

Proposal for a  
Thesis in the Field of  
Mathematics for Teaching  
In Partial Fulfillment of the Requirements  
For a Master of Liberal Arts Degree

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# 1 Tentative Thesis Title:

The Effect of Single Gender Mathematics Learning Environments on  
Self Efficacy and Post Secondary Curricular Paths:  
An Australian Case Study

## 2 Abstract

This thesis project will explore the interplay among fundamental issues of learning style, student self perception, student mathematical self concept, delivery modes of instruction, and secondary classroom interactions and the effect of these on the self efficacy and post secondary curricular paths of female mathematics and engineering university students. Females display a similar intelligence and aptitude for quantitatively driven university majors as compared to their male counterparts, yet the self perception of female students towards their mathematical ability lags, potentially affecting their choice into quantitative university courses of study. This project will probe the impact of single gender secondary mathematics learning environments of a

female population of Australian university engineering students and the contributing factors that influenced their choice towards their mathematically driven university major. A mixed gender population will be examined to enhance a cross case analysis design.

Based on research undertaken by this thesis, a secondary school mathematics curriculum unit of study will be developed focusing not only on course content, but on the utilization of specific teaching and learning styles that are gender specific for a single gender mathematics classroom. The ways of teaching and learning referenced in this developed curriculum unit will directly relate to the research conducted in this thesis project and will be focused upon increasing mathematics enjoyment, achievement and mathematics related self concept of female students .

### 3 Thesis Project Description

#### Introduction

The gender gap in mathematics has been a topic of considerable research over the past several decades. As our world grows even more dependent on technologically driven competencies, women's participation in mathematics can affect future career and economic opportunities. Over recent decades, women have made increased strides in pursuing mathematically orientated college degrees, yet men outnumber women two to one in quantitative university concentrations (Stage & Maple, 1991). In fields such as

engineering, women’s participation is still below 20%. In the United States, for the academic year 2004-2005, women’s completion of bachelor’s degrees, in what may be considered more mathematically intensive university majors, are listed in the table below.

U.S. Bachelor’s Degrees Conferred

By Major and by Gender

2004-2005

Major	Total	Male	Percent	Female	Percent
Accounting	37772	15192	40%	22530	60%
Math & Statistics	14351	7937	55%	6414	45%
Physical Science	18905	10934	58%	7971	42%
Finance	27998	18119	65%	9879	35%
Computer & Information Science	54111	42125	78%	11986	22%
Engineering	79743	65164	82%	14579	18%

Source: U.S. Department of Education, National Center for Educational Statistics, 2004-2005 Integrated Post Secondary Education Data System, 2005.

Women are underrepresented in many mathematically related college majors. In particular, the gender imbalance of women’s percentage participation in engineering seems more striking as the demand for engineers over the next several years is projected to grow between 10% and 20% (U.S. Bureau of Labor and Statistics, 2007). This equity gap may be related to a woman’s prior mathematics experiences and the learning environments which produced her perception of her mathematical self (Solomon, 2007).

Being an educator who has taught at both coeducational and female single gender secondary schools, it has been my personal experience that female students from single gender high schools develop stronger perceptions of their mathematical abilities, have increased self efficacy and more often choose quantitatively driven university majors than female students from coeducational high schools.

### Self Efficacy

Self efficacy can be defined as a person's self perception of their ability to successfully complete a task. Over the last several decades, significant research has been undertaken in response to the writings of noted social-cognitive theorist, Albert Bandura (1977), whose work seeks to clarify and explore the sources of efficacy. There is debate over whether self perception of ability is a precursor to student achievement, or whether achievement shapes a student's perception of their ability. Marsh(1991) suggests that "reciprocal pathways" between increased self perception of ability and increased achievement exist. His studies indicate that self perception of ability in mathematics, and mathematics achievement, are positively correlated and are more closely related than in any other academic domain. In a study of self efficacy and mathematics, Pajares and Miller (1994) determined that students' belief of their ability to solve different math problems was actually an indicator of their success in solving those problems. Students need to believe that they will be successful before they can be successful. This finding is significant for educators who desire to work toward increasing mathematics academic success as well as opening a window of opportunity for women into more mathematically based careers.

Self perception of mathematical ability is uneven between genders. Although mathematics achievement between genders is not significantly different, male mathematics students consistently display increased self efficacy and self perception of their abilities when compared to their equally competent female counterparts. (Brown & Josephs, 1999, Pajares & Miller, 1994, Correll, 2001,). “High school students’ perceptions of their mathematical competence influenced decisions to persist on the path leading to careers in quantitative professions” (Correll, 2001). If women are to pursue mathematically driven postsecondary courses of study, they need to ascertain not only an accurate assessment of their mathematical abilities, but to see themselves as skilled and competent.

