

The Efficacy of Single-Sex Education: Testing for Selection and Peer Quality Effects

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Received: 1 April 2010 / Accepted: 25 November 2010 / Published online: 16 January 2011
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Abstract To address selection and peer quality effects in tests of the efficacy of single-sex schools, the achievement of girls attending a public single-sex middle school in the Southwest United States ($N=121$) was compared to that of (a) girls who applied but were not admitted to the same school ($N=229$) and (b) girls who applied to and attended a coeducational magnet school ($N=134$). Achievement scores were collected over 3 years for the ethnically diverse participants (41 African Americans, 27 Asian Americans, 163 European Americans, 251 Latinos, and two Native Americans). After controlling for selection and peer quality effects, there was no significant effect of the gender composition of schools on achievement. Implications for educational policy are discussed.

Keywords Single-sex education · Academic achievement · Gender · Peer quality · Selection effects

Introduction

The number of single-sex schools and classrooms in the United States has increased dramatically in recent years. As part of the No Child Left Behind Act, Congress amended Title IX regulations in 2006, easing the restrictions on sex-segregated education. Specifically, the act approved federal

funding for innovative education programs, including single-sex schools and single-sex programs within existing coeducational schools. According to the National Association for Single-Sex Public Education, there are currently 92 single-sex public schools and 448 coeducational public schools that offer single-sex classes in the United States (NASSPE 2009), and that number is expected to increase during the next decade (Salomone 2006). Although single-sex schooling is making something of a comeback in the U.S., it has been common in many parts of the world for decades (e.g., Australia, Great Britain, New Zealand). Thus, research on single-sex schooling has relevance worldwide, despite obvious limits to the generalizability of findings across cultures.

As single-sex educational contexts become increasingly common in American public schools, it is important that scholars carefully examine and weigh the costs and benefits of separating students on the basis of gender. The Supreme Court has stated that actors must give “exceedingly persuasive” justification when drawing distinctions on the basis of sex in education (see *United States v. Virginia* 1996). Additionally, the No Child Left Behind Act called for “scientifically based research” to guide education practices and programs such as the creation of single-sex classrooms and schools (U.S. Department of Education 2003). It is not clear, however, that such persuasive scientific evidence in favor of single-sex education exists. Reviews of the empirical literature on the outcomes of single-sex schooling report that evidence for their efficacy is mixed (Bracey 2006; Haag 1998; Mael et al. 2005). Furthermore, nearly all reviews cite design flaws, especially the possible presence of selection effects, as significantly hindering the interpretation of existing studies (Bracey 2006; Campbell and Wahl 1998; Marsh 1989; Mael et al. 2005; Salomone 2006). Indeed, the possible presence of

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selection effects is a limitation of single-sex schooling research conducted around the world. As a consequence, it is impossible to disentangle effects of single-sex schooling per se (i.e., sex composition of schools) from effects caused by other student and school related variables (e.g., teacher quality, students' economic backgrounds).

The primary purpose of the present study was to examine the efficacy of single-sex schooling in the United States using a design that allowed for tests of selection and peer quality effects. Although single-sex schooling has been hypothesized to affect several attitudinal and behavioral outcomes (e.g., self-esteem, interests), we focused here on academic achievement, using a statewide, standardized test of academic skills. Specifically, we obtained standardized achievement scores and school characteristics from three groups of students: (1) girls attending a public single-sex middle school, (2) girls who applied to the same public single-sex school but were rejected and therefore subsequently attended public coeducational middle schools, and (3) girls attending a public magnet, coeducational middle school.

Perspectives on Single-Sex Education: Overview

There is strong disagreement in the U.S. and abroad concerning the issue of single-sex schools. Some individuals believe such schools enhance educational outcomes, whereas others believe such schools produce detrimental outcomes, or outcomes that are indistinguishable from those of coeducational schooling. Furthermore, both the proponents and opponents of single-sex schooling draw on diverse sets of arguments to support their position.

Proponents of Single-Sex Education

A host of differing rationales for single-sex education have been proposed (see Bracey 2006). Some proponents argue that single-sex education is beneficial for girls because teachers' and peers' sexist attitudes and behaviors interfere with girls' learning in coeducational environments (Sadker and Sadker 1994). They note, for example, that boys tend to seek out and receive the majority of teacher attention in coeducational classes, especially in stereotypically masculine subjects such as mathematics and science (Lee et al. 1994). Furthermore, because boys endorse cultural gender stereotypes to a greater degree than girls (Blakemore et al. 2009), classrooms that do not include males are thought to be more supportive of girls' academic achievement in counter-stereotypic domains such as math and science than classrooms that include males (Shapka and Keating 2003).

