In the following report, Hanover Research examines the implementation of single gender math classes at the middle school level, particularly focusing on the impact of this type of schooling on female student achievement and other positive outcomes.
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EXECUTIVE SUMMARY AND KEY FINDINGS

INTRODUCTION

Single sex education in secondary schools has been the subject of considerable controversy, debate, and discussion for a number of years. Proponents of this type of schooling have touted numerous advantages for female students in particular, including expanded educational opportunities, personalized learning and instruction, and greater autonomy.¹ Advocates argue that female students benefit particularly from single gender schooling in mathematics, a subject that has been traditionally stereotyped as a male domain. However, evidence from controlled experiments and randomized trials has generated a host of divergent, and often politicized, conclusions about the effectiveness of this type of education.

Single sex education in public school systems has faced the additional challenge of significant legal scrutiny. For much of recent history, the prevailing government position was that gender-segregated education was illegal. In 2001, however, the No Child Left Behind Act (NCLB) reversed longstanding federal bans on sex-segregated classrooms and cleared the way for states to begin operating single-sex classrooms.² The implementation of this NCLB provision was not without significant controversy, however, some of which still endures today.

In this report, Hanover Research specifically examines the implementation of single gender math classes at the middle school level, particularly focusing on the impact of this type of schooling on female student achievement and positive outcomes. The report comprises the following sections:

- **Section I: Overview of Single Gender Education** reviews the history of single sex education, as well as recent literature on the current state of single gender schooling in the United States. The section also examines key advantages and disadvantages of single sex classes, implementation strategies and logistics, and minority stakeholders’ perspectives on this type of schooling concept.

- **Section II: Implementation of Single Gender Math Education** examines the implementation of single gender math education in particular, focuses on ways in which advocates highlight the necessity of single gender math classes, and provides information about the effect of single gender math education on students’ achievement and outcomes.

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KEY FINDINGS

- Single sex education in the United States is currently the subject of contentious debate, even though the 2001 No Child Left Behind legislation eradicated federal bans on sex-segregated classrooms. In 2014, the United States Department of Education’s Office for Civil Rights clarified new requirements for single sex classrooms, including that such classrooms must: 1) demonstrate that the single sex nature of the class is substantially related to achieving a particular objective; 2) ensure that enrollment in the single sex class is completely voluntary (through an opt-in, rather than an opt-out, process); 3) offer a substantially equal coeducational class in the same subject; and 4) avoid discriminating against faculty members based on gender when assigning educators to single sex classrooms.

- According to the NASSPE, as of the 2011-2012 school year, at least 506 U.S. public schools offered single sex educational opportunities. Additionally, about 390 of those were coeducational schools that offered single sex classrooms, but also retained some coeducational activities. The remaining 116 were completely single sex schools, the majority of which appeared to be operated under charters.3

- Proponents and opponents of single sex classrooms debate about perceived advantages and disadvantages of this type of schooling. Advocates typically point to advantages such as decreasing classroom distractions, allowing teachers to cater their teaching methods to personality differences between genders, and giving students greater freedom to pursue activities that are stereotypically assigned to members of the opposite sex. However, opponents argue that single gender classrooms simply enforce gender stereotypes, and require logistically complicated and expensive implementation strategies. Opponents also argue that single gender classrooms can be discriminatory, particularly if they negatively affect different outcomes for male and female students.

- Districts interested in implementing single sex education should be prepared to engage with stakeholder groups on various levels. Internally, these constituencies include the school board, the district administration, teachers, and students. Externally, districts are advised to engage with parents as well as the media. The National Association for Single Sex Public Education further suggests five steps that districts should take in the implementation of a single sex program: 1) train teachers; 2) engage parents; 3) include the school board; 4) educate the media; and 5) continue the professional development process with teachers.

