

## MASTER'S PROGRAM

### Curricula for M.Ed.

#### ENG062 TEXT ANALYSIS AND RESEARCH ESSAY PROGRAM

This is required reading for all M.Ed. students. Read through the reports and highlight key points in **yellow** as you analyze the strategies of teaching. (*Alternatively, you can copy the key points and paste them into a separate file.*) Draw on the findings of applied neuroscience and reflect on how this can be projected into a classroom or teaching/learning setting. After reading each thesis and highlighting key points, send the highlighted thesis (or separate file with the points you gathered) to your tutor by email. Additionally, you will need to write an 80-page (double space, size 12 font) thesis using the key points that support the theme of your thesis.

**Note:** ENG062 reflects personal quality thinking and excellent research skills; this serves as a foundation course before you complete your 80 page analytical thesis. Your thesis will be evaluated and graded by an assigned university mentor.

By - Prof. Anita Dianne Pringle

#### **HOW BOYS AND GIRLS BRAINS DIFFER**

## 2. PREFACE

### 2.1 SUBJECT OF INVESTIGATION

There are biological brain differences that exist between men and women. How these differences develop, how these differences affect the learning process and how teachers can ensure that both genders have the opportunity to learn to their maximum potential in the classroom will be discussed.

#### NEEDS, INTERESTS AND PROBLEMS DETECTED

Education statistics consistently show differences in performance along gender lines. I believe it would be of benefit for teachers to understand why this is the case and what can be done in the classroom to help all students to excel to the best of their ability.

I feel that many students' performance could be enhanced if teachers taught with methods that are compatible with how their brain learns - which is affected by their gender. Both teachers and students would benefit from being aware of how gender effects brain functioning and learning styles. I believe that my research will be of interest to teachers as it will help them understand their students better. I also believe that it will benefit students and their parents as it will help them decide what type of education is best for them.

### 3.1 GENERAL INFORMATION

Even though educational statistics consistently show gender differences most educators are unclear as to why and how the sexes learn differently and what to do to help them.

The research in this report will explain how male and female brain patterns differ. It will also show teachers ways to help both genders maximize their learning potential.

### 3.2 SPECIFICATIONS

Male and female brains are structurally and functionally different. This affects the way they learn. Teachers need to understand these differences and structure their classes to accommodate both males and females.

I would like to establish how males and females differ in their brain structure and functioning. I would also like to establish why it is important for educators to be aware of these differences. I feel that my research explains how these differences develop and how they affect learning styles. I intend to outline teaching methodologies that are effective for each gender and ways that teachers can ensure that their classrooms are gender-friendly.

# **CONTENTS**

Technical Data.....	2
Preface.....	3
Objectives.....	4
Table of Contents.....	5
Introduction.....	6
 <b><u>Section One - A Look In The Brain</u></b>	
<u>Chapter 1 - A Brief Introduction to the Brain</u> .....	7
<u>Chapter 2 - Gender Differences in the Brain</u> .....	9
Structural Differences.....	9
Functional Differences.....	11
Developmental Differences.....	13
<u>Chapter 3 - How Do These Gender Differences Develop?</u> .....	15
Hormones in the Womb.....	15
Hormones at Puberty.....	17
What Does This Mean?.....	19
 <b><u>Section Two - Two Genders, One Classroom</u></b>	
<u>Chapter 4 - A Look in the Classroom</u>	
The Current Situation.....	20
Different Learning Styles.....	22
<u>Chapter 5 - Primary School</u>	
What Boys Need.....	25
What Girls Need.....	28
<u>Chapter 6 - Secondary School</u>	
What Boys Need.....	31
What Girls Need.....	34
<u>Chapter 7 - Single-Sex Schooling</u> .....	36
 <b><u>Conclusions and Recommendations</u></b> .....	40
 <b><u>References</u></b> .....	42

## **INTRODUCTION**

“Gender Difference Found In The Way Boys And Girls Solve Math Problems”<sup>1</sup> “Single-Sex Schools “Better For Teenaged Boys and Girls”<sup>2</sup> “The Silent Gender-Gap”<sup>3</sup> “Physician Pushes Single Sex Schools”<sup>4</sup> “Gender Dominates The School Agenda”<sup>5</sup>

Why do we so often see headlines like these? Are there really biological differences between men’s brains and women’s brains? If there are, then what are they? When do they start to form? Do they affect how children learn, and, if so, how? What implications should this have in the classroom? These are just some of the questions that this thesis aims to answer.

## **SECTION ONE: A LOOK IN THE BRAIN**

### **A Brief Introduction to the Brain**

#### **Chapter 1**

The brain has an estimated 100 billion neurons, or brain cells. Neurons each have a long tail-like attachment called an axon which has many little arms, or dendrites, branching out from it. The gaps between the dendrites are called synapses. The brain communicates with itself by sending chemical messages across the synapses.

The brain is divided into three layers - the stem, the limbic system and the cerebral cortex. The stem is the bottom-most part of the brain and attaches to the spinal cord. It has been called the most primitive part of the brain and is where instincts are processed, such as the reaction to fight or flee from danger. The medulla oblongata is part of the brain stem and contains the nerve center that controls circulation, breathing and digestion.

The limbic system is the middle layer and processes emotion. The amygdala, which controls fear and aggression, and the hippocampus, related to memory storage, are parts of the limbic system. It also includes the thalamus where external information about our environment is processed. The hypothalamus, which regulates blood pressure and body temperature, is also located in this part of the brain. The pituitary gland extends off the hypothalamus and is the “master gland” which controls the endocrine system. The cerebellum is at the base of the limbic system and is responsible for balance and stability as well as helping to co-ordinate motor skills.

The top layer of the brain is the cerebral cortex and it is the largest, most complex part of the human brain. It is responsible for “learning, perception, self-awareness, free will, and the most mysterious of all neuronal functions, consciousness.”<sup>6</sup> It is only about an eighth of an inch

thick but it contains 75% of the brain's neurons. It is extremely wrinkled and if the human brain's cerebral cortex was smooth rather than wrinkled, the brain would have to be about the same size as a basket ball, instead of about the size of two clenched fists held side by side.

The cerebral cortex is divided into two hemispheres, a left and a right. The hemispheres are in turn divided into five lobes - frontal, parietal, occipital, temporal and insular.

Although on the outside they appear symmetrical, the two hemispheres actually specialize in different skills. The right hemisphere controls the left side of the body and processes sensory input from the left side. It also deals with visual and spatial skills; creative, artistic and musical talent; abstract ideas; imagination and intuition.

The left hemisphere deals with the right side of the body as well as specializing in concert mathematics and language abilities. The Wernicke and the Broca area, used in language comprehension and production, are found in the left hemisphere. The left hemisphere also handles the facts, logic, analysis, practicality, order, deductions and linear concepts.

The two hemispheres are connected by the corpus callosum, which is like a cord that runs between them. Spaces in the brain are filled with cerebrospinal fluid which facilitates interaction between brain cells, carries hormones and nutrients to the brain, and helps cushion the brain against impact.

At first glance men and women's brains look the same; they have all the same parts in the same places. However, upon closer examination there are subtle differences in their composition and in the way they are used.

## **Gender Differences in the Brain**

### **Chapter 2**

#### **Structural Differences**

Many differences have been found between the structure of male and female brains. For example, the cerebral cortex is thicker in males on the right side and thicker in females on the left side. This means that the left hemisphere, and its associated functions, is generally more highly developed in women while the right hemisphere, and its associated functions, is generally more highly developed in men. The two hemispheres are more asymmetrical in appearance in men whereas a woman's hemispheres look more identical.

