The Alberta Journal of Educational Research *Vol. 55, No. 4, Winter 2009, 482-496*

Toni Fried
Toronto District School Board

and

Anne MacCleave
Mount Saint Vincent University

Influence of Role Models and Mentors on Female Graduate Students' Choice of Science as a Career

The purpose of this study was to examine the source, nature, and degree of influence of role models and mentors on female graduate students' choice of science as a career. Also examined was the existence of gender or area-of-study (engineering, biological science, physical sciences) differences. Results of a factor analysis of the Influence of Others on Academic and Career Decisions Scale (IOACDS, Nauta & Kokaly, 2001) demonstrated that role models and mentors influenced students in distinct ways. Significant gender, area-of-study, and undergraduate country differences were found.

L'objectif de cette étude était d'examiner la source, la nature et la mesure dans laquelle les modèles et les mentors l'influencent les étudiantes aux études supérieures dans leur choix de faire carrière en sciences. Nous avons aussi porté notre attention sur l'existence de différences sur le plan du genre ou du domaine d'études (génie, sciences biologiques, sciences physiques). Les résultats d'une analyse de facteurs selon l'échelle IOACDS (the Influence of Others on Academic and Career Decisions - Nauta & Kokaly, 2001) mesurant l'influence des autres sur les décisions académiques et professionnelles, indiquent que les modèles de comportement et les mentors influencent les étudiants de façons distinctes. Des différences significatives se sont révélées sur le plan du genre, du domaine d'étude et du pays où les étudiants ont fait leurs études du premier cycle.

Despite advances in other professional fields in recent decades, women remain in the minority in science, technology, engineering, and mathematics (STEM) careers, comprising only 22% of these fields in 2005 (Statistics Canada, 2006). In contrast, women made up slightly more than half of all doctors and dentists (55%), just over half of all professionals employed in business and finance (52%), and most (71%) of all professionals employed in social sciences and religion in 2005. Women continue to account for relatively small shares of the total university enrollment in STEM fields, making it unlikely that female representation in these occupations will increase in the near future. In Canada in 2001-2002, women represented only 30% of all math and physical science

---

Toni Fried, MA school psychology, is currently a psychoeducational consultant. This article is based on an updated and revised version of research conducted during her graduate studies at Mount Saint Vincent University. E-mail: friedt@hotmail.com
Anne MacCleave is a professor and Coordinator of Human Relations/Educational Psychology, Faculty of Education. E-mail: anne.maccleave@msvu.ca

students and only 24% of all engineering and applied science students (Statistics Canada).

Why, one might ask, is it even a problem that women are underrepresented in STEM careers if they are more than well represented in other careers? As minorities in the STEM professions, women are often inadvertently subjected to marginalization in various subtle and not so subtle ways (Williams & Emerson, 2002). Several studies have shown that women in science and technology receive lower salaries, lower status, social isolation from peers, plus poorer prospects for promotion and fewer opportunities for leadership than men (Acker & Oakley, 1993; Brush, 1991; Campbell & Skoog, 2004; Morrell, 1991; Scott, 1990; Settles, Cortina, Stewart, & Malley, 2007). Female scientists in research universities were found to have less lab space and smaller grants than men with equivalent records (MIT, 1999; Wenneras & Wold, 1997).

According to Williams and Emerson (2002), women will only be able to combat such marginalization when they have achieved a critical mass. Being a "token" makes a women feel that she does not belong or that her performance will reflect poorly on her entire sex or race (Ehrhart & Sandler, 1987). The resulting anxiety and perfectionism can be debilitating to performance. The presence of other women provides enhanced opportunities for social support and encourages women to persist in their academic/career choices. Thus more women need to be encouraged to pursue careers in the STEM professions.

If women are to be recruited for STEM careers, it is important to understand impediments to this choice. Extensive research has been conducted on the reasons why women do not initially choose to pursue STEM careers and why those who do fail to persist in their careers (Eccles, 1994). However, considerably less research exists on why STEM undergraduate women do not continue their studies at the graduate level.

Betz (1994) noted that women entering graduate school programs were as well prepared academically as men; therefore, one has to look at the institutional climate and lack of social support to explain the losses of women from graduate programs in science and engineering. Among other factors, Betz identified lack of social support in the form of mentors as a possible reason for low female enrollments in STEM graduate studies. Lack of female role models has also been identified as a possible reason for women not persisting in their pursuit of STEM careers (Ehrhart & Sandler, 1987).

The following is a brief examination of the theoretical basis for the importance of role models and mentors to academic and career development, the problem of defining these constructs, and how they are operationalized in this study. Also examined is the importance of role models and mentors for female students in STEM programs and careers.