- The majority of the literature on single sex math classrooms indicates that this type of schooling has no significant effect – and sometimes even has a negative effect – on students’ (including female students’) math achievement and other positive outcomes. However, despite fewer studies demonstrating the positive effects of single sex math classrooms, some studies argue that such classrooms do,

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in fact, benefit minority or low-income students. Research also shows that minority students are generally pleased with their experiences in single gender classrooms.
SECTION I: OVERVIEW OF SINGLE GENDER EDUCATION

This section reviews the history of single sex education, as well as recent literature on the current state of single gender schooling in the United States. The section also examines key advantages and disadvantages of single sex classes, implementation strategies and logistics, and minority stakeholders’ perspectives on this type of schooling concept.

HISTORY OF SINGLE SEX EDUCATION

While single sex public education is a relatively new convention in the United States, gender-segregated classrooms are themselves not novel. In *Debating Single Sex Education: Separate and Equal?*, Frances Spielhagen argues:

> Throughout the early days of American education [...] into the early years of the 20th century, single sex classes were a common arrangement in secondary schools. In fact, coeducational classes are a relatively new development in American education and education in general. ⁴

TITLE IX

For much of recent history – indeed, since the 1972 Congressional passage of the Title IX education amendment – the prevailing government position was that gender-segregated education was illegal. In the 1990s, organizations such as the American Civil Liberties Union (ACLU) and the National Organization for Women (NOW) threatened lawsuits against districts providing or endeavoring to provide single sex classrooms or schools. The most notable instance of this was the high-profile court case *Garrett vs. the Board of Education*, in which the ACLU and NOW sued a Detroit school board over its plan to open an all-male academy for African-American boys. ⁵ The U.S. Office for Civil Rights (OCR) also acted as a strict enforcer of the Title IX amendment.

Similarly, in 1994, the ACLU threatened to bring a lawsuit against Stanton Elementary School, an inner-city school in Philadelphia with a majority of its students below the poverty line, where a male teacher had initiated a model five-year program for a group of 20 first-grade boys who had learning problems in kindergarten. ⁶ During these years, many schools buckled under threats from the ACLU and mandates from the OCR.

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**NO CHILD LEFT BEHIND ACT (NCLB)**

The legal challenges to single sex education in U.S. public schools ended with the passage of the NCLB Act of 2001, which “opened the door for schools to experiment with single-sex classes as a means of improving educational outcomes for all students.”

Where the legality of single sex classrooms and schools was once ambiguous, NCLB clearly waived the Title IX prohibition on single sex education, and encouraged school districts to experiment with gender-segregated classes and schools.

Section 5131 of the NCLB states that “funds made available to local educational agencies under section 5112 shall be used for [...] programs to provide same gender schools and classrooms (consistent with applicable law).”

Further, the section states that “not later than 120 days after the date of enactment of the No Child Left Behind Act of 2001, the Secretary shall issue guidelines for local educational agencies seeking funding for programs described in subsection (a)(23).” These stipulations legalized single sex public classrooms, and ensured that the federal government would be held accountable to local school districts seeking funding for single sex programs.

**AFTERMATH OF NCLB**

Following the passage of NCLB in 2001, single sex campuses and classrooms have become a way for school districts to offer diverse learning options to students with the hope of a concomitant rise in educational quality and achievement outcomes. As a result, single sex education has been absorbed into the wider movement advocating greater choice in public education.

However, the provision for single sex education included in NCLB was quickly challenged. “In 2003 the Office of Civil Rights immediately began reviewing arguments about the legality of single sex classes. In 2006 the United States Department of Education confirmed the legality of single sex arrangements, a decision that emerged in the midst of the proliferation of such classes.”

The National Association for Single Sex Public Education (NASSPE) has condensed the provisions into a few clarifying circumstances under which it is acceptable for coeducational public schools to offer single sex classrooms. These schools must:

- **Provide a rationale for offering a single gender class in that subject.** A variety of rationales are acceptable (e.g., if very few girls have taken computer science in the past, the school could offer a girls-only computer science class).

