

THE ROLE MODEL EFFECT IN HIGHER EDUCATION

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## **Abstract**

This report provides review of the existing literature on the role model effect in higher education and identifies the methodological and conceptual issues that have complicated the research program before discussing how research on similar areas may provide insight into the relationship between female students and female faculty members. By examining the related literature on the determinants of college major, peer effects, and critical mass theory, the existing studies of role model effect can be interpreted as support for a more specified theory of the role model effect in higher education that highlights the importance of the gender composition of the course or field of study.

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# Chapter 1 - Gender Gap in Degree Attainment

Since 1982 women have consistently outpaced men in the number of bachelor's degrees earned annually (Jacobs, 1996). However, data from the National Center of education Statistics reveal that gender gaps in degree attainment remain in many science and technology related fields (England et al., 2007). While persistently low levels of female representation among degree recipients in these traditionally male-dominated fields have generated an array of interdisciplinary research, these studies lack a consistent interpretation of which fields have traditionally been dominated by men. Recently many authors and agencies have adopted the STEM acronym in recognition of common characteristics shared by science, technology, engineering and mathematics disciplines; such as clearly delineated paradigms and well established rules and standards for scientific practice (Xu, 2008b). In addition many of the STEM fields are classified as hard sciences under Biglan classification system and have traditionally had low level of female representation. (Biglan, 1973; Xu, 2008b).<sup>1</sup>

The National Science Foundation, which closely monitors minority participation in STEM fields, collected the data featured in Figure 1.1 which illustrates the percentage of Bachelor's degrees awarded to women in, psychology, sociology, life sciences, physical science, economics, math and computer science, and engineering in 1966-2006. A graphical display of this data captures the varying levels of female representation in STEM subfields and the differences in gender over time between subfields. While the life sciences, physical sciences, and engineering have had similar patterns of slowly increasing female participation, women's representation in economics has been relatively stagnant for the past quarter century, and has recently declined in math and computer sciences (National Science Foundation, National Center for Science and Engineering Statistics, 2011).

A growing portion of the literature attempting to understand women's field of study choices focuses on "The "Pipeline Model" as a metaphor to address two possible aspects of the

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<sup>1</sup> While the classification of economics and other social sciences under the STEM umbrella can be controversial, this paper relies on the precedent set by The National Science Foundation, which is the only federal agency whose mission includes support for all fields of fundamental science and engineering, except for medical sciences. Included among these are Life sciences, Geosciences, Social sciences, Computer sciences, Engineering, Physics & Astronomy, Psychology and Economics.

underrepresentation of women in STEM (Xu, 2008b). First, the “pipeline” addresses the importance of increasing the “flow” of females into the “pipe”, which is the volume of female students in STEM undergraduate and graduate programs. Second, the pipeline model addresses the importance of preventing “leakage”, which is female students’ premature exit from their intended program of study or academic career path. The assumption here is that increasing the portion of female doctoral recipients will lead to subsequent increases in the female representation on university faculty (Kulis et al., 2002). However, despite increases in undergraduate and post-graduate STEM degrees awarded to women, Kulis et al. note that there has not been a proportionate increase in female representation on university faculty, which suggests that there is leakage that may be related to gender disparity in hiring practices or women leaving academia prematurely (Xu, 2008a).

Noting the persistent lack of female faculty members in STEM fields,- many suggest that increasing the portion of female faculty in STEM will attract higher levels of female student participation in STEM thereby increasing the “flow” of women into the discipline. The observed correlation in STEM fields between low levels of female undergraduate students and concurrent underrepresentation of female faculty suggests that there could-be a causal relationship in which the lack of female role models available to female undergraduates deters their entry into a given field of study. However, others argue that there may be exogenous factors that make a given discipline unattractive to the majority of women thereby resulting in underrepresentation of female faculty and students alike. Thus, the assertion that increasing female faculty will increase the flow of female students into the pipeline is a subject of much debate and remains unresolved by the existing literature. The question of whether the presence of female faculty in STEM fields influences the academic choices and outcomes of female university students has yet to be answered.

In addition to increasing the “flow” of female student in STEM, recent research has suggested that the presence of female faculty members may also prevent leakage by providing female students with role models whose success in a STEM fields they can emulate. In response to the trends in undergraduate representation in Stem fields, in 2007 the Alfred P. Sloan Foundation provided a grant to the Cornell Higher Education Research Institute to study the factors that influence persistence rates in STEM field majors. The output of that project was recently published as a series of articles in *Economics of Education Review* (Kokkelenberg &

Sinha, 2010; Ost, 2010; Price, 2010; Rask, 2010). In his article introducing this new research, Ehrenberg (2010) explained that this research project was motivated by a recent National Academy of Science report which indicated that due to insufficient funding to education and research and low levels of US citizens entering STEM fields, the United States is at risk of losing its comparative advantage in these areas. Ehrenburg suggests that since only about half of students who enter college intending to major in STEM fields actually obtain a STEM degree, the most cost effective solution would be to increase the proportion of intended STEM majors who are retained in the degree program through graduation (Ehrenberg, 2010).

While qualified female students' failure to pursue or premature exit from STEM fields has clear consequences for the national economy, it also has profound consequences for women's individual earning potential. Since undergraduate education is considered a last point of entry into STEM fields, demographic imbalances at this phase of education strongly shape the subsequent gender composition of the workforce (Sonnert, Fox, & Adkins, 2007). Many researchers believe that the gender imbalance in field of study is partially responsible for the continuing gender gap in earned income. Determining what factors are causing women to be deterred from entry into STEM fields may be a first step in eliminating a portion of the gender based disparity income.