### Mathematics Classrooms and Learning Environments

Self efficacy is influenced by achievement, and achievement is influenced by authentic understanding. In mathematics, authentic understanding is often shaped by the learning environment. A particular focus of mathematics education research centers upon how students come to gain an authentic understanding in the mathematical domain. As “an going social activity within a dynamic classroom culture influenced by the teacher” (Cobb, Yackel & Wood, 1992), learning is an activity that occurs in a setting that is culturally formed in a social context (Palinscar, 1998, Augustyniak, Murphy & Phillips, 2005). “When classroom culture is taken into consideration, it becomes clear that teaching is not only about teaching what is conventionally called content, it is also about teaching what a lesson is and how to participate in it” (Lampert, 1990). The perspective

of school culture, as “a social enterprise” with embedded classroom social dynamics, needs to be considered a variable that potentially impacts the dynamics of learning in a class that is considered “a community of mathematical thinkers” (Palinscar, 1998).

Yet, is there a difference in the landscape, participation and outcomes of a single gender, specifically all female, mathematics learning community? And if so, how is the shape and dynamics of this particular learning environment unique? While curriculum is important, what the learner believes about herself as well as the environment influences learning (Ai, 2002). Women in particular desire to experience a connection of learned mathematics to the world around them (Stage & Maple, 1996). Prior research has shown that co-operative settings that encourage group work and open discourse promote mathematics learning for females. An overview of teaching mathematics in Europe showed that math courses that emphasized “group work” were successful in attracting female students (Jacobsson, 1994). However, in a coeducational environment, teachers often organize learning activities that favor male participation and learning (Fennema, 2000). For women, mathematics learning experiences can affect the selection of a math or science university concentration (Trusty, 2002).

Single gender mathematics learning has been a topic of extensive and continuing research. There is no one definitive point of view. The literature presents conflicting conclusions. Several studies indicate that females display gains in learning (Jackson, 2002, Rowe, 2002, Streittmatter, 1999). However, other studies conclude that females do not demonstrate increased mathematics achievement in a single gender school (Harker, 2000, Smith, 1994, Marsh & Rowe, 1996). Female high school students who attend a single gender school in the United States are in the minority. Due to Title IX and the

potential of gender discrimination, single gender public schools in the U.S. are an anomaly and only a very few exist. Therefore, the majority of girls educated in single gender schools in the U.S. are a smaller subset of the 8% of all private school students in the educational population (National Center for Educational Statistics, 2006). Yet, my personal experience informs me that a unique opportunity exists in an all-female math classroom. Removed from the distractions and sexual tensions of a mixed gender class, as well as the stereotyped perception that “boys are better at math,” girls can be focused on the possibility that they may actually be good at math and that this ability, coupled with their belief in that ability, can offer opportunities that may launch them towards a quantitative based post secondary curricular path.

### Research Study

A review of the literature reveals that many gender and mathematics studies have focused on girls’ achievement in secondary and primary school. These studies, for the most part, are quantitatively based using achievement data or quantitative instruments as a basis of analysis. Few studies exist which focus exclusively on a female university age population. And even fewer studies engage the voice of the participants through a qualitatively designed study. Stage and Maple (1991) state the need for more naturalistic studies that capture the voice of the student. In a paper presented at the National Institute for Science Education in 2000, a leading researcher on gender and mathematics, Elizabeth Fennema, called for more research that probed the different ways that girls learn. She also cited the lack of studies available in mathematics education that promote

the females' voice. There also appears to be a void in the literature of studies which examine the secondary classroom experiences of female university students who have chosen a quantitatively driven major; and in particular, students educated in a single gender high school. Hence, the research conducted for this thesis project will focus not only on this specific population but will also recognize the female voice through design components which will include the gathering of qualitative interview data.

Unlike other studies of gender and mathematics, the research conducted for this thesis project will focus on a population of female students who have already chosen and are currently experiencing a mathematically challenging major. Examined will be their motivations for selecting this major, with an emphasis of focusing on the impact and contribution of their secondary school math learning experience towards their self perception of their math ability and the prior pedagogical influences towards the selection of their major. The following guiding questions emerged and shape the basis of this research proposal:

1. What factors in classroom teaching and learning in a secondary single gender environment contribute to increasing self concept and self efficacy?
2. What factors in classroom teaching and learning in a secondary single gender environment contribute to a student's choice of a quantitatively based major?
3. How can understanding and implementing gender specific learning and teaching improve self efficacy and mathematical understanding?
4. How can secondary curriculum be shaped in a single gender school to promote a possible wider entry for women into the mathematics pipeline?

In particular, sampling a population of students that had attended either a single gender or a mixed gender high school would assist a cross case design and allow for

comparative analysis. However to commence this study, two other dilemmas needed to be addressed: 1. locating a university population that draws from a potentially significant base of single gender schools and 2. locating a university population that attends school during the American summer to facilitate research during my particular school break.