- **Provide a coeducational class in the same subject at a geographically accessible location.** That location may be at the same school, but the school or school district may also elect to offer the coeducational alternative at a different school which is

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8 “Sec. 4131. Local Uses of Funds.” U.S. Department of Education. [http://www2.ed.gov/policy/elsec/leg/esea02/pg60.html](http://www2.ed.gov/policy/elsec/leg/esea02/pg60.html)
9 Ibid., Section 5131(c).
geographically accessible. The term “geographically accessible” is not explicitly defined in the regulations.

- **Conduct a review every two years** to determine whether single sex classes are still necessary to remedy whatever inequity promoted the school to offer the single sex class in the first place.¹¹

According to the NASSPE, as of the 2011-2012 school year, at least 506 U.S. public schools offered single sex educational opportunities.¹² Additionally, about 390 of those were coeducational schools that offered single sex classrooms, but also retained some coeducational activities. The remaining 116 were completely single sex schools, the majority of which appeared to be operated under charters.¹³

In 2014, the United States Department of Education’s Office for Civil Rights (OCR) clarified new guidelines and requirements for single-sex classrooms. Some of these guidelines are similar to those put forth by the NASSPE in 2006, but other guidelines are much more in-depth. According to the OCR, schools that offer single sex classes or extracurricular activities must:

- Identify an important objective that they seek to achieve by offering a single sex class (such as improving academic achievement);
- Demonstrate that the single sex nature of the class is substantially related to achieving that objective;
- Ensure that enrollment in the single sex class is completely voluntary (through an opt-in, rather than an opt-out, process);
- Offer a substantially equal coeducational class in the same subject;
- Offer single sex classes evenhandedly to male and female students;
- Conduct periodic evaluations at least every two years to ensure that the classes continue to comply with Title IX;
- Avoid relying on gender stereotypes;
- Provide equitable access to single sex classes to students with disabilities and English language learners; and

"As we receive increasing inquiries about single sex offerings, we want to be clear what federal law allows [...] It is our hope that this guidance will give schools, students, and parents the tools they need to ensure compliance with the Title IX regulations on single sex classes."

- Ms. Catherine Lhamon, Assistant Secretary for Civil Rights, United States Department of Education


¹³ Ibid.
Avoid discriminating against faculty members based on gender when assigning educators to single sex classrooms.14

ADVANTAGES AND DISADVANTAGES OF SINGLE SEX CLASSES

Before delving into single gender classroom implementation strategies and logistics, it is important to consider the concrete advantages and disadvantages of this type of program. Figure 1.1, on the next page, specifically highlights some of the most prevalent advantages and disadvantages surrounding single sex schooling.

Advocates typically point to advantages such as decreasing classroom distractions and allowing teachers to cater their teaching methods and lesson plans to personality differences between genders. However, opponents argue that single gender classrooms simply enforce stereotypes of activities and goals that are typically assigned to the opposite gender (i.e., gender stereotyping). Furthermore, such programs are logistically complicated, costing school districts more money and typically leading to more limited course offerings – including fewer honors and advanced placement courses. Most importantly, however, opponents warn that single gender classrooms can be discriminatory, particularly if they differentially affect educational outcomes for male and female students.

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Figure 1.1: Advantages and Disadvantages of Single Sex Classrooms

Advantages of Single Sex Classrooms

- Decrease distractions in the classroom
- Allow teachers to cater teaching methods and style to personality differences between genders
- Increase teachers’ ability to maintain order in and control of the classroom
- Facilitate better peer interactions among students
- Give students greater freedom to pursue activities and goals that are stereotypically assigned to members of the opposite sex
- Remove the need for teachers to take into account the different maturity levels of boys and girls
- Allow students to have teachers of their own gender who could serve as more effective role models
- Less sex bias in student/teacher interactions
- Facilitate a greater sense of community in the classroom

