ABSTRACT

THE EFFECTS OF SINGLE-SEX EDUCATION ON THE SELF-EFFICACY OF COLLEGE STUDENTS TAKING INTRODUCTORY PHYSICS

by Mary Elizabeth Mills

Previous research has shown that young women can benefit from taking their science classes in single-sex classrooms. Further, women’s colleges produce a disproportionate number of female scientists. There is less research on the effect of single-sex education on young men. We investigated the effects of single-sex education on the self-efficacy of college physics students by surveying students at four colleges about their experience in their college physics class. The schools included two women’s colleges, one men’s college, and one coeducational college. Interviews were also conducted at three of the schools to get a better understanding and more personal view of the students at these schools. Results from the surveys show on average, women at women’s colleges and men at coeducational colleges have the same self-efficacy, while men at men’s colleges have a lower self-efficacy and women at coeducational colleges have the lowest self-efficacy. Data from the interviews support these results.
THE EFFECTS OF SINGLE-SEX EDUCATION ON THE SELF-EFFICACY OF COLLEGE STUDENTS TAKING INTRODUCTORY PHYSICS

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DEDICATION

This thesis is dedicated to the people who have been a constant presence in my life, full of encouragement and support. First, to the chemistry education research group who took me in as one of their own and helped me to feel at home at Miami. Second, to my Graduate Student Women Group who have been a continuous source of reassurance and without all the lovely ladies involved, I would not have made it through to graduation. Lastly, I would like to dedicate this to my father, Steve Mills. Throughout my time at Miami University, he has always been there for me no matter what. Thanks Dad!
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Chapter 1: INTRODUCTION

1.1 Introduction

Young girls have many opportunities today that they did not have as few as 50 years ago. They have the chance to go to any college they choose and major in any subject they enjoy. From there, they can have any career. They are told this from a young age. However, only a small percentage of women take physics in college. No biological differences have been found which would cause women to perform less well in physics than men (Blue & Heller, 2003). They themselves are choosing not to go into most STEM (Science, Technology, Engineering, and Mathematics) fields, like physics, math, engineering, and computer science. There are many examples of strong women in physics with lives, families, and great careers but still we wonder why there are not more women in physics.

1.2 Specific Aims

Previous research has shown that young women in college can benefit from taking their STEM field classes in either single-sex classrooms at coeducational schools or at women's colleges (Gillibrand, Robinson, Brawn, & Osborn, 1999; Robinson & Gillibrand, 2004; Sanford & Blair, 2002; Sebrechts, 1992; Spielhagen, 2007; Stowe, 1991). We explore this phenomenon to see whether this is the case not only for women, but also for men at men's colleges. Through this thesis project, we hope to answer two questions. First, do women benefit by being physics majors at a women's college rather than at a coeducational college or university; can this give them a path to become strong, self-confident women that are committed to the field of physics? Second, does single-sex education affect men in a similar way such that we can make recommendations for students to either attend or not attend a men’s college?

To this end, we surveyed and interviewed students at four schools in the fall of 2010. The schools that were studied include two women's colleges, one men's college, and one small,
coeducational, liberal-arts college. These schools were chosen by the size of their student body, size of their physics classes, availability of a major in physics, and similarity in mission plan. Thus the coeducational institution, the College of Wooster, a liberal-arts school between 1000-2000 students, was chosen because it paralleled the teaching missions and sizes of the student bodies of the women’s colleges, Agnes Scott College and Mount Holyoke College, as well as the men’s college, Wabash College.

An email with a link to an online survey, see Appendices G-J, was sent to the introductory calculus-based classes and physics majors at all four schools during September. The surveys consisted of multiple choice and short answer questions about the students' self-efficacy in physics, their thoughts about attending single-sex and coed colleges, as well as information about their previous schooling. (Self-efficacy is defined as “people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives” and will be discussed further in Section 2.3.) The last question on each survey asked about willingness to be interviewed. Out of the 226 students that were sent the survey, 88 students completed it and 5 students were interviewed. The interviews occurred on campus, in October and November. The interviews gave a more personal and anecdotal view of single-sex versus coeducational colleges.
Chapter 2: LITERATURE REVIEW

2.1 Current Status of Women in Physics

Research on women in physics has been ongoing since at least the 1960's (Meitner, 1960; Weeks, 1960). However, the majority of recent research spawned from a famous paper, commissioned by the Rockefeller Foundation, “Who Will Do Science?” (Berryman, 1983). In this paper, the author talked about losses in the pipeline of women in quantitative fields. The status of women and minorities in science at the advanced degree level is also discussed and the author gives some possible causes as to why there is such a problem. The widely used phrased “leaky pipeline” is the most popular way of discussing this problem. The term describes the flow of women from high school physics classes to faculty positions in physics and how the flow is losing an abnormally large number of women.

Another famous paper from the American Association for the Advancement of Science, “AAAS Presidential Lecture: Voices from the Pipeline” (Widnall, 1988), examined the statistics of women in science, analyzed surveys given to graduate students, and presented some environmental issues that are part of the cause of the leaky pipeline. These two papers helped lead the way for many more revelations about women in physics.

The government (eg: Congressional Commission on the Advancement of Women and Minorities in Science, Engineering, and Technology Development, 2003; National Science Foundation, 2000), nonprofit organizations and professional societies (eg: American Association of University Women, 2010; American Association of University Women, 2010; American Association of University Women, 2001) have been following with the status of women in physics for the last few decades. These are just a few of the numerous reports that discuss the status and statistics of the current state of women in STEM, how a greater number of women in science needs to be achieved to improve the workforce of the country, and possible solutions to the problem.
Data from the American Institute of Physics show that in 2001, 46% of students in high school physics classes were girls (Ivie & Ray, AIP report: Women in Physics and Astronomy, 2005). This can be seen in Figure 2-1 below. Because male and female high school students take physics in almost equal numbers, the sharp drop off of female students who take physics in college is unexpected.

![Figure 2-1: The percentage of female high school students who took physics from 1987 to 2001. Taken from Ivie & Ray, AIP report: Women in Physics and Astronomy, 2005.](image)

The most recent data from the American Institute of Physics show that women make up about 25% of the physics bachelors given in the United States. This can be seen in Figure 2-2. For all STEM fields, the number of bachelors received by women is about 55%; this number seems quite high. However, about 65% of biological science bachelors are given to women. Because there are not only more bachelors degrees given in biological sciences to both men and women but also a much larger percent are given to women, it balances out the approximately 25% for computer science, physics, and engineering and makes the overall percentage of bachelors given to women in STEM fields above 50%. This makes readers think that men and women are equal in number in all STEM fields while this is only the case for certain fields (American Institute of Physics, 2007).
Figure 2-2: The percentage of bachelors degrees given to women in STEM fields from 1964-2004. Taken from American Institute of Physics, 2007.

Data on the number of PhDs in STEM (Ivie & Ray, AIP report: Women in Physics and Astronomy, 2005) show that only about 15% of the PhDs in physics are given to women and only approximately 45% are given to women in all STEM fields, as seen in Figure 2-3. Where are all of the women going? Why is the retention rate so small? Are the women that are not getting a PhD in physics finding jobs in physics without having a PhD or are they changing fields? These questions will not be answered here, but the consequences are discussed.

Figure 2-3: The percentage of PhDs given to women in STEM fields from 1958-2003. Taken from Ivie & Ray, AIP report: Women in Physics and Astronomy, 2005.
2.2 Research on Science and Gender

Much of the previous research on science and gender has examined why females do not continue in physics. Some of those reasons will be presented here.

One thing we can discount in the cause of the leaky pipeline is biology – sex is known not to make a difference in ability to do physics. In 2003, Blue and Heller examined whether sex makes a difference in students’ ability to do physics. They matched like men and women by the students’ high school backgrounds and pretest scores in an introductory college physics class. After completing a course in introductory calculus-based physics in college, the students were given a post-test. This post-test was compared between like students. Because the only differentiating factor was sex, if there was a difference, it could have been concluded that there was a biological difference due to sex that affected a student’s ability to do physics. However, it was determined that there was no difference in the post-test. Thus, there was not difference due to sex (Blue & Heller, 2003).

A distinction could be made between sex and gender; sex is a biological construction that divides people into two categories, male (men) and female (women), while gender is a social construct that gives characteristics to divide people into two categories of masculine and feminine. The research presented here does not make a difference between sex and gender and thus uses them interchangeably. Although we believe there is a distinction because the literature pertinent to this study does not differentiate between sex and gender, these two words will be used for the same concept; both will refer to the biological division of man and woman.

However, one thing that may make a difference is the belief that STEM fields do not fulfill communal goals. Many people believe that scientists in these disciplines are not working with or helping other people; they are working as a “lone scientist” – a scientist who works completely on his or her own without the contact of others. A study completed by psychologists at Miami University looked at how communal goals influence people’s interest in STEM fields (Diekman, Brown, Johnston, & Clark, 2010). They found that this problem is an even greater determining
factor for whether a student chooses a STEM field than a student’s self-efficacy in that field. This is interesting because many scientists in these fields are doing science that will directly, or indirectly, aid many people. Diekman, et. al. believed that psychological science can be used to help break down the barrier and realign the view of STEM and communal goals. They recommend using psychological science to help correct this perception and draw attention to those fields that help people in a way that may be obscure to the general population.

In 2005, the American Institute of Physics asked women who have a PhD in physics and are faculty members of a physics department what they think about the underrepresentation of women in physics and any problems they had encountered due to this problem. Those women physicists gave reasons why they were, at the time, discouraged by physics. Figure 2-4 (Ivie & Guo, AIP Report: Women in Physics and Astronomy, 2005) from the American Institute of Physics' Statistics Research Center shows the top reasons why women physicists are discouraged about physics. The reasons, in order of highest response to lowest, were interaction with colleagues, funding, research, personal life, and climate for women, and family obligations. Three concerns that are particularly troubling were climate for women, personal life, and family obligations. The fact that 43% of women believe that their climate is discouraging is very disheartening for younger women who are just starting out in the field. 48% of women say that their personal life and 35% say that their family obligations discouraged them from a career in physics.

![Table 17. Reasons Responding Women Physicists Gave for Being Discouraged About Physics](image)

Table 17. Reasons Responding Women Physicists Gave for Being Discouraged About Physics

<table>
<thead>
<tr>
<th>Reason</th>
<th>Percent</th>
</tr>
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<tbody>
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<td>Research</td>
<td>49</td>
</tr>
<tr>
<td>Funding</td>
<td>52</td>
</tr>
<tr>
<td>Interaction with colleagues</td>
<td>55</td>
</tr>
<tr>
<td>Climate for women</td>
<td>43</td>
</tr>
<tr>
<td>Personal life</td>
<td>48</td>
</tr>
<tr>
<td>Family obligations</td>
<td>35</td>
</tr>
</tbody>
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*Respondents could choose more than one answer.

Figure 2-4: Reasons that women physicists said they are discouraged about physics. Taken from Ivie & Guo, AIP Report: Women in Physics and Astronomy, 2005.
Figure 2-5 (Ivie & Guo, AIP Report: Women in Physics and Astronomy, 2005) shows areas where women physicists thought improvement was needed. Again going from the highest to lowest percent, the areas of improvement were: attitude about women in physics, balance of child care in family, daycare availability, discrimination, travel with young children, and daycare cost. At least 55% women cited each of those areas. The most important idea is that women perceive that they are being discriminated against and they would like something done to fix it.

<table>
<thead>
<tr>
<th>Area</th>
<th>Percent</th>
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<tbody>
<tr>
<td>Daycare cost</td>
<td>55</td>
</tr>
<tr>
<td>Daycare availability</td>
<td>65</td>
</tr>
<tr>
<td>Travel with young children</td>
<td>58</td>
</tr>
<tr>
<td>Balance of child care in family</td>
<td>69</td>
</tr>
<tr>
<td>Discrimination</td>
<td>65</td>
</tr>
<tr>
<td>Attitude about women in physics</td>
<td>80</td>
</tr>
</tbody>
</table>

Figure 2-5: The percentage of women physicists that agreed the following needs improvement. Taken from Ivie & Guo, AIP Report: Women in Physics and Astronomy, 2005.

One of the major reasons that more women do not continue in physics is that female students believe they cannot balance a family and a career. Because girls are not shown role models, they do not believe they can have everything they want and so they sacrifice their career in order to have a family (International Union of Pure and Applied Physics, 2008; Nattras, 2009; Whitten, et al., 2007). It has been shown that there is discrimination against job candidates who are pregnant or have children (Mason, 2008). Some scientists even believe that it is not possible for women with families to give enough attention to research. This is odd because these scientists do not believe this is a problem for male scientists with children. “In fact, research shows that male scientists are far more likely to have children than female scientists; two years after their Ph.D.'s, nearly 50 percent of men, but only 30 percent of women, had children” (Mason, 2008). This information comes from Mary Ann Mason, who has written multiple articles and books on
scientist mothers and how being a mother affects their careers. The statistics presented in the two-part “Do Babies Matter?” (Mason & Goulden, 2004; Mason & Goulden, 2002) are scary for women in science. Some of the most disturbing points are given below:

- The worst time for women who pursue careers in academia to have a baby is within five years of earning a Ph.D.
- Women who do have babies then are nearly 30 percent less likely than women without babies ever to get a tenure-track position.
- Of those women in the study who had babies early on, only 56 percent earned tenure within 14 years after receiving their Ph.D.
- Of men who became fathers early on, 77 percent earned tenure.
- Of men who never had babies, 71 percent got tenure.
- Men who took a university job without children were 70 percent more likely than their female counterparts to become parents.
- Only one-third of women who took a university job without children ever became mothers.
- Over all, male professors were much more likely to marry and have a family than female professors.
- Only 44 percent of all the tenured women in the study were married and had children within 12 years of earning their PhDs.
- 70% of tenured men married and became fathers during that time period.
- About a quarter of tenured women were still single without children 12 years after earning their doctorates but only 11 percent of men were.
- In 1999, only 48 percent of men who were married and were full professors in the sciences and social sciences had wives who worked full time.
- But, 91 percent of women who were married and were full professors in those disciplines had spouses who worked full time.

Many students are discouraged by the idea of having to balance a career in physics and a family. They are worried about having to give up their career and unwilling to give up a family. While the statistics given above are only for women in academia, and statistics are not available for
those outside, we assume those women probably have the same issues with being a scientist mother.

Those women who can balance a career and family are often times not out in the open and easy to use as a role model. In addition, female physics students only see women physics professors on a daily basis; students do not often get the opportunity to see women outside of academia so there is no way to observe how other women in physics are able to balance work and family. One reason for this is society. It is one of the hardest obstacles for girls and young women in college to get past. Society is not promoting the best images of scientists; girls’ potential role models are being buried horrible stereotypes presented by the media (International Union of Pure and Applied Physics, 2008; Nattras, 2009; Whitten, et al., 2007).

In 1997, Seymour and Hewitt wrote a book that book examines the results of a three-year, multi-campus survey about the reasons why undergraduate students switch from science, mathematics, and engineering (SME) majors to nonscience majors (Seymour & Hewitt, 1997). They explain that, “young women show a greater concern to make their education, their career goals, and their personal priorities fit coherently together” (pg 236, Seymour & Hewitt, 1997). Seymour and Hewitt also investigated problems that are outside of students' control like impostor syndrome, negative experiences with faculty and male peers, patterns of socialization, acceptance of the theory of inherent gender differences, and lack of encouragement from faculty, peers, friends, and family. They also discussed problems balancing family and career. The students were concerned about being able to have children and be financially independent. They were much less concerned with getting married. They assumed that it would happen and spent less time worried about how that would affect their career.

Seymour and Hewitt listed a number of strategies that women use to “survive” SME majors. Tactics needed include individual coping skills, like strong interest, confidence in one's abilities, assertiveness, learning to be more open and direct, not taking criticism personally, learning to let go of being self-critical, being able to relate comfortably to men, being less intimidated by faculty and male peer groups, and being ready to tackle all the work of the major. Bonding with other women in the major also helps; forming study groups, living together, and creating an
atmosphere for themselves are ways that women can help and support each other. In addition, finding a faculty mentor or advisor whom they can go to with questions or problems helps build students' coping skills.

Classrooms can be very unfriendly in high school, which can make girls' self-impression about themselves and their ability to do physics plummet. Girls can be intimidated by the boys in their classes and can be afraid to ask for help or even answer questions in class. They lack assertiveness and self-confidence, which can make physics classes even worse for girls if they are in a classroom with their male peers (Whitten, et al., 2007; Kessels & Hannover, 2008; Stowe, 1991; Bug, 2003; Rollin, 2008). In their high school physics classes, girls are not given the opportunity to see women in action. Their teachers are most likely men (Neuschatz, McFarling, & White, 2008) and their textbooks probably have a disproportionately larger number of pictures of men as scientists than women (Bug, 2003; Guzzetti, Hynd, Skeels, & Williams, 1995). This subconsciously shows girls that women are unsuited to be physicists.

Another problem with education is teachers. Most high school physics teachers are wonderful physics teachers and help students to see what physics is truly like, although there are some that are not and do give a wrong impression of what physics is. However, for most high school physics students this is not the case (Neuschatz, McFarling, & White, 2008). Teachers of either sex may be unconsciously evaluating their male and female students unevenly; they may be promoting a double standard even though they do not realize it. Over the course of a woman's career, this does significant harm without her realizing it is happening. Having teachers that are more aware of their actions and the treatment of their students will help to eliminate this. In addition, teachers should be more positive in their discussion of science and women. Many girls are being told, whether directly or not, that they cannot be scientists simply because they are girls (Whitten, et al., 2007; Nattras, 2009; International Union of Pure and Applied Physics, 2008; Stowe, 1991; Kessels & Hannover, 2008; Bug, 2003; Rollin, 2008).
2.3 Self-Efficacy

One big factor that may effect why women leave physics is lower self-efficacy. Bandura defined self-efficacy as “people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives. Self-efficacy beliefs determine how people feel, think, motivate themselves and behave. Such beliefs produce these diverse effects through four major processes. They include cognitive, motivational, affective and selection processes” (Bandura, 1994).

Bandura states that the most successful way of building a strong efficacy is through mastery experiences. While successes help a person’s self-efficacy to grow, failures can weaken it. Overcoming difficulties through determination without letting setbacks stop a person from accomplishing a task is the key to beneficial mastery experiences. As a person’s self-efficacy grows and she or he realizes they can achieve success, they are quicker to bounce back and persevere when presented with complications.

The second way of creating a high self-efficacy is through models – if a person sees others that are similar to them achieving, then it helps he or she realize that they too can succeed. The person can put themselves in other’s shoes. However, if a person sees others failing, she or he can believe that they too will fail no matter what they try. It is necessary to have good role models to help students, especially underrepresented students, realize they can succeed.

The third way to a stronger self-efficacy is through social persuasion. A person needs to know that they are doing well and can gain approval from mentors and peers. This can help to give a person the encouragement they need to succeed. However, it is much easier to undermine a person’s self-efficacy by complementing them unrealistically before a failure. This occurs when a peer or mentor complements someone even though they know that the person is going to fail. By not critiquing the person or helping them to improve the peer or mentor builds them up without preparing them for what is to come. Thus they “fall harder” when they are unsuccessful. Those to whom this happens often are less likely to take risks and will avoid challenges.
There are four psychological processes that are affected by self-efficacy. The first is cognitive processes. People like to set goals for themselves and those goals are first planned through thought. A person who has a high self-efficacy will be able to picture himself or herself achieving and doing positively, while a person who has low self-efficacy will see himself or herself failing and thus have high self doubt. In order to accomplish a goal it is necessary to remain on task even while facing setbacks and failures. This is both influenced by a person’s self-efficacy and influences a person’s self-efficacy. It also encourages good analytical thinking.

The second is motivational processes; self-efficacy is crucial to self-motivation. People who are able to motivate themselves to achieve can set goals and accomplish them easier. The three forms of cognitive motivation are casual attributions (attribution theory), outcome expectancies (expectancy-value theory), and cognized goal theory (goal theory). In attribution theory, casual attributions affect motivation, performance, and affective reactions. A person who has a high self-efficacy will attribute their failure to inadequate effort, while a lower self-efficacious person will attribute a failure to inability. In expectancy-value theory, a person’s motivation is fueled by the expectation that certain behaviors will produce certain results. She or he will act according to whether or not they think they can accomplish the task and what they think about the likely outcome of the task. In goal theory, goals operate mostly through self-influence instead of motivation and direct action. People make self-satisfaction conditional on fulfilling goals, and thus give direction to their actions and create incentives to keep going until they accomplish their goals. They seek self-satisfaction from fulfilling goals; they place value and meaning on certain situations and are then prompted to increase their efforts when dissatisfied by their performances. Motivation based only on a person’s goals is controlled by three types of self-influences: self-satisfying and self-dissatisfying reactions to her or his performance; perceived self-efficacy for goal attainment; and readjustment of personal goals based on his or her progress. People set goals for themselves, decide how much effort they want to exert, how long to persevere when setbacks arise, and exert strength in the face of failure. High self-efficacy helps a person to keep going and put forth more effort when they fail.
The third is affective processes – a person’s coping abilities determine how he or she will manage stress, depression, or other anxiety producers during the course of a task. The ability to push aside troubling thoughts and anxiety arousal is the key to succeeding.

The last process is selection process. Self-efficacy affects how a person chooses what activities and environments in which they persist. A person will avoid a situation that they believe they cannot handle whether due to coping problems or inability to accomplish the task. One major example of the effect of selection processes is career choice. If a person has a high self-efficacy, she or he will widen her or his range of career options. The stronger the interest, the better the person will prepare his or her self, and thus the greater the success.

Self-efficacy can be affected by the phase of life in which a person is situated. Infants and small children are just starting to build their self-efficacy with the help of their families. Infants are born without a sense of self and it is crucial that they learn about the world around them as they grow. They need to be in control of actions, like learning how to feed themselves. Young children are developing their physical, linguistic, social, and cognitive skills. In order to help them become more efficacious, they must have the ability to explore the world around them more and watch their parents and siblings to use as models for how to perform responsibilities and tasks throughout their life.

As children grow, their peers become another setting in which to develop their self-efficacy. While siblings can be good models, it is necessary for children to have people around them their own age so they can judge themselves in relation to someone more similar to them. This is especially important because children choose peers that have similar interests and values. This helps them to validate their self.

As a student gets older, school becomes a crucial agency for refining cognitive self-efficacy. A student’s belief in his or her capabilities to master school related activities affects their goal, their level of interest in academic activities, and their accomplishments in school. The teacher’s self-efficacy is a key part of the learning environment. Those teachers who have a high self-efficacy about their teaching can help to motivate their students and boost cognitive development.
However, teachers who have a low sense of self-efficacy rely heavily on negativity to get students to learn and participate in classroom activities. Classroom teaching and learning structures affect the development of self-efficacy due to the emphasis placed on social comparison instead of self-comparison appraisal. Cooperative learning environments, where students work together, are more likely to encourage positive self-evaluations of ability and higher goals than individualistic or competitive learning environments (Bandura, 1994).

2.4 Single-Sex Education

One way we may be able to help those women with a lower self-efficacy succeed in physics is through single-sex education. In the last 10 to 15 years, there has been a resurgence of interest in single-sex education. Thus, research has been done to examine how single-sex classrooms affect students' performance, self-confidence, choice of profession or career, and many other areas of student life.

Single-sex education, also known as single-gender education, occurs when male and female students attend separate classes or separate schools. Such segregation was common before the mid-twentieth century when schools, colleges, and universities became coeducational. Now in some areas of the country, students and parents have the option of single-sex or coeducational schools instead of being forced into one or the other. However, in many cultures and religions single-sex education is traditional and even mandatory (American Association of University Women, 2010; National Association for Single-Sex Public Education, 2010; U.S. Department of Education, 2005).