In one blind test on fourteen brains obtained after autopsy scientists found that "in women an important area of the corpus callosum was thicker and more bulbous than in men."<sup>7</sup> This allows for more communication between the left and right hemispheres, allowing more parts of a woman's brain to work together simultaneously.

The hippocampus is larger in women. The amount and speed of neuron transmissions in the hippocampus is also higher in females, which enhances short-term memory storage.

Dr. Godfrey Pearlson did MRI (magnetic resonance imaging) scans of 15 men and 15 women and found that the inferior parietal lobe was larger in men, with men having "roughly 6 percent more inferior parietal lobe tissue than women."<sup>8</sup> This is the part of the brain that is used for judging speed, estimating time and mental rotation tasks. Albert Einstein's inferior parietal lobe was unusually large and post-mortem studies of physicists and mathematicians have shown above average size.

Researcher Sandra Witelson has found that "women's brain cells are about 15 percent

more densely packed than men's in the prefrontal cortex, the portion of the brain located behind the forehead."<sup>9</sup> This is an area responsible for processing language. Another study, commenting on the degree of difference in neuron concentrations between men and women, said, "The differences are so large, and the variance is so small, that there is not even any overlap in the distributions between male and female. The brain tissue of every single woman in this study has a significantly higher concentration of neurons than any man had."<sup>10</sup>

Other differences include a larger amygdala in males, which may account for increased aggression. A study done by Le Vay also found that "the interstitial nuclei of the hypothalamus was twice as large in men" as in women.<sup>11</sup> This is the area that controls sexual behavior.

The thalamus processes information faster in women, especially at certain times of the menstrual cycle. The massa intermedia of the thalamus is "smaller or even entirely absent in males. In one study comparing the massa intermedia in women and men - including only those men who had a massa intermedia - the massa intermedia was, on average, 53% larger in females."<sup>12</sup>

The cerebellum has stronger interconnecting pathways in the female brain, which means more intercommunication.

The parietal lobe is also more highly active in females, with more information moving through it per second. In fact, the female brain in general is more active than the male. Ruben Gur, from the University of Pennsylvania, has done brain imaging tests which "show that the resting female brain is as active as the activated male brain."<sup>13</sup>

There are also differences in hormonal composition. Women obviously have more estrogen and progesterone than men, while men have higher testosterone levels. The effects of

hormones on brain functioning are discussed in more detail later in this report.

There are also differences in certain chemical levels. For example, girls “produce more serotonin” than boys do.<sup>14</sup> Serotonin is a quieting agent.

### Functional Differences

Even the same parts of the brain are used differently by men and women. Men’s brains on a whole seem to be more specialized, while women’s brains seem to be more multipurpose. One researcher summed up his findings by saying that “men are more likely to use a small area of the brain, on just one side, for a particular task; women typically use more of the brain, on both hemispheres, for the same task.”<sup>15</sup>

A good example of this is the brain locations used for language skills. “In a study to see if nonsense words rhymed, women used both sides of their brain while men used only the left side. Both sides did equally well.”<sup>16</sup> Another study involving 38 right-handed people (19 men/19 women) also found that “in males brain activation localized to left inferior frontal gyrus (IFG) regions. In females the pattern of activation is very different, engaging more diffuse neural systems involving both left and right IFG regions” when engaged in letter recognition, rhyming and semantic tasks.<sup>17</sup>

Another example of this is the brain areas used in navigational tasks. Women are more likely to navigate by landmarks, such as “turn left after the Holiday Inn.” Men tend to use distance and direction more, such as “go half a mile and then turn north.” Neuroscientists have found that this is because they use different areas of the brain. “Women use the cerebral cortex - mostly the right parietal cortex - while men do not use the parietal cortex but instead use

primarily the left hippocampus, a nucleus deep inside the brain which is not activated in the women's brains during navigational tasks."<sup>18</sup>

Emotion is also processed in different areas of the brain. Neuroscientists at Harvard University have used MRI scans to examine how emotion is processed in the brain of children between ages 7 to 17. In young children there was no difference in emotional processing. They found that "emotional activity was localized in primitive subcortical areas of the brain, specifically in the amygdala."<sup>19</sup> However, "in adolescence, brain activity associated with emotion moves up to the cerebral cortex.... But that change occurs only in girls. In boys, the locus of emotional control remains stuck in the amygdala."<sup>20</sup>

In math, girls use both hemispheres, including the language centers, hence girls often do math out loud. Boys use only the right hemisphere and rarely talk while they are solving math problems. The same pattern is found in abstract problems with men using the right hemisphere and women using both.

Observing how brain damage affects men and women also helps us to understand where certain functions are located. One researcher found that "males are more affected by damage to the left hemisphere than females are, particularly with respect to language function."<sup>21</sup>

Another study done by Doreen Kimura found that "speech disorders occur most often in women when damage is sustained in the anterior of the brain. In men, they occur more frequently when damage is in the posterior region."<sup>22</sup> She also found that "right hemisphere damage affects spatial ability to the same degree in both sexes, suggesting that women and men rely equally on that hemisphere for certain spatial tasks."<sup>23</sup>

In tests of ability men consistently test out higher than women on certain spatial tasks.

On average men outperform women on tasks requiring them to imagine rotating an object or manipulating it in some way. They also excel at mathematical reasoning tests and navigational tests. Men also perform better than women in hitting targets and predicting and intercepting projectiles.

Women, on the other hand, outperform men in tasks involving word recall or finding words that begin with a specific letter. Women also excel at rapidly identifying and matching items. They generally are better than men at certain precision manual tasks.

### Developmental Differences

There are three different ways to measure the rate of maturation in the brain.

The most obvious way is by comparing the physical structures in a child's brain with those in an adult's brain and measuring how soon the child's brain takes on an adult size and appearance. In MRI scans one group of scientists, Caviness and associates, "found that the brain of the 17-year-old boy looks like the brain of the 11-year-old girl."<sup>24</sup>

The brain's electrophysiological activity also changes as the brain ages. Using EEGs (electro-encephalograms) scientists have found that the electrical activity of an adult's brain is more complex and multimodal than a child's. Anokhin and associates did a sophisticated analysis to see how EEGs change over time and to see when they begin to resemble adult patterns. They "found that the EEG patterns of the 17-year-old boys resemble those of the 11-year-old girls; in other words, using this method, boys are six years behind girls, and the differences between the sexes increased as children got older."<sup>25</sup>

The third way of measuring brain maturation is by the degree of myelination. Myelin is a

waxy material that insulates the axons which neurons use to communicate with each other. At birth the brain has almost no myelin but an adult's brain is full of it. The degree of myelination is easily measured by MRI scans and one study, published in 1994, found "girls' brains were three to four years ahead of the boys' brains from ages 7 - 22; the men did not catch up with the women until age 29."<sup>26</sup>

All this shows that, whichever method is used, girls' brains mature at a much younger age than boys' brains.

## **How Do These Gender Differences Develop?**

### **Chapter 3**

#### **Hormones in the Womb**

The only difference in the first few weeks after conception between male and female embryos is the chromosomes, with girls being XX and boys being XY. The default format for people is female and all embryos develop along female lines until the seventh week after conception. This is when the Y chromosome kicks into action and triggers the mother's ovaries to begin secreting testosterone into the intrauterine environment. This, in turn, causes the undeveloped gonads to form testes. The newly formed testes produce more androgens (male hormones, principally testosterone) which direct the development of the rest of the male reproductive organs. If no androgens are present then fetal development will continue along female lines, with the gonads becoming ovaries.