The educational climate in Australia presents a unique platform for this research. Unlike the U.S., a much greater proportion (35%) of secondary school students attend private schools( NSW Dept of Education & Training,2007), with a measurable portion of those attending single gender high schools. As well, 21 % of the secondary public school population in the greater Sydney area attends a single gender high school. However, this percentage drops dramatically in regions of the state outside of the Sydney area since single gender high schools are nearly non existent in those locations. Sydney, Australia is home to four major universities: University of Sydney, University of New South Wales, Macquarie University and the University of Technology. The university academic calendar, which is divided into two semesters with second semester commencing at the beginning of August, allows a reasonable window of opportunity for research.

In June, 2007 I sent an email letter to each of these universities introducing myself and the possibility of engaging in gender and mathematics research at their university with a population of their students. Two days after receiving my request, Dr. David Lowe, Dean of Teaching and Learning at the School of Engineering at the University of Technology responded to my email. He then forwarded my email to another faculty member, Betty Jacobs, who also directs the Engineering Outreach Program at the University of Technology. Within days, Betty Jacobs agreed to assist me in gathering data for my thesis project.

At the University of Technology in Sydney, the 2007 student undergraduate engineering population is 2793 students with 13% of the engineering students being women. Based on current enrollment data, of the female engineering students who attended high school in Australia, 42% attended an “all girls” high school. This striking statistic highlighted the potential of a rich data source for this project.

While the current literature highlights the need for qualitative inquiry, I did not want to limit my research only to this particular methodology. Triangulation, which uses a variety of methods by combining both quantitative and qualitative design elements, strengthens the conclusions one can draw in analysis (Patton, 2002). To facilitate the gathering of data, I designed both a questionnaire survey and a semi-structured interview format as data collection instruments. The survey has four distinct components. The first is a background demographic that asks for the participants’ school background, highest level of high school math class taken and their university major. The second component of the survey is an attribution chart of twelve choices where the participants rank their reasons for selecting their major. The third component of the survey probes learning styles and asks the participants to rank their preferred ways of learning when presented with newer mathematics concepts. Included in this section is also an open ended question which asks the participants to share their most meaningful math learning experience. The fourth and final part of the survey is a published instrument that measures a students’ self perception of their ability in mathematics. This *Self Description Questionnaire III*, designed by Herbert Marsh (1984), has been used and validated in prior research. Using a Likert type scale, students respond to over thirty prompts which when analyzed help to assess a student’s mathematical self concept. This quantitative

instrument will allow comparison between females and males as well as type of secondary school attended. The second method utilized for data gathering is a semi-structured interview which delves into a student's secondary school mathematics experience with particular focus on atmosphere, teaching style, learning styles, delivery modes of instruction, interactions between student and teacher as well as student to student interactions. Also probed during this interview is the impact of the school culture and the student's family on the direction of the student's post secondary curricular path.

After completing the design of the research instruments, and allocating a time to go to Australia to embark upon this research, I applied to the Committee on the Use of Human Subjects and completed the request for Approval of Human Subjects Research. On July 25, 2007, I received approval from Harvard University's Committee on the Use of Human Subjects Committee to commence my research at the University of Technology in Sydney. All ethics requirements at the University of Technology were also satisfied. During the first two weeks of August, I conducted research in Sydney by surveying over one hundred and twenty engineering students and interviewing, in depth, nineteen students at the University. While my intent is to primarily focus my analysis on females who attended single gender high schools, I surveyed and interviewed males from both coeducational and single gender high schools for potential comparative analysis.

## 4 Work Plan

The following table highlights the work components necessary for completing this thesis project in a timely manner. Tasks described will be attempted in a sequential manner. However, various work components may actually overlap in actual time. If work is begun immediately, completion is estimated on March 28, 2008.

<b>Task</b>	<b>Time to Complete</b>
Transcribe Interviews, Code Interviews and Create Interview Profiles	4 weeks
Create Spreadsheet of Survey Data and Sort Data by Various Categories	2 weeks
Analyze Triangulated Data	2 weeks
Determine Chapter Headings for Thesis and Organize Literature by Chapter Topics	2 weeks
Outline Chapters of Thesis	2 weeks
Complete Draft of Each Chapter ( 1.5-2 weeks per chapter)	10 weeks
Design Curriculum Unit	2 weeks
Final Copy of Thesis Completed after Last Draft	2 weeks
<b>TOTAL</b>	<b>26 weeks</b>

## 5 Glossary

1. Self Efficacy : a person's self perception of their ability to successfully complete a task.
2. Mathematics Pipeline: a student's continued participation in mathematics and the contributing factors that promote their continuation on this path.

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