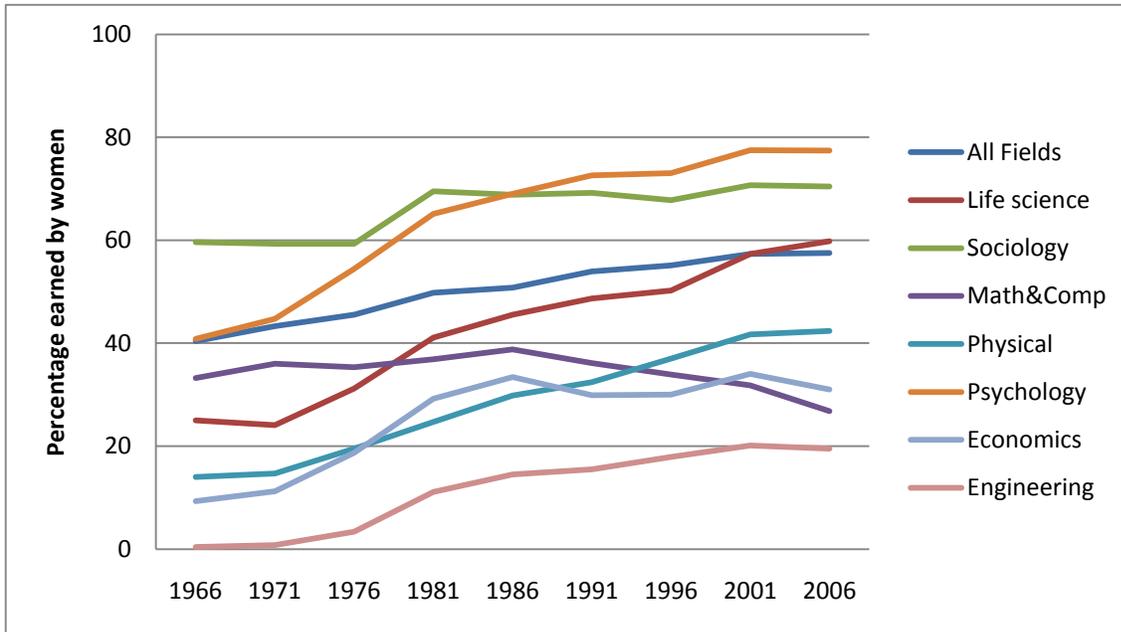
This research is not intended to achieve an elusive goal of gender parity within academic disciplines. Rather, it is part of a larger effort investigating the existence of practices, inadvertent or otherwise, that cause women to be excluded from STEM fields. Understanding what influences females' academic choices and performance is a vital step toward ensuring that young female students are choosing fields of study that allow them to exploit their natural comparative advantage. In contrast to begin motivated by a desire for gender equality in every field, research into females' choice of major is intended to ensure that equality of opportunity exists in higher education so that male and female students can rise and fall according to their merits.

Given the significance of students' choice of college major and persistence within that major research has been undertaken to determine what factors influence these choices. As part of that effort researchers have been investigating the importance of the "role model effect" in higher education. Although a large body of research on the role model effect exists at the primary and secondary level, much less has been done at the post secondary level As discussed in the following chapter the existing studies on the role model effect in higher education have produced

inconsistent results due largely to the methodological and conceptual issues that complicate this research when students matriculate to the postsecondary level.

## Figures and Tables

**Figure 1.1 Bachelor's Degrees by STEM field.**



SOURCE: Tabulated by National Science Foundation/Division of Science Resources Statistics; data from Department of Education/National Center for Education Statistics: Integrated Postsecondary Education Data System Completions Survey 2008.

## **Chapter 2 - Role Model Effect in Higher Education**

The “role model effect “ emerged in the elementary education literature in response to the idea that as children are growing up teachers become natural role models since they spend a large portion of the day with students. There is an observable gender based correlation in primary and secondary schooling where the faculty is predominantly women and female students are less likely to repeat grades than boys and are more likely to form positive views about going to college. Studies have offered possible reasons offered for why this might be a causal relationship rather than a spurious correlation: (1) Teachers may have biased interactions or expectations of students; (2) Students may be more engaged when taught by a same sex teacher; (3) Students may fear being stereotyped by a teacher according to their gender; (4) Girls and boys may respond differently to the teaching styles of men and women. (T. S. Dee, 2004; T. S. Dee, 2005; T. S. Dee, 2007; R. G. Ehrenberg, Goldhaber, & Brewer, 1995; Holmlund & Sund, 2008; Wayne & Youngs, 2003)

While many researchers have attempted to establish the existence or nonexistence of the role model effect at the primary and secondary education level, there has been relatively little research into the relationship at the post secondary level. Furthermore, the small body of studies on this topic contains methodological and conceptual inconsistencies and have not produced any consistent results or conclusions.

In perhaps the first empirical test of the role model effect, Rothstein (1995) used data from the National Longitudinal Study of the high school class of 1972 to examine the faculty gender composition of various universities and found a positive relationship between percentage of female faculty and the likelihood of female undergraduates obtaining an advanced degree. However, the result of this study also indicated that the percentage of female faculty at an institution had no effect on undergraduate degree attainment. In contrast to subsequent studies Rothstein was able to connect the results to labor market outcomes. While no direct relationship was found between percentage of female faculty and labor market earnings, obtaining an advanced degree was associated with a large increase in earnings (Rothstein, 1995).

While Rothstein (1995) compared aggregate data from various universities, Canes & Rosen (1995) lowered the level of analysis to the departmental level by utilizing panel data from

various academic departments at Princeton, University of Michigan and Whittier College to identify the relationship between year to year changes in the gender composition of a department's faculty and the gender composition of the departments' undergraduate majors. When estimated separately for each school, the authors found that the gender composition of the department had no significant impact of the portion of female majors for that department. Further estimations for the sciences and the humanities again found the percentage of female faculty members in a given department was not a significant predictor of the portion of female students that would major in the field (Canes & Rosen, 1995). Although these results appear to contradict the theory of the role model effect, it is not clear what aspect of the pipeline theory the researchers were testing. That is, it isn't clear if the presence of female faculty failed to increase the flow of female students or if the presence of female faculty failed to increase female student's level of persistence in a subject. Canes & Rosen (1995) further investigated the role of female professors by considering proportion of tenured female faculty and again found insignificant results and therefore concluded that the proportion of female faculty members in a department has no significant impact on the proportion of female students who pursue a major in that field (Canes & Rosen, 1995). However, the results of this study should not be over emphasized since it is unclear whether there was enough variation in the departments' proportion of female faculty members in the time period used for the study.

Although Canes & Rosen (1995) results were supported by Dynan & Rouse (1997) which also found no statistically significant relationship between the interaction of female students and female instructors, Robst, Keil, & Russo (1998) noted that Canes & Rosen neglected to consider the visibility and accessibility of female faculty members in their research. Robst et al. (1998) suggested that if female faculty members were primarily teaching and advising upper level undergraduates or graduate students then the general student body may not have been aware of the gender composition of varying departments.

This criticism highlights an area of complexity in assessing the role model effect literature, which is variation in the operationalization of the key independent variable being examined. Robst et al. note that measuring the availability of potential role models is often an approximation with many possible options including: female faculty in the entire university, within departments, or the faculty gender composition of courses actually taken by the students (Robst et al., 1998).

Robst et al. maintain that although faculty composition can vary widely between departments, measuring faculty gender composition at the department level may not provide an accurate assessment of available role models if students are not unaware of all professors. Rather, Robst et al (1998) choose to examine the impact of the faculty gender composition of courses actually taken by a student during his or her freshman year, using a very broad definition of role model citing Anderson & Ramesy (1990) who define a role model as someone “who possesses the skills or qualities that she or he lacks yet admires and wishes to emulate.” A role model’s behavior is observed and mimicked by an individual, although the role model may or may not have direct contact with the person. In contrast, a *mentor* is defined as a person who guides someone more junior in experience towards career accomplishments. Robst et al. note that due to data limitations they could not identify specific reasons why a faculty member may be a positive influence on a student and therefore expand the definition of role model to include mentors. Robst et al. further posit that female faculty may be considered role models because they have attained a position of power and prestige and may be able to demonstrate the successful combining of family and career roles.