Single-sex education is one form of gender segregation. It is simply when women and men are separated by their gender. It can be “separate but equal” (Schermo, 2006), where facilities and teachers are equal in quality but in separate locations for each gender; however, it can also be a results of unjust or prejudicial discrimination. Gender segregation in education can help girls and boys learn better. This can be through single-sex schools or even single-sex classrooms at coeducational schools. The government has tried to protect students from improper gender segregation in a couple of ways.
Title IX of the Educational Amendments of 1972 (United States, 1972) became a law on June 23, 1972. It states “No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity receiving Federal financial assistance...” It was a big step towards gender equality in schools, sports, clubs, healthcare, and many other areas of life.

No Child Left Behind (United States, 2002) promoted the use of single-sex classrooms for classes like physical education that include contact sports and sex education. In 2005, the U.S. Department of Education summarized the research done on single-sex education and whether it is comparable to coeducational schools. Some of the studies did find that single-sex education was better, especially for girls, but some of the studies were inconclusive (U.S. Department of Education, 2005). In 2006, the Department of Education announced new rules relating to single-sex education in public school districts - districts could create new single-sex schools and classes as long as enrollment was voluntary. However, “[s]chool districts that go that route must also make coeducational schools and classes of 'substantially equal' quality available for members of the excluded sex” (pg 1, Schermo, 2006).

Single-sex schools can be described in different ways. Most are private but there are a few public single-sex schools. Single-sex schools also vary by age of student; there are preschools, elementary schools, K-12, high schools, and colleges. There are also some schools where separate classrooms are single-sex only while the school overall is coeducational. This research project focused on single-sex education at the college level, but we will begin here by discussing previous research done on girls in single-sex, primary and secondary schools.

In 1998, the AAUW published a collection of studies on single-sex education (American Association of University Women, 2010). The collection of research involved many topics related to single-sex education in primary and secondary schooling. However, all of the research surrounded a few key points (pg 2-3, American Association of University Women, 1998):
• There is no evidence that single-sex education in general “works” or is “better” than coeducation. That does not mean it fails completely for all students at all schools. The success or failure depends on the particular group, setting, and academic or social goals.
• No matter what the educational setting, educators and policymakers need to work more to pinpoint components of a “good education”.
• Single-sex classrooms and schools produce positive results for some students in some settings. Researchers are trying to determine whether this comes from a unique quality found only in single-sex education or whether they can be replicated in a coeducational setting.
• There is no data on the long-term impact on girls or boys from single-sex education at the primary or secondary level.
• No learning environment can provide an escape from sexism. In fact, single-sex classrooms can reinforce gender stereotypes and societal roles.
• Single-sex education covers so broad a range that it defied most generalizations.

By researching women in high school, researchers saw that single-sex education can help girls in high school physics classes (Stowe, 1991; Gillibrand, Robinson, Brawn, & Osborn, 1999; Sanford & Blair, 2002; Robinson & Gillibrand, 2004). Much research has been done on single-sex classrooms at coeducational high schools. Most of the research shows that girls are more self-confident and their achievement is just as high as males in either single-sex or coed classrooms. However, some have found that this depends on their age; ninth and tenth grade girls are more likely to be rowdy and pay less attention in class without the effects that boys bring to the class (Stowe, 1991). Even in a rowdy classroom, although, girls’ success in high school physics is equal to boys’ success.

Emily Langdon, in her “Women's Colleges Then and Now: Access Then, Equity Now”, (Langdon, 2001) explained some of the history behind women's colleges and reasons why women would choose to go to one over a coed college. Women's colleges were first established to provide educational opportunities to those who were denied higher education at other types of schools and universities. She explained that women's colleges provide something that cannot be found in a coeducational setting – “a women-centered education” (pg 10, Langdon, 2001). This
focus on being a woman helps give the students positive role modeling, mentoring, leadership, and achievement in male-dominated fields using pedagogical and curricular innovations. These supportive activities aid the women in building self-confidence that they will need not only in male-dominated fields, but also in other areas of their life. Women's colleges prepare their students not only for their job or their next step in education, but also for life in the “real world”. Other research also showed that women could benefit from women's colleges (Umbach, Kinzie, Thomas, Palmer, & Kuh, 2003).

Pauline Perry examined women's colleges in England and explained that although Western society, in general, had been moving away from single-sex education, it is has become more popular in certain countries (Perry, 2000). She predicted that in the future, single-sex colleges will need to be reinvented again because of this new resurgence in interest. She explained, “[N]ew ways must be found to educate women to help make a full contribution without losing their traditional feminine strengths”.

In “The Future of Women's Colleges”, Florence Howe discussed teaching at a women's college. She made four summary statements (pg, 133-134, Howe, 1984) about the curriculum, or the “knowledge”, offered to women students:

1. Women’s education cannot be described as “equal” to men’s if the curriculum is entirely or mostly the story of male accomplishments, male lives, the thoughts and aspirations of men.
2. Such a curriculum is not simply unfair to women (and men too); it is distinctly harmful to their growth and development.
3. The traditional curriculum has a negative effect on the aspirations of women; and while it is supportive of men’s aspirations, it does not prepare them to live in an egalitarian manner with women. It prepares men to devalue women, to discriminate against them, and to support sexist institutions.
4. It is not enough to focus on the need for curricular change in higher education. Elementary and secondary education is as bad or worse and revision must begin there as well, if we are ever to be able to talk honestly about equal opportunity for women.
Shrewsbury gave advice about how to change these problems; these suggestions came primarily from feminist pedagogy; it is defined as “a theory about the teaching/learning process that guides our choice of classroom practices by providing criteria to evaluate specific educational strategies and techniques in terms of the desired course goals or outcomes. These evaluative criteria include the extent to which a community of learners is empowered to act responsibly toward one another and the subject matter and to apply that learning to social action” (Shrewsbury, 1987).

Howe's ideas of applying feminist pedagogy were developed from her experience teaching women's studies at a coeducational college and combined with her experience teaching at a women's college. She developed goals around five areas of college that she found to be significant to the improvement of equality in teaching and learning. These goals are:

- Initial planning - using women's studies as a nucleus to plan the curriculum
- Faculty education - using summer institutes and sabbaticals, visiting professorships, team-teaching, etc to revise the curriculum in 3 years
- Research support - establishing a research center to support the work of research being done, especially in an area important to that specific school
- Diversification of the faculty - bringing in feminists in various careers to teach the faculty
- Diversification of the student body - implementing special recruitment to attract older and minority women as well as having opportunities for “life experience credit” and work as adjunct faculty

Thinking specifically about girls taking STEM courses, one thing that may help retain students and improve learning, is single-sex education. Research of classroom dynamics in single-sex science classes is discussed in Debating Single-Sex Education: Separate and Equal? (Spielhagen, 2007). It is explained that there are at least two barriers that affect girls' achievement in science and mathematics: first, boys are called upon three times more often than girls and receive more informative replies for their responses; second, male characters continue to dominate in science and mathematics textbooks. However, in single-sex classes, girls are more likely to participate and ask questions.
Spielhagen examined 5th-7th graders in single and mixed-sex science and mathematics classes. The students were given a beginning questionnaire that asked about their attitudes and self-efficacy toward math and science. Throughout the year, the students were observed to determine their behaviors in the different types of classes. At the end of the class, students were given a final survey to see if their attitude and self-efficacy had changed. The results showed that single-sex classes were more interactive and had more energy and participation. The teachers did much less direct instruction in both the boys and girls' class. Additionally, if the girls needed help they would seek it but the boys would expect the teacher to realize they needed help and come to them. The teachers themselves felt like they acted more like facilitators. In the mixed classes, the teacher felt like they needed to teach more and that the atmosphere was more relaxed but with less interactive energy.

As for the students, the boys liked the mixed classes better and felt they were being “punished” in the single-sex classes. On the other hand, the girls preferred the all-girls classes. As for attitudes and self-efficacy, the single-sex classes were more positive about working hard and doing well. The girls also felt they were good at science, they would take more science in the future, and that they would like to become scientists. The study clearly gives evidence that girls can benefit from taking STEM classes in an all-girls environment. However, the study is not clear about the benefits for boys, if there are any at all.

In 1992, Jadwiga Sebrechts examined female science students at women’s colleges. She discussed their achievements and the benefit from having only other women in their classes. Because these women were more likely to have role models, they were more likely to go to graduate school and be committed to their career and field. Their role models and teachers in STEM were almost half female; this is a much greater percentage than the 11.4% of women professors at coeducational schools. Students in these fields at women's colleges were going to graduate school in disproportionately high numbers. This all shows that women's colleges are producing women in STEM at a higher rate than coeducation schools and the women they are producing are more self-confident and committed to their fields (Sebrechts, 1992).
In 2007, Whitten, et al. published phase two of their three-phase project on “what works for women in physics”. In the first phase, they examined nine physics departments at coeducational schools to assess the quality of female-friendly practices and quantity of women. In the second phase, they visited six women's colleges and compared them to each other as well as to the coed schools from phase one. They found that women's colleges try to recruit physics majors much more than the coeducational ones. This led them to examine the leaky pipeline and how the women’s colleges affect the students. Whitten, et al. explained that women tend to have a less direct path toward a major in physics than men do. They believed this should be described as “complex pathways” (pg 39, Whitten, et al., 2007) rather than a leaky pipeline. In their discussion of women's colleges, they examined what they call the “women's college effect” (pg 42, Whitten, et al., 2007) to see if it really exists. They observed that the women's colleges they visited are dedicated to recruiting physics and astronomy majors, have high expectations and goals for their students, build confidence, have a cooperative environment, a sense of mission, and have adult female role models in the faculty, upperclass majors, and/or alumnae.

Unfortunately, little research exists on men’s colleges. In fact most of the recently published articles are about the possibility of the last three men’s colleges “going coed”. The articles do not use research to explain why they are necessary or what makes them a good option for men who could go elsewhere. However, they give a myriad of personal stories and quotes from the students. For example, one student said that an advantage of going to a male-only college is that “[y]ou don’t have to worry about how you look or think about that girl who’s sitting one row away” (Bartlett, 2008).

A recent article is on self-efficacy and men’s colleges. The study examined the classroom environment at four coeducational schools and three men’s colleges. They found that men's participation in class discussion at men's colleges began at about the same rate as both men and women's participation in the coeducational classes. However, men at men's colleges increased their participation over time, while both the men and women at coeducational colleges decreased their participation. In addition, the faculty asked more questions to specific students at men's colleges, particularly to students who had not already asked a question or participated in class, and asked more follow-up questions than at coeducational colleges. The one surprise to the
researchers was that the professors did not provide more positive feedback or at least significantly less negative comments to the men at the men’s colleges (Trice, Naudu, Lowe, & Jaffe, 1996). However, even though the authors said they would discuss self-efficacy, the article does not talk about how the self-efficacy of the students at either the men’s colleges or the coeducational colleges was affected.

### 2.5 Conclusion

Thinking about the advancement toward equality and all the opportunities girls have today, we wonder why do these women not continue in physics. Could it be due to a difference in self-efficacy of male and female students? And because women are more likely to do well and feel more confident in a single-sex environment, could this be part of the solution to plugging up the leaky pipeline? If this were a solution for women, how would single-sex education affect men and their self-efficacy? We have seen the single-sex environment be a problem for boys in high school, so do these problems appear in male students at the college level? We answer these questions in this research project.
Chapter 3: METHODS

The previously discussed research in Chapter 2 has shown that young women in college can benefit from taking their STEM classes at women's colleges. Through this research project, we investigated this affect further, in addition to whether it is also true for men at men's colleges. We began with two research questions we hoped to answer:

- First, do women benefit by being physics majors at a women's college rather than at a coeducational college or university; can this give them a path to become strong, self-confident women that are committed to the field of physics and who realize they do not have to sacrifice a family for their career?
- Second, does single-sex education affect men in such a way that we can make recommendations for students to either attend or not attend a men’s college?

To gather evidence to answer these questions, quantitative and qualitative methods were employed. Internet surveys were emailed to four schools in the fall of 2010 and then interviews were conducted at three of the schools.

This multi-method research project combined quantitative (surveys) and qualitative (interviews) techniques. Feminist researchers call this mixing of methods in a single study “triangulation”. It is used for “particular feminist concerns that reflect intellectual, emotional, and political commitments” (pg 197, Reinhartz, 1992). Triangulation is a way to illuminate previously unexamined or misunderstood experiences. It is also convenient because it increases the likelihood of obtaining scientific credibility and research utility (pg 197, Reinhartz, 1992). Triangulation is also useful to give the people being studied a voice in which they can explain in greater depth what they meant on the quantitative portion of the study in a way that would not be possible on a survey.

We chose to use multiple methods because we aimed not only to give evidence of young women and men either benefitting or suffering from single-sex education but also to help them give their story as further evidence to help answer our research questions. The specifics of the methods for both the surveys and the interviews are explored in the following section.
3.1 Colleges

The fieldsites surveyed include two women's colleges, one men's college, and one coeducational college. They are all small, liberal-arts colleges. These schools were chosen as a group by the size of their student body, size of their physics classes, availability of a major in physics, and similarity in mission. The colleges are Agnes Scott College, Mount Holyoke College, Wabash College, and the College of Wooster. A summary table of the demographics for each of the schools is shown in Table 3-1 below.

Agnes Scott is a women’s college in Georgia and is considered to be one of the Seven Sisters of the South. It is a highly selective, independent, liberal-arts college affiliated with the Presbyterian Church. There are about 900 students enrolled and more than a third are underrepresented minorities. There are 33 undergraduate majors, with programs in pre-law and pre-medicine, as well as dual-degree programs in architecture, engineering, and nursing (Webmaster, Agnes Scott College, 2010). The physics department has four professors and 12 physics, astrophysics, and math-physics majors (Webmaster, Agnes Scott College, 2010; Bowling, Personal Communication, 2010).

Mount Holyoke College is a women's college in Massachusetts and is a part of the Seven Sisters. It is described as a highly selective, nondenominational, research, liberal-arts college. There are 2,200 students and 1 in 3 are either international or a racial minority (Office of Communications, Mount Holyoke College, 2010). In the physics department, there are seven professors and two research or teaching associates. There are currently 20 declared physics majors and minors (Department of Physics, Mount Holyoke College, 2010).

Wabash College is a private, independent, four-year liberal-arts college for men located in Indiana. It is one of the three non-religious, four-year men's colleges left in the United States. (The other two are Morehouse College, a historically black college in Georgia, and Hampden-Sydney in Virginia.) Wabash has about 900 students who major in 21 different areas (Webmaster, Wabash College, 2010). The physics department has four faculty members, 10
majors, and 3 minors (Webmaster, Wabash College, 2010; Sayre, Personal Communication, 2010).

The College of Wooster is a private, independent, research, liberal-arts college located in Ohio with ties to the Presbyterian Church. There are about 2,000 students, with 54% women and 46% men (Webmaster, College of Wooster, 2010). There are currently 5 professors in the physics department with 21 declared physics majors, two of whom are chemical physics majors (Physics Department, College of Wooster, 2010).
<table>
<thead>
<tr>
<th>School</th>
<th>Type</th>
<th>Religious Affiliation</th>
<th>Total # of Students</th>
<th># of Physics Majors/minors</th>
<th># of Physics Professors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agnes Scott College</td>
<td>All-women, Private, liberal-arts</td>
<td>Presbyterian</td>
<td>900</td>
<td>12</td>
<td>4 (2 male, 2 female)</td>
</tr>
<tr>
<td>Mount Holyoke College</td>
<td>All-women, Private, liberal-arts</td>
<td>None</td>
<td>2200</td>
<td>20</td>
<td>8 (5 male, 3 female)</td>
</tr>
<tr>
<td>Wabash College</td>
<td>All-men, Private, liberal-arts</td>
<td>None</td>
<td>900</td>
<td>13</td>
<td>4 (3 male, 1 female)</td>
</tr>
<tr>
<td>The College of Wooster</td>
<td>Coed, Private, liberal-arts</td>
<td>Presbyterian</td>
<td>2000</td>
<td>21</td>
<td>5 (2 male, 3 female)</td>
</tr>
</tbody>
</table>

Table 3-1: This table shows a summary of the demographics of each of the schools used in this research project.

### 3.2 IRB Application

Because this project included human subjects, permission to was sought from Miami University's Internal Review Board (IRB) by submitting an application. Training for conducting research with human subjects is required; it was completed through the Collaborative Institutional Training Initiative (CITI) online course on January 22, 2010. After receiving approval from Miami, applications were sent to the four schools where data were collected. The applications can be seen in Appendix A, Appendix B, Appendix C, Appendix D, and Appendix E.

The Exempt IRB application was used because the project fit the exemption category number two – the research used survey and interview procedures; “any disclosure of the subjects responses outside the research could not reasonably place the subjects at risk of criminal civil liability or be damaging to the subjects' financial standing, employability, or reputation”; and the research did not include subjects younger than 18 years old.
In the IRB application, my advisor Dr. Jennifer Blue was listed as the principal investigator of the study. The application then asked about the purpose of the study, the population studied, and the methods used. The purpose was listed as, “Research has shown that young women in college can benefit from either taking their science, technology, engineering, and mathematics (STEM) classes in single-sex classrooms or at women's colleges. We hope to give more evidence that shows this is the case not only for women, but also for men at men's colleges”. The population includes introductory calculus-based physics students and physics majors from Agnes Scott College, Mount Holyoke College, Wabash College, and the College of Wooster. More about this is discussed above in Section 3.1.

The IRB application also asked about the consent process. Because we used an online survey tool, the students did not have a paper consent form to sign. However, the opening page had information about the survey that the students were required to read. The information included: the survey being optional, taking only 15-20 minutes, the fact it will not affect their grade or standing at school, the knowledge that responses of individuals will not be seen by their professors (only analyzed responses from the entire sample population), the fact they can skip questions, and our contact information. To proceed with the survey, the students had to click the “I agree” button. The next two questions of the survey asked their age and whether they give us permission to use their data at the end of the survey. The program will be able to tell who has completed the survey from the emails that were sent with the link and thus reminder emails could be sent only to those who had not yet completed the survey. The surveys are explained below in Section 3.3 and the surveys themselves are in Appendix G, Appendix H, Appendix I, and Appendix J.

The surveys ended with a thank you for completing the survey and asked students if they were willing to help us further by being interviewed in a confidential manner. If they would like to be interviewed, they clicked on a link. The link took the students to another survey that provided more information on what the interview would entail; asked for the name, email address, and school of the subject; and explained that they may or may not be selected to be interviewed and if they were it they would receive an email from us to schedule an interview in early November. The interviews had the required paper consent form, which can be found in Appendix F.
After the IRB applications requirements were accomplished and the application was completed, permission was sought by sending the application to the IRB at Miami. Miami's IRB Exempt Research Certification letter can be viewed in at the end of Appendix A. After the IRB approved the application, the additional applications for each of the other schools were completed and submitted. After every application was approved, human subject research could occur.

3.3 Survey Procedure

In mid-September 2010, an email was sent that included a link to an online survey to all students in the introductory, calculus-based classes, as well as all physics majors and minors. The surveys were done through Prezza Checkbox, an online survey tool provided by Miami University.

The surveys consisted of multiple-choice questions, with comment boxes, about the student's self-efficacy and self-confidence in physics, their thoughts about attending single-sex and coed colleges, as well as information about their previous schooling. The surveys were completed by the beginning of October. The students had the opportunity to give their contact information if they would like to be interviewed. All students were given this option, although, physics majors were the desired responders to this question.

The email was sent to 48 students at Agnes Scott, 60 students at Mount Holyoke, 55 students at Wabash, and 63 students at Wooster. Out of the 226 students that the survey was sent to, 88 students completed the survey with responses that could be used in our research, which gives a response rate of approximately 40%. The number breaks down to 30 from Agnes Scott, 11 from Mount Holyoke, 26 from Wabash, and 21 from Wooster (9 women and 12 men). The surveys that could not be used were ones that were either incomplete (had not completed the majority of the Likert scale questions) or had stated that their responses could not be used in this project.

3.3.1 Survey Design

The survey was divided into two major sections, both having multiple subsections. The first section consisted of multiple-choice questions we designed. It asked questions about a number of
demographics including previous schooling, college choice, science taken in college, and their introductory calc-based physics course taken in college. While the questions are multiple-choice, ones that can be elaborated on have optional comment boxes. Because we could ask students at the coeducational college about things like student interaction between sexes, there were four different surveys – one for each college.

The last section of questions were Likert scale questions; the students chose a number from 1 to 5, where 1 was strongly disagree and 5 was strongly agree. These questions were taken and edited from Students' Motivation, Attitude, and Self-Efficacy in Science (SMASES) (Reid, 2007). Questions in this section were on the topics of performance goals, achievement goals, attitude toward physics, and self-efficacy in physics.

Agnes Scott’s survey can be seen in Appendix G, Mount Holyoke's survey in Appendix H, Wabash's survey in Appendix I, and Wooster's in Appendix J.

3.3.2 Survey Analysis Methods
After the surveys were completed, an initial analysis was completed by creating bar graphs of each of the twenty-one Likert scale questions. The percentage for each response was compared between schools and between sexes. The results of this analysis can be found in Sections 4.1 and 5.1.

The individual responses for each person were totaled to produce a final self-efficacy score that was used to statistically analyze the data. By doing this, we could test the internal consistency of the survey, check to see if the distribution of scores was normal, and thus more easily compare the different groups of students. Results of this analysis can be found in Section 5.1.

The statistical analysis was completed with the help of Dr. Ellen Yezierski from the Chemistry Education Research program. A 2 X 2 analysis of variance (ANOVA) was conducted to evaluate the effects of two education systems (single-sex and coeducation) and sex on students’ self-efficacy in physics. To evaluate the accuracy of the p-value generated by the ANOVA, the three underlying assumptions were tested. First was that “the dependent variable is normally
distributed for each of the populations” (Green & Salkind, 2010). To make sure this was correct we performed a one-sample Kolmogorov-Smirnov test and found that the distribution of the data are normal. The second assumption is that “the population variances of the dependent variable are the same of all cells” (Green & Salkind, 2010). To test this we used Levene’s Test of Equality of Error Variances. Because the significance (0.072) is larger than 0.05, the test is not significant and the variances are not significantly different (Archambault & Schloesser, 2000). The last assumption is that “the cases represent random samples from the populations and the scores on the dependent variable are independent of each other” (Green & Salkind, 2010). The sample should be sufficiently large enough for the assumption to be valid.

The last method of analysis we used tested internal consistency of the scaled portion of the survey. The internal consistency of the instrument was determined by computing a Cronbach Alpha (0.85). These scores are reliable for the respondents of the survey if this value is above the accepted reliability coefficient of 0.7 (UCLA: Academic Technology Services, Statistical Consulting Group).

### 3.4 Interview Procedure

The interviews were a way of getting a more personal and richly described and experienced view of single-sex versus coeducational colleges. Three of the schools had students interested in being interviewed with a total of 10 people – 3 from both Agnes Scott and Wabash, 4 from Wooster. However, only 5 interviews were conducted – 2 at Wooster and Wabash, 1 at Agnes Scott. This was due to the fact that 5 of the people who initially expressed interest did not respond to any of the follow up emails asking to schedule an interview during the on campus visit. The visits for interviews occurred in October and November. The interviews were conducted on the students’ campus and were audio-recorded using microcassettes.

#### 3.4.1 Interview Design

The interviews were based on the interviews used for Whitten, et. al.’s “What Works for Women in Undergraduate Physics?” research project (Whitten, et al., 2007; Taylor, Personal Communication, 2010). Like the surveys, there are additional questions that can be asked of the
coeducational students. The interviews cover four different topics: student/faculty relations, department info, peer support, gender issues, and single-sex/coed schools. Appendix K gives the questions asked in the interviews and the methods used to execute them while Appendix F shows the Consent Letter for the interviews.