There is good evidence to show that the "male hormone alters the way in which the brain network is laid down; when it is present, the pattern is male, and when it is absent, the pattern is female."<sup>27</sup> One way of assessing its effect on the prenatal brain is by studying the effect of hormone irregularities in the womb.

Congenital Adrenal Hyperplasia (CAH) is a genetic disorder that causes the adrenal gland to produce abnormally high levels of androgens beginning about the third month of pregnancy. To see what effect, if any, this would have on cognitive abilities a study was done involving 17 females and 8 males with CAH. It was found that "the CAH girls scored significantly higher than their unaffected relatives on three different tests of spatial ability (out of five), thus providing evidence that, for females, prenatal androgen is associated with higher spatial ability.

CAH girls were also more likely to engage in aggressive play, which provides a causal link between prenatal hormones and behavior.”<sup>28</sup> Boys affected by CAH did not display any significant difference from their unaffected relatives.

On the other end of the scale is Androgen Insensitivity Syndrome (AIS). This is another genetic defect that prevents males from responding to androgens in the womb and they continue to develop along female lines as if no androgens were present. One study reported a “significant, but modest, tendency toward verbal rather than space-form abilities.”<sup>29</sup> Since most of these genetic males have external genitals that have formed more along the female lines and were raised as girls and this may also influence the results.

Turner’s Syndrome is a chromosomal defect that affects women. They have only one X chromosome instead of two. As a result the growing fetus does not develop any ovaries which, in a normal female fetus, secret small amounts of testosterone. Thus, girls with Turner’s Syndrome are not exposed to any male hormones at all in the womb and their brains retain an extremely feminine pattern. Studies have found that although women with Turner’s Syndrome “have normal range IQs and verbal abilities, they tend to have specific deficits in visual-spatial functioning.”<sup>30</sup> They have found that girls with Turner’s Syndrome “fall far below the level of normal girls in mathematics and tests for spatial ability and that their sense of direction is very poor.”<sup>31</sup>

Other studies have found that “the extra testosterone circulating in the male fetus before birth...slows down the growth of the left hemisphere, allowing the right hemisphere to develop faster.”<sup>32</sup> Areas where males tend to excel, such as some spatial tasks and abstract mathematical reasoning, are both right hemisphere functions. Males also have the majority of language and

reading problems, which is a left hemisphere skill. Left-handedness, a sign of right hemisphere dominance, is also four times as prevalent among males as females. The opposite patterns are found in females.

All this shows that the presence of testosterone in the womb plays an all-important role in the development of spatial and abstract mathematical abilities in the brain. The higher the prenatal testosterone levels, the more these brain areas are likely to develop, while the lower the testosterone levels the less these abilities are likely to develop.

Research show that the presence of female hormones, namely estrogen and progesterone, also play a role in formatting the brain, although not as much is known about their effects.

One study was done on rats by the Scientific Foundation of Neurology and it found that “estrogen boosts a variety of brain abilities including memory” and that “estrogen’s role in memory may be due to its affect on...dendrites.”<sup>33</sup> The study demonstrated “that doses of estrogen resulted in a two-fold increase in the number of dendrites in a rat embryo’s brain cells compared to those without the supplement of estrogen. The cells were taken from brain areas responsible for memory processes.”<sup>34</sup>

All this shows a definite link between prenatal hormone levels and the initial structuring of the infant’s brain. Even if hormone levels are artificially altered after birth the effect is nowhere near as great as exposure to these hormones in the womb. The format is then set in the biological make up of the brain for the person’s pattern of cognitive abilities, behavioral styles and perceptions.

### Hormones at Puberty

Throughout childhood sex hormone levels are so low that there is no significant

difference between boys and girls. However, at puberty sex hormones surge through the brain and sex differences become more pronounced. The patterns that were set back in the womb are engraved even deeper into the brain.

Increased amounts of testosterone account for increased levels of aggression in boys by increasing the size of the amygdala. Testosterone also increases the brain's ability to concentrate for long periods of time and to resist boredom, fatigue and distraction. It aids the ability to be single-minded. A study that injected adults with extra testosterone or a placebo found that the ones with the extra testosterone "suffered a significantly lower decline in their skills as the day wore on."<sup>35</sup> They had been set the task of doing math subtraction all day.

Testosterone also aids spatial skills although this is not a case of more is better. Studies seem to indicate that there is an optimum level of testosterone for peak spatial performance which "may fall in the low male range."<sup>36</sup> This is based on the fact that "low-testosterone men were superior to high-testosterone men, but high-testosterone women surpassed low-testosterone women" in spatial and mathematical reasoning tests.<sup>37</sup>

Increased estrogen levels increase the size of the hippocampus, the part of the brain used for memory storage. Research also reveals the "the female hormone estrogen prompts nerve cells to grow more connections within the brain and between the two hemispheres."<sup>38</sup> High estrogen also seems to suppress the ability to concentrate for long periods of time.

Women's hormones vary across the menstrual cycle and this has a corresponding effect on their cognitive abilities. Immediately before, during and after menstruation when both estrogen and progesterone levels are low women show "better performances on maps, mazes, and spatial tasks; cognitive tasks on which males typically excel."<sup>39</sup> However, mid-cycle, when

estrogen and progesterone are their highest, women have “better performances on speech articulation, manual dexterity, and verbal fluency; tasks on which females typically excel.”<sup>40</sup>

### What Does This Mean?

Due to this fact that initial brain wiring is so dependent on the levels of prenatal hormones, a person’s brain can be wired anywhere between the two extremes. Some baby boys may be exposed to lower levels of androgens in the womb than others and some baby girls may be exposed to higher levels than average. Thus, some boys may be born with a more feminine brain than average and some girls may have a more masculine brain. Some children have brains that are neither strongly masculine nor feminine, so-called “bridge brains.” In this report I have dealt with the stereotypical male and female brain patterns but teachers must be aware that each student is an individual and may or may not fall into their gender category.

Some girls excel at math while some boys love reading. There are girls who love competitive sports and there are boys who hate confrontation. In a class most children will generally gravitate towards their gender type, but some will always be more masculine or feminine than others in their brain functioning. The goal of this report is to help the teacher to understand the general brain differences and how to build a classroom where both extremes and everything in between are accommodated. So while I mention ways of helping girls excel at math the same methods will help boys who find math difficult. Girls who have difficulty with reading and writing will benefit from the same suggestions as the boys. Some boys will use learning strategies more commonly used by girls and some girls will use the ones more commonly used by boys.

## **SECTION 2: TWO GENDERS, ONE CLASSROOM**

### **A Look in the Classroom**

#### **Chapter 4**

##### The Current Situation

In 1992 The American Association of University Women Educational Foundation published a landmark study entitled “*How Schools Shortchange Girls.*” This report found that “girls and boys enter school roughly equal in measured ability” but that “twelve years later; girls have fallen behind in key areas such as higher-level mathematics and measures of self-esteem.”<sup>41</sup>

One reason cited for this was that “girls receive significantly less attention from classroom teachers” with “boys calling out answers eight times more often than girls.”<sup>42</sup> It noted that “the student-teacher interaction patterns in science class are often particularly biased.”<sup>43</sup>

The AAUW Report also found a “tendency...for educators to choose classroom activities that appeal to boys’ interests and to select presentation formats in which boys excel,” such as “teaching methods that foster competition”<sup>44</sup> instead of cooperative projects and activities which many girls excel at. When it comes to teaching content and materials, the report found that “the contribution and experiences of girls and women are still marginalized or ignored in many of the textbooks used in our nation’s schools.”<sup>45</sup> For example, “of the ten books most frequently assigned in public high school English courses only one was written by a woman.”<sup>46</sup>

The study also points out adolescence “is particularly difficult for girls, who are far more likely to develop eating disorders and experience depression” and that “girls attempt suicide four to five times as often as boys.”<sup>47</sup> These matters are rarely dealt with directly in schools.