A second rationale for single-sex schools is based on the belief that there are substantial, important, and biologically-based differences between the genders and that educational

instruction is more effective when it is tailored to these differences (see Gurian et al. 2001). That is, these proponents argue that single-sex education is more effective than its coeducational counterpart when classrooms are composed of a single sex and instruction is based on that sex's learning styles and propensities. So, for example, Sax (2005) argued that teachers in single-sex classrooms are most effective when they take into account sex differences in hearing by talking more loudly to all-male classrooms than all-female classrooms.

Opponents of Single-Sex Education

As is true of proponents, those individuals who argue against single-sex schools draw on diverse arguments. Some critics argue that the sex differences on education-relevant traits are trivially small (i.e., the distributions for males and females are highly overlapping) and thus the creation of classrooms that tailor to such differences are likely to produce benefits among only a small segment of the population, if they have any impact at all (Bracey 2006; Hyde 2005).

Other educators and researchers who oppose single-sex education argue that such schools are harmful because they reduce opportunities for cross-group contact, just as do schools segregated by race or socioeconomic status (Balkin 2002; Campbell and Wahl 1998). That is, these critics argue that coeducational environments are beneficial because they typically (although not always) promote tolerance and cooperation across genders, thereby reducing gender discrepancies in academic attitudes and behaviors (Elliot 2009; Rustad and Woods 2004).

Evaluating the Efficacy of Single-Sex Education

There are over 2000 empirical studies that are related in some way to the debate about the efficacy of single-sex schooling (Bracey 2006). Several major reviews of the literature on the efficacy of single-sex schools have been published. The American Association of University Women released a report in 1998 that reviewed more than 100 articles and essays on the efficacy of single-sex education (Morse 1998). The contributors to the report unanimously concluded that evidence for effects of gender composition of schools or classrooms is inconclusive. A few years later, in 2005, the American Institutes for Research prepared an extensive and systematic review of the literature on single-sex education (Mael et al. 2005). Overall, the reviewers found a greater number of studies demonstrating positive than negative effects of single-sex relative to coeducational schooling. However, the authors noted that nearly equal numbers of studies report mixed or no effects and positive effects of single-sex education.

Importantly, nearly all reviews of the literature acknowledge that the vast majority of studies of single-sex schooling are characterized by serious methodological weaknesses. The “gold standard” for assessing causal effects of school programs is random assignment, and no studies employing random assignment exist. Federal regulations require that enrollment in single-sex settings be voluntary and thus truly randomized designs are impossible to implement. Nonetheless, the weakness of non-random assignment might be addressed via methodological procedures. For example, some schools appear to have more students interested in single-sex environments than they can accommodate. In such cases, it would seem possible to randomly assign students to single-sex versus coeducational environments without violating federal regulations or ethical standards of conduct. The use of such designs is especially important because there are compelling reasons to suspect that much of the reported success of single-sex education is attributable to selection and school quality effects (Bracey 2006; Haag 1998; Mael et al. 2005; Salomone 2006).

Selection Effects

One of the challenges of evaluating the efficacy of single-sex schooling is detecting and accounting for possible selection biases. There are two types of selection effects that potentially affect the level of achievement in single-sex schools. The first possible bias is driven by students; those students who elect to attend single-sex schools may differ systematically from those students who do not elect to attend single-sex schools (i.e., *student-driven selection effects*). The second possible bias is driven by schools; those applicants who are selected by the administrators to attend single-sex schools may differ systematically from those applicants who are not selected (i.e., *school-driven selection effects*). Neither of these potentially confounding selection issues has been sufficiently addressed in past research on single-sex education (Bracey 2006; Mael et al. 2005).

Student-Driven Selection Effects

Single-sex schools are schools of choice; students who attend single-sex schools actively choose them as an alternative to their local public coeducational schools. How might student selection affect study outcomes? One possibility is that students who select single-sex schools may be more academically accomplished, identified, and motivated than their peers at coeducational institutions (Riordan 1998; Riordan 2002).

The majority of research on the efficacy of single-sex education has been conducted within the private education

sector (Mael 1998; Morse 1998). To control for potential confounds of using private schools, some studies compare only private school samples (i.e., students attending single-sex and coeducational private schools). Comparing private school students minimizes some forms of student-driven selection (e.g., the effect of paying tuition on school achievement). The use of such samples does little, however, to eliminate other forms of selection bias (e.g., academic motivation, religiosity, gender role attitudes).

The study of public single-sex schools may reduce confounds associated with the use of samples that are self-selected. They are, however, unlikely to be free of selection biases. Single-sex public schools typically differ from coeducational schools in their district in important ways. As discussed below, single-sex schools typically have selective admissions processes, whereas most coeducational schools do not. As a consequence, students with lower levels of achievement may be less likely to apply to single-sex schools than those students with higher levels of achievement. Single-sex public schools are also especially likely to be new and have unique financial and educational resources associated with them, thereby making them attractive alternatives to the local coeducational schools. No studies have addressed the possibility that single-sex public schools attract students who are more achievement oriented than their peers, a confound that would affect the conclusions drawn about the efficacy of such educational environments. We controlled for this possible confound in our study by comparing single-sex and coeducational students who *both* desired a single-sex school environment (albeit the students in coeducational schools were not admitted). That is, we tested whether gender composition of school affected achievement when student-driven selection effects were controlled (*exploratory test #1*).