Theoretical Underpinnings

Bandura's (1969) Social Learning Theory proposes that our self-efficacy expectations determine whether we choose to engage in a particular behavior and whether we persist when faced with obstacles. Among sources of efficacy information are vicarious learning or modeling and verbal persuasion and support from others (Bandura, 1977, 1982, 1986). These ideas foreshadowed distinctions between role modeling and mentoring. Whereas mastery experiences were the primary sources of men's self-efficacy beliefs, women's self-efficacy beliefs depended on social persuasions and vicarious experiences (Zeldin, Britner, & Pajares, 2007). Also drawing from Bandura's work, Hackett and Betz (1981) noted that women lacked strong efficacy expectations in male-dominated areas owing to socialization experiences and fewer vicarious learning experiences compared with men. Similarly, Campbell and Skoog (2004) identified self-efficacy beliefs such as low self-confidence as the most influential internal barrier that deters women from choosing science as a career. Hackett and Betz also addressed the importance of social support and successful role models for women's representation in male-dominated career areas. Madill, Ciccocioppo, Stewin, Armour, and Montgomerie (2004) further corroborated the importance of role models and mentors, especially female instructors, in participants' math- and science-related self-efficacy expectations.

Eccles (1994) found that boys demonstrated stronger self-efficacy and achievement expectancies in masculine domains than girls. A model developed by Eccles revealed that academic choices and achievement were influenced by both students' expectations of success and the value they attributed to a task, activity, or domain. Although over 15 years of research went into validating aspects of Eccles' model, few empirical studies in academic and career development have differentiated role models from mentors with the exception of Nauta and Kokaly (2001). Their work was grounded in Bandura's efficacy information sources of vicarious learning or modeling and verbal persuasion or support from others. Although they intended to study the influence of role models on the academic and career decisions of undergraduates across disciplines and fields, results of a factor analysis indicated that their respondents differentiated between support/guidance and inspiration/modeling.

Mentoring and Role Modeling: The Problem of Definition

When constructs are not comparable across the research literature, it is difficult, if not impossible, to build a coherent and cohesive knowledge base. Mertz (2004) noted that the term *mentor* was used inconsistently and without attention to context. To address this problem, she proposed a conceptual model to distinguish mentoring from other types of supportive relationships. Described as a work-in-progress, Mertz's model depicts a series of supportive work relationships arranged hierarchically in a pyramid with *Mentor* at the peak, representing the greatest intensity of involvement. *Patron or Protector, Sponsor or Benefactor, Counselor, Advisor, or Guide* and *Teacher or Coach* follow. *Role Model, Peer Pal, or Supporter* at the bottom of the pyramid represent the lowest intensity of involvement. Primary purposes of career advancement, professional development/advising, and psychosocial development are also identified with the various levels.

Gibson (2004) also claimed that the term *role model* was defined and used inconsistently or loosely. He noted that research on mentoring had far surpassed that of role models and called for reinvigorating the role model construct. Role modeling has both learning (models who demonstrate tasks, skills, and norms) and identification/social influence dimensions (models with whom persons identify or wish to emulate). Gibson noted that Bandura's theory focused more on the first dimension of role modeling than on the second. He proposed that role models can be positive or negative, global or specific in terms of number and variety of attributes that persons wish to emulate (two cognitive dimensions) and also close or distant ranging from frequent interaction to none at all, and up or across/down in terms of relative status (two structural dimensions). Unlike in Mertz's (2004) definition, he posited that role models could be imaginary with no actual interaction.

For the current study, role model was defined as *a person you know personally, or know of, who has influenced your career decisions by being admirable in one or more ways* whereas *mentor was a person who has influenced your career decisions by actively giving advice, encouraging (or discouraging), supporting, providing information, or helping you make decisions*. These definitions were designed to parallel Nauta and Kokaly's (2001) two factors.

Mentoring and Role Modeling in STEM Programs and Professions

Most science and engineering professors are male and are more comfortable with and accustomed to male students. They are more likely to choose, whether consciously or not, to be mentors to male rather than female students (Betz, 1994). This view is supported by earlier research that suggests that mentors choose protégés with whom they identify and that identification is likely to depend on sex, race, and social class (Shapiro, Haseltine, & Rowe, 1978). The lack of mentors for female graduate students can lead to exclusion from informal and discretionary interactions such as working with a professor on his research, serving as a research assistant, co-authoring a paper, or co-presenting at a scientific meeting (MIT, 1999). The importance of mentoring was corroborated in a recent study by Downing, Crosby, and Blake-Beard (2005), who found that 90% of female science undergraduates had a guide in the form of mentor, role model, or sponsor. Of these, mentors were the most influential in the women's pursuit of science as a career