Disadvantages of Single Sex Classrooms

- Enforce stereotypes of activities and goals that are typically assigned to the opposite gender (i.e., promotes gender stereotyping)
- Decrease teachers’ ability to maintain order and control by concentrating unruly students in the same classroom
- Decrease opportunities for male and female students to work together and socialize
- Potential for more limited course offerings (e.g., fewer honors and advanced placement courses)
- Expensive to run two parallel programs
- Potential discrimination if single sex program affects educational outcomes for one gender but decreases them for the opposite gender

Source: Economics of Education Review

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15 Text in figure quoted almost verbatim from:
SINGLE GENDER CLASSROOM IMPLEMENTATION STRATEGIES AND LOGISTICS

Examining the characteristics of successful single sex classrooms and schools is an essential process for districts seeking to implement their own gender-specific programs. Too often, single sex programs are introduced without adequate preparation or consultation with individual schools and stakeholders. A widely-cited example of such a case occurred in California in the late 1990s, when then-Governor Pete Wilson called for the systematic introduction of single sex “dual academies” to address the needs of at-risk students. Governor Wilson provided an incentive for the development of these academies by offering $500,000 to districts that introduced single sex schools.16 According to education researcher David Sadker:

California provided no training for teachers and no clear rationale for the changes, and within a few years most of these schools returned to co-education [...] The California experiment was a valuable lesson in how not to go about educational change.17

In order to avoid such a situation in the future, districts are well-advised to examine the best practices of schools that have successfully transitioned to single sex educational programs. Figure 1.2 lists the steps districts should take in the implementation of a single sex program, as outlined by the NASSPE.

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Figure 1.2: Checklist for Launching a Single Sex Program in a Public School District

Step 1: Train Teachers

Unless teachers are trained, schools run a variety of risks. A five-day training with NASSPE or comparable training with specialists in single sex education helps set the agenda for a successful project.

Step 2: Engage Parents

Hosting a forum informing parents of the benefits of single sex education, as well as answering questions and objections, is an important first step in building good relations with stakeholders. After the initial meeting, districts may send letters home explaining that parents may opt out.

Step 3: Include the School Board

As the school board is elected, and ultimately responsible to local constituents, it is quite possible that they will want to have a say in plans for single sex schooling. The board should be invited to parents’ forums as well as teacher training. "Closed-door" presentations may also be a valuable tool.

Step 4: Educate the Media

After informing parents, teachers, and the school board, it is important to engage the media. While single sex education may be experimental in the view of the government, it is important that single sex arrangements not be presented this way to the media. Instead, it is better to emphasize the research-based or "proven" basis of single sex education, as well as the fact that it is practical and effective.

Step 5: Continue Professional Development Process with Teachers

While professional development can begin with a two-day workshop, it must be implemented long-term to have a meaningful and lasting impact. Trainers should be invited back for classroom visits, additional training, or small-group meetings. NASSPE conferences are another valuable setting for teachers to network and learn new techniques.

Source: National Association for Single Sex Public Education

While NASSPE’s summary of single sex education provides a useful guidepost for implementing single sex education, and highlights the constituencies that schools should work to engage, there are a number of additional stakeholder-related factors school leaders may wish to consider when developing their transitional strategy. These may be organized broadly into two groups: internal (e.g., teachers, staff, administrators, school board) and external (e.g., parents, the media, outside organizations).

**INTERNAL STAKEHOLDERS**

**Most teachers are not trained to teach only male or female students.** While many instructors likely have the skills necessary to do so, they may feel that they are in uncharted territory. After all, few educators are trained in gender-specific teaching strategies. Training provides teachers with instructional techniques appropriate to single sex classrooms, and also offers strategies for managing these classrooms effectively.

Ideally, training should be ongoing, and schools should offer regular opportunities for teachers to discuss and develop single sex teaching strategies. Several organizations specialize in providing training and professional development for single sex schools. For example, the Gurian Institute, founded by educator Michael Gurian, author of books such as *Boys and Girls Learn Differently* and *Nurture the Nature*, provides training to schools implementing single sex formats.