School-Driven Selection Effects

Nearly all single-sex schools employ some form of selective admission. In this respect, such schools are quite unlike public coeducational schools, in which student enrollment is a function of factors that operate entirely independently of schools (i.e., a child’s family moves into a particular neighborhood). How might school selection processes affect study outcomes? As noted above, the majority of single-sex schools in existence are private and, as a consequence, most studies of the efficacy of single-sex education draw samples from private schools. The selection problems associated with private versus public schooling have long been noted. Private schools are able to select their student bodies by setting admissions criteria (e.g., prior achievement scores, religiosity). Although some studies have sought to minimize school-driven selection problems by comparing only students in private school

settings, such studies rarely (if ever) document the role of admissions in shaping schools' student bodies. It is possible that single-sex and coeducational private schools engage in markedly different admissions processes and thus that students in such schools differ systematically *prior* to enrollment.

Increases in the numbers of public single-sex schools appear to present an opportunity to reduce confounds associated with schools' selection processes. Unfortunately, the opportunity may be more imagined than real. Single-sex public schools have arisen primarily as forms of charter and magnet schools and thus, like private schools, have competitive admissions processes. Furthermore, such schools are operating under a high level of scrutiny and pressure to produce high levels of achievement (i.e., standardized test scores). Thus, it is possible that any positive outcomes associated with single-sex schools are the result of the inflation of achievement levels by admitting only those students who are already high achieving. In the present study, we tested whether school-driven selection operated to affect the achievement scores of middle school students attending public single-sex versus coeducational schools by examining students' academic records in the year *prior* to their enrollment in middle school (*exploratory test #2*). If selection effects were found, we next planned to test whether school achievement among single-sex and coeducational students continued to differ after the effects of prior achievement were controlled via statistical—and, alternatively, methodological—procedures (*exploratory test #3*).

Overall Peer Quality

One of the most common problems with single-sex education research concerns the confounding of the gender of the student body with other school characteristics, including school quality (Bracey 2006). As noted, most studies of single-sex education compare single-sex private school samples to coeducational public school samples. Private schools have the benefits of financial resources derived from tuition and often (although not always) have higher academic standards and smaller class sizes than public schools. Thus, when academic outcomes differ, it is impossible to determine whether the gender composition of the student body or some other school factor is responsible (Lee 1998). It is likely to be useful, therefore, to study the effects of gender composition within the public school system.

Importantly, public schools differ dramatically in their average level of school achievement. Furthermore, schools' achievement levels are typically correlated with a host of school-level variables, including the percent of the student body that lives in poverty, student race/ethnicity, class size,

and teacher experience. Indeed, students' achievement can be predicted by the overall achievement levels of their peers (e.g., Kurdek and Sinclair 2000). Thus, it is crucial that research on the efficacy of single-sex versus coeducational schools addresses the possible confounds associated with the overall achievement of the student body. We do so here by testing whether (a) overall student body performance on standardized tests predicts students' achievement (*exploratory test #4*), and (b) those students attending a single-sex school outperform their peers from coeducational schools, after controlling for the average performance of the student body (*exploratory test #5*). Table 1 provides a summary of these exploratory tests.

The Present Study

There is a pressing need for studies of the efficacy of single-sex schooling that adequately address selection and peer quality effects. We sought to address this need by comparing the academic achievement of girls in a public, single-sex middle school to two comparison samples. First, we compared girls attending a public, single-sex middle school (*Single-Sex Selected*) to a group of girls who applied for admission to the same single-sex middle school but were not admitted and consequently attended one of 17 neighborhood public coeducational middle schools in the same city (*Single-Sex Rejected*). This group was an ideal comparison in many respects. These girls had a desire to attend a single-sex school and had completed the application process. Additionally, the single-sex school reported that it used a lottery to randomly select attendees from the pool of eligible applicants, and thus it seemed possible that those students rejected for admission would be equivalent to those who were accepted in terms of baseline achievement. Importantly, we used longitudinal data to examine whether the two samples (i.e., *Single-Sex Selected* and *Rejected*) were equivalent in years prior to, and after, attending the single-sex versus coeducational schools.