With regard to math, the study found that while “differences between girls and boys in

math achievement are small and declining...girls are still less likely than boys to take the most advanced courses and be in the top-scoring math groups.”<sup>48</sup> With respect to science however “the gender gap... is not decreasing and may, in fact, be increasing.”<sup>49</sup> The report put this down to the fact that “even when girls take math and science courses and do well in them, they do not receive the encouragement they need to pursue scientific careers.”<sup>50</sup>

In 1998 Professor Kleinfeld published another report entitled “*The Myth That Schools Shortchange Girls: Social Science in the Service of Deception*” which considers the state of boys in the American school system. This report acknowledged that while “females lag behind in two academic areas: mathematics and science achievement...males lag behind females in two other academic areas and by far wider margins: reading achievement and writing skills.”<sup>51</sup>

Professor Kleinfeld notes that “from grade school through college, females receive higher grades and obtain higher class ranks. They also receive more honors in every field except science and sports.”<sup>52</sup> These are tangible measurements of how girls are doing in school.

Boys are also nearly four times as likely as girls to have learning disabilities or behavioral disorders and end up in special education classes.

With respect to post-secondary education the report pointed out that “in 1995, for example, women won 55% of the bachelor’s degrees and 55% of the master’s degrees” in America.<sup>53</sup>

When it comes to classroom interaction patterns, this study “found no consistent pattern of male or female favoritism appears. Teachers do give more attention to boys but this attention has to do with keeping boys in line. Whether teachers give more academic attention to boys, the kind that might indicate bias, is unclear.”<sup>54</sup> Some teachers might favor boys while others girls,

but no definite bias was observed.

Professor Kleinfield found that loss of self-esteem was not merely a female phenomenon, but that students must be taken as individuals. Just as many boys as girls experience self-esteem problems in adolescence. However, she found that the majority of both boys and girls report high measures of self-esteem in high school.

This report also pointed out that a disproportionate amount of time and resources are spent on programs to encourage girls while issues that concern boys are neglected.

In Britain the Times of London reported “that on national-curriculum tests 14-year-old British boys are, on average, more than three years behind girls in English.”<sup>55</sup>

Another imbalance in the school system has to do with sports, with only 37% of school athletes being girls. On the other hand, girls make up the majority of student government officials, after-school club leaders, and school-community liaisons.

The fact is that in some ways the school system disadvantages boys while in other ways it disadvantages girls. This is due to the fact that boys and girls have differences in brain structures and hormonal influences and therefore have different academic fortes and learning styles and teachers have different teaching styles. In order to prevent these from becoming a hindrance in the learning process it is necessary for teachers to understand how male and female brains differ in their learning styles and preferences.

### Different Learning Styles

One difference is found in reasoning strategy. Boys tend to favor deductive, or top-down, reasoning. They prefer to start with a general principle and then apply it to actual cases. Girls

tend to reason the other way, inductively, or bottom-up. They prefer to begin with the concrete examples and then arrive at the governing principle.

Boys also tend to excel at abstract reasoning while girls prefer concrete reasoning. This is why men tend to excel at engineering and architecture, areas that involve abstract design and math.

Girls tend to use words and talk as they are learning while boys are more likely to learn silently. Boys are more likely to prefer jargon, coded language and abbreviations when explaining something while girls prefer common everyday language.

This preference for codes is found in written material as well, especially in higher grades. Boys like to use symbols, diagrams, graphs and other forms of codes and symbolism while girls do better if it is explained with words.

Girls are generally better at listening, following conversations and retaining large amounts of information that they have heard. Teachers orally explaining something to the class would favor girls. They are more prone to accept what is said whereas boys are more likely to interrupt to ask for clarification or evidence to back something up.

Boys are less able to control boredom than girls are as well as often having a shorter attention span. Once a child is bored learning shuts down and they are more likely to engage in disruptive behavior.

Boys use more space when they are learning than girls do. If you put a girl and a boy at the same table to work, the boy will usually spread his work into the girl's space, not vice versa. Boys literally learn better if they have space to spread their work out. They also need more movement and physical activity. It helps keep their brains stimulated and helps control fidgeting.

Boys and girls also differ in their approach to group work. Girls are more sensitive to those around them while boys will focus on the task to do, insensitive to the others in the group. Cooperative learning comes more naturally to girls and is a style that they prefer. Boys are much more motivated by competitive activities. It is also very important to boys to establish a pecking order in the group while girls are more likely to work together without a definite leader or group hierarchy.

## **Primary School** **Chapter 5**

### **What Boys Need**

In the primary school classroom it is the boys who are more obviously disadvantaged. Some claim that this is because “the schools are too feminine or the overwhelmingly female teachers are unable to meet boys “learning needs effectively.”<sup>56</sup> It is true that about 90% of primary school teachers are women and therefore their teaching style would naturally be more in tune with the female mind.

The main education goals in the early years of primary school are on acquiring reading and writing skills, skills that naturally tend to develop later in boys than in girls. This, combined with the fact that boys are generally more active and have shorter attention spans, means that boys are often labeled as “slow learners,” or as having “hyper-active” or “attention-deficient” disorders or “discipline problems,” and sent to special help classes.

Boredom in class is more of a problem for boys than for girls for two reasons. One is because boys have a shorter attention span than girls. Secondly, once they are bored they have a much harder time controlling it and paying attention anyway, whereas girls are usually better at managing their boredom. One way to help prevent boredom is by adding a physical activity component to the lessons. For example, when learning letter sounds the students could stand up if they hear the letter in a word. There are many games, such as “Simon Says” or “I Spy,” that can be adapted to learning activities.

Hyperactivity is a problem found much more often in boys than girls. This is due to lower levels of serotonin, the chemical that calms. Sixty-second stretch and movement breaks

between lessons can help boys to maintain concentration. For students who are constantly fidgeting and wiggling in their seats some teachers have found that giving them stress balls to occupy their hands helps them to listen better and stops them from distracting the rest of the class. Making a hyperactive boy sit in detention through recess may only make the problem worse. What he needs is a chance to burn off his energy. It would be more effective to make him run a few laps at recess before being allowed to play.

Physical activity is especially important after the age of ten when boys begin producing more testosterone, which can increase aggression. Extended physical activity burns up testosterone.

When teaching reading and writing it is often helpful to use a multi-sensory approach. Jan Miller, a primary school teacher, made letter packets for each child and explained, “We used these to create new vocabulary words for reading a story. Kids became more involved and seemed excited about finding the words in the new story. Each child was given a bright index card to follow along with the reading of the story. This seemed to keep students on track with the story.”<sup>57</sup>

If possible it usually has a positive effect on boys if they can have a male role model for reading, since many boys might see this as a girl’s activity. Teachers may be able to encourage their fathers to read to them at home.

Reading fiction also helps boys to learn to understand others better, to imagine what they are thinking and feeling and to empathize with them. Stories about others can help boys come to a better understanding of themselves and learn how to verbally express themselves.