3.4.2 Interview Analysis Methods

We employed an interview technique to aid in our discovery of a more personal view of why students chose to go to the school. In addition, we explored the effect this choice had on their view of their physics class and self-efficacy in physics. Because our research questions investigated how students benefited from being a physics major at single-sex colleges, we needed to acquire information from students that chose a single-sex college. The questions in the interview were designed to gain insight into the lives of the students and the institution. In Whitten, et. al.'s “What Works for Women in Undergraduate Physics?” research project, they identified a number of factors that help women in physics. Seymour and Hewitt also discovered problems and strategies that hurt or help female SME majors, respectively. We hoped that the interviews would give more evidence of these factors, problems, and strategies.

After data collection was complete, the interviews were transcribed verbatim. The interviews were then analyzed using content analysis and codebook design. Analysis of these data involved a codebook analysis (Crabtree & Miller, 1999), which was guided by the assumptions of feminist theory (Reinhartz, 1992). The codebook was created using main topics and keywords from the survey data and analysis, from open coding, and also from codes generated after reading previous research (Seymour & Hewitt, 1997; Whitten, et al., 2007). These codes were then grouped into four overarching themes present in all interviews: education, environment, perceptions, and relationships. The codebook, listed by theme, can be seen in Appendix L. Variations of these words were also included in the coding of the transcripts, for example both “confidence” and “confident” fell under the codeword “confidence” and the theme “perceptions”. Examples of coding are in Appendix M.

After coding, the quotes were then compared to responses on the surveys to see if there was any deviation or support of the survey results. Quotations or sections of the interviews that have
strong or outstanding correlations to survey questions and that give more insight into why or why not a student would choose a single-sex college or that gave more evidence relating to the results of the survey were identified. These data will be presented in Section 4.2.

The interviews were also analyzed using Wordle™ (Feinberg, 2009), an online program that creates a word cloud from the provided text. The words are ranked in order of frequency by using the size of the font to denote the rate of recurrence. In order to use this program, the transcripts were edited by first deleting the questions and then deleting commonly used words like “okay” and “like”. The edited transcripts were then copied and pasted into the program. The Wordle™ for each interview can be seen in Section 5.2.1.
Chapter 4: DATA

4.1 Survey Data

After the surveys were concluded, an initial analysis was completed by creating bar graphs of each of the 21 Likert scale questions. The percentage for each response was compared between schools and between sexes. The responses for each of the individual questions were totaled, with 1 being a low self-efficacy and 5 a high self-efficacy, to give a total score of 105. These total scores were then averaged and compared.

4.1.1 Individual Questions

The first 5 statements examined in-class participation where “participate” was defined as attending class, completing all assignments, and doing anything else needed for their introductory calculus-based physics class as stated in the course’s syllabus. These questions had answers of 1 to 5:

- 5 if they ALWAYS participate
- 4 if they OFTEN participate
- 3 if they SOMETIMES participate
- 2 if they RARELY participate
- 1 if they NEVER participate,

where a higher score would indicate a higher self-efficacy.
The first statement was “I participate in my introductory calculus-based physics class” and the responses are shown in Figure 4-1 below. Men at either the men’s college or coed college were much more likely to participate in their intro calc-based physics class. Women at the women’s colleges were also likely to participate, but the women at the coed college generally participated sometimes or rarely in their class.

Figure 4-1: This chart gives the responses for the first statement by the percentage of students that answered with each number of the Likert scale.
The second statement was “When I participate in my introductory calculus-based physics class, I do it to get a good grade” and the responses are shown in Figure 4-2 below. The trend is almost the same where the men at both schools participate to get a good grade. The women at the women’s colleges participate more often to get a good grade than the women at the coed school.

![Chart](image)

Figure 4-2: This chart gives the responses for the second statement by the percentage of students that answered with each number of the Likert scale.
The third statement was “When I participate in my introductory calculus-based physics class, I do it to perform better than other students” and the responses are shown in Figure 4-3 below. The responses to this question lean heavily toward rarely or never participating to perform better than other students. However, two groups stood out - the men at the coed college by sometimes participating to perform better than other students and the women at the coed college by never participating to perform better than other students.

Figure 4-3: This chart gives the responses for the third statement by the percentage of students that answered with each number of the Likert scale.
The fourth statement was “When I participate in my introductory calculus-based physics class, I do it so that other students think I’m smart” and the responses are shown in Figure 4-4 below. Again the trend is towards rarely or never participating to make other students think they are smart.

**Figure 4-4:** This chart gives the responses for the fourth statement by the percentage of students that answered with each number of the Likert scale.
The fifth statement was “When I participate in my introductory calculus-based physics class, I do it so that the teacher pays attention to me” and the responses are shown in Figure 4-5 below. Responses from all students were split mostly between sometimes, rarely, and never participating so the teacher pays attention to them.

![Chart](image)

Figure 4-5: This chart gives the responses for the fifth statement by the percentage of students that answered with each number of the Likert scale.
Overall for the first set of statements, the responses were spread throughout the five answers. However, there is a trend towards agreeing from the women at the women’s colleges as well as a trend towards disagreeing from the women at the coed college.

![Summary for Statements on Participation](image)

Figure 4-6: This chart is a summary of the responses from the first 5 statements on participation in class. The percent of responses was averaged for each type of student response.
The second set of statements covered the students’ fulfillment due to perceived achievement in their calc-based physics class. These questions had answers of 1 to 5:

- 5 if you STRONGLY AGREE with the statement
- 4 if you AGREE with the statement
- 3 if you HAVE NO OPINION on the statement
- 2 if you DISAGREE with the statement
- 1 if you STRONGLY DISAGREE with the statement,

where a higher score would indicate a higher self-efficacy.

The first statement was “During a physics course, I feel fulfilled when I achieve a good grade on a test” and the responses are shown in Figure 4-7 below. We see that the women at both the women’s colleges and the coed college felt fulfilled when they achieve a good grade on a test. The men were more spread out across responses of have no option to strongly disagree.

Figure 4-7: This chart gives the responses for the sixth statement by the percentage of students that answered with each number of the Likert scale.
The second statement was “During a physics course, I feel fulfilled when I gain confidence with the content” and the responses are shown in Figure 4-8 below. The women at the women’s colleges and all of the men feel fulfilled when they gain content with the course. However, the women at the coed college are mostly divided between strongly agreeing and agreeing with the statement.

![Bar chart](image-url)

**Figure 4-8:** This chart gives the responses for the seventh statement by the percentage of students that answered with each number of the Likert scale.
The third statement was “During a physics course, I feel fulfilled when I am able to solve a difficult problem” and the responses are shown in Figure 4-9 below. The majority of students at all schools strongly agreed that they feel fulfilled when they are able to solve a difficult problem. It is interesting to see that percentage of responses from the men at the coed college and women at the women’s colleges is almost equal as is the percentage of responses from the women at the coed college and men at the men’s college.

![Graph](image)

**Figure 4-9:** This chart gives the responses for the eighth statement by the percentage of students that answered with each number of the Likert scale.
The fourth statement was “During a physics course, I feel fulfilled when the teacher accepts my ideas” and the responses are shown in Figure 4-10 below. About 50% of the women at the women’s colleges and the men at the coed college strongly agreed that they feel fulfilled when the teacher accepts either ideas, were as about 50% of the women at the coed college agree with the statement and the men at the men’s college are split between no option, agree, and strongly agree.

![Figure 4-10](image)

**Figure 4-10:** This chart gives the responses for the ninth statement by the percentage of students that answered with each number of the Likert scale.
The fifth statement was “During a physics course, I feel fulfilled when other student accept my ideas” and the responses are shown in Figure 4-11 below. Around 30-35% of students the women’s colleges and the men at both colleges strongly agreed that they feel fulfilled when other students accept their ideas. The rest of their responses were split mostly between no opinion and agree, except for the men at the coed college where around 35% responded as disagreeing with the statement. The women at the coed college responded with 45% agreeing with the statement.

![Bar chart showing responses to the statement](image)

**Figure 4-11:** This chart gives the responses for the tenth statement by the percentage of students that answered with each number of the Likert scale.

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Overall for the second set of statements, the responses were mostly in the strongly agree category. It is interesting that the women at the women’s colleges were much more likely to feel better when they receive outside feedback from peers, professors, or by completing a difficult task.

Figure 4-12: This chart is a summary of the responses from the second set of statements on perceived achievement in class. The percent of responses was averaged for each type of student response.
The next set of statements was about their attitude toward their calc-based physics class. These questions had answers of 1 to 5:

- 5 if you STRONGLY AGREE with the statement
- 4 if you AGREE with the statement
- 3 if you HAVE NO OPINION on the statement
- 2 if you DISAGREE with the statement
- 1 if you STRONGLY DISAGREE with the statement,

where a higher score would indicate a higher self-efficacy.

The first statement was “I look forward to my physics class” and the responses are shown in Figure 4-13 below. Around 50% of the men at the coed college agreed with this statement, 40 to 50% of the students at the single-sex institutions had no opinion on the statement, and the women at the coed college were spread across the board.

![Figure 4-13: This chart gives the responses for the eleventh statement by the percentage of students that answered with each number of the Likert scale.](image)

46
The second statement was “Physics class is fun” and the responses are shown in Figure 4-14 below. Around 50% of the men at the coed college said they strongly agree with the statement and about 50% of the men at the men’s college said they had no opinion about the statement. The women at the coed college were split between all responses except no opinion and the women at the women’s colleges were mostly split between strongly agree, agree, and no opinion.

Figure 4-14: This chart gives the responses for the twelfth statement by the percentage of students that answered with each number of the Likert scale.
The third statement was “I feel satisfied after my physics class” and the responses are shown in Figure 4-15 below. The responses to this statement were spread all over, where the men at the coed college and women at the women’s colleges felt more satisfied than the women at the coed college or the men at the men’s college.

Figure 4-15: This chart gives the responses for the thirteenth statement by the percentage of students that answered with each number of the Likert scale.
Overall for the third set of statements, the responses were varied by student type. The men at the coed college mostly strongly agreed, agreed, or had no opinion where as the men at the men’s college mostly had no opinion. The women at the coed college were spread across the board and the women at the women’s colleges mostly strongly agreed, agreed, or had no opinion like the men at the coed college.

Figure 4-16: This chart is a summary of the responses from the third set of statements on the student’s attitude toward their physics class. The percent of responses was averaged for each type of student response.
The last set of questions examined their self-efficacy in their calc-based physics class. These questions had answers of 1 to 5:

5 if you STRONGLY AGREE with the statement
4 if you AGREE with the statement
3 if you HAVE NO OPINION on the statement
2 if you DISAGREE with the statement
1 if you STRONGLY DISAGREE with the statement,

where a higher score would indicate a higher self-efficacy except for the fourth statement, “I have to work hard to pass physics”, where a higher score would indicate a lower self-efficacy.

The first statement was “I find it easy to get good grades in physics” and the responses are shown in Figure 4-17 below. The men at the coed college either strongly agreed, agreed or had no opinion about the statement. Most of the men at the men’s college and women at the coed college either agreed or had no opinion. The women at the women’s college were spread out between strongly agree, agree, no opinion, and disagree.

![I find it easy to get good grades in physics.](image)

Figure 4-17: This chart gives the responses for the fourteenth statement by the percentage of students that answered with each number of the Likert scale.
The second statement was “I am good at physics” and the responses are shown in Figure 4-18 below. The men at the coed college mostly had no opinion about the statement. The men at the men’s college mostly either agreed or had no opinion about the statement. The women at the coed college mostly disagreed while the women at the women’s college were spread out between strongly agree, agree, no opinion, and disagree again.

**Figure 4-18:** This chart gives the responses for the fifteenth statement by the percentage of students that answered with each number of the Likert scale.
The third statement was “I find physics easy” and the responses are shown in Figure 4-19 below. About 40% of the men at the coed college strongly agreed with the statement, while the men at the coed college were spread between agree, have no opinion, and disagree. Around 40-50% of the women had no opinion about the statement.

Figure 4-19: This chart gives the responses for the sixteenth statement by the percentage of students that answered with each number of the Likert scale.
The fourth statement was “I have to work hard to pass physics” and the responses are shown in Figure 4-20 below. This statement is the only one where a higher score indicates a lower self-efficacy. This was due to the feeling that the harder a student would have to work, the more likely they were to get frustrated with the work and the less likely they would be doing well. The responses are spread across the scale. However, it is interesting that there were no responses from the men at the coed college and only around 0.05% of the responses from the women at the women’s colleges for strongly agree.

Figure 4-20: This chart gives the responses for the seventeenth statement by the percentage of students that answered with each number of the Likert scale.
The fifth statement was “I perform better than most of my classmates in physics” and the responses are shown in Figure 4-21 below. More of the men felt they performed better than most of their classmates or had no opinion about the statement while the women mostly felt they did not perform better or had no opinion.

![Figure 4-21: This chart gives the responses for the eighteenth statement by the percentage of students that answered with each number of the Likert scale.](image)
The sixth statement was “My friends ask me for help in physics” and the responses are shown in Figure 4-22 below. Around 60% of the men at the coed college agreed that their friends ask them for help in physics but only between 30-40% of the men at the men’s college and the women at the three schools agreed with the statement.

![Figure 4-22](chart.png)

Figure 4-22: This chart gives the responses for the nineteenth statement by the percentage of students that answered with each number of the Likert scale.
The seventh statement was “I help my friends with their homework in physics” and the responses are shown in Figure 4-23 below. It is curious that the percentages of responses for the statement above and this statement are not the same. Most people from all schools responded that they help their friends in physics.

![Chart](image)

Figure 4-23: This chart gives the responses for the twentieth statement by the percentage of students that answered with each number of the Likert scale.
The last statement was “I am an intelligent student” and the responses are shown in Figure 4-24 below. Between 40-50% of the men at the coed college and women at the women’s colleges said they strongly agreed with the statement that they are an intelligent student. About 50% of the men at the men’s college agreed with the statement while 70% of the women at the coed college agreed with it.

![Chart](image)

**Figure 4-24:** This chart gives the responses for the twenty-first statement by the percentage of students that answered with each number of the Likert scale.
Overall for the last set of statements, the responses were generally the same for each of the student types. Most of the responses were either agree or no opinion, however almost 20% of the men at the coed college and the women at the women’s colleges strongly agreed with the statements.

Figure 4-25: This chart is a summary of the responses from the last set of statements on the self-efficacy. The percent of responses was averaged for each type of student response.
To examine the data on the whole, we added the responses from each individual and then took the average by student type. The total possible score was 105. The men at the coed college and the women at the women’s colleges appear to have a score that is close – within 2 to 3 points. The men at the men’s college have a lower score, about 5 to 7 less than the men at the coed college or the women at the women’s colleges. The women at the coed college had a score much less than that of the men at the men’s college or the women at the women’s college.

![Average Score Per Participant Type](image)

**Figure 4-26:** This plot shows the total average score for each of the four types of students. The total possible score is 105, dictating the highest self-efficacy. We can tell there is a definite difference in the students, however we were unsure of the statistical significance. This plot is also found in Section 5.1 as Figure 5-3.
4.2 Interview Data

The five students interviewed were given pseudonyms. The first letter of the pseudonym corresponds to the first letter of the name of the school. The woman from Agnes Scott was named Agnes, the women from the College of Wooster were named Clara and Constance, and the men from Wabash were Walter and Winston. A summary of the following results can be seen in Table 4-5 below.

4.2.1 Profiles of the Interviewed Students

Agnes, the woman from Agnes Scott College, was a transfer student in her third year that had started at a large public university. After taking some time off for medical problems and the fact she disliked the school where she began her college education, she decided to transfer to a smaller school. Agnes applied to liberal-arts colleges that were small and were either coeducational or single-sex. After reading literature on the benefits of women’s colleges, she decided that this would probably be an advantage – a place where she could get the individual attention she wanted and thought she needed. It was also a place where she would not have to worry about the “perils of an environment with men”.

The first woman interviewed from the College of Wooster, Clara, was an undeclared freshman who thought she wanted to be a physics major. She had some stereotypical gender struggles in high school with being able to do science. She came to Wooster because she was looking for a small, liberal-arts college where she could have a community and individual attention. At first she was not sure if she could survive academically at Wooster, but she after her first few weeks she believed that Wooster was the perfect place where she could be herself.

Constance, the second woman from the College of Wooster, was a sophomore math major. She was taking the first semester of physics because it was a requirement for her major. However, she did not plan to take the second semester of physics because she did not need it, did not have time for it, and did not want to take it. Constance seemed to be disappointed with her physics class. This may have stemmed from the fact that she seemed to be a little unsure of herself and
may have lacked the confidence needed to persevere and achieve in physics. She formed a study group with a few other women but they did not ask help from any of the guys in their class. She had not spent much time in the physics department, even though the math department is in the same building, and she did not know the other physics professors.

The first man from Wabash College was Walter, a sophomore chemistry major; he was also a racial minority. He was very self-aware for a person his age and was very interested in talking about single-sex education and the problems of gender in science. Walter was interested in being a physics major when he came to Wabash, however after flipping a coin and taking chemistry first, he fell in love with chemistry. He was an independent worker who saw the environment as very cooperative and encouraging. He also self-evaluated and did not care what the other students thought or how they were doing in class.

Winston, the second man interviewed from Wabash College, was a sophomore physics major that transferred from a large public university. He did not care that Wabash was a single-sex institution; he cared only about the strong academics. He was an independent worker that did not mind helping others or seeking help when it was needed. Winston was rather laid back when it came to school, getting things done, and knowing that he could succeed.
### 4.2.2 Education

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>Counts</th>
<th>Codes</th>
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</thead>
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<tr>
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<td>Classroom, teaching, work, grades, exams, physics, learning, preparation, future, individual attention</td>
</tr>
<tr>
<td>Clara</td>
<td>13</td>
<td>Individual attention, teaching, learning, advice, physics, work, professors, preparation, research</td>
</tr>
<tr>
<td>Constance</td>
<td>4</td>
<td>Teaching, learning, preparation, research, work</td>
</tr>
<tr>
<td>Walter</td>
<td>7</td>
<td>Learning, skills, future, physics, recruitment, chemistry, work</td>
</tr>
<tr>
<td>Winston</td>
<td>7</td>
<td>Teaching, learning, future, tutors, help</td>
</tr>
</tbody>
</table>

Table 4-1: This table gives a summary of the number of times each interviewee discussed the theme education and how the excerpt was coded.

Agnes enjoyed working independently, however, she did not keep herself from seeking assistance from either students or her professor when she needed it. She also helped her peers when they came to her with questions. This happened most often the night before a quiz, which they took weekly, or an exam. Her peers never discouraged her although they were intimidating at times. Even though Agnes sought a place without male peers, it did not matter to her that her physics professor and mentors outside of the physics department are male. She went to all of them for advice and help on homework.

One thing that she found discouraging was the amount of work done for her physics class. There was not a lot of homework; what was assigned was more of a suggestion rather than a requirement, was never collected, and solutions were provided. Agnes did believe that because
there is little graded work in the class she put the stress on herself, rather than it coming from the professor or the class itself. On the stress of her physics class she said:

“Oh goodness, yes! Of course I have! I never really have that problem in my physics class. I think this class has very little homework. I actually really like the way it’s structured. The homework is optional, you can do the problems, or you can not do the problems and the solutions are provided for you. But you have weekly little quizzes that are really straightforward and then you have two exams. That’s a little stressful that you only have two exams to determine the bulk of your grade. Because if you’re having a bad day, it sucks for you. I don’t really like that aspect of it, but it’s, it’s a lot less stressful in the interim period. But of course I feel discouraged by the amount of work I have to do. I think sometimes that comes more from me than from the work itself, but it’s a lot; it’s hard.”

Agnes did think about becoming a physics major and would have loved to take more physics if possible. However, she was a double major (one science, one humanities) and it was difficult to fit more physics into her already full schedule. She would be a math-physics major as well if she could have fit it in to the already crammed schedule.

Something else that she found discouraging is the fact that she wanted to go into engineering and ASC did not have an engineering program. Although she sought a liberal-arts college, she worried that her education may be inferior to others when she is seeking a job or a graduate school. This could cause problems with counterparts of the opposite sex. Agnes was definitely afraid that affirmative action could give her a position that she was not worthy of and could not perform as well as others that received an engineering degree.

On the other side, she thought that ASC would prepare her for graduate school or the workplace. The individual attention from her professors, as well as research experience, will give her an advantage. But like above, it may not have prepared her as well as an engineering school would. Even with this potential problem, Agnes would not have changed schools from a liberal-arts college to a college or university that had an engineering program.
As for the women at the coeducational college, Clara sought help from her physics professor when she needed it for homework or exams. She was thinking about being a physics major, but was planning on waiting until the middle of second semester so she could give herself some time and not rush into something she may regret later. Because of this, Clara did not often seek advice or mentoring from any of the physics professor and her current academic adviser was in a department that is not beneficial to her studies. This showed that Clara did not have a mentor nor was she seeking one.

Clara liked the fact that her class was very cooperative. She tended to study and do homework with a group of guys. She was glad that the other students in her class were not like those in high school. She describes her educational experience:

“But, here it’s totally different. It’s very cooperative. I work with really only guys on a lot of my homework and stuff and there is no competitiveness. We’ll come down at 1:00 in the morning and help each other and I can call my friends up and we help each no matter what. We’d rather both of us do well instead of one of us do better, which I think is because we don’t have a curve and we don’t have the whole 60% class passes and then the 40% fails which I think is really important that we do not have that. It’s so cooperative.”

Clara thought that the individual attention she received at Wooster along with the research opportunities, including the Senior Independent Study program, will prepare her for graduate school or a career better than some of her other friends at other schools. She said, “There are a lot of aspects of Wooster that will help you socially and academically will better you for that and especially graduate school.”

However, when she talked about single-sex education, Clara thought that it would have been detrimental to her education and her real world skills. Had she gone to a women’s college, she thought that she would have done worse in classes and lab, especially when it came to working with people of the opposite sex. She explained:

“And I mean it’s personal thing. I think guys are better at some things than girls. Just, we’re better at a lot of other things than they are. So I think that’s why
feeding off of each other is so important. I don’t think my lab experience would be as good because in the real world you’re going to have to work with guys and girls. Everyone is going to have to work with each other.”

Constance did go to office hours occasionally, however, she was disappointed by the fact her professor did not list her office hours on the syllabus but instead posted them on her door. While the professor may have intended this to look more open and inviting, especially if she was in her office often, Constance did not like having to guess when her professor was in her office and did not email her to arrange an appointment. She was unwilling to go look at the office door in case her professor was not there and she did not want to go back or track her down. When she went in for help it was beneficial, but she did not do it often. She explained:

“I’ve only gone to see her once. I’ve had a lot of questions so I probably should go to see her more. I find it a little frustrating when she doesn’t have office hours on the syllabus. So that makes it less a lot less likely talk to her about one of the questions, but there were some that I did and she was really helpful and was very responsive.”

Constance did like the fact that “[s]he’s very concerned with are you learning, like you’re graded on how well you’re learning it and also how well you know it, but I like the emphasis on how well you’re learning it. She will give you a lot of points for test corrections and homework corrections, which I really appreciate.”

As for the class itself, she was discouraged by the amount of work and did not take the second semester introductory physics course. Overall, Constance did believe that Wooster will prepare her for graduate school or a career, especially because of Senior Independent Study and the emphasis placed on learning. She said, “I really like the emphasis on educating like giving you enough preparation so that you can still learn and still expand and not feel like your confined to one specific field or one specific place after you graduate.”