Mentoring for women has received considerable attention in STEM programs and professions in some parts of North America at various entry points of the science career pipeline. These programs target students transitioning from high school to undergraduate studies (e.g., Elizabeth Cannon's well-known SCIber Mentor program for high school students at the University of Calgary and University of Alberta's WISEST summer program designed to encourage high school girls to study engineering or science). Programs also help students transitioning from undergraduate to graduate studies (e.g., the WISE/Women in Science and Engineering Program that offers scholarships, programs, and services throughout the undergraduate experience). Programs also target professionals beginning STEM careers or those who wish to maintain STEM careers and develop professionally within them. The efficacy of an undergraduate mentoring program for sustaining an interest in science was addressed by Campbell and Skoog (2004), who reported that 90% of the program fellows pursued science careers. Surveyed fellows reported that the support, encouragement, and expertise provided through the mentor relationships were among the most compelling factors influencing their career choice.

Gibson (2004) noted that persons tended to identify with multiple role models, except in cases where there was limited availability. This case would certainly apply to women in STEM programs and professions that are male-dominated. Settles et al. (2007) treated role modeling as one among several levels of support in a broader framework of mentoring. When compared with male mentors, they claimed that, "female mentors may be more likely to serve as role models and provide psychosocial support" (p. 273).

Purposes of the Study

Because the constructs of mentoring and role modeling are used interchangeably and defined inconsistently in the literature, it was important to examine whether the distinctions found by Nauta and Kokaly (2001) when factoring the Influence of Others on Academic and Career Decisions Scale (IOACDS) would hold true for a graduate science student sample. These distinctions might have particular relevance to female graduate science students owing to the scarcity of female role models in STEM careers. Thus it was also important to discover whether and to what extent role modeling and mentoring influenced academic and career decisions. If mentoring were found to be influential, steps could be taken to increase this form of support or sustain existing programs.

The purpose of this research was to test the construct validity of the IOACDS (Nauta & Kokaly, 2001) on a graduate student population and use this instrument to examine the degree of influence that role models/mentors have on female graduate students' choice of science as a career. Using the Career Choice Information scale, the source and degree of influence of male and female role models and mentors in the university setting were examined. Also explored were the questions of whether the influence and types of role models and mentors differed between male and female science graduate students in general and in the biological, engineering, and physical sciences.

The following research questions guided this study:

1. What are the psychometric properties of the IOACDS with this sample of graduate science students?
2. Are there differences in responses to the IOACDS between: (a) male and female graduate students? (b) graduate students in different areas of study (i.e., biological sciences, physical sciences, and engineering)?
3. Are there differences in types of role models and mentors identified as having been the most influential in career decisions between: (a) male and female science graduate students? (b) graduate students in different areas of study (i.e., biological sciences, physical sciences, and engineering)?

In addition, two emergent questions were addressed:

1. Are there differences in responses to the IOACDS between students who had completed their undergraduate studies in different countries (i.e., Canada, China, other non-Canadian universities)?
2. Are there differences in types of role models and mentors identified as having been the most influential in career decisions between students who had completed their undergraduate studies in different countries (i.e., Canada, China, other non-Canadian universities)?

Participants

After ethics approval from our university and third-party permission from the Dean of Sciences at a large Atlantic Canadian University were received, the department heads, coordinators, and professors of the 21 science departments selected for the study were contacted. Approximately 832 surveys were distributed, either by seminar attendance or mailbox delivery, to the graduate students of the various departments. Participants included male and female graduate students pursuing master's or doctoral degrees in 21 programs in a large Atlantic Canadian University in 2003. The 21 programs consisted of biological sciences (biology, biochemistry, microbiology, physiology, and anatomy), engineering (industrial, chemical, civil, electrical, internetworking, petroleum, biomedical, biological, food science, and engineering math), physical sciences (physics, chemistry, oceanography, and earth sciences), computer science and mathematics/statistics. These programs were categorized into three broad categories of engineering, biological and physical sciences (which now included computer sciences, and mathematics/statistics) in order to ensure large enough sample sizes. Statistics Canada's (2001) categorization of major fields of study was followed to create the three broader categories.

The response rate of 44.6% (371 surveys returned from 832 distributed) is only an estimate. Given the method of distribution, some students may have received more than one survey, although it is unlikely that participants would complete the survey more than once. However, an overlap in survey distribution may underestimate the actual return rate.

Of the 371 respondents, 139 or 37.5% (98 or 70.5% male, 41 or 29.5% female) were enrolled in engineering, 145 or 39.1% (93 or 64.2% male, 52 or 35.8% female) in the physical sciences and 87 or 23.5% (39 or 44.8% male, 48 or 55.2% female) in the biological sciences.