Specifically, we began by testing whether the gender composition of middle schools affected academic achievement at the end of sixth grade when student-driven selection effects were controlled (*exploratory test #1*). Next we tested for the operation of school-driven selection in producing the apparent effect of gender composition of school (i.e., whether the two groups differed in achievement *prior* to beginning middle school; *exploratory test #2*). Because school-driven selection effects appeared to operate, we next examined whether girls who applied and were admitted to the single-sex school showed superior sixth and seventh grade test performance to those girls who applied but were not admitted, after statistically controlling for individuals' prior (fifth grade) levels of achievement (*exploratory test #3*). Next, we tested whether overall peer

Table 1 Summary of exploratory tests, analyses, and results

Exploratory Test	Analysis	Result
#1: Test of school type, controlling for student-driven selection	Compare <i>Single-Sex Selected</i> and <i>Single-Sex Rejected</i> in sixth grade.	<i>Single-Sex Selected</i> > <i>Single-Sex Rejected</i>
#2: Test of school-driven selection effects	Compare <i>Single-Sex Selected</i> and <i>Single-Sex Rejected</i> in the year prior to their enrollment in middle school.	<i>Single-Sex Selected</i> > <i>Single-Sex Rejected</i>
# 3: Test of school type, controlling for school-driven selection effects	(a) Compare <i>Single-Sex Selected</i> and <i>Single-Sex Rejected</i> in sixth and seventh grades, controlling for fifth grade achievement.	<i>Single-Sex Selected</i> > <i>Single-Sex Rejected</i>
	(b) Compare <i>Single-Sex Selected</i> and <i>Matched Single-Sex Rejected</i> in sixth and seventh grades, controlling for fifth grade achievement.	<i>Single-Sex Selected</i> > <i>Matched Single-Sex Rejected</i>
#4: Test of overall peer quality	Examine fifth grade achievement and peer quality as predictors of sixth grade achievement in the total sample (<i>Single-Sex Selected</i> and <i>Rejected</i>).	<i>Peer quality and fifth grade achievement are both significant predictors of sixth grade achievement</i>
#5: Test of school type, controlling for overall peer quality	Compare <i>Single-Sex Selected</i> and <i>Coed Magnet</i> in sixth and seventh grade, controlling for fifth grade achievement.	<i>Single-Sex Selected</i> = <i>Coed Magnet</i>

performance predicted students' achievement, after controlling for individuals' prior (i.e., fifth grade) school achievement (*exploratory test #4*). Because overall peer performance was found to predict individuals' achievement, and was confounded with school type (i.e., we had data from only one single-sex school, which had a high-performing student body), we next compared girls attending the target public single-sex school to girls at a coeducational magnet school in the same city (*Coed Magnet*). The coeducational public magnet school, like the single-sex school, had a mission of providing students with a challenging academic curriculum. Both schools also required students to apply for admittance, with acceptance based on prior academic performance, writing samples, and teacher recommendations. As part of its mission, the single-sex middle school (but not coeducational magnet school) serves predominately low-income, students of color, and thus the student bodies at the two schools differ (see Table 2). However, because of the similarities in the admissions processes, the comparison allows us to consider issues related to peer quality. Again, we used longitudinal data to examine whether the two samples were equivalent

in years prior to and after starting middle school. Crucially, we tested whether students in the target single-sex and coeducational magnet school showed equivalent levels of achievement at sixth and seventh grade, after controlling for individuals' prior (i.e., fifth grade) achievement scores (*exploratory test #5*).

Method

Participants

Participants included 484 girls between the ages of 10 and 13 years ($M=11.51$, $SD=.37$). The total sample included 41 African Americans, 27 Asian Americans, 163 European Americans, 251 Latinos, and two Native Americans. Almost half of the sample (49.19%) was eligible to receive free or reduced-price lunches. Participants were drawn from three samples in the Southwest United States. The first group, *Single-Sex Selected*, included 121 girls attending a public single-sex middle school in the Southwest. The second group, *Single-Sex Rejected*, included 229 girls who

Table 2 Participant characteristics, by school group

School group	n	Mean age	Free or reduced-price lunch	Asian Amer.	African Amer.	European Amer.	Latino	Native Amer.
<i>Single-Sex Selected</i>	121	11.44	57.4%	1.6%	18.6%	28.7%	51.2%	0%
<i>Single-Sex Rejected</i>	229	11.56	62.29%	2.9%	5.1%	18.6%	72.8%	.4%
<i>Matched Single-Sex Rejected</i>	122	11.52	57.0%	3.9%	3.9%	19.5%	71.9%	.8%
<i>Coed Magnet</i>	134	11.50	18.0%	13.7%	5.0%	64.7%	15.8%	.7%

The *Matched Single-Sex Rejected* group is a subset of the *Single-Sex Rejected* group. The *Matched Single-Sex Rejected* group was matched to the *Single-Sex Selected* group based on fifth grade achievement test scores

applied to the same single-sex middle school attended by the *Single-Sex Selected* group but who were not admitted and, as a consequence, attended one of 17 public coeducational middle schools. The third group, *Coed Magnet*, included 134 girls who did not apply to the single-sex school and instead applied for and attended a public magnet coeducational school. Demographic information for the three comparison groups appears in Table 2.