Prior to Robst et al. (1998) there was a great deal of variation in how “role model” was defined and measured at the university level. While these studies have all been focusing on the role of female faculty of student outcomes, they used different methods to quantify the presence of female faculty including: % female faculty at an institution, % female faculty in a department or subfield, % of total credits taken with a female instructor, % of credits in a given discipline with female instructor. Following Robst and Russo, the practice of not distinguishing between role models and mentors became a common although often un-acknowledged aspect of the role model literature. Therefore, in the research that followed Robst et al. (1998), the convention became to utilize the presence of a female instructor as the key independent variable.

However, Robst et al. (1998) used an unconventional dependent variable in their research. They used data from the State University of New York at Binghamton to analyze the likelihood of students being retained for their second year. While subsequent studies addressing the “leakage” aspect of the pipeline model focused on a student’s retention within a given field of study, Robst et al. (1998) examined student retention in the university without regard to changes in field of study. They found no evidence of role model effects when considering the gender composition of faculty for all courses taken by female students. However, a positive and

significant effect was found for women who took at least one third of their courses in science, math, and computer science (SMC). Robst et al. also found a positive interaction effect indicating that the role model effect was stronger when female students had a greater percentage of credits in SMC courses. Thus, Robst et al. concluded the faculty gender composition in SMC courses is important for female students and it becomes more important the greater the number of courses in these disciplines. However, retention of male students was not found to be a function of SMC courses, indicating a gender differential in response to faculty composition (Robst et al., 1998).

In research following Robst et al. (1998), Robb & Robb (1999) noted that much of the previous literature on the role model effect in higher education was motivated by the need for institutions to predict /influence enrollment rates. As a result such research was primarily specific to the institution in which the study was based and focused on modeling groups of aggregated students and institutional characteristics. In contrast, Robb & Robb (1999) developed a model of personal choice by following students who studied first year microeconomics at Brock University, a midsize public university in Ontario between fall 1989 and spring 1995. They first estimated the effect of instructor gender on the grades earned in the course including indicator variables for the instructor and instructor\*gender variable designed to capture the significance of the instructor gender. This marked the first time in this body of literature that course grades were used as the dependent variable. Their results revealed that the gender of the instructor had no significant impact on female students' performance in the course. An additional estimation of the likelihood that a student will take additional courses in economics also included individual instructor dummies and role model interaction variable. Once again the role model variable proved to be insignificant; although the teacher dummies were highly significant. The authors report that additional tests indicated that the use of a single instructor-gender dummy variable could be rejected in favor of the set of individual teacher dummies. The authors caution that they cannot conclude that instructor gender does not affect student outcomes. Rather they suggest that the small sample of instructors examine may have biased their results.

The research program on the role model effect in higher education has been complicated by the use of multiple measurements of the dependent variables. Essentially, researchers are attempting to determine if female students' academic interest and outcomes are influenced by their instructors' gender. However, there are many ways of measuring students' interest and

outcomes. To date scholars have not reached a consensus on the method of measuring students' interest and outcomes which are most appropriate for this research. As a result, the research program contains a number of studies, the results of which are difficult to directly compare. In recognition of this problem, more recent literature often seeks to determine the effect of instructor gender on a number of possible outcomes such as: course completion, course performance, additional courses, and major choice.

Similar to Robb & Robb (1999), more recent research by Rask & Bailey (2002) investigated whether the gender of the instructor in first year university microeconomics affected the performance of female students, or the likelihood that students will continue in economics. The authors note that while this study is comparable to Dynan & Rouse (1997), there are significant differences. While Dynan & Rouse surveyed students at a highly selective university, Harvard, Rask & Bailey (2002) use data from a medium-size Canadian undergraduate school. Although they employ similar methodology, their data was taken over time and resulted in a much larger sample than that used by Dynan & Rouse (1997). Furthermore, Rask & Bailey (2002) used the choice of additional courses in economics in the next academic year as the outcome of interest while the earlier studies utilized choice of major. The authors expected a positive and significant coefficient on the interaction term if female instructors had a differential role-model effect on female students. Rather, the interaction term proved to be insignificant in every variation of the model used in their testing-down strategy. As a result Rask & Bailey concluded that there was no evidence of a female-role-model effect on performance in microeconomic principles. The authors' attempt to determine if a role model effect appeared as to influence students decision to continue in economics, indicated that fewer women continued in economics than did men, even when conditioned on first-year performance. They also found no indication that a female instructor made any difference to the probability of continuation for female students (Rask & Bailey, 2002).

Rask & Bailey (2002) note that one should exercise caution in drawing conclusions about the possibility of the role model effect based on their results. The authors suggest that perhaps these results should not be interpreted to mean that female economics professors have no role model effect. They argue that individual characteristics of the sample of professors they examined could have biased their results. For example, suppose that female students are discouraged from entering economics by the teaching style of their male teachers. This

discouragement also could have applied to current female professors who previously went through their university education but went on to become female economists. It may be that they selected the economics profession because in some way they responded more positively or were more like their male professors. This similarity may be in their mannerisms, thought processes, confidence level, etc. In other words, there may be a role-model effect that is obscured by the particular set of female instructors under examination. This alternative interpretation was also offered by Robb & Robb (1999) in response to their findings of insignificant role model effects.

Jensen & Owen (2000) use a large multi-school sample to investigate how student characteristics interact with teaching techniques and department characteristics to influence student's decision to continue to study economics beyond their initial course. An interesting finding of Jensen & Owen (2000) is that if economics instructors spend 30 minutes of each class period covering topics that are considered to be of traditional importance to women there is an increase in the confidence level of both male and female student. They also found that these gains in confidence were significantly reduced if the instructor was male. These survey responses indicate that the presence of a female instructor does have differential impact on female students. However, since it is difficult to measure qualitative variables like "confidence" and "interest" it is difficult to determine the how significant the role model effect is.

In addition to utilizing survey responses, examining students' decisions to take additional courses in a given subject has also emerged as common method of measuring students' level of interest. For example, Jensen & Owen (2001) examine students' choice to continue the study of economics beyond their first course using data from 93 sections of introductory economics taught in 34 coed liberal arts schools. They find that when looking at the probability of being encouraged, the instructor gender had a differential effect on male and female students. Holding all other variables constant, the probability that a female student becomes encouraged to take an additional course was 18% points lower when the instructor was male. Given that a substantial portion of female students in introductory economics had no intention of taking additional courses at the start of their introductory course, this is a significant result.

Ashworth & Evans (2001) also found evidence of an encouragement effect. While previous studies mentioned here have examined students' decision to study economics at the university level (Dyner & Rouse, 1997; Fournier & Sass, 2000; Jensen & Owen, 2001) Ashworth & Evans utilize survey data of 16 year olds to investigate the decision to study

economics at the students' first opportunity. Since the decision to study economics at the university level is likely influenced by experiences in secondary economics or failure to take secondary economics Ashworth & Evans argue that this research is pertinent in addressing the underrepresentation of women in this field.