Although most of the students had received their undergraduate degrees from Canadian universities (206 students or 55.5%), a large number had received their undergraduate degree from a foreign university, especially China. In fact, 77 students (20.7%) had received their degree from a Chinese university. Only half the students were born in Canada (181 or 48.8%) and spoke English as their first language (189 or 50.9%). Eighty-one (or 21.8%) students were born in China and 83 (or 22.4%) indicated Chinese as their first language.

Of the 224 students (60.4%) who had decided on their career, 57 (25.4%) indicated that they would like to work in academia (teaching and conducting research), and 145 (64.7%) indicated that they would like to work in industry. A smaller number (22 or 10%) indicated that they would like to pursue further studies in another field such as education or the health professions.

Twenty-four surveys were discarded from the total of 371 returned owing to missing data (i.e., not all three parts of the survey were completed). The final sample included in subsequent data analysis totaled 347.

Instrumentation

A quantitative questionnaire comprising three parts was administered.

1. Background information included sex, age, degree program, year of study.
2. Influence of Others on Academic and Career Decisions Scale (IOACDS).
3. Career Choice Information scale.

Influence of Others on Academic and Career Decisions Scale

This survey instrument developed by Nauta and Kokaly (2001) was selected owing to its content relevance, broad applicability, and grounding in Bandura's well known theory. Given the thoroughness of the processes used to develop this instrument and assess its validity, the IOACDS also provided a basis for statistical comparison. The IOACDS was used to assess the degree and type of role model influences on the academic and vocational decisions of undergraduate students. Comprising two subscales with a total of 15 items, the Support/Guidance subscale consists of seven positively worded items (e.g., There is someone who helps me consider my academic and career options) and one negatively worded item (e.g., There is no one who shows me how to get where I am going with my education or career). The Inspiration/Modeling subscale consists of four positively worded items (e.g., There is someone I am trying to be like in my academic or career pursuits) and three negatively worded items (e.g., There is no one I am trying to be like in my academic and career pursuits). The IOACDS is scored using a 5-point Likert scale (1=*Strongly agree* and 5=*Strongly disagree*). Reverse scoring is used for negatively worded items.

The scale was developed through a two-stage process. In the first stage, survey items were generated in order to ensure relevant content. A diverse group of 116 undergraduate students from a large Midwestern United States university were asked to indicate which role model in several categories (family members, teachers, advisors, coaches, famous people/characters, others) had the most influence on their academic and career decisions. Students were also asked how that person had influenced them, and their responses were grouped into five categories: (a) Gives advice, (b) Encourages/supports, (c) Inspires, (d) Models, (e) Helps make decisions. An initial 35-item pool of seven items for each of the five categories of influence was developed. Respondents indicated agreement or disagreement with each item on a 5-point Likert scale.

In the second stage, the psychometric properties of the initial IOACDS item pool were assessed, and items were selected for the final scale. A second diverse group of 190 undergraduate students from a large Midwestern US university was asked to complete the initial 35-item IOACDS. An exploratory factor analysis using principal-axis method and oblique rotation was conducted. A two-factor solution resulted in Factor 1 (Support/Guidance) consisting of eight items and comprising 34% of the variance plus Factor 2 (Inspiration/Modeling) made up of seven items and accounting for 26% of the variance. The remaining items were discarded owing to ambiguous loadings.

Adaptations to the IOACDS. Minor adaptations were made to the IOACDS to suit this research study with graduate science students. Statements were changed from present to past tense. Statements containing "academic or career" were changed to "academic/career." The numbers were rearranged from 1 2 3 4 5 to 5 4 3 2 1 in the 5-point Likert scale so that 5 became *Strongly agree* and 1 became *Strongly disagree*. In other words, the higher numbers indicated greater strength of agreement. The 15 items of the IOACDS were randomly selected for positioning in this version of the scale.

Career Choice Information

The Career Choice Information scale comprised general questions about whether participants had decided on their career and what their choice was. A list (male or female academic advisor, undergraduate professor, graduate professor, and other) was provided along with definitions of role model and mentor. Respondents were asked to indicate the degree of influence that these university-based role models and mentors had on a 5-point Likert-type scale ranging from 5=*encouraged me greatly* to 1=*discouraged me greatly*. They completed this measure twice, once for role models and once for mentors. These descriptors acknowledged that mentors and role models might have a negative as well as a positive influence.

Results

Psychometric Properties of the IOACDS

The psychometric properties of the IOACDS were assessed using a principal components factor analysis with Varimax rotation. A two-factor solution appeared to provide the most interpretable configuration of variable clusters. Factor 1, renamed the *Mentor* factor and consisting of 7 items, accounted for 28.6% of the variance and Factor 2, renamed the *Role Model* factor and consisting of 6 items, accounted for 23.6% of the variance. Factor 1 had an eigenvalue of 4.29, Factor 2 had an eigenvalue of 3.53, and cumulatively the two factors accounted for 51.6% of the total variance.