Measures

Standardized Test Scores

Standardized state achievement test scores were obtained from school district records for each participant (Texas Education Agency 2010). For each student, math and reading test scores from their fifth, sixth, and seventh grade school years were analyzed. For each subject test, students received a score ranging from 1200 to 3330, with a “passing” score of 2100. Math and reading scores were significantly correlated for all samples ($r=.30$ to $.38$), and thus we used a combined score (i.e., the sum of the math and reading scores) as a measure of students’ overall academic achievement.

Peer Quality

For comparisons of sixth grade achievement, peer quality was operationally defined as the average standardized test score in math and reading of the students in the sixth grade at the target middle school during the 2007–2008 school year. For seventh grade comparisons, peer quality was defined as the overall average academic performance of seventh graders at the target school during the 2008–2009 school year. A peer quality score (i.e., average school performance) was obtained for the single-sex middle school, the coeducational magnet middle school, and the 17 coeducational middle schools in which the *Single-Sex Rejected* girls enrolled. These indices appear in Table 3. The average combined math and reading score for this sample of 19 middle schools ranged from 4135 to 5177.

Results

Overview of Data Analytic Strategy

Data analysis included five steps (see Table 1 for an overview). In the first step, we compared the achievement of *Single-Sex Selected* and *Single-Sex Rejected* groups in sixth grade (i.e., after 1 year of middle school). That is, we tested whether achievement varied across school type

Table 3 Sixth grade peer quality indices for middle schools attended by *Single-Sex Selected*, *Coed Magnet*, and *Single-Sex Rejected* girls

School	n	Peer Quality Index
<i>Single-Sex Selected</i>	121	4915
<i>Coed Magnet</i>	134	5177
<i>Single-Sex Rejected</i>		
Public School 1	23	4210
Public School 2	7	4384
Public School 3	9	4593
Public School 4	12	4342
Public School 5	21	4812
Public School 6	14	4325
Public School 7	6	4460
Public School 8	3	4867
Public School 9	5	4322
Public School 10	16	4475
Public School 11	5	4478
Public School 12	8	4135
Public School 13	26	4585
Public School 14	15	4290
Public School 15	15	4866
Public School 16	10	4879
Public School 17	14	4469
Subtotal	209	
Grand Total	464	

The *Single-Sex Rejected* sample included an additional 13 girls for whom we were could not locate middle school attendance records, and 7 girls who attended the same coeducational middle school for which student body achievement data could not be located

(single-sex vs. coeducational) when student-selection was controlled (*exploratory test #1*). In the second step, we compared the *Single-Sex Selected* and *Single-Sex Rejected* groups in fifth grade—that is, the year prior to middle school—to test for the presence of school-driven selection bias (*exploratory test #2*). Because school-driven selection effects appeared to operate, we tested—in a third step—whether achievement varied as a function of school type (single-sex vs. coeducational) when selection effects were controlled (*exploratory test #3*). In the fourth step, we investigated the role of overall peer quality in predicting students’ school achievement (*exploratory test #4*). In the fifth and final step, we examined whether achievement varied as a function of school type, when effects of peer quality were controlled via the use of a high performing magnet school as a comparison sample (*Single-Sex Selected* and *Coed Magnet*, *exploratory test #5*).

We tested for multicollinearity problems before running regression models. Multicollinearity was not a problem in any of the models reported here, according to tolerance and variance inflation factor (VIF) statistics (see Myers 1990).

Table 4 Mean overall achievement scores for each school year, by school group

School group	Fifth grade			Sixth grade			Seventh grade		
	n	M	SD	n	M	SD	n	M	SD
<i>Single-Sex Selected</i>	121	4735.63 ^a	289.56	109	4942.74	349.31	96	4735.83	237.97
<i>Single-Sex Rejected</i>	223	4593.15	303.67	221	4650.37	374.84	204	4511.27	319.31
<i>Matched Single-Sex Rejected</i>	122	4737.52 ^a	296.66	118	4785.03	367.11	107	4618.24	305.88
<i>Coed Magnet</i>	134	4980.69	265.54	133	5161.56	313.44	128	4826.03	240.61

The *Matched Single-Sex Rejected* group is a subset of the *Single-Sex Rejected* group. The *Matched Single-Sex Rejected* group was matched to the *Single-Sex Selected* group based on fifth grade achievement test scores. Possible overall achievement scores ranged from 2400 to 6660. Values within the same column that share the same superscript are not significantly different from one another

Test of School Effect, Controlling for Student-Driven Selection

To address exploratory test #1, we compared the achievement scores of *Single-Sex Selected* and *Single-Sex Rejected* groups at the end of sixth and seventh grade. Means and standard deviations are presented in Table 4. Independent samples *t*-tests indicated that girls admitted to the single-sex school had significantly higher achievement scores at the end of sixth and seventh grade than did girls who were rejected for admission, $t(328)=6.81$, $p<.001$ and $t(242.7)=6.80$, $p<.001$, respectively. (Seventh grade *t*-test accounts for unequal variances.) That is, the single-sex students outperformed the coeducational students at the end of sixth grade, even when *student-driven* selection effects were controlled (i.e., all students had applied to attend a single-sex school).