Teachers can also help boys to develop their verbal skills by doing lots of story telling

and myth making. Activities that encourage them to express themselves verbally help the development of the left hemisphere.

When introducing boys to math “you can stimulate their interest by focusing on the properties of numbers per se.”<sup>58</sup> For example, ask them to imagine all the possible numbers between 1 and 2, i.e. 1.001, 1.002 etc. Then ask them to imagine all the numbers between 2 and 3. There is infinity between each. Then ask the students, “Which is larger? The set of numbers between 1 and 2 or the set between 1 and 3? The numbers between 1 and 3 should obviously be twice as many as between 1 and 2, but how can one infinity be twice as large as infinity?”<sup>59</sup> Most ten-year-old boys will be fascinated by a question like this.

Or ask your students to imagine that they are driving a car at the speed of light. What would happen if they turned on their headlights? This would make a good introduction to the Special Theory of Relativity and most 8-year-old boys will be intrigued.

Boys often find mathematical story problems frustrating and confusing. With regard to story problems one researcher notes, “For boys, embedding the algebra question in a linguistic context makes the problem more difficult. The boy has to use the cerebral cortex to decode the story; then he must translate the question into a format suitable for processing by the hippocampus; and then re-translate the solution back into the format required by the question.”<sup>60</sup>

Boys are also more likely than girls to suffer from a lack of motivation in school. One way of motivating them is to use activities with an element of competition. Putting time limits on activities to present a challenge can also help. If you tell a boy that he has two minutes to do three math questions he will usually rise to the occasion.

Cooperative activities are also helpful to boys as they help them to develop their social

skills. Activities which combine a verbal element with a spatial one are also good since they give them a chance to develop their verbal skills while still doing something that they feel comfortable with.

Teachers also need to be aware of how boys deal with emotional issues. If a boy is angry, or experiencing another strong emotion, he will need cool down time before he can verbalize and think rationally about whatever has happened. There is no point in trying to deal with a boy in the heat of the moment. The teacher would be better off giving the boy some physical activity to do for a few minutes and then discuss the incident with him.

### What Girls Need

Less obvious is how the primary school classroom disadvantages girls. Girls excel in reading and writing skills and generally do very well in primary school. However, when they get to the higher grades where spatial skills become more important many girls begin to flounder. A lot of attention has been given as to how to help girls excel in advanced math and sciences in the higher grades but the real time to help them develop their spatial skills is in primary school, when the brain is more flexible. One researcher observed that while teachers and parents insist that boys overcome whatever difficulties they may have with reading and writing at an early age, and give them whatever extra help this may require, there is “no such insistence to induce the female to learn about spatial-mechanical relationships. Thus the male overcomes his initial handicap at school, but by the time certain spatial skills are required by the curriculum, the female may be too old to acquire them.”<sup>61</sup> Thus the North Central Regional Educational Laboratory, in their report “*Pathways to School Improvement*,” recommends “introducing higher level math in primary school and using specific terms” as well as “encouraging girls to take higher level math courses

beginning in the seventh grade.”<sup>62</sup>

It often helps girls to master math better if the thought process is externalized. Jill Lamming, a teacher at Spring Branch Elementary School in the USA explains, “I have found that talking through strategies and outlining processes on a chart or overhead as we go helps girls to better visualize and work through what might seem second nature to boys. Diagramming information has also proven to be a useful visual tool for girls.”<sup>63</sup> This brings math out of the abstract realm and makes it more tangible and concrete.

When introducing girls to algebra, story problems are a good way to teach it. Putting the question in story format helps girls to understand it better as well as making it more interesting and relevant. It helps them see the practical side of algebra.

Using real objects and manipulatives also helps girls get a better understanding of math concepts. For example, when studying about money each child could be given real coins to work with.

Using a hands-on approach in science also helps girls understand the concepts involved. When studying about simple machines Jan Miller, a third grade teacher, says, “I actually brought in all types of simple machines for them to manipulate. I brought in materials for a lever, a fulcrum, and a load, and they had to create how to move the load, what made it easier or harder, what worked and what didn’t.”<sup>64</sup>

Girls should be encouraged to explore machines and find out how things work. Old radios, toasters, and clocks can be dismantled and, depending on the age of the students, put back together again. If a written record is kept of where the parts came from this combines a spatial activity with a verbal one and is good for the girls as well as the boys.

Especially in the second half of primary school girls should be encouraged to use computers. Teachers should pay attention that girls get their fair share of time on the computers and that the boys don't take over.

Girls also enjoy variety in the teaching process. A combination of pair work, group work, peer tutoring, class discussions and debates, and role-plays appeal to most girls. When doing group work however, Debbie Abilock, a primary school librarian, recommends that "assigning specific roles for members of cooperative groups mitigates against stereotypical behaviors - a girl doesn't always become the group's "Recorder" or "Timekeeper" and a boy doesn't always dominate the keyboard and mouse."<sup>65</sup>

While boys and girls both need encouragement, girls are more likely to just watch everyone else participate instead of getting involved themselves unless they are encouraged to do so. Teachers should make a conscious effort to call on every student every day. Some teachers try to alternate girls and boys.

Girls have less self-confidence when it comes to risk-taking so teacher support is vital. Girls also feel more confident to express themselves and take risks in smaller groups rather than in front of the whole class.

Competitive activities also benefit girls since competition stimulates the brain and teaches girls how to compete, a skill that is needed as they grow up.

Schools should also make sure that attention is given to the achievements of girls in school assemblies. Along with praising the school's football team mention should be made of the extra-curricular activities that girls are involved in. School newspapers should also carry stories about women and girls in the school and community.

## Secondary School Chapter 6

### What Boys Need

The needs of boys in secondary school are not an area that has received much attention. As Professor Judith Kleinfield put it, “Teachers are concentrating on the problems of girls, but they are dismissing the problems of boys.”<sup>66</sup> Considering that boys have a much higher dropout rate and are less likely to go on to university than girls something clearly should be done.

Boys who don’t master reading in primary school run into serious problems in high school. Their self-esteem suffers and they are at a high risk of dropping out of school altogether.

One teacher who teaches remedial reading classes in high school finds that “boys learn better if hands-on activities become part of the literary lesson.”<sup>67</sup> For example, she may combine a reading activity with a geographical one. In one activity she got her students to make large cardboard maps of the continents complete with papier-mache mountains and then had the students to do research and write up little reports on different aspects of their continent.

With some students it may be helpful to start over at the beginning and try to give them a foundation in phonetics and why words are written the way they are. When they were first introduced to phonetics in the first and second grade their brains may not have been developed enough to grasp the relationship between sounds and symbols. One student who did a phonetics based reading program in tenth and eleventh grade improved from a second grade reading level to being able to read novels for pleasure. He says, “I always knew there must be some kind of secret to reading, but nobody ever taught me the code.”<sup>68</sup>

Mentoring can also be very successful in helping poor readers improve. Having older,

capable boys work with younger ones helps create a more positive impression of reading as something that males also do.

Teachers should also review their required reading novels and the supply of books in the school library to ensure that there are books that will appeal to boys. Non-fiction and historical books, such as autobiographies of soldiers or explorers, often appeal to boys. Books with lots of action, humor or fantasy can also stimulate a boy's imagination and keep them interested.

Teachers can help boys to appreciate that different types of reading material, such as comics, magazines, newspapers, and websites all constitute reading practice.