The first man interviewed at Wabash, Walter, went to office hours for help from his professor and had even gone to other professors when he needed help. He was interested in physics,
however, it did not have the same appeal as chemistry. He was discouraged by the large amount of work in his physics class and on this topic he clarified:

“The workload that is given to us doesn’t exactly promote knowing physics. Maybe you know it for that quiz or that section of time but you don’t grasp it like, fully if you maybe lighten up on what you have to have done, and focus more so on the conceptual thinking or that mathematic problems or any particular problems in physics that you may have.”

Walter noticed that some of his professors used more masculine examples of things, like football, in his classes. He did not find this any more helpful, but did think it could have helped some of the other guys understand the concepts better.

He believed that his experience at Wabash would help him in graduate school or the workplace because of all the work. The large workload helped him learn the time management skills that he will need to achieve success in the future. However, he did not think that a coeducational school would have been any better. It may have helped socially, but he thought that he is much more focused on his studies than he would have been at a coeducational college or university.

Winston did not talk in depth about the learning aspect of his time at Wabash. However, he did say that he was not discouraged by the amount of work he has to do in physics. It seemed that physics comes easy to him. He said, “Next year I get to start dynamics, quantum mechanics, classical that will greatly increase. So, I’m anticipating that and looking forward to it.”

In comparing it to his experience at the large, public university he thought if he had stayed he would not have been as challenged. He remembered telling a friend, “I don’t want you bashing Purdue because I don’t think Wabash can be that harder.” But he said, “I take back that statement now. Wabash is harder just from the sheer fact of the need to take more classes and the professors expect more of you.” He had seen the places where people before have gone after Wabash. He explained, “I know it will just help me, I just have to drudge through it or something.”
4.2.3 Environment

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Table 4-2: This table gives a summary of the number of times each interviewee discussed the theme environment and how the excerpt was coded.

Agnes believed that the environment was warm and friendly and that the professors were approachable. However, her professor did not spend much time trying to develop a personal relationship with his students. As she said, “We arrive, he arrives. He teaches physics, we leave.” He was available for help during office hours and through email, however he did not chat or ask about things outside of physics.

The department held Physics Lunch where the students and professors were invited to eat together and talk in the dining hall. The professors that attend this were always incredibly approachable; they like when students joined them. Agnes did not say whether she had ever joined them.

When Agnes first arrived at Agnes Scott, there was a physics club on campus that was very active and hosted movies in the observatory, however she had not heard anything lately and did
not know if they were still active. There were other groups on campus that are science related – the American Chemical Society and Tri Beta; she was involved in both of those. If the physics club were still active she would have liked to join, but did not think she would have enough time with her busy workload.

Another program on campus, called GEMS (Generating Excellence in Math and Science), was very helpful for building community and support. It was designed for science majors and is basically a scientific mentoring program. The students who are involved go on field trips to local science museums, universities, and lectures. There is also additional tutoring in the program where the women involved can get assistance with their work; this is in addition to the campus-wide tutoring center. Agnes did not get to participate because she transferred in and was a bit disappointed that she missed this opportunity.

In class there was a sense of cooperation rather than competition; any competition was internal and aided the students in working harder while still being able to lend a hand to a friend in need. As she explained it:

“So I feel like it’s a combination of just being competitive within yourself but then cooperative with other people, I think that ultimately helps you learn better because when you’re studying in a group, you’re going to offer whatever information you know. And everyone is going to learn from it. So, yeah I think it definitely facilitates learning and it makes you feel less nervous you know when you’re in class and stuff like that. That if you don’t know someone or someone else knows something that you don’t, you don’t necessarily feel bad about speaking up, asking questions.”

Overall the campus had a feeling of empowerment. She described the environment:

“For the most part I think it’s an empowering, positive thing. I think it helps me in the science classroom to not constantly worry about whether I will be able to keep up with the males around me… It gives me an environment in which I could learn where I don’t have to worry so much. And I think that helps me absorb the material better, if my mind’s not getting it in its own way by being
stressed out and nervous, and intimidated. I won’t say that I’m never nervous or intimidated, because that would be untrue. But for the most part, I feel more relaxed in the science environment around all females when I’m learning.”

She also explained, “Everyone cares about what they’re doing and if you don’t understand something, they’re going to help you understand it. So I feel along the stereotypical lines of male versus female, it’s a more nurturing environment, for your intellect.” She worried that the wonderful feeling of empowerment and confidence will end when she goes to graduate school, but decided that probably was not the case. “I think it definitely made me more confident, if not more confident, more comfortable when I don’t feel confident. That I can sort of gain that confidence and then it can stick with me when I go to grad school or work.”

However, Agnes believed that some of the superior aspects of the women’s college environment would occur at a smaller, coeducational, liberal-arts college. The one big difference is that:

“I feel like you come into this environment with the understanding that, that is how it is. And all your professors come to work here knowing that that’s sort of the creed of the school, is to encourage women, to you know, to get to their potential. The administration know this, the faculty when they apply for jobs here know this, all the student here who come here know that too. So I feel like, it’s sort of like an environment wide understanding of that’s what you’re doing every single day. I don’t think you would get that at as strongly at a coed school, especially a big coed school. They’re more like a machine.”

Clara also found a community at Wooster and was glad that she had found her place so early compared to friends at other schools. She was happy to be at Wooster and thought that it was very cooperative and nurturing.

However, when asked about single-sex colleges, she said when she was applying for colleges, “I found one that was single-sex and I was like oh my gosh I couldn’t go there. I remember telling my mom that.” Clara thought that the environment would have been a lot more competitive and cutthroat because females can be socially and academically aggressive toward other females. She
also said that a single-sex environment might be a little more focused, which would be good academically. But students there could be lacking a social education that is necessary for the real world.

Constance came to Wooster because of the environment she felt when she visited while in high school. She never considered going to a women’s college because “[i]t would be weird to me to want to separate yourself that much from guys especially because this is the time in your life when people start having serious relationships and meeting guys that they’re going to be more serious with.” However, it may have made a difference in classes where there are still some immature guys. She said, “[P]ersonally I usually don’t feel intimidated by guys in the classroom. But for me personally, I don’t think it would make a huge difference.” She thought that overall, it probably would not have prepared her better for graduate school or a job than Wooster did. In fact, it may have been worse because that is not what the real world is like.

Constance felt that her physics classroom was more cooperative, but professors can sometimes promote a more competitive environment by doing things like posting a distribution of grades after an exam. She felt that this could make students who are used to being in the higher bracket feel insecure. Constance also thought if the classroom was more competitive that she might be more motivated, but in a different way than she was currently being motivated; a way that was more stressful and less beneficial in the long run.

Walter saw his professors as giving the students the best of both worlds. He said, “…they encourage you to pursuing physics and then also they’re almost like a fellow student here, just young and vivacious trying to bring energy here and the department in general.” This lead to a very open and nurturing environment where all the professors in the department left their doors open and were willing to help students no matter if they are in their class or not. He said, “They are very approachable, very approachable. Their office doors are always open and that’s kind of a sign and they’re right there and you just knock on the door and they are like, ‘hey’ with so much enthusiasm.”
Walter thought that the environment is very cooperative. He did not like to work in groups because while they could be advantageous they could also harm you when everyone in the group agreed on something wrong. He knew that there are student science groups on campus, but he did not participate in them.

Overall, Walter felt “…that a single-sex college will help me focus a little bit more, it will take out some of the distractions.” He came into Wabash with a girlfriend and he thought that might have helped stabilize their relationship. This may have helped him not notice the fact that he was attending a men’s college as much as he would have if he had been single.

However, Winston felt that, “The single-sex atmosphere is really nothing. It really has no effect.” He thought that the class could be described as cooperative competition. He explained, “I assume it only helps because everyone wants to do their best and they want everyone else and I want everyone else to do their best. There is no crap.”

As for respect, Winston felt that the professors all respected him. They gave him a hard time because he was a chemistry and physics double major, but they were only joking. He thought they were approachable and had conversations with all of the faculty members. He did go in to get help from his professors. On this he said, “I’m sure they have official office hours, I just usually stop by and say hi see if the doors are open.” This shows that the professors were promoting an open and warm environment between themselves and the students.

Winston also talked about the community in the physics department. There was a Society of Physics Students chapter at Wabash and they had a weekly get-together called “Physics and Cookies at 4”. They also have other meetings and activities.

Overall on campus, Wabash had the Gentlemen’s Rule. This means, “…the students are expected to conduct themselves at all time both on and off campus as a gentleman and responsible citizen.” He also showed that there is a sense of brotherhood on campus by ending his interview with the school quote “Wabash always fights”.
4.2.4 Perceptions

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<tr>
<td>Constance</td>
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<tr>
<td>Walter</td>
<td>14</td>
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<tr>
<td>Winston</td>
<td>11</td>
<td>Community, gender, respect, self-competition, helpful, self-sufficient</td>
</tr>
</tbody>
</table>

Table 4-3: This table gives a summary of the number of times each interviewee discussed the theme perceptions and how the excerpt was coded.

Agnes was considerably self-aware regarding her abilities and limitations. She knew that she was a rampant perfectionist and it caused problems; she was working on getting over her perfectionism. This was hard because she was also laid back when it came to the overall process of attaining her degree. She said one of her advisers was “very anal about me planning out everything I’m going to take… and I still want to study abroad, so that creates a little bit of rift there but it’ll get done… And I just tell him to relax and it doesn’t really work.”

Agnes was also aware of the gender issues in the sciences and the fact that a single-sex education can assist in the easing of those problems in the classroom. It did not matter to her whether or not she had a male or female professor. However, there was one thing that occurs in the sciences at ASC that is a bit troubling. She explained:

“I feel that sometimes students will feel more open with the female science faculty than the male science faculty. I’ve heard rumors on campus, I haven’t seen
this directly, but I’ve heard rumors on campus that some of the older generation male science faculty feel like they are somehow helping women in the science field as opposed to being equal to women in the science field. Sort of helping them enter the male dominated field as opposed to just existing in it together as equals. I mean, with some of my science professors I feel more intimidated by some of the male professors than some of the female professors. But there are male science professors that I won’t feel intimidated with at all, so it’s more on an individual basis. And I’ve heard that not even with just the older generation male science faculty and students, but even between the science male faculty members and female faculty members. There’s still that feeling of helping women in the science as opposed to being equals. But I don’t think that it’s necessarily uncalled for, I think that may just be a generational thing, like that’s how it is for them, but the younger male professors don’t necessarily feel that way.”

However, one thing that made a big difference for her is that she was a couple years older than the average college student. Not too much that it would make her a non-traditional student, but it may have been just enough that it gave her an advantage over her peers. Agnes had more experience in college and with life that may have help her be more self-aware than your average college student.

Clara seemed relatively self-aware and confident about her plan for a physics major, however part of this may have stemmed from her being a freshman. This did not affect her view of the professors and the environment. Clara believed that the faculty respected the students and her professor gave them more opportunities and respect than she felt in high school.

As for anything related to gender differences, she did not see any problems. However, she said, “I think with labs people just tend to break up with girl and girl and guy and guy. It’s just how it works, but I hang out with all the physics guys. To me it’s not really a big deal, but I see some people just kind of branch off into that.” So there was some splitting of gender in the classroom and lab, but Clara did not think it affected how they learn or the atmosphere of the class or lab. And she had not seen discrimination from either the professors or the students.
Constance had not seen any problems with gender. The only example was some immature guys in her physics class that would sometimes cause problems. Her professor tended to be hard on them, but Constance believed that this would happen no matter their gender. However, Wooster did have something called the “Wooster Ethic” that promoted respect. This may have helped to prevent harassment or discrimination.

Constance thought that the other professors in the department were approachable but she did not have much contact with other professors. When asked if she had to go up to another professor in the department, would she prefer a female other a male, she said, “I don’t know; probably female.” When asked why she replied, “I don’t know. I just feel like that it’s really good.” This shows that she may be more uncomfortable talking to men she does not know than women that she does not know.

When asked about discrimination from her peers she talked about her lab partner. At the beginning of the semester he was not very helpful and tried to rush her. When she asked him to explain something he tended to get irritated and patronizing. However, later on in the semester she started sticking up to him and he seemed to respect her more.

Walter believed that the faculty respected the students. He explained, “In the physics department they are very encouraging and supportive in what else we’re doing and what to do, and near the introductory physics course, being in the introductory physics course, they understand that most of the guys that take that course won’t be physics majors or minors for that matter.”

He had not interacted with the female professor in the department but that was only because he had not needed to talk to her. He did not feel that he would have any problems going to her to ask her questions. He said, “She has had experiences that could be beneficial to me… I don’t think that she would be less or more approachable or … just because she is a female.” The only reason he thought that a student would treat her differently is because she had a different teaching style than the other professors in the department. Walter wondered, “about the female professors that come to an all male college”. He said:
“[T]hey know that this is an all male college when they come here so they already put themselves in a huge minority, from everyone else, and so, I think it is very interesting. I am grateful that we have them, but I wonder like, what they do coming here, what made them come to an all male college, how much did the all male college affect their decision to come here and I find it kind of different.”

When asked about the male and female faculty, Winston said that he did not care what the professor’s gender was when he wanted to talk to them. He also said that he did not see a division between the males and females in the department. However, he explained, “I could assume that because it’s in physics that there is, but I’ve just never seen anything that would cause me to think that there was.” He did think that the female professor was treated differently – but not because of her gender. Winston explained:

“…she is not especially well liked for her teaching style because she will ask you questions back and then it’s for your to figure out yourself and some of the students are like I didn’t come here to have you ask me a question to help me figure out. I came here because I don’t know what the crap I’m doing. So, again, no gender issues. It’s more of just her teaching style.”

Winston was not discouraged by the other students in his class. Instead, he said, “[I]t’s more of a personal thing for me because I just get aggravated not getting A’s. So, the 85 percent on my last exam I was not happy with… I thought I did better than that and I was anticipating doing better than that so, it wasn’t a peer thing it was more just that I’m happy that my peers do well. I know it’s not my fault or my problem if my peers do bad.”
### 4.2.5 Relationships

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Table 4-4: This table gives a summary of the number of times each interviewee discussed the theme relationships and how the excerpt was coded.

One big thing that may have helped Agnes in science is that she was trying to build more personal relationships with her professors and advisers; she was actively seeking a mentor. She explained, “[I talk to my professors] pretty often actually. I have to meet with them once every semester before registration, so I meet with them then and talk to them about what I’m doing and where I’m going. But most often we communicate through email if I have a question that tends to be the easiest way to do it”. She talked to them looking for advice and knew that they wanted to help but they could not tell you want to do. So, Agnes built in precautions when she talked to her advisers while she still remembered that they were more experienced in the field and that they may have been able to help. She was also thinking about becoming a professor herself one
day and wanted to build a relationship with a mentor so that she had the experience to be a mentor in the future.

Clara had already started building relationships with professors in the department. She saw herself as growing in the department – “So, I think I’m kind of growing right now. It’s pretty good for being a freshman and knowing a bunch of people already.” She was also thinking that this would help in the future if she declares a physics major. When asked about gender differences and whether it mattered that her professor was female she said, “I’m not really a person who looks at that. I mean, in some ways it’s kind of easier talking to a woman, but just advising and for classes and stuff it really doesn’t matter. I rather talk to who is actually knowledgeable in the subject, rather than not.”

It was also helpful that she had already started building bonds with her peers in the physics department. She was involved in the physics club and participated in the movie nights and field trips. Unfortunately she did not have time to participate in their big project, physics outreach to local elementary schools, but hoped to be able to in the future. She had also started building friendships with students in her physics class though a homework study group. She considered the guys close friends. “My friends always make jokes, I call them my physics boyfriends, my physics boys. They are my best friends…”

Constance had not spent much time in the physics department and did not know many of the professors or other students. She began studying with a group of women from her class but once things got busy she stopped going. Constance was aware that there was a physics table at lunch one day a week and that she was welcome to come. However, she said, “[M]y friend that I usually work with is always really, extremely motivated and she goes to physics table every week and I feel kind of intimidated to go to physics table.”

Walter thought the professors in the physics department were very open and were willing to have a more personal relationship. He explained:

“Any time you go into any professor’s classroom you like go in and they are talking about physics and you walk out talking about, just shooting the breeze
trying to joke about what you saw online. So you kind of get the best of both worlds, where they encourage you to pursuing physics and then also they’re almost like a fellow student here, just young and vivacious trying to bring energy here and the department in general.”

He did not talk much about his peers except for the fact that they did not discourage him. He said:

“I don’t really pay attention to what other people are saying in regards to my performance in the class, I think self-evaluation means more to me then what someone else says because everyone has their own standards and I don’t compare myself to other students. Because that doesn’t like, if he doesn’t know anything about physics and I know more physics than him that doesn’t mean I know anything about physics… Our goal isn’t per se to show physics dominance over the other.”

Winston talked about the professors in the fact that he had a more personal relationship with them. They teased him about being a chemistry major and coming to Physics and Cookies at 4 from his organic lab. He talked with the entire faculty and often just stopped by their office to say hi when their doors were open. However, he did not talk much about his relationships with his peers. He was involved in the Society of Physics Students, but did not work in a study group.
### 4.2.6 Summary Table

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<td>Independent worker</td>
<td>•Performed better than in HS</td>
<td>•Found her professor helpful but was frustrated about office hours</td>
<td>•Not involved overly in physics department</td>
<td>•Comfortable with all physics professors</td>
<td></td>
</tr>
<tr>
<td>Cooperative and empowering environment</td>
<td>•Involved in physics department</td>
<td>•Personal and professional relationship with professors</td>
<td>•Laid back but confident</td>
<td>•Involved in physics department</td>
<td></td>
</tr>
<tr>
<td>Need for outside approval</td>
<td>•Not involved in physics department</td>
<td>•Physics major first, then chemistry major</td>
<td>•Not involved in physics department</td>
<td>•Physics major</td>
<td></td>
</tr>
</tbody>
</table>

Table 4-5: This table shows a summary of the interviews and describes the factors that affected their self-efficacy.
Chapter 5: DISCUSSION

5.1 Conclusions from the Surveys

5.1.1 Conclusions from the Bar Graphs
We combined the responses to the questions on the survey about self-efficacy from Agnes Scott, Mount Holyoke, and the women from Wooster to get a total average score for the women. To examine the total average score for men we combined the responses to the questions on the survey about self-efficacy from Wabash and the men from Wooster. By plotting the responses for each sex, we see that there is a slight difference. The statistical significance will be discussed in Section 5.1.2. This chart can be seen in Figure 5-1 below.

Figure 5-1: This plot shows the total average score for women versus men. The total possible score is 105, dictating the highest self-efficacy.
We then looked at the average scores for the single-sex colleges versus the coeducational college. The statistical significance will be discussed in Section 5.1.2. This chart can be seen in Figure 5-2 below.

Figure 5-2: This plot shows the total average score for the single-sex colleges versus the coeducational college. The total possible score is 105, dictating the highest self-efficacy.
Finally, we separated the two education systems for men and women and plotted the average score again. We can see that there is definitely a difference between the different types of students. The statistical significance will be discussed in Section 5.1.2. This chart is shown in Figure 5-3 below and is the same as Figure 4-26.

Figure 5-3: This plot shows the total average score for each of the four types of students. The total possible score is 105, dictating the highest self-efficacy. We can tell there is a definite difference in the students, however we were unsure of the significance. This plot is also seen in Section 4.1.1 as Figure 4-26.
5.1.2 Statistical Analysis of the Survey

Two independent-samples t-test were conducted; the first to compare males and females and the second to compare the two education systems. The first t-test showed there was no significant different in the scores for males (M = 72.13, SD = 10.39) and females (M = 73.57, SD = 12.84); \( t(87) = -0.58, p = 0.57 \). Thus, just being male or female is not a predictor of score on this survey.

The second t-test showed there was no significant different in the scores for single-sex education (M = 73.1, SD = 11.07) and coeducation (M = 71.62, SD = 14.17); \( t(88) = 0.502, p = 0.62 \). This means that there is no difference in the scores when comparing all students at the single-sex institutions and all students at the coeducational institution; there is no way to predict a score based only on which type of education system a student is enrolled in. From these two tests, we can see we needed to look at the combination of education type and sex.

A 2x2 ANOVA was then completed to see if there was interaction between sex and education system. The means and standard deviation for self-efficacy as a function of education and sex are presented in Table 5-1.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Education System</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women</td>
<td>Single-Sex</td>
<td>75.53</td>
<td>1.79</td>
</tr>
<tr>
<td></td>
<td>Coed</td>
<td>64.89</td>
<td>3.78</td>
</tr>
<tr>
<td>Men</td>
<td>Single-Sex</td>
<td>70.18</td>
<td>2.14</td>
</tr>
<tr>
<td></td>
<td>Coed</td>
<td>76.67</td>
<td>3.27</td>
</tr>
</tbody>
</table>

Table 5-1: This table shows the mean and standard deviation for the 2x2 ANOVA that examined the interaction between sex and education system. These data was then plotted to look for the interaction. This is shown in Figure 5-4.
The ANOVA indicated a significant interaction between education system and sex, $F(1,85) = 8.93, p = 0.004$, partial $\eta^2 = 0.095$. The plot for the ANOVA can be seen in Figure 5-4.

![ANOVA Plot](image)

**Figure 5-4:** This plot comes from the 2x2 ANOVA and shows that there is an interaction sex and education system. The data from this plot can be seen in Table 5-1.

The last method of analysis used tested internal consistency of the scaled portion of the survey. The internal consistency of the instrument was determined by computing a Cronbach Alpha (0.85). This suggests the scores are reliable for the respondents of the survey because this value is above the accepted reliability coefficient of 0.7 (UCLA: Academic Technology Services, Statistical Consulting Group).
5.1.3 Overall

These data show that the self-efficacy of the women at the women’s colleges and the men at the coed college are essentially equal, where as the men at the men’s college and the women at the coed college have a lower self-efficacy. This means that either something is going on at the women’s college, that is not at the coed college, to help the women feel like they can achieve or that the women who choose to go to a single-sex college are different in some way that make them more self-efficacious. This also means that there is something going on at the men’s college that could be negatively affecting the men or the men who chose to go to a men’s college are less self-efficacious.

By looking at the demographics of the women at the coed school, we see some basic things about their college choices. Most of them did not apply to a women’s college nor would they have gone if they had applied. This already makes the women at the women’s college stand out because they chose or were told by their parents to go to a women’s college. However, the lack of willingness to go to a women’s college must be a small factor, if it plays a part in a women’s self-efficacy in physics at all because our conclusion supports the previous research (eg: Stowe, 1991; Gillibrand, Robinson, Brawn, & Osborn, 1999; Sanford & Blair, 2002; Robinson & Gillibrand, 2004) about the success of the students a women’s college. In addition, we know that female students at coed schools have a hard time with self-confidence and achievement (Seymour & Hewitt, 1997). Thus, it must be that women in physics will greatly benefit by going to a women’s college.

If we then take a closer look at the men’s college, we see that the admission requirements are a bit less selective than those at the other schools. And because students usually take physics in the first or second year of school, we think this might be a factor. None of the men at the coed college said they applied to a men’s college and none of them said they would attend one if they had. Men’s colleges promote a feeling of brotherhood that is not found at a coed school. The men that attend these institutions might just be different, in neither a good nor bad way, and an environment like this could be beneficial. However, unlike a women’s college, the men’s college might just take time to get used to and adjust to a new more encouraging environment.
However, it could just as likely be that men, in general, do not succeed in a single-sex environment as seen in previous research about high school students (Stowe, 1991). Because there are only three men’s colleges left in the United States it would be hard to determine what is going on at these types of institutions.

5.2 Conclusions from the Interviews

The interviews were analyzed in two different ways, using Wordle™ and through codebook analysis using feminist theory. These two methods will be discussed below.

5.2.1 Wordle™

Wordle™ was used to discover the most reoccurring words in each of the interviews. It is “a toy for generating ‘word clouds’ from text that you provide. The clouds give greater prominence to words that appear more frequently in the source text” (Feinberg, 2009). The word clouds for each of the interviews can be seen below.

