-tailed.

Table 4: *Favorite and least favorite school subjects reported by middle school and high school students*

Middle School		High School	
Male	Female	Male	Female
Favorite Subjects			
Gym (38.3)	Math (32.6)	Math (21.8)	Math (25.1)
Math (32.9)	Gym (20.5)	Science (11.0)	English (13.3)
Science (14.6)	Science (13.0)	History (9.8)	Science (10.7)
Social Studies (8.2)	Art (12.4)	Gym (9.8)	Art (10.4)
PE/Health (3.5)	English (11.1)	Agriculture (6.1)	History (8.6)
Least Favorite Subjects			
Science (22.5)	Science (27.0)	English (25.5)	Math (29.3)
Math (22.5)	Math (23.8)	Math (19.6)	Science (18.3)
English (20.6)	English (19.2)	Science (16.0)	English (16.0)
Language Arts (16.8)	Social Studies (12.4)	History (6.7)	Social Studies (8.3)
Social Studies (7.9)	Language Arts (7.5)	Spanish (5.5)	History (8.0)

Note: Top 5 responses are shown in each category with percentage of students reporting the subject in parentheses.

also at the top of the list of least favorite subjects, with English coming in third for both males and females. Overall, the middle school data provide little evidence of a gender difference in interest in science.

For the high school students, math and science were among the most popular subjects for both males and females. Beyond those two subjects, English, art, and history were popular among the females, whereas gym and history were popular among the males. Least favorite subjects were math, English, and science. Math and science were mentioned by more females than males, whereas English was mentioned by more males than females. These data suggest the emergence of a gender difference in interests during the high school years, in which significant numbers of females begin to view math and science as undesirable subjects in school.

Anticipated college majors reported by middle and high school students are shown in Table 5. Overall, math, medicine, and science were mentioned most frequently by both the middle and high school students. However, the responses differed noticeably for males and females. The most frequently mentioned majors among middle school males were science, engineering, sports, and math. For middle school females, the most frequently mentioned majors were medicine, math, education, and veterinary. Among high school students, males mentioned math, engineering, and computers most frequently, whereas females mentioned medicine, education, and nursing most frequently. These data suggest that males tend to remain strongly oriented toward math and science as they proceed into the high school years whereas female interests tend to migrate toward the medical and education fields.

Career interests reported by middle and high school students are shown in Table 6. Among the male middle school students, professional athlete was mentioned most frequently, followed by farmer and mechanic. Among the female middle school students, veterinarian, teacher, and doctor/surgeon were mentioned most often. Among the high school students, results were similar except that a large number of males reported engineering as a career interest. Our data also indicated that males were much less sure of their career interests than females, as significantly more males than females gave 'Don't Know' responses. Perhaps males perceive more career options than females do, or less need to make career choices early in their lives.

Encouragement and participation in science.

Eight survey items measured the extent to which students were encouraged to pursue science and whether they had actually participated in science-related activities in the past. Participants responded with 'Quite Often,' 'Occasionally,' 'Rarely,' or 'Never' to each item. The distribution of responses to these items is shown in Table 7 for middle and high school students. As can be seen in this table, the rate of participation in science-related activities was relatively high for all students. However, these percentages are probably more reflective of the mandatory nature of many of these activities rather than an actual interest in science. These data also clearly show that students are more likely to receive encouragement from their teachers than from parents or other relatives. Chi-square analysis revealed several significant gender differences in the distribution of responses for these survey items. Among middle school students, males reported significantly more encouragement from their parents to pursue their interest in science than did females, χ^2 (3) = 13.32, $p < .01$. Also, a significantly higher proportion of