To further identify key influences on the decision to study economics, Ashworth & Evans (2001) estimated two multinomial logit models of the decision to study economics; first at the A-level (upper level secondary school) and then at the university level. Results from the estimation of the decision to study A-level economics show support for the theory of a role model effect. They report that male teachers of economics discourage female students from taking the subject, while female students are more attracted to study economics when the subject is taught by a female teacher. This suggests that the role model effect of female teachers may influence the "flow" of female students into the discipline. Furthermore the authors find that female students are more likely to study A-level economics if there are other female students studying economics at their institution (Ashworth & Evans, 2001).

Ashworth & Evans (2001) second estimation finds that having had a female secondary teacher does not significantly influence the decision to study economics at the university level. This suggests that perhaps the role model effect has less potential to decrease "leakage". The variable capturing the ability of fellow students indicates that increasing the overall ability of the peer groups can increase the likelihood that a student will study economics at the university level. The authors conclude that to encourage young women to study economics it may be necessary to generate a critical mass of female economics students within the institution. They also note that more female professors could also help to attract women at the university level (Ashworth & Evans, 2001).

Utilizing data from the political science department at Brigham Young University which consistently produces more male than female graduates, Butler & Christensen (2003) addressed the possibility of the role model effect in undergraduate teaching by introducing a new dependent variable, course completion. The authors used data from a required course in the major to test the hypothesis that female instructors have a positive role model effect on their students. The structure of the course creates an interesting platform to investigate this hypothesis. The course met three times a week, twice for lectures and once for a lab conducted by a graduate teaching assistant (TA). In each lab session the TAs were responsible for grading writing assignments,

administering quizzes reviewing the lecture, answering questions, and handling all complaints. Butler & Christensen argue that the prominent role of TAs allowed researchers to test the role model effect by equating TA effect with instructor effects. Furthermore, students were unaware of the TAs gender when they register for a lab section; a blind grading system was in place; and the course used both objective and subjective methods of evaluation via the writing assignments and the multiple choice final exam.

Butler & Christensen (2003) suggest that the role model effect could manifest as either a general effect, where female students are more enthusiastic about the course, or a specific effect in which female students are more likely to complete the course and perform better on assignments. In the first estimation, Butler & Christensen used course completion as the outcome of interest. Results indicated that 88.3 % women in labs with male TAs were expected to complete the course while 96.3 % of females with female TAs were expected to complete the course. Results further indicated that there were no consistent differences in students' course performance based on the gender of the TA, suggesting that the gender of the instructor may not be a significant factor in student performance. Butler & Christensen conclude that although the women with female teaching assistants may not learn the material better, there is strong motivational component of female instructors acting as role models (Butler & Christensen, 2003).

In contrast to Butler & Christensen (2003) which looked at only a single department in a single university, Bettinger & Long (2005) used a large longitudinal dataset of nearly 54,000 first time, fulltime freshmen enrolled in four-year colleges in Ohio in fall 1998 to investigate how the gender of the instructor effects the likelihood that a female student will take additional courses in a given subject. The descriptive data of the samples reveals that women are underrepresented majors in computer science (14%), economics (29.8%) and engineering (16%), however women are overrepresented in English, psychology, education and social work. Additionally, females comprised less than 1/3 of the faculty teaching introductory courses in history, economics, political science, chemistry, physics, math, business computer science and engineering (Bettinger & Long, 2005).

In their estimation Bettinger & Long (2005) specify the key explanatory variable as the proportion of the courses in subject 'k' that student 'i' took from female instructors during the first semester student 'i' was exposed to the department. The authors include a vector of controls

for student demographics and ability (age, gender, race, state of residency, and ACT score), and an additional vector which controls for individuals' interactions with a particular subject including whether the subject is in the student's intended major. Since Bettinger & Long (2004) showed that instructor attributes may affect student interest, Bettinger & Long (2005) also included controls for whether the faculty member was part-time (i.e., adjunct) or graduate-student instructor. The results of their estimation show that the role model effect varies by field of study. They authors report that for the majority of humanities and social sciences having a female instructor positively and significantly influence the number of subsequent credits female students took with particularly strong and positive effects found in mathematics, statistics, geology, sociology and journalism. However, this effect was the opposite for political science, where a female instructor was associated with a decrease in the total number of credit hours taken by female students. Similarly, having a female faculty member decreased the likelihood that female students would major in economics or psychology. While there was no significant role model effect observed in engineering, physics and computer science. Bettinger & Long (2005) repeated the analysis to see the impact that male faculty members would have on male students in a woman dominated field. The results revealed that male students who had male professors in initial education courses took 12.9 more subsequent credits and were much more likely to choose education as their major, indicating qualified support for a role model effect in this scenario.

Hoffmann & Oreopoulos (2009) noted that while Bettinger & Long (2005) advanced the existing research work by adding within course and within student variation, they neglected to investigate the interaction effects on more immediate classroom outcomes, like grades or dropout rates. Therefore, Hoffmann & Oreopoulos (2009) estimated the effects of a same sex instructor on alternative measures for the dependent variable by focusing on college classroom performance while using both within student and within instructor variation. By focusing on large first year undergraduate classes where teachers did not grade students exams and did not receive differential treatment from teachers, Hoffman & Oreopoulos argued that it is possible to

equate gender effects with role model effects<sup>2</sup> They used three student outcome variables by course level: (1) course completion (dropped course- binary), (2) grade (standardized variable~(0,1), (3) the number of additional course taken in the same subject in subsequent years (sd~z(0,1)).

Hoffmann & Oreopoulos (2009) first estimation involved regressing student achievement on whether the instructor was female, controlling for course and year. For females the authors found no significant difference in the likelihood of dropping a class based on whether the instructor is male or female. However, male students were 1.8% more likely to drop a course with a female instructor. The difference between the female and male student effects is the predicted relative effects between gender groups from facing a female instead of male instructor. Thus, they interpret their findings as male students reacting negatively to female instructors rather female students reacting positively (Hoffmann & Oreopoulos, 2009).

In their second estimation, Hoffmann & Oreopoulos (2009) pooled males and females in the same regression and used course by gender fixed effects instead of course fixed effects. The coefficient estimates of the female student\*female instructor interaction when students' background controls are included showed the expected change in average achievement for females relative to males from assignment to a female instructor. Pooling males and females together allows for the inclusion of class fixed effects. With class fixed effects and student controls females are about 15% less likely than males in the same class to drop a course in a class with a female instructor. Conversely males are one 1% less likely to drop the class if the instructor is male. This research highlights the only consistent result in the existing literature: female students are more likely to complete a course if their instructor is female.