Agnes’s Wordle™ shows that she talked about what she knows and how she feels many times throughout the interview. She also talked about her professors, physics, and getting help. Figure 5-5 shows the Wordle™ created from her interview.
Clara’s Wordle™ shows that she talked about what she knows and thinks many times. She also talked about her people, physics, and friends. Figure 5-6 shows the Wordle™ created from her interview.
Figure 5-6: This figure is the Wordle™ created from the first interview done at the College of Wooster (Clara).
Constance’s Wordle™ shows that she talked about what she knows, thinks, guys, and class many times throughout the interview. Unlike the previous two interviews, there were not one or two words or topics that she used more often than the rest. Figure 5-7 shows the Wordle™ created from her interview.

Figure 5-7: This figure is the Wordle™ created from the second interview done at the College of Wooster (Constance).
Walter’s Wordle™ shows that he talked about physics, what he knows and thinks most often throughout the interview. He also talked about professors, other students and class. Figure 5-8 shows the Wordle™ created from his interview.

Figure 5-8: This figure is the Wordle™ created from the first interview done at Wabash College (Walter).
Winston’s Wordle™ shows that he talked about physics, chemistry and what he knows most often. He also talked about Wabash, class, and other people. Figure 5-9 shows the Wordle™ created from his interview.

Figure 5-9: This figure is the Wordle™ created from the second interview done at Wabash College (Winston).
5.2.2 Women’s Colleges
Although we were only able to interview one student from the women’s colleges we surveyed, there is some information we can pull from her interview. Agnes was an independent worker who sought help when she needed it and actively sought a mentor. She also knew about the benefits of a women’s college. I believe that these greatly benefitted her and will help her succeed at college and in whatever she chooses to do afterward. It is not a necessity that she had read the literature on women’s colleges, however it helped to persuade her into going to a women’s college. This is something that could help more high school girls choose women’s colleges and could help to show them what it is like at a women’s college.

The fact that she wants a mentor and is willing to reach out for help from her cooperative classmates as well as her physics professor will help her in her other classes. However, her need for outside approval from peers and faculty is something common with women and could harm her confidence if she does not get approval when she needs it. She may be able to overcome it, but until then it will affect her self-efficacy.

5.2.3 Women at Coeducational Colleges
The two women interviewed from the College of Wooster were very different in their attitude toward physics and in their self-efficacy. The first interviewee, Clara, was very excited about physics. She worked with a group of guys from her class on homework, sought help from her professor when she needed it, and believed that she was doing better than she was in high school. She also liked the individual attention she got from her professors and looked forward to the Senior Independent Study project she will have to do in her senior year. Clara is also involved in the department through the physics club. All of these factors contribute to her high self-efficacy.

Constance, the second interviewee was having a hard time in her physics class. The amount of work was discouraging and she had been busy earlier in the semester and was unable to turn in some homework. She had started out working with some of the other women in her class but because she had gotten busy she stopped going. She found her professor helpful when she talked to her, but was frustrated that her office hours were not posted on her syllabus and instead were on her door. She was not involved in the department and did not know any of the other
professors. She also did not talk to the guys her class. All of these problems figure into her lower self-efficacy.

Neither one of the women thought that a women’s college would be beneficial to their studies or their future plans. In fact, they thought that it might hurt their chances at graduate school and the “real world” both academically and socially. They felt the atmosphere might be more cutthroat and much less cooperative. Overall, they felt that women’s colleges are fundamentally wrong because they separate women from a group of people that could be helpful and that the world outside of school is nothing like the environment and atmosphere of women’s college. However, we believe that Constance may have profited from being in a nurturing and empowering environment. It seems like Clara would survive in a coeducational environment but Constance needs a warmer, more motivating environment and a women’s college maybe the answer to her lower self-efficacy.

5.2.4 Men’s Colleges
Unfortunately, we were unable to interview any of the men at the coeducational college. Even though we will not be able to compare their insights to the men from the men’s college, there are a few important points to be made. Although the men were very different, we believe that they will benefit from going to a men’s college.

Walter was very self-aware for a person his age and was very interested in talking about single-sex education and the problems of gender in science. He was an independent worker who sees the environment as very cooperative and encouraging however, he knew when he needed help and how to find it. He also self-evaluated and did not care what the other students think or how they are doing in class. Walter was not very involved in the department and did not know all the other professors in the department although he had both a personal and professional relationship with those he did know. He had a high self-efficacy and probably could have done well at a coeducational, liberal-arts college, but Wabash was probably the best fit for him.

Winston was physics and chemistry major who transferred from a large public university. He does not care that Wabash was a single-sex institution; he cares only about the strong academics. He was an independent worker that does not mind helping others or seeking help when it was
needed. He was very involved in the Society of Physics Students and other activities in the physics department; he considered himself to be first a physics major and second a chemistry major. He was very comfortable with the professors in the department and often stopped by all the professors’ offices to talk about both physics and personal matters. Winston was rather laid back when it comes to school, getting things done, and knowing that he can succeed. Winston had a high self-efficacy and all of these factors proved it. He could have succeeded at a coeducational, liberal arts college just as well as he would have at Wabash, but it needed to be a school with strong academics that would challenge him and keep him interested.

5.2.5 Overall

Overall most of the students that we interviewed had a high self-efficacy in physics. They had mentors, sought help when they needed it from professors and peers, thought that they were doing well in the physics class, and in some cases, self-evaluated their work without regard to their peers. However, those in their classes that were not doing well and did not have a high self-efficacy could have self-selected out of the study; this could be an implication of their lower self-efficacy.

Through this study, we sought to answer two questions:

• First, do women benefit by being physics majors at a women's college rather than at a coeducational college or university; can this give them a path to become strong, self-confident women that are committed to the field of physics?
• Second, does single-sex education affect men in such a way that we can make recommendations for students to either attend or not attend a men’s college?

The first question can be answered partially; some women do benefit from taking their physics classes at a women’s college as seen in the results of the survey. These women believe that their single-sex, women-centered education had helped them in their studies in college and would continue to do so after they left their empowering environment. They saw they had role models and that they would not have to sacrifice a family for their career or vice versa. We did not get enough responses from women physics majors at any of the schools to respond with a definitive yes as to whether or not being a physics major at a women’s college would be the best option for the women who are interested in being a physics major. However, it might be true that if women
physics students benefit from taking physics at a women’s college, then women physics majors would benefit as well.

The second question is a bit trickier. The survey results showed that the men at the men’s college had a significantly lower self-efficacy than the men at the coeducational college. This could just occur at this men’s college and could be either a factor of the environment or because of the lower selectivity of this college compared to the coeducational college. We believe that the two students interviewed will benefit from going to a men’s college, but that may be because they chose to go to the men’s college themselves. They did not seem to follow the trend of the average student in their physics class. Again this could be a case of students with lower self-efficacy self-selecting out of the study. More information is needed from other men’s colleges and from the coeducational college before we could make any recommendations.

5.3 Implications for Teaching
First of all, Figure 5-1 should not be taken complacently. Although it appears that women, on average, have a self-efficacy that is greater than or equal to their male counterparts, the difference was not statistically significant. In addition, our sample was small and consisted of already high achieving students. For students in different situations or who have a lower scholastic achievement, the results maybe drastically different and teachers should realize that more and different work might be needed to improve the status of women in their physics classes.

5.3.1 Women’s Colleges
Professors at these two women’s colleges already do a good job of promoting a nurturing and empowering environment where their students know that they can succeed and when they do not they know they have the ability to get assistance from wherever they need it. Male professors should remember to encourage their students without giving off the feeling they that are coddling their students and female faculty or treating them as less than equal. They should get to know their students on both a personal and professional level by being involved in the department community activities.
5.3.2 Women at Coeducational Colleges
Professors at coeducational colleges should help their female students feel welcome to come talk to them when they are in need. They should not overprotect them or treat them any different than their male peers in respect to grades or examination. The female students may be intimidated by their male professors or peers and this could cause them to hesitate when seeking help from the males in the department. In order for them to succeed, they should know that they can make it and that their professors support them. They should also be more involved in the department and have a mentor that they can go to when they need advice on a personal or professional level. Professors should also get to know their students outside of class and outside of their knowledge of the subject material. By providing a community based on both a personal and professional level, they help their students to be successful in the class and in the future as a scholar and a person.

5.3.3 Men’s Colleges
Professors at this men’s college are also doing something similar to their counterparts at the women’s colleges. They are providing nurturing and empowering environment where their students know that they can succeed. They also show their students that they can get assistance when they need it. They have been fostering relationships that are both personal and professional by having an open door policy and by creating a community within the department.

5.4 Limitations of this Study
First, this study was only of a very small sample of students at both women’s colleges and coeducational, liberal arts colleges. There are over 50 women’s colleges and at least that many coeducational, liberal arts colleges that offer a physics major. Each of these colleges and universities provide a different environment for their students.

Second, people choosing not to participate in the survey and interview made the already small sample even smaller. There were a number of students who started the survey and either did not complete it or asked for their results not to be used in the study. Also, some of the students who may have had a lower self-efficacy may have self-selected out of the survey by not completing it. This may have limited the responses from students whose self-efficacy was below our determined average. Thus our average may have been slightly inflated, but because those
students chose not to response, we do not know and cannot estimate the effect. As for the effects on the interviews, we originally had 10 students that expressed interest in being interviewed, but 5 of them did not respond to the follow up email. Because of this we were unable to get qualitative data from men at the coeducational college and from more women at the women’s college. Students who had a lower self-efficacy may have also self-selected out of the call for interviews.

Third, because part of the results was gathered using qualitative methods, any data that resulted from that part of the study cannot be generalized to other schools and other students. This is due to the nature of qualitative research – recommendations can be made from the quantitative data with qualitative data that supports it and observation can be made from the qualitative data; but conclusions cannot be directly drawn from the qualitative data.

5.5 Future Work

To make this a more comprehensive comparison, more colleges would need to be involved in the survey study and more interviews need to be completed with students at these colleges and the additional colleges. It would also be helpful to see how the students did in their classes to compare whether or not a higher self-efficacy lead to a higher achievement. It would also be helpful to do a longitudinal study where students who came in to college with the intent to be a physics major could be studied to see if their major changed and how their self-efficacy evolved during college.
BIBLIOGRAPHY


United States. (2002). No Child Left Behind. Washington, DC.


Appendix A: IRB Application For Miami

MIMI
UNIVERSITY

Human Subjects Research:
Exempt Certification Application

HS Research Protocol: All research projects, involving human subjects, regardless of funding source must submit an application to the compliance office prior to the initiation of the research. Some research requires IRB review and approval and some research is exempt from complete review, however, at Miami, the Compliance Office is the only authority that certifies the Exempt Status (ES). If your research meets the requirements (Sections D, below), you may use this application. If it does not, submit an application for IRB review.

Completed ES applications must be emailed as attachments to humansubjects@muohio.edu. If you have questions, contact the Office for the Advancement of Research and Scholarship: (513) 529-3600.

A. Personnel Information (Information):

Primary Investigator Status: ☒ Faculty ☐ Staff ☐ Graduate* ☐ Undergraduate*

PRIMARY INVESTIGATOR:

Name: Jennifer Blue
UniqueID (ex: smithja): bluejm
Department: physics
Phone: (513) 529-1380
Email address: bluejm@muohio.edu
CITI Online Training (date): 11/7/2008
MU Application training (date): 09/11/2002

* FACULTY ADVISOR (required for student PI's):

Name:  
UniqueID (ex: smithja):  
Department:  
Phone:  
Email address:  
CITI Online Training (date):  
MU Appl. training (date):  

Note: All primary investigators and personnel that will be in contact with subjects or data that can be linked to subjects must complete initial online human subjects research training and then refresher training every 3 years. Check to be sure all training is up-to-date before submitting your application: Training Completion Dates

B. PROJECT INFORMATION (Info):

Project Title: Enter Project Title

Human Subjects Research Dates:
Projected beginning date: 08/32/2010 (e.g. Jan 01 09) (and after Compliance Office approval)  
Expected ending date: 08/18/2001
| Funding Source: | None | If externally funded, enter OARS Proposal Approval Form number: |

C. SUBJECT OF RESEARCH (Info):

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

Is the data being collected primarily *about* a program or other entity (i.e. not *about* living humans) and collecting minimal demographic or personal information about the respondents (e.g. age-class, gender, ethnicity, etc)?
D. EXEMPTION CATEGORIES (Info)

Please indicate the Exemption Category below (1-6) that applies to your research. Check each box for which the statement following it is true, including the boxes in the second column. The descriptions are not all-inclusive, see the guidance for further explanation. Note: research involving prisoners can never be exempted from IRB review. If your research involves taste or food quality, the ingredients are approved as safe, and the food is known to be at or below the acceptable levels of environmental contaminants, contact the compliance office for further information.

**Instructions:** Select the most relevant exemption category below. Provide an adequate description of your research in Section E to justify the application of this exemption to your research.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Research will be conducted in established or commonly accepted educational settings (e.g. schools, training centers) involving normal educational practices, such as research on instructional strategies or research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods. The activities in which the students engage will be practices that would occur in the absence of any research.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 2. | Research will involve the use of: i) educational tests (e.g. cognitive, diagnostic, aptitude, achievement), ii) survey procedures, iii) interview procedures (which includes focus groups), **OR** iv) observation of public behavior uninfluenced by the research.  
**Check the appropriate boxes below** This category can apply **if:**
- information obtained will be recorded in such a manner that subjects **could not** be identified (directly or through information that could identify the subjects) **OR**
- any disclosure of the subjects responses outside the research **could not** reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects’ financial standing, employability, or reputation.  
**Information on limitations**
- this research will not involve include subjects less than 18 years of age.  
This category (2) can be applied when subjects are <18 only when:
- the research involves the observation of public behavior and the researcher will not participate in the observed activity (no surveys or interviews and a teacher cannot videotape her students while teaching and qualify for exemption category 2). |
|   |   |
| 3. | This research will involve the use of educational tests (cognitive, diagnostic, aptitude, etc), survey procedures, interviews, or observation of public behavior and is not exempt under (2) above, but **OR** the subjects will be elected or appointed public officials or candidates for public office.  
**Federal statutes require without exception that confidentiality of collected information must be maintained beyond the end of the research (e.g. course grades).** |
4. **(Info)** This research involves the study of existing data or specimens and:
   - The data is publicly available; **OR**
   - Miami researchers have never or will never access data with subject identifying information (original collected data may have identifiers but it must be edited before MU researchers have access and the data must arrive on campus without identifiers to qualify).

5. **(Info)** This research will be funded or conducted at the request of and approved by the head of a federal agency for the purpose of studying:
   - A public benefit or service program, **or**;
   - Procedures for obtaining benefits or services under a program, **or**;
   - Changes in payment or alternatives to a public benefit or service program.
E. Research Description (Complete all sections. If you believe a section does not apply to your research, you must explain and justify this; Refer to the guidance document for help).

(Information)

i) Purpose, Population and Methods: Use the space below to briefly describe the purpose and nature of the research and the methods to be used. (Information)

Research has shown that young women in college can benefit from either taking their science, technology, engineering, and mathematics (STEM) classes in single-sex classrooms or at women’s colleges. We hope to give more evidence that shows this is the case not only for women, but also for men at men’s colleges.

The schools to be examined will include one women’s college, one men’s college, and one coeducational, small liberal-arts college. These schools were chosen as a group, by the size of their student body, size of their physics classes, availability of a major in physics, and similarity in mission plan. We will examine introductory-calculus based students and physics majors from Mount Holyoke College, Wabash College, and the College of Wooster.

The students will be recruited both from their introductory-calculus based physics course and from the list of declared physics majors. Students will be offered the chance to participate in the study and assured that their participation will have no bearing on their grade in the course.

ii) Consent Process: Use the space below to briefly describe the consent process that will be implemented. (Information)

Because we will be using an online survey tool, students will not have a paper consent form to sign. However, we will have an opening page with the information about the survey. This information will include: the survey being optional, taking only 15-20 minutes, the fact it will not affect their grade or standing at school, the knowledge that responses of individuals will not be seen by their professors (only general responses from the entire sample population), the fact they can skip questions, and our contact information. They can then proceed to the survey by checking an “I agree” button. We will also ask their age and whether they give us permission to use their data at the end of the survey.

The interviews will end with “Thanks for completing the survey, if you are willing to further helps us in this research by being interviewed by the researchers in a confidential manner, click here.” The “Click here” will take the student to another survey that provides a more information on what the interview would entail and only collects the name, email address, and school of the subject. See attached for the consent form that explains the project, interview, and security protocols.

iii) Materials and Other Information: Use the space below to list survey or interview questions or attach the survey/interview questions (MS-Word or PDF) in one file along with this document (2nd file) to the email message when submitting your application. Include some response in the space below, e.g. see attached file or indicate that this research does not involve interviews or surveys. Include any other information (Information)

See attached for survey, interview protocols, and interview consent form.

F. INVESTIGATOR’S ASSURANCE STATEMENT
I have read Miami University's policy concerning research involving human subjects and by signing below:

1. I agree to accept responsibility for the ethical conduct of research conducted in this project;
2. I agree to obtain approval from the Institutional Review Board or Departmental Review Board prior to modifying any of the procedures that might affect an exempt determination;
3. I attest that the information submitted in this application is true to the best of my knowledge.

Students: send your application to your faculty advisor.
Faculty: submission by attachment using your MU email address to humansubjects@muohio.edu serves as your signature and pledge to abide by the conditions stated above. This cover page document should be sent in its current format (Word Doc), no original signatures are required

Primary Investigator Signature ____________________________ Date: 06/04/2010

Faculty Advisor Signature ____________________________ Date:

Notes: (for administrative use only):
15 Jun 10

To: Jennifer Blue
    Mary Elizabeth Mills

RE: Are Single-Sex Colleges Better for Physics Students?

The project indicated above and as described in your application for registering Human Subjects (HS) research has been reviewed to determine if it is regulated research or meets the criteria of one of the categories of research that can be exempt from Institutional Review Board review and approval (per 45 CFR 46). The exact determination for your research is indicated below.

☑ The research described in the application is regulated human subjects, however, the research meets the criteria of at least one exempt category included in 45 CFR 46 and associated guidance.

The Applicable Exempt Category(ies) are: 2

If you are considering any changes in this project that may alter the risk level or wish to include a vulnerable population (e.g. children) that was not previously specified in the application, you must consult the Research Compliance Office before implementing these changes.

It is the responsibility of the researcher listed above to ensure that all future research assistants not listed on the application that will aid in collecting data or have access to data with subject identifying information meet the human subjects research training requirement (CITI Online Training). All exempt research is subject to post-certification monitoring and audit by the compliance office. Exempt research is not transferrable, this certificate only applies to the researcher specified above.

☐ The application does not include enough information to make a determination (see the note below).

☐ The research does not meet the criteria for IRB exemption, therefore you must obtain IRB approval before conducting this research.

Neal H. Sullivan, Research Compliance Officer
Appendix B: Agnes Scott IRB

Category E Instructions for Research Proposals by non-Agnes Scott College Students

Students from other colleges wishing to conduct research with human subjects at Agnes Scott College must follow the instructions listed below:

1) Contact the Office of Institutional Research (link here) for permission to conduct research at Agnes Scott College. You will be requested to submit a proposal or your IRB application to the Office of Institutional Research.

2) Download and complete this form. Since the form is a Word document, you can add and delete space as needed. Be sure to answer all questions completely. If a question is not applicable, answer “N/A” rather than leaving the question unanswered.

Shaded check boxes may be selected by double clicking on the appropriate box and choosing “checked” as the “default value” from the dialog box.

3) Discuss your responses to this form with your supervisor (class professor or research advisor). Also consult with your supervisor about all consent forms and research methods (e.g. written or online survey, elicitation images, or words, etc.) that you intend to use in your research. Your supervisor must approve all final forms and research methods before you submit your request to the IRB. If you are asked to make revisions, those revisions should also be approved by your supervisor before you resubmit your proposal or any forms.

4) Once your supervisor has approved your IRB proposal, email this form as an attachment, along with consent forms if appropriate, and any other pertinent documents or forms to: irb@agnesscott.edu.
**Student Investigator**

Name: Mary Elizabeth Mills

Campus Address: Miami University Department of Physics 620 E. Spring Street Oxford, OH 45056

Phone #: 513-324-8721

Email: millsme2@muohio.edu

Supervisor’s Name: Dr. Jennifer Blue

Supervisor’s Phone #: 513-529-1380

Supervisor’s Email: bluejm@muohio.edu

☐ I have discussed this form, and all attached surveys and research methods that will be part of my project, with my supervisor. My supervisor has approved the project and all forms. **Note:** your proposal will not be reviewed by the IRB until this box is checked.

---

**Project**

Title: Are Single-Sex Colleges Better for Physics Students?

Anticipated Starting Date: 09/13/10

Anticipated Completion Date: 08/19/2011

State the purpose/objective/aims of your research

Research has shown that young women in college can benefit from either taking their science, technology, engineering, and mathematics (STEM) classes in single-sex classrooms or at women’s college. We hope to give more evidence that shows this is the case not only for women, but also for men at men’s colleges.

Describe the methods of data collection and record-keeping. Attach copies of all surveys, interview schedules and questions, or other pertinent documents.

The will be done using three different schools - one women's college, one men's college, and one coeducational, small liberal-arts college. These schools were chosen as a group, by the size of their student body, size of their physics classes, availability of a major in physics, and similarity in mission plan. We will examine introductory-calculus based students and physics majors from Agnes Scott College, Wabash College, and the College of Wooster.
The students will be recruited both from their introductory-calculus based physics course and from the list of declared physics majors. Students will be offered the chance to participate in the study and assured that their participation will have no bearing on their grade in the course.

We will use an online survey (Prezza Checkbox) that will be sent as a link to the students. The survey will end with "Thanks for completing the survey, if you are willing to further help us in this research by being interviewed by researchers in a confidential manner, click here." The "click here" will take the student to another survey that provides more information on what the interview would entail and collects the name, email address and school of the participant.

See attached for surveys, interviews, and consent forms.

Participants (double click on the appropriate boxes and choose “checked” as the default value)
- [ ] Children/minors (under 18 yrs old)
- [ ] Adults
- [ ] Pregnant Women, Fetuses or Neonates
- [ ] Institutionalized persons (e.g. prisoners)
- [ ] Cognitively impaired persons (e.g. with cognitive, psychiatric, or developmental disorders, or under the influence of alcohol or drugs).
- [ ] Other:

- Institutional affiliation of participants: Agnes Scott College, Wabash College, the College of Wooster (this project has been approved at all other institutions including my home institution)
- Anticipated number of participants: 200-250 at most
- How will participants be recruited?
  Using the class list and list of physics majors, an email will be sent the students with a link the survey. Also, a 2 minute video will be played in class the day the email is sent out as a way to explain the project and to show it is a department OK’ed project.
- Describe participant incentives, if any.
  Students will be helping future physics students.
- Describe possible emotional, physical, or other risks to participants, if any. “Risk” is defined as the probability of physical, psychological, social or economic harm or injury as a result of participation in a research study. “Minimal risk” is when the probability and magnitude of harm or discomfort in the research are not greater, in and of themselves, than those ordinarily experienced in daily life or during the performance of routine physical or psychological examinations or tests.
  Minimal risk
• Describe benefits for participants, if any.
   Students will be helping future physics students.

• Describe deception with participants, if any. Withholding details about the specifics of one’s hypothesis does not constitute deception. However, misleading participants about the nature of the research question or about the nature of the task they will be completing does constitute deception.
   There is no deception.

• If your project study includes deception, please describe the process you will use, why the deception is necessary, and a full description of your debriefing procedures.