Table 5: *Expected college majors among middle school and high school students*

Middle School		High School	
Male	Female	Male	Female
Science (6.3)	Medicine (8.5)	Math (6.7)	Medicine (8.6)
Engineering (6.3)	Math (6.8)	Engineering (6.4)	Education (6.2)
Sports (5.7)	Education (6.5)	Computers (5.2)	Nursing (5.0)
Math (5.4)	Veterinary (6.2)	Mechanics (4.6)	Math (4.7)
Agriculture (5.1)	Science (5.2)	Science (4.3)	Science (4.7)
Business (4.7)	Law (3.3)	Business (4.0)	Veterinary (4.1)
Mechanics (4.1)	Music (2.9)	Agriculture (4.0)	Business (3.8)
Medicine (3.2)	Cosmetology (2.9)	Carpentry (3.7)	Art (3.8)
Architecture (2.8)	Nursing (2.6)	Medicine (3.4)	Cosmetology (3.8)
History (2.5)	Photography (2.3)	Music (3.1)	Psychology (2.7)
	Theatre/Drama (2.3)		

Note: Top 10 responses are shown in each category with percentage of students reporting the major in parentheses. 'Don't Know' responses are not included.

males than females participated in science experiments in middle school, χ^2 (3) = 13.10, $p < .01$. Among high school students, females reported significantly more participation in science experiments in elementary school than did males, χ^2 (3) = 10.55, $p < .05$. None of the other gender differences were found to be significant.

Personal connections to science.

Four survey items examined students' personal connections to science. Participants responded with 'Yes,' 'No,' or 'Don't Know' to each item. The distribution of responses to these items is shown in Table 8 for middle and high school students. Interestingly, while there is little difference in knowledge about male and female scientists among middle school students, high school students (both male and female) reported a greater knowledge of male scientists than female scientists.

Unfortunately, many of the students did not even recognize their own science teachers as people who use science in their jobs. Among middle school students with male science instructors, only 65.3% responded (Yes) that they knew of a man who uses science in his job. For those with female science instructors, only 56.7% responded (Yes) that they knew of a woman who uses science in her job. Among high school students, 64.9% of those with male science instructors responded (Yes) that they knew of a man who uses science in his job. Of those with female science instructors, 64.3% responded (Yes) that they knew of a woman who uses science in her job.

Perceived opportunities for rural students.

Because our university is located in a rural area, and many of our students come from the area, we were interested in whether students perceive this rural setting to be an obstacle for those who want to pursue science. Three survey items measured students' perceptions of their opportunities in science as compared to students living in more urban areas. Participants responded with 'Much More,' 'More,' 'About the Same,' 'Less,' or 'Much Less' to each item. The distribution of responses to these items is shown in Table 9 for middle school and high school students. The data for both middle school and high school students suggest that they generally do not feel disadvantaged in their opportunities to learn about or participate in science as compared to students in more urban

Table 6: *Career interests among middle school and high school students*

Middle School		High School	
Male	Female	Male	Female
Professional Athlete (12.0)	Veterinarian (12.1)	Engineering (7.4)	Teacher (8.9)
Farmer (7.3)	Teacher (10.7)	Mechanic (4.0)	Veterinarian (7.1)
Mechanic (5.4)	Doctor/Surgeon (8.8)	Computers (3.4)	Nurse (6.2)
Engineer (4.1)	Nurse (5.9)	Farmer (3.4)	Doctor/Surgeon (5.6)
Military (3.8)	Cosmetologist (4.9)	Accountant (3.1)	Cosmetologist (5.3)
Game Designer/Tester (3.5)	Photographer (4.6)	Carpenter (3.1)	Medical (4.1)
Architect (3.2)	Professional Athlete (3.3)	Teacher (2.8)	Physical Therapist (4.1)
Doctor/Surgeon (3.2)	Music (3.3)	Business/Business Owner (2.8)	Forensic Science (3.3)
Business/Business Owner (2.8)	Lawyer (3.3)	Automotive (2.8)	Social Worker (3.3)
Carpenter (2.8)	Actor/Actress (2.9)	Fish/Wildlife (2.8)	Lawyer/Attorney (3.0)
	Marine Biologist (2.9)	Law Enforcement (2.8)	Photographer (3.0)

Note: Top 10 responses are shown in each category with percentage of students reporting the career in parentheses. 'Don't Know' responses are not included.