Hoffman & Oreopoulos (2009) concluded that reactions from students over the gender of a teacher may matter less than reactions from a teacher over the gender of a student. The authors maintain that since college instructors do not typically interact in a one-on-one basis with students in first year classes and do not typically grade tests, there is little chance for instructor bias to influence performance. Hoffman & Oreopoulos further assert that their results are not

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<sup>2</sup> “ To do so the author utilize detailed student and administrative data from the University of Toronto arts and Sciences , fall and winter school terms from 1996-2000 limiting their sample to fulltime entering students from Ontario high schools between the ages of 17 -290 yrs old.

likely due to students being reminded of particular stereotypes about themselves due to instructor gender since there are many students of both sexes in the larger classes they examine. They interpret their findings to suggest that instructor gender plays only a minor role in determining college student achievements.<sup>3</sup>

Table 2.1 summarizes the research results previously discussed in this section organized according to results for a given measure of the dependent variable. For simplicity and ease of comparison the studies featured in the chart are limited to those in which the effect of the female instructor/ female student interaction was being examined. This table highlights the inconsistency of the research results both within and among studies. Much of this inconsistency is due to the many factors that complicate the study of the role model effect at the university level, making it difficult to develop a research design yielding consistent interpretations and results.

A problem I identified with the existing research on the role model effect is that many of the researchers just replicated studies from the primary and secondary level with data taken from the university level. For example Hoffmann & Oreopoulos (2009) research entitled “A professor like me the influence of instructor gender on college achievement” is a replication of Dee, (2005) research entitled “ A teacher like me: Does race, ethnicity, or gender matter” using university level data.

When moving from the secondary level to the university level, the nature of the students’ role in their education changes. Students are much more in control of their course and instructor selection in the university system. As a result studies that attempt to replicate the methodology used to investigate the role model effect at the secondary level are often misspecified. For example, since college students have the authority to choose their courses, selection bias has become a common problem in this literature. Researchers have to contend with the possibility that female students may be more likely to select courses with female professors due to

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<sup>3</sup> Hoffmann & Oreopoulos (2009) note however that influencing performance is difficult; some may find their small effect from manipulating instructor gender impressive. All the estimates in this paper involve replacing one instructor at the margin for another who differs by gender. Additional nonlinear effects may exist from more dramatic changes in the proportions of male or female faculty in a department or institutions.

preferences or interests in a particular discipline. For example, women's studies faculty are heavily female and female students may self-select into these courses and choose to continue in these courses based on their interest in the subject matter. However, it is difficult for researchers to distinguish between overlapping interests and the presence of a role model effect. This type of self-selection has the potential to bias studies that simply compare the outcomes of male and female students who have male rather than female instructors.

Similarly, college students have the ability to drop courses, whereas at the secondary level the majority of their courses are mandatory, and students are not allowed to drop courses without dropping out of school entirely. This type of attrition has the potential to be a problem when attempting to estimate the effect of female instructors on students' grades, as course grades can only be estimated for students who complete the course. In the existing studies female instructors have been shown to consistently decrease female students' rates of course attrition. The presence of a female instructor seems to encourage students in the lower end of the course grade distribution to complete the course. This effectively increases the proportion of female students in the left tail of the grade distribution and drags down the average score for females which can result in misleading research findings.

Furthermore, correcting this bias is difficult since any behavior that is expected influence dropout rates can also be argued to influence course performance. Very few of the existing studies have controlled for this bias, which could explain some of the inconsistency found in the estimations of the female instructor effect regarding course performance.

Problems with availability of data and inconsistency between data sets could also be responsible for some of the inconsistencies in results. The majority of the existing literature is still mostly small in scale and limited to a single or a few institutions, making it difficult for researchers to draw widely applicable conclusions from their results. Therefore, it is difficult to know if the inconsistent results indicate a weakness of the theory of the role model effect or if the results differ because the samples vary. Few if any sources exist with enough information to allow researchers to perform large scale analysis.

Other complicating factors arise from a lack of conceptual or theoretical clarity. In this examination of the existing literature on the role model effect in higher education, little evidence was found to indicate that the researchers took the existing literature regarding the determinants of females choice of major into consideration when developing their research designs.

Accordingly, the following section will examine the literature related to the determinants of students' field of study to determine if the role model effect research program could build off of results from related studies.

## Figures and Tables

**Table 2.1 Research Results by Dependent Variable**

<b>Dep Var</b>	<b>Positive Effect</b>	<b>Insignificant</b>
Course Grade	Carrel and Scott (2010); Hoffman & Oreopoulos (2009)	Butler & Christen (2003); Robb & Robb (1999)
Additional Courses	Jensen & Owen (2001); Bettinger & Long (2005); Carrel and Scott (2010)	Dyan & Rouse(1997);Rask & Bailey (2002);Hoffman & Oreopoulos (2009);Robb & Robb (1999);
Course Completion	Butler & Christen (2003); Hoffman & Oreopoulos (2009)	
Major Choice	Sonnert et al.. (2007) Carrel and Scott (2010)	Ashworth & Evans (); Bettinger & Long (2005); Rask& Bailey (2002);
Retained at University	Robst & Russo (1998)	

This table was constructed by the author to summarize several main studies in the literature and highlight the inconsistency in research design and results in the role model effect research program.

## **Chapter 3 - Determinants of College Major**

By examining the related literature on determinants of college major, peer effects, and critical mass theory, the inconclusive role model effect results can be interpreted as support for a more specified theory of the role model effect that highlights the importance of the gender composition of the course or field of study. The most significant determinants of major choice identified in the literature can be divided into two groups (1) individuals characteristics that reflect students' aptitude and abilities, (2) those that reflect the environment in which the students' are exposed to a given subject.

### **Individual Characteristics**

#### *1) Ability and Preparation*

A prominent theory explaining women's underrepresentation and STEM fields is the notion that there is a gender based difference in ability or preparation that causes the gender discrepancy in these fields. Studies across STEM fields mirror the findings of Ashworth & Evans (2001) that greater mathematical aptitude and prior knowledge of the subject influence the decision to study economics. Such results indicate that general ability and preparation are important factors in undergraduates' choice of major. However, Dynan & Rouse (1997) found that, contrary to common expectations, mathematics background explains only a limited part (15%) of the gender difference in student's decisions to major in economics following an introductory course. Additional research by Turner & Bowen (1999) utilized SAT scores to examine the extent to which students' academic preparation or achievement could explain gender differences in their choice of college major. Their results support Ashworth & Evans (2000) finding that differences in academic preparation between men and women can explain observed differences in their college major choices. However, an additional result of their research indicated that a significant portion of the college major decision is not determined by academic preparation and achievement. Rather, they found that a much larger portion in the gender gap of

college major can be attributed to a combination of factors related to an individuals' preferences, environmental factors, differences in college experience, etc (Turner & Bowen, 1999).