Another theme to emerge from focus groups of teachers involved in single sex education is the need for administrative support. Local school-level administrators, as well as representatives from the district administration, should plan to attend trainings and provide additional support for teachers once the school year has begun. By attending meetings and taking an active role in the process of implementing single sex schooling, district administrators can support and sustain teacher “buy-in,” conveying their confidence in single sex education.

Finally, it is important to highlight the staffing challenges school systems may face in transitioning to single sex programs – namely, teachers’ reluctance or aversion to teaching in single sex schools. According to researcher Frances Speilhagen, one large Southeastern school district found that it had difficulty recruiting teachers, particularly men, to teach in single sex schools. While the district received plenty of applications, it found that male teachers feared potential charges of sexual harassment and inappropriate behavior if they worked for an all-girls school. By contrast, female teachers had no problem working in the all-boys school.

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22 Ibid., p. 4.
EXTERNAL STAKEHOLDERS

Once a district decides to pursue single sex schooling, senior management within the school system must embrace the single sex approach, projecting clear and unequivocal support not only to teachers, but to external audiences as well. Administrators should keep students and parents fully informed of the rationale behind the school’s approach, and should actively promote the issue within the school and broader community. Research suggests that proactive and supportive senior management is crucial in realizing the potential of a single sex initiative. When senior management is merely accommodating – or projects a sense of detachment or disinterest – the positive benefits of single sex schooling may be much more limited.23

In dealing with parents, school districts should be clear in noting that single sex schooling is optional, and should also offer information related to how and when the option may be advantageous to their children. Even advocates of single sex education acknowledge that it is not ideal for every child. For example, for a sensitive boy or assertive girl, the teaching strategies promoted by advocates of single sex education may be ineffective or even detrimental to development.24 Districts should communicate how single sex teaching can help some students, but should also provide parents with resources to help determine whether the environment is right for their child.

FEMALE-SPECIFIC TEACHING STRATEGIES

A 2011 presentation on gender-based education by South Charlotte Middle School in Charlotte, North Carolina highlights some of the main strategies under which girls specifically thrive:

- Collaborative groups;
- Use of manipulatives for math;
- Real life applications;
- Relaxing music; and
- Unconditional positive reinforcement.25

Past research has also focused on the most effective ways to structure class time for female students. Ms. Caroline Butler, a middle school math teacher who specializes in gender-based education, suggests that middle-school girls learn best from a combination of first larger group, then smaller group, followed by larger group teaching again (Figure 1.3). She also notes that girls learn best when the lecture begins with more abstract ideas, followed

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by exploration of the topic and group collaboration, and then final discussion in a large group.  

Figure 1.3: Optimal Class Structure for Girls

![Diagram of class structure]

Source: South Charlotte Middle School

An article published in *Middle Matters* also emphasizes several strategies for working with female students in the classroom. Specifically, the article states that it is crucial to “take time to explain instructional processes, answer their questions, consider their suggestions, and probe their hypotheses,” as well as to use project-based learning that connects lessons to real-world applications. “Circle discussions” are also another key strategy that may lead to positive female student outcomes:

Circle discussions tend to be successful when working with girls because each girl has a chance to be heard and respected. [...] Stations can also be used with girls – but I would not recommend placing a time limit on each station. Instead, indicate what is expected by the middle or end of the class, and allow the girls an opportunity to move freely from station to station. Again, monitoring their progress is critical. Allow girls the opportunity to color assignments before handing them in, keep noise distractions to a minimum, and provide time for collaboration.

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26 Ibid., p. 13.
27 Quoted verbatim from: Ibid.
29 Ibid.
MINORITY STAKEHOLDERS’ PERSPECTIVES

Single sex classrooms have often been touted as a method of benefiting minority or low-income students in particular, and research has demonstrated that such students are generally pleased with this type of educational model. As one example, the single-sex high school for girls in the Chicago Public Schools system is made up of primarily low-income and minority students, and boasts high college placement rates. Additionally, the girls at the school are satisfied with their single sex education, with many students expressing that they enjoy being able to share their own opinions and participate fully in class.