When doing writing assignments, it may be helpful to offer boys a choice of different writing formats to choose from for the task. Teachers should also provide boys with oral feedback on their writing process, not just written comments on the finished product. Geoff Hannan, a leading expert in the field of boys' education, suggests a way of helping boys organize their thoughts known as his "Go for 5" technique. Boys are encouraged to look for five examples to support a theory, find five reasons for something happening, plan five steps in an experiment, or list five objects in a theme. This is useful because "boys tend to find it more difficult to break up a task into steps, and need to be helped to consider alternatives to their first thought or idea."<sup>69</sup> It "encourages them to use reflective thinking more and broaden their outlook."<sup>70</sup> When boys use this approach the quality of their essays and other written work greatly improves.

The National Literacy Trust in the UK offers some suggestions on how to help boys who are underachieving. They recommend "sitting under-achievers with high-achievers."<sup>71</sup> This not only challenges the high-achievers to explain the problem to their partner but also gives the under-achievers the chance to hear a second explanation from a peer on their own language level.

They also recommend that teachers “offer clear targets for each lesson and organize tasks step by step.”<sup>72</sup> Many boys do not cope well with long explanations and vague instructions. When teachers focus on meeting the challenges of the assignment rather than simply on its completion as the goal of the exercise more boys will be motivated to do it.

Homework assignments should be used as a way of extending and enriching the classroom work. To encourage boys to complete their homework the assignments should be focused and brief. If teachers also promptly collect, mark and return homework assignments boys will be more motivated to complete them.

Boys generally feel more secure in a scheduled environment with definite boundaries. Having a good classroom routine with consistent standards and discipline makes boys feel more comfortable and more able to concentrate on learning. It also increases their respect for the teacher.

Just as the boys are much more prone to be at the bottom of the heap when it comes to reading ability, they are also more prone to be at the top of the heap when it comes to mathematical ability. Most students who complain of boredom in math class are boys and often nothing is done to stimulate them. Schools should ensure that they offer advanced classes that challenge their gifted students just as they offer remedial classes to help slower students.

A comprehensive sports program in the school is also beneficial for boys. Physical activity helps them regulate testosterone and to work off frustration. Sports also help to build character and self-worth. It has been found that boys who are involved in sports are also “more likely to get better grades and to go to college.”<sup>73</sup>

## What Girls Need

In recent years a lot of emphasis has been placed on helping girls to excel in math and science. For example, the North Central Regional Educational Laboratory's report "Pathways to School Improvement" made several suggestions on how to make math more female friendly. These included such things as using "questions and comments to encourage girls' thinking skills and talk with girls about ideas and concepts."<sup>74</sup> Teachers should also ensure that they "call on boys and girls equally and provide equal time to girls" instead of letting a few dominant boys take the spotlight.<sup>75</sup> Teachers need to "be attentive to girls' requests for help and arrange tutorials" as well as "discuss math anxiety with girls who are having problems."<sup>76</sup> This report also encouraged teachers to "make independent and small group mathematics available to all, to encourage girls to participate in such experiences and to design math activities which are fun, relaxed and collaborative."<sup>77</sup>

Other research has also found it effective to "increase the aural quality of math teaching - in other words, putting math on the blackboard or on paper but also talking math with girls. "Talking it" uses more verbals and relies less on the single-sense visual blackboard teaching strategy."<sup>78</sup> All these suggestions can also be applied in science.

Suggestions and programs such as these have resulted in a dramatic reduction in the gender gap and "girls now take as much math and science in high school as boys and test nearly at par."<sup>79</sup> The only significant gender difference in math and science that still exists is in the highest and most abstract forms, such as advanced algebra, calculus and physics. This is due, in part, to the fact that boys have a more highly developed right hemisphere, which specializes in the abstract.

Another area where girls may be easily pushed aside is technology. As one researcher noted, “some [girls] simply do not gravitate toward the spatial stimulant of the computer screen as vehemently as a male does.”<sup>80</sup> Teachers need to offer plenty of encouragement to girls to take technology classes. They need to make sure that girls get their fair share of time on the computers if there are not enough for each student to have one. Extra tutorials may be necessary to help boost girls’ confidence. Pair work is a good way to give girls a chance to talk through what they are learning and help each other. Care should be taken though that one partner doesn’t just do everything, leaving the other one to simply watch.

Schools should also provide positive female role models and school counselors. Girls should know that there is someone for them to talk to if they are experiencing problems or harassment at school.

Career counseling is also essential to make girls aware of their options. This should start at the beginning of high school so that girls can begin forming ideas and plan their courses accordingly.

## **Single Sex Schooling**

### **Chapter 7**

What about single sex schooling? This has traditionally been opposed in the name of equality, with feminist groups claiming that segregation would lead to discrimination.

However, since “boys’ and girls’ brains mature at different rates and in different ways, and learn best using different relational and teaching methods,” separate sex education only seems logical.<sup>81</sup>

Dr. Leonard Sax, of the National Association for the Advancement of Single Sex Public Education, points to the fact that in the early years of schooling “there is striking and undisputed evidence that boys develop much more slowly than girls. For example, a 4-year-old girl’s brain looks similar to a 6-year-old boy’s brain.”<sup>82</sup> He believes that one of the causes of the large increase in behavioral disorders and Ritalin prescriptions among young boys “could be the accelerated curriculum now promoted in kindergarten, which some boys cannot handle because of different development rates.”<sup>83</sup> They suffer from brain overload which causes stress and frustration. This further impedes learning and increases disruptive behavior.

In single sex classrooms the whole teaching method is geared towards styles that are compatible with the male or female brain. This is especially true in the areas of mathematics, science and language arts. The teacher can select reading material that the students will enjoy. Very few boys enjoy reading “*Jane Eyre*” while most girls can’t understand why “*The Lord of the Flies*” is considered literature. Science and mathematics can also either be presented in a practical, relevant way with lots of verbalization, or it can be presented in a theoretical, analytical way with lots of formulas and examples on the blackboard. The teacher’s expectations take brain

patterns and development rates into account.

At a high school level single sex education plays another role as well. Besides allowing teaching methods to be tailored to a specific gender it removes classroom tension resulting from trying to impress or being intimidated by the opposite sex. Providence University professor of sociology Cornelius Riordan observes that “coed schools are not about academics. Kids at a coed school are concerned first and foremost with where they stand in the adolescent society.”<sup>84</sup>

Many teachers report much less classroom disruption and more concentration on the lessons at hand in single sex classrooms. Ileana Garcia, a tenth grade student in the United States who transferred to an all-girls school, says that she finds that “it’s more relaxed, and there’s less distractions during class and less worry about how you look.”<sup>85</sup> Boys as well can find the presence of girls in the classroom extremely distracting.

Some studies claim that self-esteem is higher in single sex schools. This is especially true in the case of girls. One study found that in coed schools “the most important factor in determining a girl’s self-esteem was her appearance: if a girl thought she was pretty then her self-esteem was high. If she didn’t think she was pretty, then her self-esteem was in the dirt.”<sup>86</sup> On the other hand, in single sex schools self-esteem was made up of a more complex mix of factors. It included “school performance, social experience, family income, as well as personal appearance.”<sup>87</sup> Boys in coed school as well often find their self-esteem more dependent on their success with girls than boys in single sex schools.

Students in single sex schools also benefit from a more diverse set of role models. All the top achievers in every subject are their sex; hence younger students see that it is socially acceptable to strive in that direction. They have a less stereotypical view of subjects than those

in coed schools.