Subsequent research by Dickson (2010) investigated whether variation in academic preparation could explain gender differences in proportion of Bachelor's degrees obtained by men and women supports the findings of Turner & Bowen (1999). In Dickson (2010), results from a multinomial logistical model used to determine if students with similar academic backgrounds make similar major choices early in college indicated that when SAT scores and high school class rank have been controlled for, significant differences in the initial college major choices between male and female students remain. Dickson also notes that the gender based differences in college major choice are of a much greater magnitude than the racial and ethnic disparities (Dickson, 2010). In addition, Ost (2011) examined the differences in life and physical science majors as part of the Cornell research project and found further support for this conclusion. Ost (2010) results indicated that after controlling for various measures of high school performance many of the gender gaps within fields remained, noting that the remaining gaps were smaller than the raw gaps suggesting that preparation accounts for some but not all of the major choice of females.

These and similar studies conducted across STEM fields indicate that while academic preparation and ability may explain part of the gender gap in fields of study, they cannot explain everything. This suggests additional factor(s) that influence major choice are discouraging female students from pursuing STEM fields.

## *2) Course Performance*

Research indicates that students' differential course performance and their differential responses to their course grades can contribute to the gender gap in students' field of student. Rask (2010) explains that there is significant evidence that relative performance in introductory courses is an important determinant of undergraduate major choice ( Dynan & Rouse, 1997; Jensen & Owen, 2001; Rask & Bailey, 2002; Rask and Tiefenthaler, 2008; Robb and Robb,1999; Sabot & Wakeman-Linn, 1991). Students' performance in introductory courses as indicated by their course grade is consistently the most significant determinant of students' choice of major. Accordingly course grades are a key aspect of major persistence in the studies funded by Sloan Foundation to address undergraduate education in STEM fields (Ost, 2010; Rask, 2010). In fact,

the importance of ability and high school preparation is likely less significant than expected because measures of course performance capture much of a student's advantage in these areas. Sabbot & Wakemanlinn (1991) explain that the process of choosing courses is a utility maximization exercise where in the utility from the chosen courses is derived from both intrinsic and extrinsic satisfaction. Internally utility is gained from the sense of accomplishment and increased knowledge gained from taking the course. However, the extrinsic utility is obtained through external recognition in response to the student's evaluated course performance (ie. scholarships, honor societies, parental approval, etc) (Sabbot & Wakemanlinn, 1991). Accordingly, the influential role of course grades in academic decision making in college has been extensively documented. For example, in his study of student retention at the University level, Robst et al. (1998) found that student performance is the most important factor in determining retention for male and female students, noting that a one point increase in GPA leads to a 5% increase in the likelihood of student returning to college for the second year.

While course performance is clearly an important factor in the field of study choices of male and female students, the existing research also indicates that there is a gender based differential in the way students respond to both absolute and relative grades. Owen (2010) reported a differential effect for male and female students when utilizing a regression discontinuity design to determine the effects of grades earned in introductory economics classes on the decision to major in economics. Owens' results indicate that female students' receiving an A for a final grade in the first economics class is associated with a meaningful increase in the probability of their majoring in economics, even after controlling for the numerical grade earned in the class. This suggests that female students respond strongly to feedback from the letter grade and are encouraged to continue to study the subject. However the author finds no evidence of a similar effect for male students (Owen, 2010).

Sabbot & Wakemanlinn further discuss the importance of grades by noting that graded course performance functions as a feedback mechanism that allows students to identify their relative strengths (1991). This notion that the context matters was first reflected in research by Dynan & Rouse (1997) which revealed that it is the relative not absolute performance of students that can determine their field of study. Results from this analysis using survey responses of students enrolled in introductory economics courses at Harvard University indicated that female students in their sample did not perform as well in their economics courses as they did in their

remaining courses, while male students score higher in economics relative to their remaining courses. Controlling for the differences in relative grades was found to greatly diminish the gender gap in economics majors, suggesting that relative rather than absolute measures of success in economics may leave women feeling discouraged about their economic aptitude.

Later research by Jenson & Owen (2001) supported the results Dynan & Rouse (1997) by revealing that students who receive higher grades in economics relative to their other courses and who feel confident that they understand economics are more likely to continue to study economics. Furthermore, the expected course grade was more important to female students than male suggesting that perhaps female students' insecurities in the field of study lead them to rely more on external feedback to judge their performance (Jensen & Owen, 2001).

Using data collected over 16 years from a liberal arts college Rask & Tiefenthaler (2008) found that, holding all other characteristics constant, men who take economics courses are less responsive to relative grades than are women, which increases the likelihood that greater numbers of men with poor relative performance will continue in the major. However, female students with poor relative performance are more likely to abandon economics and pursue a different major. The likelihood of less qualified male students continuing to study economics while more qualified women leave the major is compounded by the notion that male students have an advantage when examinations are administered in multiple choice format while female students outperformed male students in essay exams (Lumsden & Scott, 1987). This suggests that although a female student's lower grade on a multiple choice exam may not indicate a lower level of technical aptitude she is likely to interpret it as such and become discouraged from taking additional courses in the field.

Further exacerbating the gender gap in college majors is the modern trend of grade inflation in certain disciplines. Sabot & Wakemanlinn (1991) explain that when grading policies are uniform across disciplines students are able to simultaneously maximize their grades and exploit their comparative advantage by choosing to major in the subject in which they excel. However, the authors report that as a result of varying levels of grade inflation across departments students are being sent mixed signals about their relative strengths and weaknesses for given fields. Sabot and Wakemanlinn found that even when grading policies do not accurately reflect students' comparative advantage, grades continue to influence course selection, which results in a conflict between the incentives offered to the students (via grades) and

institutional attempts to increase enrollment in STEM fields. The authors find that when comparing economics, the largest low grading department, and English, the largest high grading department, male students intending to major in economics are 18.2% less likely to enroll in a second course if they receive a B instead of an A, while they are 27.6 % less likely to take an additional course if they receive a C rather than an A with females being more sensitive to grades than male students. Similar figures for English are 14% and 20.3 % where in contrast to economics males and females did not differ in their responsiveness rates (Sabot & Wakemanlinn, 1991). These results indicate further support for the contention that female students are more sensitive to their grades and that there is a course specific source of the grade sensitivity gap between men and women.

This is also evidence that females respond more strongly to grade incentives than do males, is likely driven by the gap in their reported levels of confidence as suggested by Jensen & Owen (2001) whose survey result indicate that women enter economics courses with lower relative math ability and lower overall self confidence than male students. Similarly, Ballard & Johnson (2005) find that female students have lower expectation for their performance in microeconomics than do male students. This difference remains even after controlling family background and previous academic and mathematical experience. In contrast, Nowell & Alston (2007) use survey data from students enrolled in economics and quantitative courses at a large public university to analyze the difference between students' expected and actual grades students. Their investigation of students' tendency to overestimate their course grades revealed that male students are more likely to exhibit signs of overconfidence. Together this research suggests that the gender gap in grade sensitivity could be attributed to the gender gap in confidence level.