**Voluntary Participation & Protection of Identity**
(Note: this section does NOT apply to unobtrusive observation of public behavior)

• For research involving participants who are minors (under the age of 18), will permission be obtained from the parents/guardians?
  ☒ N/A  Participants will not be minors
  ☐ Yes  Please attach parental consent form.
  ☐ No  Please explain why not

• How will you document informed consent? For explanation, see “Prepare an Informed Consent Form” on the IRB website. Check all that will apply.
  ☒ Signed consent form. Include consent form with this application as a separate attachment.
  ☒ ‘Click’ consent for an on-line survey. Include the on-line survey with this application as a separate attachment.
  ☐ Consent statement to accompany anonymous paper survey. Include your survey with this application as a separate attachment.
  ☐ Oral consent (please explain the reason below)
  ☐ I will not be documenting consent (please explain why below)

Because we will be using an online survey tool, student will not have a paper consent form to sign. However, we will have an opening page with the information about the survey. This information will include: the survey being optional, taking only 15-20 minutes, the fact it will not affect their grade or standing at school, the knowledge that responses of individuals will not be seen by their professors (only general responses from their entire sample population), the fact they can skip questions, and our contact information. They can then proceed to the survey by checking and "I agree" button. We will also ask their age and whether they give us permission to use their data at the end of the survey.
The survey will end with "Thanks for completing the survey, if you are willing to further help us in this research by being interviewed by researchers in a confidential manner, click here." The "click here" will take the student to another survey that provides more information on what the interview would entail and collects the name, email address and school of the participant. See attached for the consent form that explains the project, interview, and security protocols.

- Will information be collected that allows you or others to identify the human subjects?
  
  [ ] No  All information will be collected anonymously.
  
  ☒ Yes  Explain how you will protect the confidentiality of the individual participants.

  Because I am interviewing students, I will need to collect their name, institution, major, and email. However, none of this information will be connected to their actual interview, in either the audiotape or the transcription. All the data will be stored on a secure server specifically for research data of this nature. In addition, all print copies will be kept in a locked file cabinet and only myself and my advisor will be allowed to see it. My thesis and any other paper/presentation that comes out of this project will not have their names included.

- What do you intend to do with your data or results? Who will have access to your data?

Do you plan to present, publish, or otherwise distribute information about your research findings? Explain.

  The data will be used in my Master’s thesis. Only myself and my advisor will have access to the raw data, but the analyzed data will be available to any one in the study, as well as included in my thesis. I also hope to publish a paper and present at a national conference.

---

For IRB use only:  

Proposal #: E__________________

[ ] Approved  [ ] Approved with revisions  [ ] Not Approved

________________________  ________________________  ____________________
Print Chair’s Name  Chair’s Signature  Date
Appendix C: Mount Holyoke IRB

MOUNT HOLYOKE COLLEGE
INSTITUTIONAL REVIEW BOARD FOR THE OVERSIGHT OF RESEARCH
INVOLVING HUMAN SUBJECTS

PROPOSAL FOR RESEARCH INVOLVING HUMAN SUBJECTS

Date submitted: 06/17/10

Title of Proposed Research Project: Are Single-Sex Colleges Better for Physics Students?
Proposed starting date of project: 08/23/2010
Proposed ending date of project: 08/19/2011

Principal Investigator(s) name:
   Department:
   email:
   Phone:
   Signature(s):

For Visiting Principal Investigator(s):
   Mount Holyoke College liaison: Janice Hudgings
   Liaison’s department: Physics
   Signature of liaison:

For Student Principal Investigators: Mary Elizabeth Mills
   Faculty Supervisor name: Dr. Jennifer Blue (bluejm@muohio.edu)
   email: millsme2@muohio.edu
   Department: Miami University - physics
   Course number, if appropriate (including independent research courses):
   I have read and approve of this proposal:

   Signature of Faculty Supervisor:

Has this proposal been subject to departmental review or review by another IRB?

   Yes   No

If “Yes” please attach copies of all documentation submitted for that review, along with the written response (approval, approval with modification, disapproval) from the department or other IRB.

Note: If a student proposal or proposal of a visiting PI is submitted electronically, the advisor/liaison must document approval either by 1) emailing his/her approval to the IRB
or 2) submitting a copy of this page of the proposal with original signatures to the IRB, Mary Lyon Hall, room 101. The IRB will not review a student proposal or a visiting PI proposal until advisor/liaison approval is received.
1. Briefly describe the purpose of this study (attach additional pages if necessary):

Research has shown that young women in college can benefit from either taking their science, technology, engineering, and mathematics (STEM) classes in single-sex classrooms or at women's colleges. We hope to give more evidence that shows this is the case not only for women, but also for men at men's colleges.

2. Participants: Describe the number and type of participants, the source from which they will be recruited, the method of recruitment. [Human subjects under age 18, with the exception of college students, require written permission from a parent or legal guardian. ATTACH A COPY OF YOUR PARENT PERMISSION LETTER, if appropriate]

The will be done using three different schools - one women's college, one men's college, and one coeducational, small liberal-arts college. These schools were chosen as a group, by the size of their student body, size of their physics classes, availability of a major in physics, and similarity in mission plan. We will examine introductory-calculus based students and physics majors from Mount Holyoke College, Wabash College, and the College of Wooster.

The students will be recruited both from their introductory-calculus based physics course and from the list of declared physics majors. Students will be offered the chance to participate in the study and assured that their participation will have no bearing on their grade in the course.

3. Describe the research procedures to be used (what participants will be asked to do, or what treatments will be applied to each subject) in detail. [ATTACH COPIES OR DESCRIPTIONS OF PROCEDURES]

We will use an online survey (Prezza Checkbox) that will be sent as a link to the students. The survey will end with "Thanks for completing the survey, if you are willing to further help us in this research by being interviewed by researchers in a confidential manner, click here." The "click here" will take the student to another survey that provides more information on what the interview would entail and collects the name, email address and school of the participant.

4. Risk to participants: Given the fact that in any study it is possible for participants to experience some degree of discomfort, anxiety, concern about failure, etc., what will you do to minimize the possibility that this will occur, and how will you address or reduce it if it does occur?

These should be no risk to the students, but if the participants feel uncomfortable answering a question or during the interview they are allowed to skip any question they wish or stop the interview at any time.

5. How will you obtain informed consent? [DESCRIBE PROCEDURES AND ATTACH
Because we will be using an online survey tool, student will not have a paper consent form to sign. However, we will have an opening page with the information about the survey. This information will include: the survey being optional, taking only 15-20 minutes, the fact it will not affect their grade or standing at school, the knowledge that responses of individuals will not be seen by their professors (only general responses from their entire sample population), the fact they can skip questions, and our contact information. They can then proceed to the survey by checking and "I agree" button. We will also ask their age and whether they give us permission to use their data at the end of the survey.

The survey will end with "Thanks for completing the survey, if you are willing to further help us in this research by being interviewed by researchers in a confidential manner, click here." The "click here" will take the student to another survey that provides more information on what the interview would entail and collects the name, email address and school of the participant. See attached for the consent form that explains the project, interview, and security protocols.

6. If necessary, how will you debrief participants? [DESCRIBE PROCEDURES AND ATTACH COPIES OF DEBRIEFING LETTER, IF APPROPRIATE]

It is part of the interview/interview procedures. See attached.

7. Participants' rights:
   A. How will confidentiality or anonymity (whichever is appropriate) be guaranteed?
      (Include a description of how data will be handled to insure confidentiality or anonymity)

The students' names will not be attached to their surveys or interviews. All the data will be stored on a secure server specifically for research data of this nature. In addition all print copies will be kept in a locked file cabinet and only myself and my advisor will be allowed to see it.

   B. How will participants' right to terminate or refuse participation be guaranteed?

The students can stop the survey at any time and there will be a question at the end of the survey that asks if we can use their data after they have started. The interview can be stopped at any time. After either are completed, they are welcome to contact us and have us not use their data.

8. For Principal Investigators (faculty and students) whose research is supported by Federal grants:
   1. Attach a copy of the funded grant proposal;
   2. Provide written, documentary evidence that you have completed a training program in the ethical conduct of research as required by Federal Law. Please refer to the options posted on the IRB website. Alternative documentation may be accepted. Please consult with the Chair of the Institutional Review Board.
9. For students and other researchers without previous experience conducting research with human subjects:
   Please provide additional background information and qualifications illustrating that you have received training in the ethical conduct of research conduct (include names of relevant courses):

   Dr. Jennifer Blue: Collaborative Institutional Training Initiative (CITI) online training 11/7/2008
   Mary Elizabeth Mills: CITI online training 01/22/2010, Data Protection/Online Survey 05/31/2010
CHECKLIST

__X__ Attach a copy of departmental review form and response, or other institutional review form and response, if applicable.

____ Attach description of procedures (section 3)

__X__ Attach copies of informed consent (section 5), debriefing (section 6), parent permission letters (section 2), as required.

____ Attach copies of funded grant proposals, if required (section 8).

____ Attach documentation of completion of training program in the ethical conduct of research, if required (section 8).  **Note that some researchers may be required to complete such training after review of their proposal.**

__X__ E-mail all materials to Institutional Review Board as attachments (e-mail: institutional-review-board@mtholyoke.edu) or send a copy (with signatures) to the Office of Sponsored Research, 101 Mary Lyon Hall. **E-mail submission is strongly encouraged** for faster response. If you are a student submitting by e-mail, documentation of the approval of your advisor is required (email approvals are encouraged) before the IRB can initiate the review of your proposal.  All submissions will be acknowledged.
Appendix D: Wabash IRB

Research review declaration

Principal Investigator (PI): Mary Elizabeth Mills Department/Program: Physics – Miami University
Project Title: Are Single-Sex Colleges Better for Physics Students?

Address: Department of Physics Miami University 133 Culler Hall Oxford, OH 45056
E-Mail: millsme2@muohio.edu Phone: 513-324-8721

PI Status: Faculty __ Staff __ Student __ Non-Wabash  X  (explain below)

____________________________
Part A: To be completed by Principal Investigator

In my judgment, the above named research project (check one and append electronic copies of all required supporting documents):

Is exempt from expedited or full IRB review  X  
Qualifies for expedited IRB review _____
Requires full IRB review _____

I certify that the statements herein are accurate and complete. I agree to protect the rights and welfare of the human subjects participating in my research, to abide by University guidelines for securing informed consent, to safeguard the confidentiality of my research data, and to inform the chair of the IRB should any changes in the research protocol or human subject issues arise during the course of this research.

Signature of Principal Investigator:____________________________  Date:________

Part B: To be completed by advisor/sponsor (for students and non-Wabash researchers)

Faculty/Staff Advisor/Sponsor: Eleanor Sayre

Campus Address: Goodrich Hall 312 E-Mail: sayree@wabash.edu Phone: 1-765-361-6141

I have reviewed this application and will oversee this research in its entirety. In my judgment, the above named research project:

Is exempt from expedited or full IRB review _____
Qualifies for expedited IRB review _____
Requires full IRB review ____

Signature of Sponsor: _________________________________ Date: _________

NOTE: The Sponsor and the Principal Investigator MUST be in agreement as to the research review status of the project BEFORE it is forwarded to the appropriate Departmental Reviewer.

Part C: To be completed by Departmental Reviewer

____ I agree with the research review status self-assessment(s) indicated above.

____ I disagree with the research review status self-assessment(s) indicated above, and have not been able to reach an agreement with the Principal Investigator and/or Sponsor. The full IRB will have to consider this research protocol.

Signature of Departmental Reviewer: _________________________________ Date: ______

For ALL categories of review, including Exempt, please forward this signed form to the IRB Chair
Directions: If you believe that your project qualifies for exemption, please submit the following materials to the Departmental Reviewer: (a) a completed electronic copy of this form; (b) a signed copy of the Research Review Declaration and a copy of your certificate of completion for the IRB online training program via campus mail. Please check all applicable items in Parts A and B and provide all relevant information in Part C. Research activities will only be considered for exemption from further review when all items in Part A and at least one item in Part B apply.

**Part A:**

1. ___X___ The research does not involve prisoners, fetuses, pregnant women, the seriously ill, or mentally or cognitively compromised adults as subjects.

2. ___X___ The research does not involve the collection or recording of behavior which, if known outside the research, could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subject's financial standing, employability, or reputation.

3. ___X___ The research does not involve the collection of information regarding sensitive aspects of the subjects’ behavior (e.g., drug or alcohol use, illegal conduct, sexual behavior).

4. ___X___ The research does not involve subjects under the age of 18 (Exception: research with subjects under the age of 18 may still be subject to exempt review if they are participating in projects that fall under categories 1, 3, 4 and/or 5 in Part B). Studies under Part B-2 that include minors should be submitted for expedited review.

5. ___X___ The research does not involve deception.

6. ___X___ The procedures of this research are generally free of foreseeable risk to the subject.

**Part B (Check all categories that apply to your research project):**

1. _____ The research will be conducted in established or commonly accepted educational settings and will involve normal educational practices (e.g., research on regular and
special education instructional strategies, research on instructional techniques, curricula, or classroom management methods).

2. ___X__ The research will involve the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior. Information will be recorded anonymously (i.e., so that the human subject cannot be identified, directly or through identifiers linked to the subject). [NOTE: Survey/interview/observational research in which elected or appointed public officials or candidates for public office serve as subjects is exempt whether or not data collection is anonymous].

3. _____ The research will involve the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens. These sources are either publicly available or the information will be recorded anonymously (i.e., in such a manner that subjects cannot be identified, directly or through identifiers linked to the subject).

4. ____ The research (including demonstration projects) will be conducted by or subject to the approval of federal department or agency heads, and is designed to study, evaluate, or otherwise examine:

   (i) public benefit or service programs (e.g., social security, welfare, etc.);

   (ii) procedures for obtaining benefits or services under those programs;

   (iii) possible changes in or alternatives to those programs or procedures;

   (iv) possible changes in methods or levels of payment for benefits or services under those programs.

5. ____ The research involves taste or food quality evaluations or consumer acceptance studies and the tested products are wholesome foods without additives or foods which contain additives at or below levels found to be safe by the FDA or approved by the EPA of the Food Safety and Inspection Service of the US Department of Agriculture.

Part C

Please provide the information that is requested below. For exempt research, submission of a formal research proposal is not required. However, if the information requested below is contained in clearly identified fashion in a research proposal, you may append the proposal in lieu of completing some or all of the items below as long as you indicate where in the proposal (give page, line numbers) the relevant information can be found.
1. What is the purpose of the proposed study (the research question) and what is the research hypothesis?

Research has shown that young women in college can benefit from taking their science, technology, engineering, and mathematics (STEM) classes in single-sex classrooms or at women's colleges. We hope to give more evidence that shows this is the case not only for women, but also for men at men's colleges.

2. Describe the proposed subject sample. If subjects under the age of 18 will participate in your research, indicate the expected age range of the samples.

The will be done using three different schools - one women's college, one men's college, and one coeducational, small liberal-arts college. These schools were chosen as a group, by the size of their student body, size of their physics classes, availability of a major in physics, and similarity in mission plan. We will examine introductory-calculus based students and physics majors from Mount Holyoke College, Wabash College, and the College of Wooster.

3. How will subjects be recruited and selected?

The students will be recruited both from their introductory-calculus based physics course and from the list of declared physics majors. Students will be offered the chance to participate in the study and assured that their participation will have no bearing on their grade in the course. They will receive an email from me regarding the survey. Also, introductory physics teacher will inform them about the email before they receive it so they know it is an approved survey.

4. Describe fully the following:

(a) all research methods and procedures that will be employed in this study.

We will use an online survey (Prezza Checkbox) that will be sent as a link to the students. The survey will end with "Thanks for completing the survey, if you are willing to further help us in this research by being interviewed by researchers in a confidential manner, click here." The "click here" will take the student to another survey that provides more information on what the interview would entail and collects the name, email address and school of the participant.

(b) approximately how much time each subject is expected to devote to the research.

Surveys 15-20 minutes, interviews 30-45 minutes

(c) how data will be collected and recorded (with or without identifiers? what instruments, materials, or equipment will be used? will audio- or videotapes be employed in data collection?). Append copies of all written instruments and/or describe any apparatus with which subjects will be in direct contact.
Survey data will be collected using Prezza Checkbox, an online survey tool. The data will be stored on a secure server dedicated to data of this nature. The interviews will be audio taped and then transcribed.

(d) methods for obtaining informed consent or assent in the case of minors. For minors, indicate how the consent of parents or legal guardians will also be obtained. Append copies of all materials used to obtain informed consent or assent. Model forms may be found at Forms and Instructions.

Because we will be using an online survey tool, students will not have a paper consent form to sign. However, we will have an opening page with the information about the survey. This information will include: the survey being optional, taking only 15-20 minutes, the fact it will not affect their grade or standing at school, the knowledge that responses of individuals will not be seen by their professors (only general responses from the entire sample population), the fact they can skip questions, and our contact information. They can then proceed to the survey by checking an “I agree” button. We will also ask their age and whether they give us permission to use their data at the end of the survey.

The interviews will end with “Thanks for completing the survey, if you are willing to further help us in this research by being interviewed by the researchers in a confidential manner, click here.” The “Click here” will take the student to another survey that provides more information on what the interview would entail and only collects the name, email address, and school of the subject. See attached for the consent form that explains the project, interview, and security protocols.

(e) methods for preserving confidentiality (including plans for storing/disposing of tapes and other data records at the conclusion of the research).

The audiotapes and transcripts will be stored in a locked file cabinet. After the project ends, the tapes will be destroyed and the transcripts kept in the locked cabinet.

5. Indicate any benefits that are expected to accrue to subjects as a result of their participation in the research. In the event that subjects will be paid, describe all payment arrangements, including how much subjects will be paid should they choose to withdraw from the study prior to completion of the research.

The knowledge that this may help future students in physics.

6. Describe any relationship between researcher and subjects, such as: teacher/student; superintendent/principal/teacher, employer/employee. If such a relationship exists, how will it affect the subject's ability to participate voluntarily and how will the Principal Investigator handle it?

There is no relationship between myself and the subjects.
**Note to PI:** Please append to this document any additional information that is applicable (consent forms, debriefing scripts, survey instruments, etc.), and submit it all to the Departmental Reviewer as a single, paginated Word file. Please give the file a unique filename in this format: [email username]+[date].doc (Example: smithj12-07-04.doc)

**Note to Departmental Representative:** Please forward this file electronically to the Chair of the IRB, and forward via campus mail a signed copy of Research Review Declaration and a copy of the certificate of completion for the online IRB training program.
Appendix E: Wooster IRB

The College of Wooster Human Subjects Research Exempt Application

As part of the goal of protecting humans who participate in research conducted at The College of Wooster faculty, staff, and students both on and off campus, The College of Wooster complies with federal policy for the protection of human subjects (Department of Health and Human Services Policy for Protection of Human Research Subjects). This form is used by The College of Wooster’s Human Subjects Research Committee to assure compliance with federal guidelines and, more generally, to assure that participants in research are treated ethically.

Before you complete this form you are to read carefully The College of Wooster’s Policy on Protection of Human Subjects. Copies are available from Gary Gillund (email GGillund) or your department or program chair.

The following form must be completed before conducting any research with human subjects. In addition, no research may be conducted until an application has been approved by the HSRC. Please complete the form completely, accurately, and clearly. You may type your responses to most items directly on this form. Occasionally you are asked to attach additional pages.

Return the completed form to the area reviewer for your department or program. The area reviewers are listed at the end of this document.

If you think your research does not fit in the category of Exempt from Review, please use the HSRC Full Exp Review Form.

The HSRC will make every attempt to provide you with information on the status of your application within two weeks of submission.

Researcher’s Name: Mary Elizabeth Mills

Researcher’s email and campus addresses: millsme2@muohio.edu

Adviser’s Name (if primary researcher is a student): Dr. Jennifer Blue

Adviser’s email address: bluejm@muohio.edu

Department or Program: Physics – Miami University
Title of Research Project: Are Single-Sex Colleges Better for Physics Students?

Questions to determine the category of review.  Part A

1. Does the research involve as subjects prisoners, fetuses, pregnant women, the seriously ill, or mentally or cognitively compromised adults?
   __ Yes  _X_ No

2. Does the research involve the collection or recording of behavior which, if known outside the research, could reasonably place subjects at risk of criminal or civil liability or be damaging to the subject’s financial standing, employability, or reputation?
   __ Yes  _X_ No

3. Does the research involve the collection of information regarding sensitive aspects of subjects’ behavior (e.g., drug or alcohol use, illegal conduct, sexual behavior)?
   __ Yes  _X_ No

4. Does the research involve subjects under the age of 18?
   __ Yes  _X_ No

5. Does the research involve deception?
   __ Yes  _X_ No

6. Do the procedures of this research place the subject at any foreseeable risk (above what would be expected in everyday activities)?
   __ Yes  _X_ No

If you answered ‘yes’ to any of the items in Part A, your research does not qualify as Exempt from review. Please use the form for full and expedited review.
Part B

1. Will the proposed research take place in a formal classroom setting and involve normal educational practices (e.g., research on regular and special education instructional strategies, research on instructional techniques, curricula, or classroom management methods)?

   __ Yes  _X_ No

2. Does the proposed research exclusively involve the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, where information is recorded anonymously (i.e., so that the human subject cannot be identified, directly or indirectly through identifiers linked to the subject)? [If the proposed research involves additional methods, an expedited review is required. All survey/interview/observational research in which elected or appointed public officials or candidates for public office serve as subjects is exempt from HSRC review, whether or not data collection is anonymous.]

   _X_ Yes  __ No

3. Does the proposed research involve the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens? These sources must be either publicly available or the information must be recorded anonymously (i.e., in such a manner that subjects cannot be identified, directly or through identifiers linked to the subject).

   __ Yes  _X_ No

4. Is the proposed research (including demonstration projects) to be conducted by or subject to the approval of federal department or agency heads, and designed to study, evaluate, or otherwise examine (i) public benefit or service programs (e.g., social security, welfare, etc.); (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs?

   __ Yes  _X_ No

5. Does the proposed research involve taste or food quality evaluations or consumer acceptance studies, where the tested products are wholesome foods without additives, or foods which contain additives at or below levels found to be safe by the FDA or approved by the EPA of the Food Safety and Inspection Service of the U.S. Department of Agriculture?

   __ Yes  _X_ No

If you answered ‘no’ to all of the items in Part B, your research does not qualify as Exempt from review. Please use the form for full and expedited review.
Abstract: Please provide, in terms the average person can understand, a concise summary of the proposed research, including methods.

Research has shown that young women in college can benefit from either taking their science, technology, engineering, and mathematics (STEM) classes in single-sex classrooms or at women's colleges. We hope to give more evidence that shows this is the case not only for women, but also for men at men's colleges.

The will be done using three different schools - one women's college, one men's college, and one coeducational, small liberal-arts college. These schools were chosen as a group, by the size of their student body, size of their physics classes, availability of a major in physics, and similarity in mission plan. We will examine introductory-calculus based students and physics majors from Mount Holyoke College, Wabash College, and the College of Wooster.

The students will be recruited both from their introductory-calculus based physics course and from the list of declared physics majors. Students will be offered the chance to participate in the study and assured that their participation will have no bearing on their grade in the course.

We will use an online survey (Prezza Checkbox) that will be sent as a link to the students. The survey will end with "Thanks for completing the survey, if you are willing to further help us in this research by being interviewed by researchers in a confidential manner, click here." The "click here" will take the student to another survey that provides more information on what the interview would entail and collects the name, email address and school of the participant.

Research Subjects

Expected number of subjects: 200

Age range of subjects: 18-25

Population to be studied (e.g., College of Wooster sophomores, children at The College of Wooster Nursery School, voting age citizens walking on the sidewalk in downtown Wooster, etc.)
- introductory calculus-based physics students at the College of Wooster, Mount Holyoke College, and Wabash College.