Ruth Whertvine, who teaches at Anderson Alternative Middle School in Kanas City, says, “This year our school separated girls into classes by themselves. It has helped the girls to concentrate. They seem more focused.”<sup>88</sup> Another teacher at Smith-Hale High School notes with respect to boys, “They help each other out more. Boys work better when they’re with just boys, there are more conflicts when the genders are mixed. When girls do come in the class becomes totally different.”<sup>89</sup> Students do better when they work with others who instinctively understand them.

Students in single sex schools also do better statistically than those in co-ed schools. Girls in all-girl classes average higher test scores in math and science and take more math and science courses than girls in co-ed schools. In a six year study of test score data for 270,000 Australian students found “that boys and girls in single-sex schools scored, on average, 15 to 22 percentile points higher than peers in coeducational settings.”<sup>90</sup>

They are also more likely to go on to university.

Some claim that these advances are due to more dedicated teachers and smaller class sizes in many single sex schools. However, a study done by the British Office for Standards in Education “found that superior performance by students in single sex schools results directly from single sex education rather than socioeconomic factors.”<sup>91</sup>

One of the greatest criticisms of single sex schooling is that students “will not be prepared for a co-ed world” and will miss out on developing important social skills.<sup>92</sup>

Headmistress Anne Dyer of Stone Ridge School, a girls’ school, agrees that “children should have exposure to the opposite sex and encourages the students to have outside activities, which

give them the opportunity to meet boys.”<sup>93</sup>

Dr. Leonard Sax recommends a practical way of accomplishing this. He recommends, “Single sex classes in coeducational schools are the cheapest way to get it done. For example, boys would attend math classes in the morning and girls would attend in the afternoon. Training for teachers in different teaching methods for girls and boys would be relatively easy.”<sup>94</sup>

Not only would this method reduce the cost of providing single sex classes but it would also provide opportunity for socialization between the sexes while still providing a single sex learning environment.

Not all students would like to be in a single sex school and many excel in a co-educational environment. So it is up to each student and their parents to decide what is best for them. However, they should have the option.

## **CONCLUSIONS AND RECOMMENDATIONS**

I feel that my research here has conclusively proved that there really are differences between the biological structure and functioning of men's and women's brains. These differences, which are triggered by hormone levels, start in the womb and continue to develop as the child grows to adulthood.

Gender differences in the brain have a definite effect on interests, learning styles and behavior. Almost all school statistics show differences in performance and achievement along gender lines. My research has shown that schools, while they may not be the cause of these differences, still have an important role to play in making sure that both boys and girls have the opportunity to reach their full academic potential.

I feel that it is important that teachers be educated about gender differences and how they affect learning and classroom behavior. I think that schools would benefit by organizing day seminars and booklets for their teachers since very few teachers have received any specific information about brain and gender differences. If teachers and students were aware of how gender affects brain functioning and learning, both teachers and students would understand themselves and each other better. This would reduce misunderstandings and frustrations in the classroom.

In my report I have suggested practical ways of dealing with gender differences in the classroom. These approaches show ways of making subjects such as math, science, and language compatible with the male or female learning style.

I would also recommend that schools consider the possibility of single sex classes, especially for higher level math, sciences and language. I think parents and students should have

the option of single sex schooling if they prefer it.

I feel that in the future awareness of gender differences in brain functioning and learning styles will become more widely known and accepted. However, in the meantime I intend to use my research in my own teaching. I also intend to promote gender awareness in education because I feel that if subjects are taught in a gender-compatible way, the number of students who do well at school and who enjoy school will increase.

## REFERENCES

- 
1. APA News Release  
[www.apa.org](http://www.apa.org)
  2. The Age, Karen Kissane, 23/06/01  
[www.theage.com.au](http://www.theage.com.au)
  3. Education Week - on the web, Cornelius Riordan, 17/11/99  
[www.edweek.org](http://www.edweek.org)
  4. Gazette.Net, Ellen Shiau, Feb. 20, 2002  
[www.gazette.net](http://www.gazette.net)
  5. Guardian Unlimited, David Williams, May 18 2002  
[www.education.guardian.co.uk](http://www.education.guardian.co.uk)
  4. Robert E. Kingsley, "Concise Text of Neuroscience," Lippincott, Williams & Wilkins, 2000,  
page 525
  7. Anne Moir & David Jessel, "Brain Sex - The Real Difference Between Men & Women,"  
1989, Dell Publishing, page 47
  8. Science Daily, "It's Not Just Einstein: Study Shows Difference In Male Brain," 12/10/99  
[www.sciencedaily.com](http://www.sciencedaily.com)
  9. C.Health, "'Women's brains' more densely packed in 'executive' portion of brain," Helen  
Branswell, November 16, 2001  
[www.canoe.ca](http://www.canoe.ca)
  10. National Association for Single Sex Education  
[www.singlesexeducation.com](http://www.singlesexeducation.com)
  11. W. Rogers & R. Rogers, "The Psychology of Gender & Sexuality," Open University Press,  
2001, page 26, 27
  12. National Association for Single Sex Education  
[www.singlesexeducation.com](http://www.singlesexeducation.com)
  13. Michael Gurian, "Boys and Girls Learn Differently," 2001, Jossey-Bass, page 29
  14. Michael Gurian, "Boys and Girls Learn Differently," 2001, Jossey-Bass, page 34

- 
15. National Association for Single Sex Education  
[www.singlesexeducation.com](http://www.singlesexeducation.com)
  16. Brain Briefings, "Gender and The Brain," 08/98  
[www.sfn.org](http://www.sfn.org)
  17. The Talking Pages, Literacy Organization, Research Information, "Sex Differences in the Functional Organization of the Brain for Languages" 1995  
[www.talkingpage.org](http://www.talkingpage.org)
  18. National Association for Single Sex Education  
[www.singlesexeducation.com](http://www.singlesexeducation.com)
  19. National Association for Single Sex Education  
[www.singlesexeducation.com](http://www.singlesexeducation.com)
  20. National Association for Single Sex Education  
[www.singlesexeducation.com](http://www.singlesexeducation.com)
  21. Anonymous Report  
[www.psych.uiuc.edu](http://www.psych.uiuc.edu)
  22. Doreen Kimura, "Sex Differences in the Brain," Scientific American, June 2002, page 8
  23. Doreen Kimura, "Sex Differences in the Brain," Scientific American, June 2002, page 8
  24. National Association for Single Sex Education  
[www.singlesexeducation.com](http://www.singlesexeducation.com)
  25. National Association for Single Sex Education  
[www.singlesexeducation.com](http://www.singlesexeducation.com)
  26. National Association for Single Sex Education  
[www.singlesexeducation.com](http://www.singlesexeducation.com)
  27. Anne Moir & David Jessel, "Brain Sex - The Real Difference Between Men & Women," 1989, Dell Publishing, page 27
  28. Diane F. Halpern, "Sex Differences In Cognitive Abilities," 1992, Lawrence Erlbaum Associates, Inc., page 115, 116
  29. Diane F. Halpern, "Sex Differences In Cognitive Abilities," 1992, Lawrence Erlbaum Associates, Inc., page 116