Additional recent research conducted as part of the Cornell Research Project corroborates the claim that there is a gender gap in grade sensitivity. Ost (2010) results showed that women are more sensitive to grades both in terms of major field performance and outside course performance. For female students, a 1 point increase in major specific GPA improved their probability of persisting by 13.4 % where as for males the figure was 10.7%. Similarly an increase in overall GPA lead to a much steeper decline in persistence for females than for males. However, this gender differential does not hold in the life sciences where major specific grades have a similar impact regardless of gender. In addition, men in the life sciences are more affected

by outside options than women. Ost (2010) indicates that while the reason for a grade response differential in the physical sciences but not the life sciences is unclear, one possibility is that students' response is a function of perceived minority status as opposed to gender per se (Ost, 2010). A similar explanation could be suggested in regard to the results of Sabot & Wakemanlinn (1991).

The existing literature on course performance indicates that the gender gap of choice major can at least partially be attributed to female students' differential response both to their absolute and relative course grades. Additionally, the existing research indicates that female students' grade sensitivity is due largely to their lack of confidence in STEM fields. Thus, the combination of female students insecurity in STEM and grade inflation in other disciplines female students are deterred from entering STEM fields even though those field may actually be where their true area of comparative advantage lies.

### ***Environmental Factors***

An additional group of explanations for the gender gap in college major is most commonly, although clumsily, classified into the category of "classroom environment". Factors relating to the classroom environment are those that are often outside of female students' control and unrelated to the students' personal background. Although male and female students experience courses in the same environment, there is often a gender based differential response to that environment which can explain a portion of the gender gap in higher education.

#### ***1) Stereotype Threat***

Researchers suggest that female students' underperformance in STEM course could be due in part to the "stereotype threat" effect. First, posited by sociologist Claude Steel, stereotype threat emerges when individuals' are in a position where they can potentially confirm negative stereotypes about a group to which they belong. In his fundamental research in this area Steele (1997) found that when students perceived that negative stereotypes were being applied to them by an instructor with differing demographic characteristics their course performance suffered. (Spencer, Steele, & Quinn, 1999) attempted to determine if the stereotype threat applied to female students' performance in mathematics arguing that women face the negative stereotype that they have less mathematic ability as men. After conducting a variety of tests, Spencer et al.

concluded that stereotype threat may underlie gender differences in advanced math performance (Spencer et al., 1999).

Ost (2010) noted that while definitive conclusions cannot be drawn from these studies, social psychological studies of stereotype threat suggest that students who exhibit signs of stereotype vulnerability are less able to gauge their performance and subsequently have unstable academic self concept which is often associated with increased sensitivity to positive and negative external. Reflecting this literature, Ost (2010) results indicating that females in physical science have a stronger response to grades than females in life sciences may be due to the fact that women are a minority in physical science but not in life sciences (Ost, 2010).

In addition to impaired performance and increased grade sensitivity, stereotype threat has a number of additional consequences, including reducing female students' intention to pursue STEM related fields in college (Davies, Spencer, & Steele, 2005; Davies, Spencer, Quinn, & Gerhardstein, 2002). However, studies show that when female students are exposed to women that have performed successfully in mathematics and science related fields, they perform better than female students who do not have examples of women with such performance (SWE). Related to the above method, research has confirmed that having the test administered by a member of the stigmatized group can reduce stereotype threat. For example, women will experience less stereotype threat on a math test if the test is administered by a female teacher (Marx & Goff, 2005).

## 2) "*Chilly*" Classroom

An additional factor that can influence the classroom environment is known as the "chilly environment. Notably, in their landmark 1982 study, Hall & Sandler discovered that female attrition from undergraduate science programs was due in part to experiencing peers and faculty create a classroom environment that was "chilly" for female students (Hall & Sandler, 1982). More recent research finds that rather than facing blatant sexism female students are now often excluded, or ignored. Accordingly, (Crawford & Macleod, 1990; Tobias, 1994) focuses on the social construction of gender in higher education by emphasizing that inequality in higher education is not maintained by actively discriminating against women, but rather, culturally imbedded ideas of masculinity and femininity are used in ways that leave women feeling marginalized or alienated. Accordingly, Tobias (1994) found that capable students were

discouraged by introductory science courses not due to the difficulty of the course but by the lack of a feeling of community in the classroom.

Some research suggests that part of the disconnect women feel in a male dominated classrooms may stem from the differences in the ways men and women respond to various learning styles. For example, Bartlett (1996) explains that the educational literature in this area centers primarily on Kolb's (1981) theory of learning which categories the way student's process information into 4 learning styles. Kolb, (1981) considered most economics majors to be "assimilators" who rely on abstract conceptualization to absorb information and process it through observation and reflection, while "convergers" process information with active experimentation. Alternatively "divergers" use concrete experience to take in information and later process this information with observation and reflection (Bartlett, 1996; Kolb, 1981). Bartlett reports that European American males and Asians show the highest tendency to be assimilators and are also dominantly represented in economics. This finding is in accordance with Fry and Kolb (1979) which found that students generally tend to major in a field where the teaching techniques reflect their learning styles. However, since Kolb suspects that 41% of women are also abstract learners, their representation among economics major is expected to be higher than current levels (Fry & Kolb, 1979). Although gender parity can be found in many introductory classes, the proportion of females who chose to major in economics is dramatically lower. More recently Jensen & Owen (1999) suggested that pedagogy and techniques of evaluating students that have traditionally been used in economics courses may favor male learning styles and increase the disinterest and discouragement felt by young women in introductory economics courses.

### *3) Tastes and Preferences*

Accordingly, Dynan & Rouse (1997) suggested that the unexplained gender gap in major choice could be attributed to differing tastes and preferences, and unmeasured factor such as the female students understanding of the nature of economics or the limited knowledge of the full scope of the substantive content of the economics field. Dynan & Rouse report that when upperclassmen were asked why they failed to take introductory economics in their first year of study, women were over twice as likely to reply that "they did not think economics was interesting" (Dynan & Rouse, 1997). Similarly, utilizing survey data from upper level secondary

students in the United Kingdom to investigate the decline in participation in economics and the underrepresentation of women, Ashworth & Evans (2001) found that once it is being studied students opinions of and level of interest in economics do not differ significantly according to gender. However, a gender difference was found among those who had chosen not to study economics, suggesting that female students are more sensitive to the lack of information available to them about economics and are unwilling to venture into this unknown field (Ashworth & Evans, 2001).

#### *4) Female role model effect*

The role model effect is also considered by some to influence the college students' choice of major. In contrast to the environmental factors listed above which deter female students entry and persistence in STEM, the role model effect is thought to encourage female participation in STEM. Most recently Price (2010) analyzed students' first semester STEM courses to see if the race or gender of the instructor effected persistence of initial STEM majors in a STEM field after the first semester and first year. Price found that female students are less likely to persist when more of their STEM courses are taught by female instructors (Price, 2010). These counter-intuitive results are part of the larger body of research regarding the role model effect in higher education discussed previously and further highlight the inconsistent research results surrounding this issue.