Table 7: *Encouragement and participation in science among middle school and high school students*

Item	Middle School		High School	
	Male	Female	Male	Female
Did teachers encourage your interest in science?	69.2	66.8	68.7	74.5
Did your parents encourage your interest in science?	45.7	39.9	42.0	42.3
Did other relatives encourage your interest in science?	30.9	24.7	30.5	27.2
Have you participated in science fairs?	21.3	19.1	29.1	31.9
Have you visited science museums?	43.0	53.8	51.5	57.3
Did you participate in science experiments in elementary school?	69.7	70.9	65.3	75.4
Did you participate in science experiments in middle school?	72.8	68.1	65.6	73.0

Note: Numbers represent combined percentages for 'Quite Often' and 'Occasionally' responses. Percentages are based on valid responses only.

areas. However, middle school students do perceive somewhat less opportunities to pursue science as a career as compared to students from more urban areas. By high school, female students appear to have a more positive outlook on their opportunities to pursue science as a career, whereas males continue to feel disadvantaged as compared to urban students.

Discussion

The students in our study had relatively neutral attitudes toward science (see Figure 1, Table 2). Lowest scores were obtained for the 'enjoyment of science' and 'motivation in science' scales, whereas 'value of science in society' and 'perception of the science teacher' were rated the highest. These findings suggest that although most students neither enjoy nor have an interest in science, they nevertheless recognize the importance of science in today's world. In fact, students are earning more high school credits in mathematics and science than they did two decades ago (U.S. Department of Education, 2007). Ratings were generally more positive for high school students than for middle school students, except for the 'self-concept in science' scale where high school students had lower scores. This finding may reflect the increased difficulty of science-related coursework at the high school level (AAUW, 1991).

Gender differences in attitudes toward science were also evident in our sample. Females scored lower than males on the 'enjoyment of science,' 'motivation in science,' 'attitude toward science in school,' and 'self-concept in science' scales. They also reported a greater level of 'anxiety toward science' than did males. Interestingly, the gender differences were larger and statistically significant among the high school students, indicating a gender gap that widens with education level.

Gender differences in favorite and least favorite subjects were also more evident among high school students than middle school students. The top three favorite and least favorite subjects were almost identical for middle school males and females (see Table 4). For the high school students, however, English was much more popular among females than males, and science was much more popular among males than females. Interestingly, math topped the list of both favorite and least favorite subjects for high school females, suggesting that students have strong opinions about math as a school subject – they either love it or hate it.

Table 8: *Personal connections to science among middle school and high school students*

Item	Middle School				High School			
	Male		Female		Male		Female	
	%Y	%N	%Y	%N	%Y	%N	%Y	%N
Do you have a relative who is an engineer/scientist?	25.1	40.6	20.0	39.7	30.9	37.0	24.3	43.5
Do you have a family friend who is an engineer/scientist?	24.1	33.0	19.3	41.3	27.2	34.6	24.3	38.5
Do you know any women who use science in their jobs?	52.1	23.2	58.4	13.8	52.5	22.5	66.3	14.8
Do you know any men who use science in their jobs?	54.3	22.2	52.5	17.0	65.1	16.0	71.9	11.2

Note: Percentages are based on valid responses only; percentages for 'Don't Know' responses are not included.

Table 9: *Perceived opportunities in science as compared with university students in more urban areas*

Item	Middle School				High School			
	Male		Female		Male		Female	
	%M	%L	%M	%L	%M	%L	%M	%L
Rate your opportunities to learn about science.	36.6	22.4	36.4	16.1	39.9	20.2	40.0	14.6
Rate your opportunities to participate in science.	39.8	19.4	38.0	14.1	39.3	19.9	42.4	14.6
Rate your opportunities to pursue science as a career.	30.3	38.6	25.5	37.0	29.8	36.8	32.9	25.7

Note: Percentages for 'Much More' and 'More' responses were combined and appear in the table as %M; percentages for 'Less' and 'Much Less' responses were combined and appear in the table as %L; percentages for 'About the Same' responses are not included. Percentages are based on valid responses only.