Only variables and factor loadings of .40 or greater were included on a factor. Of the 15 variables included in the two-factor rotation, a total of 13 met this criterion for inclusion on a factor. Two of the original variables were discarded because they did not load highly on either factor. As indicated in Table 1, both factors had items with high to moderately high loadings with enough items to form two distinct clusters.

Table 1
Two Factors of the IOACDS with Items and Factor Loadings

Number	*Item*	*Loading*
	Factor 1: Mentor	
1.	There was someone I could count on to be there if I needed support when I made academic/career choices.	.766
3.	There was someone who supported me in the academic/career choices I made.	.795
8.	There was no one who supported me when I made academic/career decisions.	.653
11.	There was someone who helped me consider my academic/career options.	.678
13.	There was someone who helped me weigh the pros and cons of academic/career choices I made.	.665
14.	There was someone who stood by me when I made important academic/career decisions.	.769
15.	There was someone who told me or showed me general strategies for a successful life.	.670
	Factor 2: Role Model	
4.	There was no one I was trying to be like in my academic/career pursuits.	.726
6.	There was someone I was trying to be like in my academic/career pursuits.	.788
7.	In the academic/career path I am pursuing, there was someone I admire.	.709
9.	I know of someone who had a career I wanted to pursue.	.686
10.	In the academic/career path I am pursuing, there was no one who inspired me.	.615
12.	There was no one particularly inspirational to me in the academic/career path I am pursuing.	.658

Table 2
ANOVA Comparing Factor Scores on the IOACDS by Gender

Gender	*N*	*M*	*SD*	*df*	*F*	*P*
			Factor 1: Mentor			
Male	224	16.930	4.589	1	2.18	.1403
Female	135	17.806	4.410	1	2.18	.1403
			Factor 2: Role Model			
Male	218	13.087	3.092	1	9.11	.0027**
Female	134	12.097	3.083	1	9.11	.0027**

Note. ***p*<.01; *N* varies because incomplete surveys had to be discarded.

Factor scores were generated on the two rotated factors and used in the subsequent analysis of the IOACDS. Factor scores more accurately captured the variation in the dataset.

Comparison of Factor Scores by Gender

A one-way analysis of variance test (ANOVA) was used to compare factor scores on the IOACDS by sex (see Table 2). Men had significantly higher scores on Factor 2, the Role Model factor, than women, indicating that they identified role models as having influenced their academic/career decisions more frequently than did women. No significant sex differences were found on scores for Factor 1, the Mentor factor. Although not significant, women had higher mean scores on the Mentor factor, indicating a tendency in that direction.

Comparison of Factor Scores by Area of Study

A one-way analysis of variance test was used to compare factor scores on the IOACDS by area of study (see Table 3). Least-squares means procedure was used as a follow-up post hoc test to indicate which groups had significant mean differences. Significantly higher scores on Factor 1 indicated that more engineering and biological science students than physical science students identified mentors as having influenced their academic/career decisions. No

Table 3
ANOVA Comparing Factor Scores on the IOACDS by Area of Study

Gender	*N*	*M*	*SD*	*df*	*F*	*P*
			Factor 1: Mentor			
Engineering	134	17.752	4.464	2	4.03	.0187*
Physical	140	16.376	4.637	2	4.03	.0187*
Biological	85	17.938	4.292	2	4.03	.0187*
			Factor 2: Role Model			
Engineering	133	12.910	3.214	2	0.67	.5127
Physical	137	12.459	3.176	2	0.67	.5127
Biological	82	12.806	2.875	2	0.67	.5127

Note. **p*<.05; N varies because incomplete surveys had to be discarded.

Table 4
ANOVA Comparing Types of Role Models and Mentors Identified by Gender

Gender	*N*	*M*	*SD*	*df*	*F*	*P*
			Role Model (female academic advisor)			
Male	159	3.283	0.969.	1	6.54	.0111*
Female	88	3.614	0.863	1	6.54	.0111*
			Mentor (female other)			
Male	28	2.929	0.900	1	5.70	.0237*
Female	7	3.714	0.951	1	5.70	.0237*

Note. $^*p<.05$.

significant area of study differences were found on scores for Factor 2, the Role Model factor. No significant Gender x Area of Study interactions were found for either factor.

Comparison of Types of Most Influential Role Models and Mentors

When identifying role models, more women than men identified female academic advisors as influential for their career decisions. When identifying mentors, more women than men identified female others (i.e., coaches and chaplains) as influential for their career decisions (see Table 4). More engineering than physical science students identified female peer role models as having influenced their career decisions (see Table 5).