Similarly, in 2010, “Chicago’s only public all-male, all African-American high school made history when every one of its graduating seniors was accepted into a four-year university.” In line with the minority girls’ satisfaction with their single sex education in Chicago, minority boys were also happy with the gender difference-driven curricula at the school. One student, for example, expressed his “gratefulness that the school ‘taught [him] to become a young man,’ and that there are ‘males [there] to guide [him] through [his] everyday problems like a father figure would.’” The author of the study therefore suggests that having teacher role models may be particularly beneficial for minority students, who may not have role models of their respective genders at home.

Proponents of single sex schooling in public schools also argue that “historically, families with money have had a choice to send their children to single sex schools in the form of private schooling,” and that with single sex schooling in public schools, “all students, including those in poverty and minorities, will have the same choices as those who can afford private schools.”

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31 Ibid., p. 9.
32 Ibid. pp. 9-10.
SECTION II: IMPLEMENTATION OF SINGLE GENDER MATH EDUCATION

This section examines the implementation of single gender math education in particular. As such, the section specifically focuses on ways in which advocates highlight the necessity of single gender math classes (i.e., noting physical differences in male and female brains, as well as stereotype threat) and provides information about the effect of single gender math education on students’ achievement and outcomes.

PHYSICAL DIFFERENCES IN MALE AND FEMALE BRAINS

Advocates of single gender education have historically emphasized key physical differences in the brain that affect the way boys and girls learn, therefore suggesting that students should be grouped by gender in academic classes. For example, the corpus callosum – a system of nerves that connects the right and left hemispheres of the brain – is approximately 20 percent larger in females than it is in males. Dr. Craig Ogden of Georgia Southern University suggests that the larger corpus callosum in females is the reason that they “seem to be able to use both sides of the brain in processing information, and are able to multitask more efficiently than [males].”

Physical differences also include sensory strengths and weaknesses, as shown below in Figure 2.1. Single gender classroom proponents argue that these are crucial differences, and that single gender classrooms allow teachers to cater their lesson plans accordingly. For example, as girls typically do not see as well as boys and like the room to be brighter, a teacher of a girls-only class might adjust the light accordingly.

Figure 2.1: Differences in Boys’ and Girls’ Sensory Perception

<table>
<thead>
<tr>
<th>SENSORY</th>
<th>GIRLS</th>
<th>BOYS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditory</td>
<td>▪ Hear 2-4 times better than boys</td>
<td>▪ Often sit in the back of the classroom</td>
</tr>
<tr>
<td></td>
<td>▪ Hear softer sounds and higher pitches</td>
<td>▪ Have a better tolerance for noise</td>
</tr>
<tr>
<td></td>
<td>▪ Hearing is sharper</td>
<td>▪ Can locate sound better</td>
</tr>
<tr>
<td></td>
<td>▪ Lose their hearing earlier; hearing loss is more profound</td>
<td></td>
</tr>
<tr>
<td>Visual</td>
<td>▪ Like bright lighting</td>
<td>▪ See better than girls and like the room to be darker</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Color blindness is more common</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Retina is thicker</td>
</tr>
<tr>
<td>Touch</td>
<td>▪ Associated with emotions</td>
<td>▪ Higher tolerance for pain</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Higher tolerance for hot and cold</td>
</tr>
</tbody>
</table>