Noticeable gender differences in expected majors and career interests were found among both middle school and high school students (see Tables 5 and 6). Our data suggest that males tend to be attracted to math, engineering, and technology fields whereas females are attracted to education and health-related fields (see also AAUW, 2010; Miller et al., 2006). Interestingly, even though math and science were the least favorite school subjects for females, the majority of the expected college majors and career interests reported by females were precisely in these areas. For high school females, four of the top five college majors and three of the top five career interests were related to math and science.

The fact that females exhibit such a high rate of interest in science-related disciplines is somewhat surprising given their relatively low scores on the attitude scales as well as their rating of math and science among their least favorite school subjects. One possible explanation is that females do not recognize that science is a major component of their most frequently-cited expected college majors (e.g., doctor/surgeon, nursing, and veterinary). Indeed, the vast majority of the science-related college majors and career interests cited by high school females were medical- or health-related. Females may thus take science courses not because they are interested in or enjoy them, but rather because they are a necessary means to their desired health-care career goals (Miller et al., 2006).

Another possible explanation for the disparity between females' attitudes and career choices is that students perceive the word 'science' differently than do scientists. Whereas scientists use this word to include both the life and physical sciences, students may associate the word with a specific subset of science rather than the entire field of science. According to a local high school teacher (H. Knudson, personal communication), students tend to associate 'science' with the physical sciences (i.e., chemistry and physics), which students find very challenging because of the math and vocabulary component. On the other hand, students tend to struggle less with the life sciences (e.g., biology and environmental science). The association of the word 'science' to the physical sciences would be particularly problematic for females, who tend to be less attracted to the physical sciences than the life sciences (U.S. Department of Labor, 2009). Corroborating evidence for this idea was found in student responses to our scale item: 'When I hear the word "science," I have a feeling of dislike' (see Table 1). Overall, females reported significantly more agreement with this item than did males (female, $M = 2.97$; male, $M = 2.85$; $t = 2.04$, $p = .001$) thus indicating a stronger dislike for the word 'science.'

Overall, students in our study reported receiving more encouragement to pursue their interests in science from teachers than from parents or relatives. Several researchers (George, 2006; Raved & Assaraf, 2011; Schibeci & Riley, 1986) also found that one of the strongest contributors to student attitudes toward science was teacher encouragement. Thus, students who receive encouragement from their teachers to pursue science may demonstrate significantly more positive attitudes toward science than those who do not.

Previous studies have found that teachers' content knowledge and use of engaging teaching strategies are also highly associated with student attitudes towards science and motivation to engage in science (Disinger & Mayer, 1974; National Science Board, 2007). For example, Osborne et al. (2003) and others (AAUW, 1991) have argued that teacher subject knowledge is a determinant of effective teaching, and effective teaching is the gateway for generating interest among students. Thus, one strategy for improving science attitudes and interests among U.S. students is to ensure that students are taught by well-prepared and committed STEM teachers (Lotter, Harwood, & Bonner, 2006; National Science Board, 2007).

Conclusion

Despite nearly 25 years of research focused on gender differences in attitudes toward science, recommendations to counter this trend, and presumably the implementation of these recommendations, gender differences in attitudes toward science still exist among middle school and high school students in the U.S. Our study found that females are more anxious about science, have less motivation in and enjoyment of science, and tend to rank science as one of their least favorite subjects. However, somewhat ironically, we also found that many of the females in our study expected to pursue a college major and subsequent career in a health-related, science field.

Teachers likely play an important role in influencing student attitudes toward science. In this study, we found that teachers were more likely to encourage students' interest in science than parents. Therefore, providing frequent, high-quality professional development opportunities in both life science and physical science for ALL elementary and secondary teachers may be one way of diminishing the gender gap. Integrating experiential, hands-on science activities into existing curricula that are fun and engaging and captivate a student's natural curiosity will surely enhance science education for students at all grade levels. Finally, based on our work, we suggest that secondary teachers be more purposeful in linking science in school with health-related career opportunities in the sciences.

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