Emergent Research Questions

Because graduate students who had completed their undergraduate studies in China represented a sizable and distinct cluster, we decided to examine how their scores differed from those of graduate students who had completed their undergraduate studies in Canada or other non-Canadian countries. A one-way ANOVA was used to compare factor scores on the IOACDS by undergraduate country using least-squares means as a follow-up.

More students who had attended Canadian undergraduate programs than Chinese or other non Canadian undergraduates identified mentors as having influenced their career decisions. More Chinese undergraduates than Canadian or other non-Canadian undergraduates identified role models as having influenced their career decisions (see Table 6).

Table 5
ANOVA Comparing Types of Role Models and Mentors by Area of Study

Gender	*N*	*M*	*SD*	*df*	*F*	*P*
			Role Model (female peer)			
Engineering	4	4.750	0.500	2	12.30	.0195*
Physical	4	3.750	0.500	2	12.30	.0195*
Biological	1	5.00	0.000	2		

Note. $^*p<.05$.

Table 6
ANOVA Comparing Factor Scores on the IOACDS by Undergraduate Country

Undergraduate Country	*N*	*M*	*SD*	*df*	*F*	*P*
			Factor 1: Mentor			
Canada	200	18.515	4.072	2	19.45	.0001**
China	76	15.185	4.466	2	19.45	.0001**
Other Foreign	76	16.235	4.734	2	19.45	.0001**
			Factor 2: Role Model			
Canada	196	12.383	3.143	2	4.52	.0116*
China	75	13.621	2.693	2	4.52	.0116*
Other Foreign	74	12.518	3.270	2	4.52	.0116*

Note. $^{**}p<.01$; $^{*}p<.05$.

A comparison of types of role models revealed that more Canadian undergraduates than Chinese undergraduates identified female academic advisors, both female and male undergraduate professors, and male graduate professors as having influenced their career decisions. More Canadian undergraduates than Chinese undergraduates identified male undergraduate professors and male graduate professors as mentors who were most influential when they were making their career decisions (see Table 7).

Discussion

The results of the factor analysis of the IOACDS corroborate Nauta and Kokaly's (2001) finding that role models and mentors are two distinct entities that influence students in distinct ways. This factor pattern was a notable outcome of this study. This factor solution also lends support and focused attention on the *learning/modeling* and *verbal persuasion/support from others* self-efficacy factors outlined in Bandura's Social Learning Theory in that they closely parallel the *role model* and *mentor* factors in this study.

Consideration of these distinctions has implications for educational practices and the conduct of further research in this area. The *role model* and *mentor* factors, unlike other factors (such as social influences outside the university setting), are more in the control of universities and program areas. Further, the quality of role models/mentors may be just as important as the quantity (Zeldin & Pajares, 2000). Further examination of distinctive qualities of role models/mentors and various types of each is warranted. New instruments with more nuanced distinctions could be developed based on ideas from Mertz (2004) and Gibson (2004).

Gender Differences

The finding that more men than women identified role models as influencing their career decisions was not surprising given that there are more male role models in STEM graduate programs. Women's scores on the Mentor factor indicated a tendency toward higher scores than men, although not at the level of statistical significance. Perhaps it is sufficient for men to observe and emulate someone they admire, whereas women may require a more hands-on,

Table 7
ANOVA Comparing Types of Role Models and Mentors Identified by Undergraduate Country

Undergraduate Country	*N*	*M*	*SD*	*df*	*F*	*P*
			Role Model			
			Female Academic Advisor			
Canada	128	3.523	0.913	2	3.12	.0461*
China	63	3.175	0.993	2	3.12	.0461*
Other Foreign	50	3.320	0.913	2	3.12	.0461*
			Male Undergraduate Professor			
Canada	189	4.074	0.872	2	15.80	.0001**
China	70	3.400	0.954	2	15.80	.0001**
Other Foreign	68	3.691	0.902	2	15.80	.0001**
			Female Undergraduate Professor			
Canada	156	3.577	0.944	2	4.81	.0088**
China	62	3.145	0.973	2	4.81	.0088**
Other Foreign	53	3.321	1.043	2	4.81	.0088**
			Male Graduate Professor			
Canada	188	4.085	0.829	2	4.86	.0083**
China	68	3.691	0.981	2	4.86	.0083**
Other Foreign	69	3.913	1.025	2	4.86	.0083**
			Mentor			
			Male Undergraduate Professor			
Canada	173	3.977	0.908	2	9.29	.0001**
China	68	3.456	0.836	2	9.29	.0001**
Other Foreign	62	3.613	1.014	2	9.29	.0001**
			Male Graduate Professor			
Canada	171	3.930	0.878	2	4.10	.0176*
China	64	3.545	0.925	2	4.10	.0176*
Other Foreign	63	3.778	1.023	2	4.10	.0176*

Note. ***p*<.01; **p*<.05.

personal approach of mentors. This view would be in keeping with Zeldin, Britner, and Pajares (2007), who noted that relationships are primary to women. Given the importance of relationships, a peer mentor does not necessarily have to represent a low level of interaction as depicted in Mertz' (2004) model. More attention could be focused on encouraging and developing mentorship qualities in professionals and students in the university setting. As one example, female undergraduate science students could be encouraged to work collaboratively, mentor each other, and continue this pattern into graduate programs.