How will potential subjects initially be contacted? (Please attach copies of ads, recruitment forms, etc.)
- Through an email sent to the students with a link to the survey.

Please state how the subject’s confidentiality will be protected.
- The students’ names will not be attached to their surveys or interviews. All the data will be stored on a secure server specifically for research data of this nature. In addition all print copies will be kept in a
locked file cabinet and only myself and my advisor will be allowed to see it.

What direct or indirect benefit to the research subjects may result from this study?
- We can use this to help future physics students.

Is any deception involved in your research? If so, please explain and justify the deception.
-No.

______________________________

Written consent document.

If you do not plan to use a consent form, please include an explanation and justification.

Because we will be using an online survey tool, students will not have a paper consent form to sign. However, we will have an opening page with the information about the survey. This information will include: the survey being optional, taking only 15-20 minutes, the fact it will not affect their grade or standing at school, the knowledge that responses of individuals will not be seen by their professors (only general responses from their entire sample population), the fact they can skip questions, and our contact information. They can then proceed to the survey by checking and "I agree" button. We will also ask their age and whether they give us permission to use their data at the end of the survey.

The survey will end with "Thanks for completing the survey, if you are willing to further help us in this research by being interviewed by researchers in a confidential manner, click here." The "click here" will take the student to another survey that provides more information on what the interview would entail and collects the name, email address, and school of the participant. See attached for the consent form that explains the project, interview, and security protocols.

Funding support for the study (check one of the statements below):

_ X_ This research is unfunded and will be conducted even if there are no funds.

__ Funding is pending, but the research will be conducted even if the funding is not approved. Identify the potential funding source:

__ Funding is pending and the project will not begin until funds are available. Identify the potential funding source:

__ The research is funded. State the funding source:

I have read and agreed to abide by the requirements contained in the statement of principles governing the protections of the rights and welfare of human subjects promulgated by The College of Wooster.

Researcher Signature __________________________           Date ________________

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For Faculty Advisors of Student Research:

Federal guidelines mandate that research be of sufficient merit to justify the participation of human subjects. The HSRC prefers to confer most of the responsibility for determining merit to advisors. Please sign below and check a box to help us evaluate the merit of the student application.

Adviser signature: ___________________________________________

_ X_ I have discussed the proposed research with the student applicant named above and find the research to be of sufficient merit to justify the use of human participants.

__ I have discussed the proposed research with the student applicant named above but have made no determination of merit.

__ I have discussed the proposed research with the student applicant named above and find the research is not of sufficient merit to justify the use of human participants.

Completed applications may be sent to any committee member:
Gary Gillund, Chair of the HSRC, Psychology Department
Joan Furey, Communication
Rod Korba, Communication
Bryan Karazsia, Psychology
Ellen Falduto, Institutional Research
Dorothy Brown, Off-campus representative
Appendix F: Consent Form

Dear Participant:

My name is Mary Elizabeth Mills and I’m a Master’s student in physics at Miami University, working with Dr. Jennifer Blue.

You are invited to participate in a research study of physics students’ self-efficacy in an introductory calculus-based physics class. I will ask you a number of questions about how you think about yourself in relation to your physics class. Your audiotape and transcript will be given a code, so no one other than me will be able to identify you as the interviewee. You will not be asked to include your name during the interview, thus your answers cannot be associated with you. Nonetheless, the audio recordings and transcripts will be treated as confidential information, stored in a secure location for the duration of the project, and accessed only by myself and my adviser. The audiotapes will be destroyed after the data has been analyzed.

This session should take approximately 30 minutes. Your participation is voluntary and you may withdraw from the session at any time or decline to answer any questions that make you uncomfortable. You will not be asked to do anything that exposes you to risks beyond those of everyday life. The benefit of the study, is that it will help us understand more about how people think about themselves in their physics classes. At the end of the study, you may contact me for the results, in thesis form, which will be completed by August 2011. The generalized results may be presented at professional conferences or published in articles describing the results of the research.

If you have further questions about the study, please contact either me, at 513-529-5625 or millsme2@muohio.edu, or Dr. Blue, at 513-529-1380 or bluejm@muohio.edu. If you have questions about your rights as a research participant, please call the Office of Advancement of Research and Scholarship at 513-529-3600 or humansubjects@muohio.edu.

Thank you for your participation. We are very grateful for your help and hope that this will be an interesting session for you. You may keep this portion of the page.

__________________________________________________________________________________

I agree to participate in the study of self-efficacy in physics. I understand my participation is voluntary and that my name will not be associated with my responses. However, I know that this session will be audio recorded. By signing below, I acknowledge that I am 18 years or older.

Participant’s signature ___________________________ Date: __________
Appendix G: Agnes Scott Survey

Questions with a * are required.

*1. Before you begin the survey, please read the paragraph below.
This survey will ask you questions about your experiences in your introductory calculus-based class. It will only take 15-20 minutes. The survey is optional and will not affect your grade or standing at school. The individual responses to the survey will not be seen by your professors or anyone at your school. However, they will be able to see the general responses from the entire sample population. If there is a question you would not like to respond to, you may skip it. If you have any questions, concerns, or would like us not to use your data after you complete the survey you can contact myself, Mary Elizabeth Mills, at millsme2@muohio.edu or my adviser, Dr. Jennifer Blue, at bluejm@muohio.edu.
If you would like to take the survey, please select "I agree" below.
   I agree   No

*2. Are you at least 18 years old?
   Yes
   No

*3. Do you give us permission to use your data in our research?
   Yes
   No

4. What is your sex?
   Female
   Male

5. What is your age?
   17
   18
   19
   20
   21
   22-24
   25+

6. Are you an American student or an International student?
   American
   International

7. What is your race?
   American Indian
   Asian
   Black
   Hispanic
Pacific Islander
White
Multiracial

8. What type of high school did you go to? (select as many as apply)
   Public
   Private
   Homeschooled
   Coeducational
   Single-sex
   Large (more than 2000)
   Medium (500-2000)
   Small (fewer than 500)

9. Did you take physics in high school?
   Yes
   No

10. How many years of physics did you take in high school?
    1
    2
    3
    4

11. What level? (select all that apply)
    regular
    honors
    Advanced Placement (AP)
    International Baccalaureate (IB)

12. What types of colleges or universities did you apply to? (select all that apply)
    Public
    Private
    Liberal Arts
    Technical
    Large (more than 15,000)
    Medium (3,000-15,000)
    Small (fewer than 3,000)
    Coeducational
    Single-sex

13. Why did you choose Agnes Scott? (select all that apply)
    cost
    scholarships
    major
    religion
classes
parents
professors
friends
sports
activities
size
location

14. Would you have gone to a coeducational college or university?
   Yes
   No

15. Why or why not?

16. Do you think your introductory calculus-based physics class would be any different if it was coeducational?
   Yes
   No

17. Why or why not?

18. What STEM (science, technology, engineering, and math) classes have you taken at Agnes Scott?
   Anatomy
   Astronomy
   Biochemistry
   Biological Sciences
   Chemistry
   Computer Science
   Engineering
   Environmental Studies
   Geography
   Geology
   Mathematics
   Neuroscience
   Physics
   Statistics

19. Are you a STEM major?
   Yes
   No

20a. Which STEM field are you majoring in?

20b. What is your major?
21. What grade did you expect at the start of your introductory calculus-based physics class?
   A
   B
   C
   D
   F
   Audit
   Drop

22. Does your professor encourage you to do well?
   Yes
   No

23. Is your professor helpful outside of class?
   Yes
   No

24. Do you attend office hours?
   Yes
   No

24a. How often do you attend office hours?
   once a day
   once a week
   once a month
   never

24b. Why don't you attend office hours?

25. Does your professor affect how confident you are in doing your homework, quizzes, or tests?
   Yes, she/he makes me more confident
   Yes, he/she makes me less confident
   No, she/he has no affect on my confidence

26. Do you have a faculty mentor?
   Yes
   No

26a. In what department is your faculty mentor?

27. Are the other students in your class friendly and encouraging?
   Yes
   No
28. Do you have a study group that meets regularly outside of class?
   Yes
   No

29. Are the other students in your class more competitive or cooperative?
   Competitive
   Cooperative

30. Have you seen discrimination in this physics class?
   Yes
   No

30a. What kind of discrimination have you seen?

30b. Was it gender discrimination?
   Yes
   No

31. Have you been or felt discriminated against in this class?
   Yes
   No

31a. How have you been or felt discriminated against?

31b. Was it gender discrimination?
   Yes
   No

For the next five questions, “participate” is defined as attending class, completing all assignments, and doing anything else needed for your introductory calculus-based physics class as stated in the syllabus.

For the next 5 questions of the survey, please answer with the following scale:
   5 if you ALWAYS participate
   4 if you OFTEN participate
   3 if you SOMETIMES participate
   2 if you RARELY participate
   1 if you NEVER participate

32. I participate in my introductory calculus-based physics class.
   
33. When I participate in my introductory calculus-based physics class, I do it to get a good grade.
   
34. When I participate in my introductory calculus-based physics class, I do it to perform better than other students.
35. When I participate in my introductory calculus-based physics class, I do it so that other students think that I'm smart.

1 2 3 4 5

36. When I participate in my introductory calculus-based physics class, I do it so that the teacher pays attention to me.

1 2 3 4 5

For the next part of the survey, please answer with the following scale:
5 if you STRONGLY AGREE with the statement
4 if you AGREE with the statement
3 if you HAVE NO OPINION on the statement
2 if you DISAGREE with the statement
1 if you STRONGLY DISAGREE with the statement

37. During a physics course, I feel fulfilled when I achieve a good grade on a test.

1 2 3 4 5

38. During a physics course, I feel fulfilled when I gain confidence with the content.

1 2 3 4 5

39. During a physics course, I feel fulfilled when I am able to solve a difficult problem.

1 2 3 4 5

40. During a physics course, I feel fulfilled when the teacher accepts my ideas.

1 2 3 4 5

41. During a physics course, I feel fulfilled when other students accept my ideas.

1 2 3 4 5

For the next part of the survey, please answer with the following scale:
5 if you STRONGLY AGREE with the statement
4 if you AGREE with the statement
3 if you HAVE NO OPINION on the statement
2 if you DISAGREE with the statement
1 if you STRONGLY DISAGREE with the statement

42. I look forward to my physics class.

1 2 3 4 5

43. Physics class is fun.

1 2 3 4 5

44. I feel satisfied after my physics class.
For the next part of the survey, please answer with the following scale:
5 if you STRONGLY AGREE with the statement
4 if you AGREE with the statement
3 if you HAVE NO OPINION on the statement
2 if you DISAGREE with the statement
1 if you STRONGLY DISAGREE with the statement

45. I find it easy to get good grades in physics.
1 2 3 4 5

46. I am good at physics.
1 2 3 4 5

47. I find physics easy.
1 2 3 4 5

48. I have to work hard to pass physics.
1 2 3 4 5

49. I perform better than most of my classmates in physics.
1 2 3 4 5

50. My friends ask me for help in physics.
1 2 3 4 5

51. I help my friends with their homework in physics.
1 2 3 4 5

52. I am an intelligent student.
1 2 3 4 5

*53. Please tell us your birthday. (mm/dd/yyyy)

*54. Now that you have completed this survey, do you still give us permission to use your data in our research?
   Yes
   No

Thank you for completing this survey. If you are willing to further help us in this research by being interviewed by researchers in a confidential manner, click here.
Appendix H: Mount Holyoke Survey

Questions with a * are required.

*1. Before you begin the survey, please read the paragraph below.
This survey will ask you questions about your experiences in your introductory calculus-based class. It will only take 15-20 minutes. The survey is optional and will not affect your grade or standing at school. The individual responses to the survey will not be seen by your professors or anyone at your school. However, they will be able to see the general responses from the entire sample population. If there is a question you would not like to respond to, you may skip it. If you have any questions, concerns, or would like us not to use your data after you complete the survey you can contact myself, Mary Elizabeth Mills, at millsme2@muohio.edu or my adviser, Dr. Jennifer Blue, at bluejm@muohio.edu.
If you would like to take the survey, please select "I agree" below.

I agree

*2. Are you at least 18 years old?
   Yes
   No

*3. Do you give us permission to use your data in our research?
   Yes
   No

4. What is your sex?
   Female
   Male

5. What is your age?
   17
   18
   19
   20
   21
   22-24
   25+

6. Are you an American student or an International student?
   American
   International

7. What is your race?
   American Indian
   Asian
   Black
   Hispanic
Pacific Islander
White
Multiracial

8. What type of high school did you go to? (select as many as apply)
   Public
   Private
   Homeschooled
   Coeducational
   Single-sex
   Large (more than 2000)
   Medium (500-2000)
   Small (fewer than 500)

9. Did you take physics in high school?
   Yes
   No

10. How many years of physics did you take in high school?
    1
    2
    3
    4

11. What level? (select all that apply)
    regular
    honors
    Advanced Placement (AP)
    International Baccalaureate (IB)

12. What types of colleges or universities did you apply to? (select all that apply)
    Public
    Private
    Liberal Arts
    Technical
    Large (more than 15,000)
    Medium (3,000-15,000)
    Small (fewer than 3,000)
    Coeducational
    Single-sex

13. Why did you choose Agnes Scott? (select all that apply)
    cost
    scholarships
    major
    religion
classes
parents
professors
friends
sports
activities
size
location

14. Would you have gone to a coeducational college or university?
   Yes
   No

15. Why or why not?

16. Do you think your introductory calculus-based physics class would be any different if it was coeducational?
   Yes
   No

17. Why or why not?

18. What STEM (science, technology, engineering, and math) classes have you taken at Mount Holyoke?
   Anatomy
   Astronomy
   Biochemistry
   Biological Sciences
   Chemistry
   Computer Science
   Engineering
   Environmental Studies
   Geography
   Geology
   Mathematics
   Neuroscience
   Physics
   Statistics

19. Are you a STEM major?
   Yes
   No

20a. Which STEM field are you majoring in?

20b. What is your major?
21. What grade did you expect at the start of your introductory calculus-based physics class?
   A
   B
   C
   D
   F
   Audit
   Drop

22. Does your professor encourage you to do well?
   Yes
   No

23. Is your professor helpful outside of class?
   Yes
   No

24. Do you attend office hours?
   Yes
   No

24a. How often do you attend office hours?
   once a day
   once a week
   once a month
   never

24b. Why don't you attend office hours?

25. Does your professor affect how confident you are in doing your homework, quizzes, or tests?
   Yes, she/he makes me more confident
   Yes, he/she makes me less confident
   No, she/he has no affect on my confidence

26. Do you have a faculty mentor?
   Yes
   No

26a. In what department is your faculty mentor?

27. Are the other students in your class friendly and encouraging?
   Yes
   No
28. Do you have a study group that meets regularly outside of class?
   Yes
   No

29. Are the other students in your class more competitive or cooperative?
   Competitive
   Cooperative

30. Have you seen discrimination in this physics class?
   Yes
   No

30a. What kind of discrimination have you seen?

30b. Was it gender discrimination?
   Yes
   No

31. Have you been or felt discriminated against in this class?
   Yes
   No

31a. How have you been or felt discriminated against?

31b. Was it gender discrimination?
   Yes
   No

For the next five questions, “participate” is defined as attending class, completing all assignments, and doing anything else needed for your introductory calculus-based physics class as stated in the syllabus.

For the next 5 questions of the survey, please answer with the following scale:
   5 if you ALWAYS participate
   4 if you OFTEN participate
   3 if you SOMETIMES participate
   2 if you RARELY participate
   1 if you NEVER participate

32. I participate in my introductory calculus-based physics class.
   1  2  3  4  5

33. When I participate in my introductory calculus-based physics class, I do it to get a good grade.
   1  2  3  4  5

34. When I participate in my introductory calculus-based physics class, I do it to perform better than other students.
35. When I participate in my introductory calculus-based physics class, I do it so that other students think that I'm smart.

36. When I participate in my introductory calculus-based physics class, I do it so that the teacher pays attention to me.

For the next part of the survey, please answer with the following scale:

5 if you STRONGLY AGREE with the statement
4 if you AGREE with the statement
3 if you HAVE NO OPINION on the statement
2 if you DISAGREE with the statement
1 if you STRONGLY DISAGREE with the statement

37. During a physics course, I feel fulfilled when I achieve a good grade on a test.

38. During a physics course, I feel fulfilled when I gain confidence with the content.

39. During a physics course, I feel fulfilled when I am able to solve a difficult problem.

40. During a physics course, I feel fulfilled when the teacher accepts my ideas.

41. During a physics course, I feel fulfilled when other students accept my ideas.

For the next part of the survey, please answer with the following scale:

5 if you STRONGLY AGREE with the statement
4 if you AGREE with the statement
3 if you HAVE NO OPINION on the statement
2 if you DISAGREE with the statement
1 if you STRONGLY DISAGREE with the statement

42. I look forward to my physics class.

43. Physics class is fun.

44. I feel satisfied after my physics class.
For the next part of the survey, please answer with the following scale:
5 if you STRONGLY AGREE with the statement
4 if you AGREE with the statement
3 if you HAVE NO OPINION on the statement
2 if you DISAGREE with the statement
1 if you STRONGLY DISAGREE with the statement

45. I find it easy to get good grades in physics.
   1 2 3 4 5

46. I am good at physics.
   1 2 3 4 5

47. I find physics easy.
   1 2 3 4 5

48. I have to work hard to pass physics.
   1 2 3 4 5

49. I perform better than most of my classmates in physics.
   1 2 3 4 5

50. My friends ask me for help in physics.
   1 2 3 4 5

51. I help my friends with their homework in physics.
   1 2 3 4 5

52. I am an intelligent student.
   1 2 3 4 5

*53. Please tell us your birthday. (mm/dd/yyyy)

*54. Now that you have completed this survey, do you still give us permission to use your data in our research?
Yes
No

Thank you for completing this survey. If you are willing to further help us in this research by being interviewed by researchers in a confidential manner, click here.
Appendix I: Wabash Survey

Questions with a * are required.
*1. Before you begin the survey, please read the paragraph below. This survey will ask you questions about your experiences in your introductory calculus-based class. It will only take 15-20 minutes. The survey is optional and will not affect your grade or standing at school. The individual responses to the survey will not be seen by your professors or anyone at your school. However, they will be able to see the general responses from the entire sample population. If there is a question you would not like to respond to, you may skip it. If you have any questions, concerns, or would like us not to use your data after you complete the survey you can contact myself, Mary Elizabeth Mills, at millsme2@muohio.edu or my adviser, Dr. Jennifer Blue, at bluejm@muohio.edu.
If you would like to take the survey, please select "I agree" below.
I agree    No

*2. Are you at least 18 years old?
   Yes
   No

*3. Do you give us permission to use your data in our research?
   Yes
   No

4. What is your sex?
   Female
   Male

5. What is your age?
   17
   18
   19
   20
   21
   22-24
   25+

6. Are you an American student or an International student?
   American
   International

7. What is your race?
   American Indian
   Asian
   Black
   Hispanic
Pacific Islander
White
Multiracial

8. What type of high school did you go to? (select as many as apply)
   - Public
   - Private
   - Homeschooled
   - Coeducational
   - Single-sex
   - Large (more than 2000)
   - Medium (500-2000)
   - Small (fewer than 500)

9. Did you take physics in high school?
   - Yes
   - No

10. How many years of physics did you take in high school?
    - 1
    - 2
    - 3
    - 4

11. What level? (select all that apply)
    - regular
    - honors
    - Advanced Placement (AP)
    - International Baccalaureate (IB)

12. What types of colleges or universities did you apply to? (select all that apply)
    - Public
    - Private
    - Liberal Arts
    - Technical
    - Large (more than 15,000)
    - Medium (3,000-15,000)
    - Small (fewer than 3,000)
    - Coeducational
    - Single-sex

13. Why did you choose Wabash? (select all that apply)
    - cost
    - scholarships
    - major
    - religion
classes
parents
professors
friends
sports
activities
size
location

14. Would you have gone to a coeducational college or university?
   Yes
   No

15. Why or why not?

16. Do you think your introductory calculus-based physics class would be any different if it was coeducational?
   Yes
   No

17. Why or why not?

18. What STEM (science, technology, engineering, and math) classes have you taken at Wabash?
   Anatomy
   Astronomy
   Biochemistry
   Biological Sciences
   Chemistry
   Computer Science
   Engineering
   Environmental Studies
   Geography
   Geology
   Mathematics
   Neuroscience
   Physics
   Statistics

19. Are you a STEM major?
   Yes
   No

20a. Which STEM field are you majoring in?

20b. What is your major?
21. What grade did you expect at the start of your introductory calculus-based physics class?
   A
   B
   C
   D
   F
   Audit
   Drop

22. Does your professor encourage you to do well?
   Yes
   No

23. Is your professor helpful outside of class?
   Yes
   No

24. Do you attend office hours?
   Yes
   No

24a. How often do you attend office hours?
   once a day
   once a week
   once a month
   never

24b. Why don't you attend office hours?

25. Does your professor affect how confident you are in doing your homework, quizzes, or tests?
   Yes, she/he makes me more confident
   Yes, he/she makes me less confident
   No, she/he has no affect on my confidence

26. Do you have a faculty mentor?
   Yes
   No

26a. In what department is your faculty mentor?

27. Are the other students in your class friendly and encouraging?
   Yes
   No
28. Do you have a study group that meets regularly outside of class?
   Yes
   No

29. Are the other students in your class more competitive or cooperative?
   Competitive
   Cooperative

30. Have you seen discrimination in this physics class?
   Yes
   No

30a. What kind of discrimination have you seen?

30b. Was it gender discrimination?
   Yes
   No

31. Have you been or felt discriminated against in this class?
   Yes
   No

31a. How have you been or felt discriminated against?

31b. Was it gender discrimination?
   Yes
   No

For the next five questions, “participate” is defined as attending class, completing all assignments, and doing anything else needed for your introductory calculus-based physics class as stated in the syllabus.

For the next 5 questions of the survey, please answer with the following scale:
   5 if you ALWAYS participate
   4 if you OFTEN participate
   3 if you SOMETIMES participate
   2 if you RARELY participate
   1 if you NEVER participate

32. I participate in my introductory calculus-based physics class.
   1  2  3  4  5

33. When I participate in my introductory calculus-based physics class, I do it to get a good grade.
   1  2  3  4  5

34. When I participate in my introductory calculus-based physics class, I do it to perform better than other students.
35. When I participate in my introductory calculus-based physics class, I do it so that other students think that I'm smart.

1 2 3 4 5

36. When I participate in my introductory calculus-based physics class, I do it so that the teacher pays attention to me.

1 2 3 4 5

For the next part of the survey, please answer with the following scale:
- 5 if you STRONGLY AGREE with the statement
- 4 if you AGREE with the statement
- 3 if you HAVE NO OPINION on the statement
- 2 if you DISAGREE with the statement
- 1 if you STRONGLY DISAGREE with the statement

37. During a physics course, I feel fulfilled when I achieve a good grade on a test.

1 2 3 4 5

38. During a physics course, I feel fulfilled when I gain confidence with the content.

1 2 3 4 5

39. During a physics course, I feel fulfilled when I am able to solve a difficult problem.

1 2 3 4 5

40. During a physics course, I feel fulfilled when the teacher accepts my ideas.

1 2 3 4 5

41. During a physics course, I feel fulfilled when other students accept my ideas.

1 2 3 4 5

For the next part of the survey, please answer with the following scale:
- 5 if you STRONGLY AGREE with the statement
- 4 if you AGREE with the statement
- 3 if you HAVE NO OPINION on the statement
- 2 if you DISAGREE with the statement
- 1 if you STRONGLY DISAGREE with the statement

42. I look forward to my physics class.

1 2 3 4 5

43. Physics class is fun.

1 2 3 4 5

44. I feel satisfied after my physics class.
1 2 3 4 5

For the next part of the survey, please answer with the following scale:
5 if you STRONGLY AGREE with the statement
4 if you AGREE with the statement
3 if you HAVE NO OPINION on the statement
2 if you DISAGREE with the statement
1 if you STRONGLY DISAGREE with the statement

45. I find it easy to get good grades in physics.

46. I am good at physics.

47. I find physics easy.

48. I have to work hard to pass physics.

49. I perform better than most of my classmates in physics.

50. My friends ask me for help in physics.

51. I help my friends with their homework in physics.

52. I am an intelligent student.

*53. Please tell us your birthday. (mm/dd/yyyy)

*54. Now that you have completed this survey, do you still give us permission to use your data in our research?
Yes
No

Thank you for completing this survey. If you are willing to further help us in this research by being interviewed by researchers in a confidential manner, click here.
Appendix J: Wooster Survey

Questions with a * are required.