### Sensory

<table>
<thead>
<tr>
<th>Girls</th>
<th>Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taste and Smell</td>
<td>More sensitive to taste and smell</td>
</tr>
<tr>
<td></td>
<td>More accurate in identifying tastes and smells</td>
</tr>
<tr>
<td>Brain Activity</td>
<td>Female brain at rest is more active than the male brain at optimal performance</td>
</tr>
<tr>
<td>Verbal Skills</td>
<td>Able to speak at an earlier age</td>
</tr>
<tr>
<td></td>
<td>Speech is clearer at an earlier age</td>
</tr>
<tr>
<td></td>
<td>Better at spelling</td>
</tr>
<tr>
<td></td>
<td>Better neural connectivity</td>
</tr>
<tr>
<td>Spatial</td>
<td>Equal to boys in spatial visualization</td>
</tr>
<tr>
<td></td>
<td>Better at perceptual speed</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Special Education</td>
<td>23 percent</td>
</tr>
<tr>
<td>Developmental Differences</td>
<td>Develop fine motor skills earlier</td>
</tr>
<tr>
<td></td>
<td>First to develop their hippocampi</td>
</tr>
<tr>
<td></td>
<td>Cognitively more ready to start school</td>
</tr>
<tr>
<td></td>
<td>Under stress, use social support</td>
</tr>
</tbody>
</table>

Source: University of Oklahoma

Additionally, in the math discipline more specifically, male brains “tend to have more cortical areas, mainly in the right hemisphere, wired for spatial/mechanical processing,” which advocates of single gender education point to as a reason why boys might have an advantage in spatial-related fields such as math. Furthermore, research suggests the importance of exposing girls to “mathematics as play” in order to fully develop female neurological pathways:

It seems that the socialization of young girls may, in fact, interfere with the initial development of brain patterns that enhance mathematics learning. For instance, studies have shown that an enriched environment produces distinct physiological changes within the brain that enhance learning. Thus, if a brain receives repeated stimulation, it develops strengthened neurological pathways enabling faster and more complex processing of information. At the same time, chemical changes within the brain further increase the capacity to process complex information. The

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35 Figure quoted almost verbatim from: Vrooman, M. “An Examination of the Effects of Single-Gender Classes on Reading and Mathematics Achievement Test Scores of Middle School Students.” The University of Oklahoma, March 2009. p. 21. http://gradworks.umi.com/33/71/3371729.html

36 Ibid.
more a brain pathway is used, the faster and more permanently does that synaptic activity happen.\textsuperscript{37}

Dr. William Whalen of Northeastern University brings up further research indicating that boys and girls typically perform better under different circumstances; for example, “boys are wired to be risk-takers [who] covet risk,” while girls “shy away.”\textsuperscript{38} Additionally, while moderate stress may help boys to achieve, this same level of stress will often hinder girls’ performance.\textsuperscript{39} Overall, advocates of single sex classrooms point to the physical differences between male and female brains as a key reason why classrooms should be segregated by gender. 
Advocates argue that “through extended professional development, teachers can learn specific strategies that relate to how boys learn best and girls learn best,” which can ultimately “build [students’] self-esteem, confidence in learning, [and can also] ultimately increase academic achievement.”\textsuperscript{40}

\textbf{STEREOTYPE THREAT}

Math is a subject area that has been traditionally stereotyped as a male domain, and as such, advocates of single sex education argue that female students benefit particularly from single gender schooling in this area. According to a 2010 \textit{Psychological Bulletin} study, children, adolescents, parents, and teachers all demonstrate implicit attitudes about female inferiority in mathematics.\textsuperscript{41} This is particularly concerning due to stereotype threat, or the effect of stereotypes on competency beliefs and self-efficacy, as “correlational research does indeed show that parents’ and teachers’ stereotypes about gender and mathematics predict children’s perceptions of their own abilities.”\textsuperscript{42}

Other negative outcomes of stereotype threat that can affect girls and women in math include:

- Limiting domains of study students wish to pursue;
- Not valuing an area of study; and
- Narrowing students’ career options.\textsuperscript{43}

\textsuperscript{38} Ibid., p. 19.
\textsuperscript{39} Ibid.
\textsuperscript{40} Vrooman, Op. cit., p. 25.
\textsuperscript{42} Ibid.
Moreover, stereotypes can negatively influence actual performance. The *Psychological Bulletin* article brings up an empirical study demonstrating the risk of stereotype threat effects for girls and women in mathematics:

In the standard paradigm, half the participants (talented college students) are told that the math test they are about to take typically shows gender differences (threat condition), and the other half is told that the math test is gender fair and does not show gender differences (control). Studies find that college women underperform compared with men in the threat condition but perform equal to men in the control condition, indicating that priming for gender differences in mathematics indeed impairs girls’ math performance.⁴⁴

Although when there is no stereotype threat present, empirical evidence has suggested that there is no true correlation between gender and mathematics performance, the widespread stereotype effects for girls and women in mathematics have ultimately led to major policy decisions. For example, “schools and states may base decisions to offer single sex mathematics classes on the belief that these gender differences exist.”⁴⁵

**Advocates of single sex classes argue that there will be less stereotype threat for female students if boys are not present,** and thus girls will be able to learn better in a girls-only environment. Therefore, the rest of this subsection examines several research studies exploring female students’ math achievement and other outcomes under single sex classroom conditions.

**SINGLE SEX MATH CLASSROOMS: NO EFFECT OR NEGATIVE EFFECT ON ACHIEVEMENT AND OUTCOMES**

Based upon Hanover’s review of available studies, it appears that the majority of the literature on single sex math classrooms indicates that this type of schooling has no significant effect – and sometimes even has a negative effect – on students’ (including female students’) math achievement and other positive outcomes:

- A 1999 Arizona State University report found that single gender math and science classrooms affect the achievement of girls more than boys, but that “in general, neither can be considered winners.”⁴⁶
- A 2011 study at Georgia Southern University found that both male and female middle school students within coeducational classrooms at an urban school district were more likely to pass the Georgia Criterion-Referenced Competency Tests in mathematics, as compared to their counterparts in single sex classrooms.⁴⁷

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⁴⁵ Ibid.
A 2011 study at the University of Nebraska-Lincoln indicated that gender-specific classrooms did not have a significant effect on seventh grade students’ class participation or attitudes about math.48

A 2012 Northeastern University study examined Joseph Case Junior High School students’ results on the math portion of the Massachusetts Comprehensive Assessment System (MCAS), finding that there was no significant difference in achievement between students in single gender classrooms and those in mixed gender classrooms. There was also no difference between discipline referrals in single gender classrooms as compared to coeducational classrooms.49

A 2013 *Economics of Education Review* study found that the offering of single sex math courses was associated with lower performance on end-of-grade math exams for third through eighth graders in North Carolina public schools.50

A 2013 study at Liberty University used a non-experimental, causal-comparative design to conclude that single gender instruction had no significant impact on South Carolina eighth grade students’ achievement on the Northwest Evaluation Association’s MAP national assessment.51

SINGLE SEX MATH CLASSROOMS: POSITIVE EFFECT ON ACHIEVEMENT AND OUTCOMES

It appears that fewer studies have demonstrated positive effects of single sex math classrooms on students’ (including female students’) achievement and other positive outcomes:

A 1997 study published in *The Elementary School Journal* indicated that seventh and eighth grade girls in single sex pre-algebra and algebra classrooms were more likely to ask and answer questions than their counterparts in coeducational classrooms. The girls also stated that “the girls-only setting enhanced their ability to learn math and their view of themselves as mathematicians.”52

A 1997 study published in *Mathematics Education Research Journal* concluded that single sex math classrooms provided a more supportive environment for girls in secondary schools. However, single sex math classrooms provided a less supportive environment for boys.53


A 2008 South Carolina Department of Education survey given to more than 1,700 students showed that approximately three out of every four students in second grade through ninth grade “agreed that the single gender approach was helping them in school.” Additionally, the “strongest endorsements came from girls,” with “four out of five girls [indicating that] the classes had improved their confidence, independence, and participation, as well as both their desire and ability to succeed.”

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