Program Area Differences

Among program area differences, more engineering and biological science students than physical science students identified mentors as having influenced their academic/career decisions. It is possible that engineering and biological science programs may be putting a greater emphasis on mentoring their students than physical science programs. Further study of mentoring in these programs would be necessary in order to gain a better understanding of this difference. Regardless of program type, instructional practices and class size indirectly influence the quality of mentorship available to students. Mentoring opportunities could be provided by having tutorials and group work in addition to lectures and a smaller student-instructor ratio typically found in laboratory settings.

Type of Role Model/Mentor Differences

The identification of women with female academic academic advisors is not surprising considering that one is more likely to identify with a role model who is the same sex as oneself (Shapiro et al., 1978). The question might be raised as to whether female academic advisors have particular characteristics that make them more accessible to or more influential with female university students than with males (i.e., age, communication style, more collaborative than directive problem-solving style). Settles et al. (2007) found that women mentored by other women reported the perception of having greater voice or sense of personal agency.

One explanation for the finding that more females than males identified the influence of female others could be that female students may not have found enough role models and mentors in their program and therefore felt the need to seek advice outside the classroom. A further study could examine whether female students in general are more likely to seek advice from others than are male students. For example, Perrone, Zanardelli, Worthington, and Chartrand (2002) and Ulku-Steiner, Kutz-Costes, and Kinlaw (2000) showed that women tended to gravitate toward more collaborative than competitive problem-solving and appeared to solve problems best when they could talk things out.

Similarly, the greater identification with female peer role models by engineering students compared with physical science students could reflect a need to seek advice from their female peers in order to compensate for lack of female role models in the university setting. These peers perhaps displayed more collaborative problem-solving styles than their more competitive male counterparts.

Undergraduate Country Differences

The finding of significant differences on factor scores for students who took their undergraduate degrees in Canada versus China raised the following questions: Is mentoring predominantly a Western or North American concept? Is role model influence more salient in Chinese culture? Perhaps it is not the salience, but simply the number of role models and mentors available to undergraduate students in their respective cultures that is important. What is the gender composition in Chinese and other non-Canadian undergraduate programs? Are there more female science instructors in Chinese undergraduate programs? Are science classes larger in China? If so, there would be less opportunity for one-on-one mentoring. Although some mentoring may be taking place in lab settings, might the lecturer have relatively greater status and authority and consequently be perceived as less approachable? These questions point to complex cultural influences that would require further examination.

Significant undergraduate country differences were found for the types of role models and mentors identified. Female academic advisors, both female and male undergraduate professors, and male graduate professors were more influential as role models for students who attended Canadian undergraduate programs than for those who attended Chinese undergraduate programs. When it came to mentors, more Canadian than Chinese undergraduates identified male undergraduate professors and male graduate professors as having influenced their career decisions. These influences were revealed only for specific types of role models and mentors. When considered collectively, however, those who had attended Canadian undergraduate programs were less influenced by role models than Chinese undergraduates and vice versa for mentors. Further research would be needed to examine these influences more fully. It is interesting, however, that when types of mentors were shown to have an influence on graduate students' career choices, the sex of the mentor was not an issue. This finding may indicate that mentoring as a practice makes an important difference regardless of the sex of the mentor (Zeldin & Pajares, 2000). Consequently, when male professors mentor, they may help compensate for the lack of female role models or availability of female mentors.

Support for this interpretation comes from the literature. Madill et al. (2004) reported that female students in science, engineering, and technology did not appear to be concerned with the relative lack of female models. The findings of this and related studies strike an optimistic chord because provision of mentoring opportunities is in the control of university programs. Mentoring can come from a variety of sources both inside and outside the undergraduate and graduate classroom. Instructors, advisors, and peers can all play a role among others. Existing university-based mentoring programs can be adapted to meet the needs and resources of programs in other regions. Initiatives taken to increase the quantity and quality of mentoring services and support existing programs could make a difference in attracting more female candidates to STEM careers.

Acknowledgment

We acknowledge Rosemarie Sampson for suggesting the emergent questions in the study and Jeff Young for assisting with the statistical analysis.

References

Acker, S., & Oatley, K. (1993). Gender issues in education for science and technology: Current situation and prospects for change. *Canadian Journal of Education, 18*, 255-271.