*1. Before you begin the survey, please read the paragraph below. This survey will ask you questions about your experiences in your introductory calculus-based class. It will only take 15-20 minutes. The survey is optional and will not affect your grade or standing at school. The individual responses to the survey will not be seen by your professors or anyone at your school. However, they will be able to see the general responses from the entire sample population. If there is a question you would not like to respond to, you may skip it. If you have any questions, concerns, or would like us not to use your data after you complete the survey you can contact myself, Mary Elizabeth Mills, at millsme2@muohio.edu or my adviser, Dr. Jennifer Blue, at bluejm@muohio.edu.
If you would like to take the survey, please select "I agree" below.
I agree  No

*2. Are you at least 18 years old?
Yes
No

*3. Do you give us permission to use your data in our research?
Yes
No

4. What is your sex?
Female
Male

5. What is your age?
17
18
19
20
21
22-24
25+

6. Are you an American student or an International student?
American
International

7. What is your race?
American Indian
Asian
Black
Hispanic
Pacific Islander
White
Multiracial

8. What type of high school did you go to? (select as many as apply)
   Public
   Private
   Homeschooled
   Coeducational
   Single-sex
   Large (more than 2000)
   Medium (500-2000)
   Small (fewer than 500)

9. Did you take physics in high school?
   Yes
   No

10. How many years of physics did you take in high school?
    1
    2
    3
    4

11. What level? (select all that apply)
    regular
    honors
    Advanced Placement (AP)
    International Baccalaureate (IB)

12. What types of colleges or universities did you apply to? (select all that apply)
    Public
    Private
    Liberal Arts
    Technical
    Large (more than 15,000)
    Medium (3,000-15,000)
    Small (fewer than 3,000)
    Coeducational
    Single-sex

13. Why did you choose Wooster? (select all that apply)
    cost
    scholarships
    major
    religion
classes
parents
professors
friends
sports
activities
size
location

14. Would you have gone to a single-sex college or university?
   Yes
   No

15. Why or why not?

16. Do you think your introductory calculus-based physics class would
    be any different if it was single-sex?
   Yes
   No

17. Why or why not?

18. What STEM (science, technology, engineering, and math) classes have
   you taken at Wooster?
   Anatomy
   Astronomy
   Biochemistry
   Biological Sciences
   Chemistry
   Computer Science
   Engineering
   Environmental Studies
   Geography
   Geology
   Mathematics
   Neuroscience
   Physics
   Statistics

19. Are you a STEM major?
   Yes
   No

20a. Which STEM field are you majoring in?

20b. What is your major?
21. What grade did you expect at the start of your introductory calculus-based physics class?
   A
   B
   C
   D
   F
   Audit
   Drop

22. Does your professor encourage you to do well?
   Yes
   No

23. Is your professor helpful outside of class?
   Yes
   No

24. Do you attend office hours?
   Yes
   No

24a. How often do you attend office hours?
   once a day
   once a week
   once a month
   never

24b. Why don't you attend office hours?

25. Does your professor affect how confident you are in doing your homework, quizzes, or tests?
   Yes, she/he makes me more confident
   Yes, he/she makes me less confident
   No, she/he has no affect on my confidence

26. Do you have a faculty mentor?
   Yes
   No

26a. In what department is your faculty mentor?

27. Are the other students in your class friendly and encouraging?
   Yes
   No
28. Which students are friendly and encouraging?
   - Women
   - Men
   - Both
   - Neither

29. Are the other students in your class more competitive or cooperative?
   - Competitive
   - Cooperative

30. Do you have a study group that meets regularly outside of class?
   - Yes
   - No

31. Does your study group have both men and women?
   - Yes
   - No

32. Why does your study group not include both men and women?

33. Have you seen discrimination in this physics class?
   - Yes
   - No

33a. What kind of discrimination have you seen?

33b. Was it gender discrimination?
   - Yes
   - No

34. Have you been or felt discriminated against in this class?
   - Yes
   - No

34a. How have you been or felt discriminated against?

34b. Was it gender discrimination?
   - Yes
   - No

For the next five questions, “participate” is defined as attending class, completing all assignments, and doing anything else needed for your introductory calculus-based physics class as stated in the syllabus.

For the next 5 questions of the survey, please answer with the following scale:
   - 5 if you ALWAYS participate
   - 4 if you OFTEN participate
   - 3 if you SOMETIMES participate
2 if you RARELY participate
1 if you NEVER participate

32. I participate in my introductory calculus-based physics class.
   1 2 3 4 5

33. When I participate in my introductory calculus-based physics class, I do it to get a good grade.
   1 2 3 4 5

34. When I participate in my introductory calculus-based physics class, I do it to perform better than other students.
   1 2 3 4 5

35. When I participate in my introductory calculus-based physics class, I do it so that other students think that I'm smart.
   1 2 3 4 5

36. When I participate in my introductory calculus-based physics class, I do it so that the teacher pays attention to me.
   1 2 3 4 5

For the next part of the survey, please answer with the following scale:
5 if you STRONGLY AGREE with the statement
4 if you AGREE with the statement
3 if you HAVE NO OPINION on the statement
2 if you DISAGREE with the statement
1 if you STRONGLY DISAGREE with the statement

37. During a physics course, I feel fulfilled when I achieve a good grade on a test.
   1 2 3 4 5

38. During a physics course, I feel fulfilled when I gain confidence with the content.
   1 2 3 4 5

39. During a physics course, I feel fulfilled when I am able to solve a difficult problem.
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*53. Please tell us your birthday. (mm/dd/yyyy)
*54. Now that you have completed this survey, do you still give us permission to use your data in our research?
Yes
No

Thank you for completing this survey. If you are willing to further help us in this research by being interviewed by researchers in a confidential manner, click here.
Appendix K: Interview Questions

This program is intended to be an outline for the moderator, not a script. Introductory and concluding remarks can be paraphrased but must include: project description, discussion of confidentiality, informed consent forms, and thank yous at the end and beginning of the interview.

Small talk with the participant. Arrange things so you are facing each other and are comfortable. Get audio recorder out so that it can be situated later. Record preliminary information. Session should start no later than 5 minutes after scheduled time.

Introduction

Hello, my name is Mary Elizabeth Mills, and I’m a Master’s student from Miami University doing my thesis in Physics Education Research. Thank you for completing the online survey and agreeing to participate in this interview. This research could not take place without you donating your time.

Today we will go over some of the information covered on the survey, but in greater detail. You will have a chance not only to answer the question with a simple response like on the survey, but also give me any more information, stories or specific incidents, you would like to share. Your identity will be kept confidential when the findings are reported. The name of your institution will be included, but no specific details will be reported that could be reasonably attributed to you. However, remember that this is a small school and thus if you give information that is too personal, your fellow students and teachers could deduce that quotes used in a publication or presentation were from you. It is important that you do not share what was discussed in this room with others until the study is over.

Your participation is entirely voluntary, so feel free to let me know if you’d like to stop the interview at any time if you no longer want to participate, or if you have another commitment. You can also contact me at any time if you would like to be removed from the study entirely. Please remember that my research will be completed and a thesis will be written by August 2011.

I’ll be recording our conversation for later transcript and analysis. The recording and transcript will be kept confidential.

At this time, please read and sign the consent form. If you would like to receive notification when the results of this research are completed, please include your email address at the bottom of the form.

Pass out consent form and answer questions. Do not continue until they are sure and have handed you their form. Take this time to record preliminary information if you haven’t done so and also arrange the audio recorder microphone on the desk or table between you and the student. Do not start the recorder yet.

This interview is semi-structured, meaning that I have certain topics that I would like to cover, but I’m also interested in things that come to you that may not be completely related to the
topic at hand. Please feel free to bring these ideas or reflections up. There will also be a few minutes at the end for you to mention things that we haven’t covered that you might feel are relevant. Do you have any questions before we begin?

START the audio recorder and record start time. Begin asking questions. Lease 5 minutes at the end if they want to bring up anything extraneous. Monitor time and stick to the 30 minutes. Remember to only ask those coeducational questions to students at Wooster and the single-sex questions to students at Mount Holyoke and Wabash.

Questions

Student/Faculty Relations:
- Are your professors friendly and encouraging?
- Do your professors encourage you to work in groups outside of class?
- Are they helpful outside of class when you have questions?
- *Have you observed gender differences in the classroom during group work, during labs, or when asking questions?
- Is your faculty advisor male or female?
- How often do you seek guidance from your academic faculty advisor?
- Would you say it is sound advice?
- Do you feel pressured by your advisor to follow a certain career path or do you feel that your advisor give your options and then allows you to make the decision?
- Would you say the faculty members are approachable or unapproachable?
- Are there other members of the department that you are more likely to approach with questions, both academic and logical, including non-faculty staff?
- Would you prefer to talk to a male or female faculty/staff member, or does it not matter?
- How would you characterize your relationship with the faculty?
- Do you feel the faculty respects you?
  *Co-Ed only

Department:
- Do you have any student science groups?
- What is there purpose and how do they accomplish that purpose?
- Are there any gender specific student science groups?
- Do you ever attend any of their functions?

Peer Support:
- Would you characterize your experience in the classroom to be more competitive or more cooperative?
- How do you think this affects your learning process?
- Do you ever feel discouraged or encouraged by other students?
- Have you ever felt like you have wanted to switch majors? Why or why not?
- Do you ever feel discouraged by the amount of work that is required of physics majors as opposed to other majors?
- Have you ever thought about changing majors? Why or why not?
Gender Issues:
- Is there a sexual harassment policy on your campus? Do you know what it is?
- Do you think that there is a division between the males and females in the department?
- How would you characterize that division?
- Have you ever felt under attach by colleagues of the other sex?
- *Do you feel female and male students are treated differently either by students or by faculty?
- Do you feel female and male faculty are treated differently either by students or by faculty?
- Have gender issues come up in your classes
- What do you think about them?
- What was your response to them?
  *Co-Ed only

Single-Sex Schools:
- Why did you choose to come to Mount Holyoke/Wabash?
- Did the fact that it is a single-sex college have any affect on your decision to go here?
- How do you feel about the fact that it is only women/men?
- How does this make your classroom and lab atmosphere any different?
- Do you think it affects your learning of physics?
- How do you think your experience here will better you for graduate school or the workplace?
- Do you think you are more confident because you attended a single-sex school?
- Did you consider attending a coed college or university?
- How would your college experience be different if you had attended a coeducational school?
- Do you think you would be any more prepared for graduate school or a job?

Co-Ed School:
- Why did you choose to come to Wooster?
- How do you think your experience here will better you for graduate school or the workplace?
- Did you consider going to a single-sex college?
- How would have this make your classroom and lab atmosphere any different?
- Do you think it would have affected your learning of physics?
- How would your college experience be different if you had attended a single-sex school?
- Do you think you would be any more prepared for graduate school or a job?
- Do you think your experience at a single-sex college would better prepare you for graduate school or the workplace?
- Do you think you would have been more confident if you had attended a single-sex school?
Conclusion

STOP recorder and record end time.

Thank you so much for participating in this interview. I appreciate the personal insights and experiences that you have shared with me today. Now that the interview is over, do I still have permission to use your responses in my research?

Remember to keep your portion of the consent form as it has my contact information. If you have any questions or anything else that you would like me to mention because you think of it later or because we didn’t have time to cover it please feel free to contact us. Thanks again for your help with my research.
<table>
<thead>
<tr>
<th>Theme Codes</th>
<th>Education</th>
<th>Environment</th>
<th>Perceptions</th>
<th>Relationships</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job/career/workplace</td>
<td>Class/classroom</td>
<td>Experience</td>
<td>Professors/TA's</td>
<td></td>
</tr>
<tr>
<td>Grad school</td>
<td>Lab</td>
<td>Confidence</td>
<td>Other students/peers</td>
<td></td>
</tr>
<tr>
<td>Learning</td>
<td>Atmosphere</td>
<td>Easy/hard</td>
<td>Community</td>
<td></td>
</tr>
<tr>
<td>Teaching</td>
<td>ASC/Wabash/COW</td>
<td>Smart/intelligent</td>
<td>SPS/student groups</td>
<td></td>
</tr>
<tr>
<td>Understanding</td>
<td>Cooperation</td>
<td>Dumb/stupid</td>
<td>Personal</td>
<td></td>
</tr>
<tr>
<td>Homework/work</td>
<td>Competition</td>
<td>Male/man/boy/guy</td>
<td>Professional</td>
<td></td>
</tr>
<tr>
<td>Test/exam/quiz</td>
<td>Discrimination</td>
<td>Female/woman/girl</td>
<td>Mentor/guidance</td>
<td></td>
</tr>
<tr>
<td>Preparation</td>
<td>Single-sex</td>
<td>Gender/sex</td>
<td>Accessibility</td>
<td></td>
</tr>
<tr>
<td>Participation</td>
<td>Coed/coeducational</td>
<td>Geek/nerd/dork</td>
<td></td>
<td></td>
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<tr>
<td>Grades</td>
<td></td>
<td>Power</td>
<td></td>
<td></td>
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<tr>
<td>High school</td>
<td></td>
<td>Support/approval (inside/outside)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Easy/hard</td>
<td></td>
<td>Self-aware</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual attention</td>
<td></td>
<td>Pressure/stress</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office hours</td>
<td></td>
<td>Awkward/discomfort</td>
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<td></td>
<td></td>
<td>Respect</td>
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<td></td>
<td></td>
<td>Discouragement/encouragement</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table L.1: This table lists the codebook used to analyze the transcripts. The codes are sorted by the major theme they describe.
Appendix M: Examples of Coding

**Theme: Education**

<table>
<thead>
<tr>
<th>Code</th>
<th>Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work</td>
<td>Agnes: “I would consider being a physics major. I would like to incorporate it even more into my education than just the requirements posed by my biochem major. It requires one year of physics and one year of calculus with calc 3 recommended but not required. But I would like to go even further if I have time.”</td>
</tr>
<tr>
<td>Learning/Future</td>
<td>Clara: “I think that because you get individual attention here that you’re able when you’re older to kind of seek it out to other people and that I think IS (Independent Study) is such an exciting thing to look forward to that even preparing for that and knowing when you come here that that down the line is in like three years is like extremely scary, but like really exciting the same time you’re going to walk out of college with something that’s going to change your life and you’re going to be able say like I did this when I was only 22 years old.”</td>
</tr>
<tr>
<td>Learning</td>
<td>Constance: “Yeah, definitely. I feel like if it was more competitive it might be – I probably would work a lot harder at it, but it also wouldn’t be as – it would be motivating but kind of in the wrong way. A lot more stressful and I feel like I’ve learned stuff real fast which comes out on the test and in the lab it would be a lot more stressful. So, I like that a lot better than not competitive. It’s actually one of the reasons why I chose Wooster.”</td>
</tr>
<tr>
<td>Future</td>
<td>Walter: “Time-management. I think is, the best thing that Wabash taught me, because of the workload that we have here you really have to manage your time appropriately so that you do all of your homework and grasp it until, I think that’s very important also in the workplace, I think it makes for better workers, better people in the workplace if you use your time effectively and I think that’s something that with all the workload Wabash college does a good job of doing.”</td>
</tr>
<tr>
<td>Work</td>
<td>Winston: “No not right now because my physics is not the most time consuming at the moment. I would refer to that as sophomore hazing. I’m sorry, cultures and traditions. I’m in organic chemistry, but that is only because I’m a second year chemistry student and I’m a first year physics student. Next year I get to start dynamics, quantum mechanics, classical that will greatly increase. So, I’m anticipating that and looking forward to it.”</td>
</tr>
</tbody>
</table>
### Theme: Environment

<table>
<thead>
<tr>
<th>Code</th>
<th>Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-Sex</td>
<td>Agnes: “I do enjoy that, yes. I think, I think that it’s empowering, for the most part. There are always negatives to everything. But for the most part I think it’s an empowering, positive thing. I think it helps me in the science classroom to not constantly worry about whether I will be able to keep up with the males around me. And also, you can notice, that there are some females who are just as bright, quick, and intelligent as some of the males in my class. And I don’t really feel like I notice that as much when I’m in a classroom of 400 students, ¾ of who are male, in my physics class, which was what it was like at U of I. So it’s nice people can see that and it’s interesting to even be intimidated by a female in regard once in a while. But I, I like it. Yeah, I think it’s very different. I think it will help me stand out too, when I apply for grad schools. I think it’s something that might work in my favor, as opposed to against me.”</td>
</tr>
<tr>
<td>Cooperation</td>
<td>Clara: “I would say it’s very cooperative. But, here it’s totally different. It’s very cooperative. I work with really only guys on a lot of my homework and stuff and there is no competitiveness. We’ll come down at 1:00 in the morning and help each and I can call my friends up and we help each no matter what. We’d rather both of us do well instead of one of us do better which I think is because we don’t have a curve and we don’t have the whole 60% class passes and then the 40% fails which I think is really important that we do not have that. It’s so cooperative. It’s so much honestly better than high school. But with gender differences, I worked with my best friend from high school, a girl. We would always work together on stuff, but now I’m only working with guys. I don’t know what happened, but I think it is just a whole different atmosphere. Much less competitive than high school.”</td>
</tr>
<tr>
<td>Cooperation</td>
<td>Constance: “Generally the way I feel it is more cooperative. Occasionally like I hate when professors put up on the board like a distribution of grades. Like this is the class average is okay, but like when they put up well this is how many people got 95 or above and this is how many were below 95. It used to not bother me so much because in high school I used to be in the 95 range and now it’s more of the 80 to 85 range. So, that can be kind of discouraging. Most of the time, I don’t feel a direct competitiveness with other students.”</td>
</tr>
<tr>
<td>Cooperation</td>
<td>Walter: “We really not competitive. I would have to say for me, its somewhere in the middle but I others they have like study groups so it’s more cooperative for them, but as a whole I would definitely say cooperative though. Physics is not an easy subject, but other years you might feel this way a (oh my gosh so lost) sometimes it’s good to console a third party is cheating or not. I don’t think its competitive at all, I just bet on this exam, we just go up to the one if you survive the class, or you know, truly learn what’s going on with physic so in that regard how well someone actually does really play a factor in that?”</td>
</tr>
<tr>
<td>Single-Sex</td>
<td>Winston: “The single-sex atmosphere is really nothing. It really has no effect. I know one of my friends said when he was considering Wabash, yes his dad was a Wabash grad, he said he wasn’t thinking about it. He didn’t know if wanted to go there because of the jock guys go there. But he remembers his dad saying, well okay but if you went to a co-ed school don’t you think there would be even jocks and even jockier if that is correct English. Thank goodness I’m not an English major. Because there would be women around for them to try and impress and he said oh, yeah I guess that makes sense.”</td>
</tr>
<tr>
<td>Code</td>
<td>Excerpt</td>
</tr>
<tr>
<td>----------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Discouragement</td>
<td>Agnes: “Oh goodness, yes! Of course I have. But with the sheer volume of work and math has never really come easily to me. So, sometimes I can get very upset with myself if I’m not doing it well enough, and then I feel like I can’t do math. And so, then I have to have a student or professor help remind me that yes I can do math. But yeah, of course I feel discouraged by the amount of work I have to do, I think sometimes that comes more from me than from the work itself, but yeah, it’s a lot, it’s hard.”</td>
</tr>
<tr>
<td>Encouragement</td>
<td>Clara: “I’ve mostly felt encouraged. My lab partner, who’s like my best friend. He’s like kind of like sarcastic and tough on me in labs because he just like jokes around with me and stuff. I use to take it personally, but I’ve realized that he’s just joking, giving me a hard time about like him doing most of the work or whatever which isn’t true, but he always gets mad when I’m right on something and he’s wrong. So, it’s actually kind of nice to get to work with different people who don’t really see the same way so it kind of like nicely bounces off of someone that kind of gives you a hard time, but not in a bad way like he’s always joking around because I know he’s just kidding about it so it’s just to get me worked up.”</td>
</tr>
<tr>
<td>Encouragement</td>
<td>Constance: “Like personally I usually don’t feel intimidated by guys in the classroom. I think that some girls would speak up a little more or play dumb less because there’s definitely girls who will play dumb. There’s this girl in my math class who always. So, she normally when she’s outside of the classroom she talks in kind of a normal voice and the professor is a male professor, sometimes like when she’s asking a question she’ll adopt this really high pitched girly, oh I don’t get it and it’s just really irritating. So, I feel like there would be a less of that on an all girl campus. But for me personally I don’t think it would make a huge different.”</td>
</tr>
<tr>
<td>Respect</td>
<td>Walter: “That’s not the case. I think in that regard I am respected in the physics department, they are very encouraging and supportive in what else we’re doing and what to do, and near the introductory physics course, being in the introductory physics course, they understand that most of the guys that take that course wont be physics majors or minors for that matter and they know there’s a section that wants to go premed and they know a section that is chemistry students that need to take the physics course so I think they are perceptive to all the different like, all the people who have different aspirations in the class and I don’t see any source of disrespect from any of the professors.”</td>
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<td>Discouragement</td>
<td>Winston: “Yeah, it was just personal. I thought I did better than that and I was anticipating doing better than that so, it wasn’t a peer thing it was more just. I’m happy that my peers do well. I know it’s not my fault or my problem if my peers do bad.”</td>
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## Theme: Relationships

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<th>Code</th>
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<td><strong>Professors</strong></td>
<td>Agnes: “The way I would answer that question, is I have not had very much contact with them outside of the lab professor and Dr. Bowling, that directly teaches my course, but I do think that they are very friendly and approachable I’ve had, you know, offhand, you know, encounters with them here and there and they also every week, they have a physics lunch table. And all the physics prof, they have a big sign that says physics lunch and all the physics professors are sitting there talking and they don’t mind if you come and sit with them or if you come talk to them. They’re very friendly they love physics and they love talking about physics if you want to talk about it. So I think they’re all incredibly approachable and kind and they have, generally, I think, a great sense of humor they bring to their craft, I guess.”</td>
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<td><strong>Student Groups</strong></td>
<td>Clara: “I know there is a physics club. I think there is also math and comp sci. I am in the physics club and they do the – they go to the school, they do their whole outreach thing, but I’m not able to do this semester. But I know that’s their really big thing and then they also do like club things like movie night and they go places, like to museums and stuff.”</td>
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<td><strong>Professors</strong></td>
<td>Constance: “I think they’re pretty approachable. Both my lab professor and my professor for the lecture I really like. I think they don’t mind when I ask a question, which is always a good feeling.”</td>
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<td><strong>Professors</strong></td>
<td>Walter: “Yeah most definitely. I have been to my professors and Dr. Brown a couple times. And I’ve actually went to professors that weren’t my teachers, that aren’t my teachers, and they’ve also helped me. So it just shows that the willingness that the department wants to help students.”</td>
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<td><strong>Professors</strong></td>
<td>Winston: “Yes. I quite often walked into their offices and said hi and asked them [INAUDIBLE]. I actually thought it was actually a pretty good idea if the things could be accomplished.”</td>
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