While the research on the other determinants of college major have largely converged around a consensus, researchers remains unclear on the extent to which young women are influenced by the gender of their professors. While the mechanisms through which differential preparation, differing levels of grade sensitivity and different tastes and preferences contribute to the gender gap in STEM fields are understood and recognized consistently in the literature, there are lingering questions about the mechanisms through which female instructors may have a differential impact on female students.

## Chapter 4 - Analysis and Conclusions

In this examination of the existing literature on the role model effect in higher education, there is little evidence that researchers took the existing literature regarding the determinants of female choice of major into consideration when developing their research designs. When plainly stated the theory of the role model effect suggests that the presence of female instructors will increase female students' achievement and interest in a given field and much of the existing literature has sought to test this theory. However, after reviewing the existing literature on determinants of college major, it appears that this theory is oversimplified.

The literature discussed in the previous chapter indicates that the presence of a female faculty member has the potential to influence the academic choices and success of female students by addressing the determinants of college major that often deter women from entering STEM fields. Thus the presence of female instructor has the potential to: (1) decrease the stereotype threat, (2) reduce the "chilly" classroom climate, (3) introduce female friendly pedagogy, (4) decrease insecurity related grade sensitivity, (5) and encourage female interest & participation.

The research on determinants of college major clearly indicates that women's minority status in a classroom or discipline drives much of what actually deters females from STEM majors. Thus, the minority status of female students is a crucial component of the role model effect theory. To accurately test a more clearly specified theory that highlights the importance of minority status, researchers would need to identify female instructors in male dominated fields and examine the effect of those female instructors on their female students in courses where female students are underrepresented. However, in their efforts to control for problems associated with selection bias, many of the researchers have restricted their samples to only introductory level courses where males and females are equally represented. Thus by failing to examine the literature on determinants of college major, researchers have been testing an unclearly specified theory of the role model effect. Their attempts to determine the effect of female role models in classroom and disciplines where female are adequately or overrepresented is not a true test of the more clearly defined theory that emphasis the importance of females' minority status.

However, recent research by Carrell, Page, & West (2010), who were given access to US Air Force Academy (USAFA) data, was able to draw on unique educational and demographic aspects of the USAFA to examine a more specified theory of the role model effect in a “natural experiment” (Carrell, Page, & West, 2010). Random placement of students into classrooms at the USAFA, where approximately 17% of the students are female, together with mandatory math and science courses, allowed Carrel et al. to investigate how professor gender influences student outcomes free of the self-selection and attrition problems that plague existing research. Because students are required to take specific math and science courses beyond the first year of study, they were also able to identify the long-term effects of professor gender. An additional advantage of this data set is that course grades are not determined by an individual student’s professor. Instead, all faculty members teaching the same course give identical exams during a common testing period. Since grading practices are consistent, there not any issues with grade inflation.

Carrell et al. (2010) results suggested that although professor gender has only a limited impact on male students, it has a powerful effect on female students’ performance in math and science classes. They found that female students’ likelihood of taking future math and science courses, and their likelihood of graduating with a STEM degree increased when students’ were instructed by females. In particular, they find that among students in the upper quartile of the SAT math distribution, being assigned to a female professor eliminates the gender gap in introductory course grades and science majors completely. Carrell et al. also noted that in contrast to the results for STEM courses, the gender of professors teaching humanities courses had only a very slight impact on students’ outcomes (Carrell et al., 2010).

These results suggested that perhaps the key to understanding the inconsistent results of the role model effect is controlling for the gender composition of the students in the course. Reviewing the literature again it seems as though other studies which accounted for the gender composition of students in a field found positive results as well (Robst et al., 1998).

Furthermore the existing literature indicates that the proportion of female students and strength of the role model effect vary inversely. That is, when the proportion of female students in a classroom increases and the presence of a female faculty member becomes less and less significant. At parity there is only a very slight gender based differential effect in student outcomes that can be attributed to instructor gender (Hoffmann & Oreopoulos, 2009). This

suggests that the relationship between female faculty and female undergraduates that is a little more nuanced than originally anticipated.

Most studies have relied on precedents set by the primary and secondary school literature where typically role model and peer effects have been considered separately but new research suggests that as students transition to higher education peers can become more like role models. (Riegle-Crumb, Farkas, & Muller, 2006) have conducted research at the secondary level which is likely applicable to peer relationship at the post secondary level. The authors suggest that insights from both the social psychological and education literatures, indicate that while it is likely that friends matter for the general academic success of students, the personal relationships that girls establish with other females who are proficient in science and math can create a unique social and academic context on which they can draw as they pursue historically male dominated fields of study (Riegle-Crumb et al., 2006).

As discussed previously male dominated subjects are most likely to involve and academic climates that girls find unattractive and uncomfortable and often suffer from lower academic self-confidence and interest in these fields (Correll, 2001; Eccles, 1994; Xie & Shauman, 2003). However, female friends who are successful in science and/or math represent an important contradiction of the stereotypes surrounding females in STEM. Reigle-Crumb et al. (2006) findings support the contention that when high performing female friends are situated within a predominantly female friendship group, girls are provided with an environment in which male stereotypes of math and science do not apply, instead allowing alternative ideas of women's role in science and math to emerge. Accordingly, De Giorgi, Pellizzari, & Redaelli (2010) study of peer effects in the choice of college major indicates that one is more likely to choose a major when many of her peers make the same choice (De Giorgi et al., 2010).

Thus the previously discussed literature regarding the determinants of college major and peer group effects indicates that the presence of a critical mass of female undergraduates can affect the determinants of major choice through the same mechanisms as the presence of a female instructor. By removing the pressure and anxiety associated with minority status, the presence of a critical mass of female students has the potential to (1) decrease the stereotype threat, (2) reduce the "chilly" classroom climate, (3) decrease insecurity related grade sensitivity, (4) and encourage female interest and participation. Thus, a thorough examination of the role model effect literature suggests that female instructors and females students may be substitute

role models. However, the evidence to support this contention is largely anecdotal and observations. Additional research needs to be done to determine if female peer groups and female instructors substitute role models and identify the degree of substitutability between the two.

While the inclusion of the relevant literature in related fields has clarified some of the inconsistencies in the existing literature on the role model effect in higher education, there are lingering questions that will need to be addressed in future research. Additional research should be conducted to address the “pipeline” aspect of the literature to determine if female instructors are more instrumental in attracting female students into a discipline or if they are more effective at increasing rates of retention. Another avenue to future research is investigating how the female instructor- female student relationship changes as students matriculate into graduate and professional program. Does the strength of the role model effect increase? In post graduate education can a “mentor effect” be distinguished from a “role model effect”?

There are many interesting ways the literature on the role effect in higher education can continue to grow and develop. However, as evidenced by this report, it is important that future research evaluate the existing literature in related fields and carefully consider the context in which they conduct their studies.

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