Bandura, A. (1969). Social learning theory of identification process. In D.A. Goslin (Ed.), *Handbook of socialization theory and research* (pp. 213-262). Chicago, IL: Rand McNally.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*, 191-215.

Bandura, A. (1982). Self-efficacy mechanism in human agency. *American Psychologist, 37*, 122-147.

Bandura, A. (1986). *Social foundations of thought and action*. Englewood Cliffs, NJ: Prentice-Hall.

Betz, N. (1994). Career counseling for women in the sciences and engineering. In W.B. Walsch & S.H. Osipow (Eds.), *Career counseling for women* (pp. 237-263). Hillsdale, NJ: Erlbaum.

Brush, S.G. (1991). Women in science and engineering. *American Scientist, 79*, 404-419.

Campbell, A., & Skoog, G. (2004). Preparing undergraduate women for science careers. *Journal of College Science Teaching, 33*(5), 24-26.

Downing, R.A., Crosby, F.J., & Blake-Beard, S. (2005). The perceived importance of developmental relationships on women undergraduates' pursuit of science. *Psychology of Women Quarterly, 29*, 419-426.

Eccles, J. (1994). Understanding women's educational and occupational choices. *Psychology of Women Quarterly, 18*, 585-609.

Ehrhart, J.K., & Sandler B.R. (1987). *Looking for more than a few good women in traditionally male fields*. Washington, DC: Project on the Status of Women, American Association of Colleges.

Gibson, D.E. (2004). Role models in career development: New directions for theory and research. *Journal of Vocational Behavior, 65*, 134-156.

Hackett, G., & Betz, N.E. (1981). A self-efficacy approach to career development of women. *Journal of Vocational Behavior, 18*, 326-339.

Madill, H.M., Ciccocioppo, A., Stewin, L.L., Armour, M., & Montgomerie, T.C. (2004). The potential to develop a career in science: Young women's issues and their implications for career guidance initiatives. *International Journal for the Advancement of Counselling, 26*, 1-19.

Mertz, N.T. (2004). What's a mentor, anyway? *Educational Administration Quarterly, 40*, 541-560.

MIT. (1999). *A study of the status of women in science at MIT*. Available: http://web.mit.edu/fnl/women/women/html

Morrell, C. (1991). Uncommon knowledge: Women in science and women's studies at the University of Saskatchewan. In T. Wotherspoon (Ed.), *Hitting the books: The politics of educational retrenchment* (pp. 169-188). Toronto, ON: Garamond.

Nauta, M.M., & Kokaly, M.L. (2001). Assessing role model influences on students' academic and career decisions. *Journal of Career Assessment, 9*, 81-89.

Scott, J. (1990). Disadvantagement of women by the ordinary processes of science. In M. Ainley (Ed.), *Despite the odds: Essays on Canadian women and science*. Montreal, PQ: Véhicule Press.

Settles, I.H., Cortina, L.M., Stewart, A.J., & Malley, J. (2007). Voice matters: Buffering the impact of a negative climate for women in science. *Psychology of Women Quarterly, 31*, 270-281.

Shapiro, E., Haseltine, F., & Rowe, M. (1978). Moving up: Role models, mentors, and the patron system. *Sloan Management Review, 19*, 51-58.

Statistics Canada. (2001). *Census dictionary*. Ottawa: Ministry of Industry.

Statistics Canada. (2006). *Women in Canada: A gender-based statistical report* (5th ed.), Ottawa: Ministry of Industry.

Perrone, K.M., Zanardelli, G., Worthington, E.L., & Chartrand, J.M. (2002). Role model influence on the career decidedness of college students. *College Student Journal, 36*, 109.

Ulku-Steiner, B., Kutz-Costes, B., & Kinlaw, C.R. (2000). Doctoral student experience in gender-balanced and male-dominated graduate programs. *Journal of Educational Psychology, 92*, 296-307.

Wenneras, C., & Wold, A. (1997). Nepotism and sexism in peer review. *Nature, 387*, p. 341.

Williams, M.F., & Emerson, C.J. (2002). *Becoming leaders: A handbook for women in science, engineering, and technology*. St. John's, NL: NSERC/Petro-Canada Chair for Women in Science and Engineering and Women in Science and Engineering (WISE) Newfoundland and Labrador.

Zeldin, A.M., Britner, S.L., & Pajares, F. (2007). A comparative study of the self-efficacy beliefs of successful men and women in mathematics, science and technology careers. *Journal of Research in Science Teaching, 45*(9), 1036-1058.

Zeldin, A.L., & Pajares, F. (2000). Against the odds: Women in mathematical, scientific, and technological careers. *American Educational Research Journal, 37*(1), 241-246.