- 
30. Diane F. Halpern, "Sex Differences In Cognitive Abilities," 1992, Lawrence Erlbaum Associates, Inc., page 116
  31. Anne Moir & David Jessel, "Brain Sex - The Real Difference Between Men & Women," 1989, Dell Publishing, page 32
  32. Wendy Stainton Rogers and Rex Stainton Rogers, "The Psychology of Gender and Sexuality," 2001, Open University Press, page 27
  33. Science Foundation of Neurology  
[www.sfn.org](http://www.sfn.org)
  34. Science Foundation of Neurology  
[www.sfn.org](http://www.sfn.org)
  35. Anne Moir & David Jessel, "Brain Sex - The Real Difference Between Men & Women," 1989, Dell Publishing, page 97
  36. Doreen Kimura, "Sex Differences in the Brain," Scientific American, Sept 1992, page 7
  37. Doreen Kimura, "Sex Differences in the Brain," Scientific American, Sept 1992, page 7
  38. Allan & Barbara Pease, "Why Men Don't Listen & Women Can't Read Maps," Pease Training International, 1998, page 57
  39. Diane F. Halpern, "Sex Differences In Cognitive Abilities," 1992, Lawrence Erlbaum Associates, Inc., page 131
  40. Diane F. Halpern, "Sex Differences In Cognitive Abilities," 1992, Lawrence Erlbaum Associates, Inc., page 131
  41. American Association of University Women Education Foundation, "How Schools Shortchange Girls - Executive Summary," 1992, page 1
  42. American Association of University Women Education Foundation, "How Schools Shortchange Girls - Executive Summary," 1992, page 2
  43. American Association of University Women Education Foundation, "How Schools Shortchange Girls - Executive Summary," 1992, page 2
  44. American Association of University Women Education Foundation, "How Schools Shortchange Girls - Executive Summary," 1992, page 2

- 
45. American Association of University Women Education Foundation, "How Schools Shortchange Girls - Executive Summary," 1992, page 3
  46. American Association of University Women Education Foundation, "How Schools Shortchange Girls - Executive Summary," 1992, page 3
  47. American Association of University Women Education Foundation, "How Schools Shortchange Girls - Executive Summary," 1992, page 3
  48. American Association of University Women Education Foundation, "How Schools Shortchange Girls - Executive Summary," 1992, page 4
  49. American Association of University Women Education Foundation, "How Schools Shortchange Girls - Executive Summary," 1992, page 4
  50. American Association of University Women Education Foundation, "How Schools Shortchange Girls - Executive Summary," 1992, page 4
  51. Judith Kleinfield, "The Myth That Schools Shortchange Girls: Social Science in the Service of Deception," 1998, page 1
  52. Judith Kleinfield, "The Myth That Schools Shortchange Girls: Social Science in the Service of Deception," 1998, page 3
  53. Judith Kleinfield, "The Myth That Schools Shortchange Girls: Social Science in the Service of Deception," 1998, page 11
  54. Judith Kleinfield, "The Myth That Schools Shortchange Girls: Social Science in the Service of Deception," 1998, page 18
  55. Christina Hoff Sommers, "Where the Boys Are," Education Week, 6/12/96
  56. Judith Kleinfield, "The Myth That Schools Shortchange Girls: Social Science in the Service of Deception," 1998, page 3
  57. Michael Gurian, "Boys and Girls Learn Differently," 2001, Jossey-Bass, page 177
  58. National Association for Single Sex Education  
[www.singlesexeducation.com](http://www.singlesexeducation.com)
  59. National Association for Single Sex Education  
[www.singlesexeducation.com](http://www.singlesexeducation.com)
  60. National Association for Single Sex Education

---

[www.singlesexeducation.com](http://www.singlesexeducation.com)

61. Anne Moir & David Jessel, "Brain Sex - The Real Difference Between Men & Women," 1989, Dell Publishing, page 185
62. North Central Regional Educational Laboratory, "Pathways to School Improvements" [www.ncrel.org](http://www.ncrel.org)
63. Michael Gurian, "Boys and Girls Learn Differently," 2001, Jossey-Bass, page 181
64. Michael Gurian, "Boys and Girls Learn Differently," 2001, Jossey-Bass, page 183
65. Debbie Abilock, "Sex in the Library: How Gender Differences Should Affect Practices and Programs," Nueva Library Program, 1997 [www.nuevaschool.org](http://www.nuevaschool.org)
66. Judith Kleinfield, "The Myth That Schools Shortchange Girls: Social Science in the Service of Deception," 1998, page 26
67. Michael Gurian, "Boys and Girls Learn Differently," 2001, Jossey-Bass, page 299
68. Michael Gurian, "Boys and Girls Learn Differently," 2001, Jossey-Bass, page 301
69. Rupert Kirby, "Underachievement In Boys," 2000 [www.practicalparent.org.uk](http://www.practicalparent.org.uk)
70. Rupert Kirby, "Underachievement In Boys," 2000 [www.practicalparent.org.uk](http://www.practicalparent.org.uk)
71. Jenny Grubb, "Research Briefing on Boys and Underachievement from the TES," June 2001, The National Literacy Trust, [www.literacytrust.org.uk](http://www.literacytrust.org.uk)
72. Jenny Grubb, "Research Briefing on Boys and Underachievement from the TES," June 2001, The National Literacy Trust, [www.literacytrust.org.uk](http://www.literacytrust.org.uk)
73. Michael Gurian, "Boys and Girls Learn Differently," 2001, Jossey-Bass, page 38
74. North Central Regional Educational Laboratory, Pathways to School Improvements [www.ncrel.org](http://www.ncrel.org)
75. North Central Regional Educational Laboratory, Pathways to School Improvements [www.ncrel.org](http://www.ncrel.org)

- 
76. North Central Regional Educational Laboratory, Pathways to School Improvements  
[www.ncrel.org](http://www.ncrel.org)
  77. North Central Regional Educational Laboratory, Pathways to School Improvements  
[www.ncrel.org](http://www.ncrel.org)
  78. Michael Gurian, "Boys and Girls Learn Differently," 2001, Jossey-Bass, page 295
  79. Michael Gurian, "Boys and Girls Learn Differently," 2001, Jossey-Bass, page 295
  80. Michael Gurian, "Boys and Girls Learn Differently," 2001, Jossey-Bass, page 296
  81. Ellen Shiau, "Physician Pushes Single Sex Schools," The Gazette, Feb. 20, 2002
  82. Ellen Shiau, "Physician Pushes Single Sex Schools," The Gazette, Feb. 20, 2002
  83. Ellen Shiau, "Physician Pushes Single Sex Schools," The Gazette, Feb. 20, 2002
  84. National Association for Single Sex Education  
[www.singlesexeducation.com](http://www.singlesexeducation.com)
  85. Debra Viadero, "Evidence on Single-Sex Schooling Is Mixed," Education Week, 6/12/02  
[www.edweek.org](http://www.edweek.org)
  86. National Association for Single Sex Education  
[www.singlesexeducation.com](http://www.singlesexeducation.com)
  87. National Association for Single Sex Education  
[www.singlesexeducation.com](http://www.singlesexeducation.com)
  88. Michael Gurian, "Boys and Girls Learn Differently," 2001, Jossey-Bass, page 210
  89. Michael Gurian, "Boys and Girls Learn Differently," 2001, Jossey-Bass, page 210
  90. Debra Viadero, "Evidence on Single-Sex Schooling Is Mixed," Education Week, 6/12/02  
[www.edweek.org](http://www.edweek.org)
  91. Ellen Shiau, "Physician Pushes Single Sex Schools," The Gazette, Feb. 20, 2002
  92. Ellen Shiau, "Physician Pushes Single Sex Schools," The Gazette, Feb. 20, 2002
  93. Ellen Shiau, "Physician Pushes Single Sex Schools," The Gazette, Feb. 20, 2002
  94. Ellen Shiau, "Physician Pushes Single Sex Schools," The Gazette, Feb. 20, 2002