Test of School-Driven Selection Effect

We next investigated the possibility that school selection biases may have played a role in producing the difference in academic achievement between the two samples (single-sex and coeducational) at the end of sixth grade. Specifically, we

compared fifth grade achievement scores for *Single-Sex Selected* and *Single-Sex Rejected* groups (*exploratory test #2*). Results of an independent samples *t*-test indicated that girls admitted to the single-sex school had significantly higher achievement scores in the year prior to enrolling in the single-sex school than did girls who were rejected for admission, $t(342)=4.22$, $p<.001$ (Table 4). That is, the analysis indicated that the single-sex students were already outperforming the coeducational students prior to the start of middle school.

Test of School Type, Controlling for School-Driven Selection

To test for variation in achievement by school type when school-driven selection was controlled (*exploratory test #3*), we performed a hierarchical multiple regression analysis. Students' fifth grade achievement scores were entered first, followed by school type (dummy coded; 0=*Single-Sex Rejected* and 1=*Single-Sex Accepted*), as predictors of students' sixth grade achievement scores. Results indicated a significant effect of fifth grade achievement and school type (see Table 5). That is, after controlling for fifth

Table 5 Hierarchical regression analyses predicting achievement test scores in sixth grade

Sample	Model 1 β	Model 2 β	Model 1 R^2	Model 2 R^2	R^2 Change
<i>Single-Sex Selected</i> and <i>Single-Sex Rejected</i>			.53	.57	.04***
Fifth grade achievement	.73***	.68***			
School type		.20***			
<i>Single-Sex Selected</i> and <i>Single-Sex Rejected</i>			.54	.58	.04***
Fifth grade achievement	.74***	.67***			
Peer quality		.22***			
<i>Single-Sex Selected</i> and <i>Coed Magnet</i>			.44	.44	.00
Fifth grade achievement	.66***	.64***			
School type		.06			

* $p<.05$, ** $p<.01$, *** $p<.001$

grade achievement, girls at the single-sex school outperformed girls in coeducational schools in sixth grade. An identical regression analysis using seventh grade achievement as the dependent variable indicated the same pattern of findings; these results can be obtained from the authors.

As an alternative–methodological–means of examining the effects of single-sex schools while controlling school-selection effects (i.e., *exploratory test #3*), we compared girls who wanted to go to a single-sex school *and* who had equivalent levels of achievement prior to beginning middle school. Specifically, we created a matched control sample. That is, students from the *Single-Sex Rejected* group were matched to students in the *Single-Sex Selected* group on the basis on their fifth grade standardized test scores. This resulted in a subsample of 122 students (*Matched Sex-Single Rejected*) with scores that were equivalent to the *Single-Sex Selected* students' scores. We next compared the *Single-Sex Selected* and *Matched Single-Sex Rejected* students' sixth grade standardized achievement test scores via an independent sample *t*-test. Results indicated a significant effect of school type, $t(225)=3.31$, $p=.001$. The *Single-Sex Selected* group showed overall achievement scores that were significantly higher than the *Matched Single-Sex Rejected* group (Table 4). That is, girls attending the single-sex middle school showed higher academic achievement at the end of sixth grade than girls attending coeducational middle schools, despite the fact that the two groups were comparable in achievement the prior year. The significant difference between groups held in seventh grade, $t(201)=3.03$, $p=.003$.

Test of Overall Peer Quality

Thus far, results indicate that girls attending the single-sex school outperformed peers at coeducational schools at the end of sixth grade, even after accounting for girls' performance differences in fifth grade. However, results also indicated that the girls attending the single-sex school were non-representative of applicants to the single-sex school in terms of prior academic performance. As a consequence, girls attending the single-sex school were members of a student body that was generally higher performing than were girls attending coeducational schools. To investigate the potential role of student body quality in achievement, we used a hierarchical regression analysis in which fifth grade achievement was entered first and our peer quality index was entered second as predictors of sixth grade achievement among students attending the target single-sex school and 17 coeducational schools. Results indicated significant effects of both fifth grade achievement and peer quality on sixth grade achievement (see Table 5). After controlling for fifth grade achievement, girls attend-

ing schools with higher performing student bodies outperformed their peers at schools with lower performing student bodies. An identical regression analysis using seventh grade achievement as the dependent variable indicated the same pattern of findings; these results can be obtained from the authors.

These findings indicate that peer quality is a potential confound in tests of the efficacy of single-sex versus coeducational schools. We first sought to control for overall peer quality in our comparison of the target single-sex and coeducational schools via the use of regression analyses. This strategy was impossible, however, because our sample included only one single-sex school and its overall peer achievement level (peer quality index=4915) was higher than every one of the 17 coeducational middle schools attended by the girls in our *Single-Sex Rejected* sample. Thus, we sought to control for peer quality by comparing the target single-sex school to a high achieving coeducational magnet middle school (peer quality index=5177) in the same city (*Coed Magnet*).

Test of School Type, Controlling for Peer Quality

We began by examining fifth grade achievement among both the *Coed Magnet* and *Single-Sex Selected* samples. The *Coed Magnet* students performed significantly better than the *Single-Sex Selected* students on the state standardized test in the year prior to beginning middle school, $t(253)=7.05$, $p<.001$. Means are presented in Table 4. Thus, our subsequent analyses included students' fifth grade achievement scores as a control.

We next used a hierarchical regression analysis to investigate effects of school type (gender composition of school) on achievement when overall peer quality was controlled (*exploratory test #5*). Specifically, students' fifth grade achievement scores were entered first, and school type (dummy coded; 0=*Single-Sex Selected* and 1=*Coed Magnet*) was entered next, as predictors of students' sixth grade achievement scores. Results indicated that only prior academic performance significantly predicted achievement in sixth grade (see Table 5). School type was not a significant predictor of sixth grade achievement scores.

To examine whether the nonsignificant difference between the two schools during sixth grade also held during seventh grade (i.e., the second year of middle school), we again used a hierarchical regression model. Fifth grade academic performance and school type (dummy-coded; 0=*Single-Sex Selected* and 1=*Coed Magnet*) were entered as predictors of seventh grade achievement. As was true at sixth grade, results indicated a significant effect of fifth grade performance ($\beta=.67$, $p<.001$; $R^2=.40$, $p<.001$), and a nonsignificant effect of school type ($\beta=-.10$, $p=.10$).

Discussion

The primary purpose of the current study was to examine the efficacy of single-sex education using a design that addressed the possible presence of selection and peer quality effects. Virtually no research on single-sex schools addresses these issues, making it difficult to draw conclusions about the efficacy of single-sex versus coeducational schooling. Because random assignment of students to schools is impossible, it is important that researchers take into account individual and school level factors that affect the validity of their comparisons. Our findings highlight the importance of controlling for both selection and peer quality effects when evaluating the efficacy of single-sex schools.

Most studies of the efficacy of single-sex schooling compare samples of students attending single-sex and coeducational schools. There are many reasons to expect, however, that those students who elect to attend single-sex schools differ from those students who elect to attend coeducational schools. Researchers have hypothesized, for example, that girls who choose single-sex schools do so because they believe such schools are more rigorous academically than coeducational schools (Riordan 1998; Riordan 2002). In such cases, one might expect only the most achievement-oriented students (or those students with the most achievement-oriented parents) to apply. Indeed, this is likely to have been the case for our sample, given that the single-sex school was new and linked to unique financial and educational resources. Unfortunately, we were unable to test this hypothesis by comparing the applicants of the single-sex school to all of the non-applicants in the district. Instead, we controlled for possible student selection effects by comparing the performance of students who (a) applied to and attend a single-sex school and (b) applied to—but were rejected—from the same single-sex school and consequently attend coeducational schools. Controlling for student selection effects via comparison of either applicants to non-applicants, or admitted to rejected applicants, is rare in the literature, and yet it is vital for the interpretation of data on the efficacy of single-sex education.

Our comparison of students' academic achievement at the end of their first year of middle school (i.e., sixth grade) indicated that those girls attending a single-sex school outperformed those girls attending coeducational schools, even when student-driven selection bias was controlled (i.e., all of the girls in the sample had applied to the single-sex school). This analysis left open the possibility, however, that school-driven selection effects played a role in the differential achievement of the two samples.

To test for the possible presence of school-driven selection biases, we compared students in the *Single-Sex Selected* and *Single-Sex Rejected* groups in the year before

they started middle school. Although the selection process for admission to the public single-sex school was reported to be a lottery, the girls admitted to the school (*Single-Sex Selected*) had significantly higher achievement scores in fifth grade than the girls who were not admitted (*Single-Sex Rejected*). This result highlights the importance of considering issues related to school-driven selection effects in all studies of single-sex schooling.

To address the role that school-driven selection effects may have played in producing the sixth grade achievement difference among single-sex and coeducational school students, we employed two strategies. We first used regression analyses in which prior achievement was entered as an initial predictor variable. As a second method of comparison, we created a matched sample of the girls who were not admitted and yet were equivalent to the admitted girls on fifth grade achievement scores. Both analyses yielded the same finding: girls who attended the target single-sex school showed significantly higher academic achievement than girls who attended coeducational schools, even after accounting for differing levels of performance in the year prior to starting middle school.

These findings indicate that selection biases do not fully account for previously reported differences between students in single-sex and coeducational schools. These results do not, however, address the question of whether students' academic success at a single-sex school is due to the gender composition of the school or to some other school characteristic, such as overall peer quality. Some researchers have suggested that many of the benefits of attending a single-sex school could stem from qualities of the school environment that are unrelated to gender (e.g., Haag 1998). To the extent the single-sex school employs selective admissions processes, the overall quality of the student body is likely to be one such factor that affects individual students' achievement. To explore this possibility, we examined the effects of overall peer quality within both single-sex and coeducational contexts.

Consistent with other work (Kurdek and Sinclair 2000), regression analyses indicated that the overall achievement level of the student body was a significant predictor of individual students' achievement, even after accounting for variations in individuals' performance in the year prior to middle school. School district data indicated that the target single-sex school in this study was the highest achieving of the 18 regular (i.e., non-magnet) public middle schools in the sample. Furthermore, our findings suggest that this high level of performance was the result, at least in part, of the non-representative quality of these students' academic performance prior to the start of middle school. Because school type (single-sex vs. coeducational) was severely confounded with overall peer quality, we were unable to use regression analyses to control for this difference across schools.

Instead, we compared the academic achievement of students at the single-sex school (*Single-Sex Selected*) to those students at a high performing, coeducational, magnet middle school (*Coed Magnet*). Both schools had a mission of providing students with a challenging academic curriculum and required students to apply for admittance. Both schools also drew non-representative (high performing) fifth grade students to their institutions, albeit the single-sex school served a higher proportion of Latina and economically challenged students than the magnet coeducational school. If the gender composition of the student body affects achievement when student bodies are similar in quality (i.e., high performing), sixth grade achievement among the *Single-Sex Selected* students and *Coed Magnet* students should differ. Results indicated that, after controlling for prior academic achievement, students at the two schools performed similarly in both sixth and seventh grade. This finding provides support for the notion that it is overall peer quality, rather than the gender composition of the schools, that explains single-sex school students' outperformance of coeducational school students.

Although this study offers many important insights, it is also important to acknowledge its limitations. First, we used only standardized test scores to compare girls' achievement in single-sex and coeducational environments. Using a standardized measure allowed us to compare achievement outcomes across schools, which is difficult to do when using grades or teacher reports. However, future studies should examine a broader range of outcomes, including academic self-confidence, interest in math and science, cross-sex interactions, and gender stereotyping. Future studies should also consider using multiple measures of peer and school quality. In the current study, we used the average achievement level of students' schoolmates as a standardized measure of peer quality. This index undoubtedly is associated with a wide range of student (e.g., SES) and school (e.g., teacher quality) characteristics and thus cannot be conceived of as a single causal agent. Nonetheless, because middle schools draw unequal numbers of high performing elementary school students through their doors, the educational milieu of middle schools differ. It will be important for future studies of single-sex and coeducational schools to disentangle the effects of these qualities from those effects associated with the gender of the student body.

Finally, the current study examined the efficacy of only a single public single-sex school. There is a need for a comprehensive, nationally-representative study of single-sex public schools, especially one that examines the possible operation of school and student-driven selection processes. Future studies should also explore the role of the cultural and national context in shaping the outcomes of single-sex schools. The circumstances surrounding the creation and operation of single-sex schools in the U.S. differs from those

for single-sex schools in other nations, making it impossible to generalize across countries. Nonetheless, the likelihood that selection effects operate and serve to skew research findings is probably high across countries and thus the methodological and statistical procedures used here might usefully inform research within diverse national and cultural contexts.

Overall, the data from the current study suggest that the efficacy of single-sex schools may not be a function of the gender composition of the school. Instead, it appears that the performance of single-sex schools is sometimes inflated by selection biases on the part of both students and schools. These selection biases lead single-sex schools to have non-representative (i.e., higher performing) student bodies. Overall peer quality, in turn, predicts student achievement, irrespective of the gender composition of the school. Although caution must be exercised when generalizing the results to all single-sex schools, the findings do raise questions about the validity of previous studies that have reported significant achievement differences between single-sex and coeducational schools. If we had failed to consider selection and peer quality effects in our comparisons, we would have assumed equality across student bodies, and incorrectly concluded that the single-sex instruction is superior to coeducational instruction. Going forward, researchers need to directly address issues of selection and peer quality—and other forms of quality—in their studies of outcomes associated with different school types.

This study also has important implications in terms of current educational policies. The re-organization of coeducational classrooms and schools into single-sex programs is costly in terms of time and effort, and should not be undertaken without solid evidence that such efforts will yield superior educational outcomes. Our data suggest the confounds associated with selection and peer quality effects are likely to contribute to the positive results seen in many studies of the effects of single-sex schooling, and thus we urge school administrators and policy makers to use caution when drawing on existing research outcomes to justify the segregation of students by biological sex.

Authors' Note This work is based, in part, on a master's thesis completed by the first author under the supervision of the third author. The authors thank the members of the thesis committee, Judith Langlois and Cristine Legare, for their helpful comments and suggestions concerning the work. This research was supported by funds from the Debra Beth Lobliner Fellowship. A previous version of this paper was presented at the biennial meeting of the Society for Research on Adolescence, March 2010, Philadelphia, PA.

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