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ORIGINAL ARTICLE

The Gender Gap in Advanced Math and Science Course Taking: Does Same-Sex Education Make A Difference?

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Abstract A large representative sample (N=20,816) of Israeli Jewish high school students served to explore differences between coeducational and same-sex schools in advanced math and science courses. Data were obtained from the Israeli population census of 1995 and from the Israeli Ministry of Education. Results from logistic regressions suggest that girls at all-female state religious schools did not differ from girls at coeducational state schools in placement in advanced math, physics and biology courses. But girls at all-female religious schools took advanced computer science courses at a much higher rate than girls at coeducational schools. This finding is attributed to a different curricular policy and not directly to the all-female environment.

Keywords Single-sex schooling · High school · Science · Gender differences · Israel

Introduction

Concern over the persistent gender gap in math and science is one of the reasons for the renewed interest in same-sex education. Proponents of same-sex education argue that an all-female setting may help girls overcome gender stereotypes and provide them with a more suitable learning environment. Therefore, they maintain, same-sex education can help to reduce the gender gap in fields of study that girls are less prone to choose (e.g. Cooper and Weaver 2003). Yet, the evidence on the effect of an all-female setting on girls' participation and attainment in math and science remains largely inconclusive. The Israeli education system provides an interesting opportunity to test the effect of same-sex schooling on the math and science gender gap. In Israel, public education includes religious schools—both same-sex institutions and separate classes for girls and boys at coeducational schools. Using data from an Israeli population census and matriculation examinations, the study compares enrollment in advanced math and science courses of Israeli Jewish students in three types of state high schools: secular coeducational, religious coeducational with same-sex classes, and same-sex schools. So while most previous research on same-sex schooling has usually focused on achievement and attitudes, the present study explores girls' curricular choices in coeducational and same-sex schools.

The comparison focuses on four advanced-level matriculation subjects: math, physics, biology and computer science. According to previous research, in Israel, as in the United States (e.g. Friedler and Tamir 1990; Miller et al. 2006), math, physics and computer science are perceived as "masculine" subjects, while biology is perceived as a "feminine" subject. Chemistry is not clearly identified as "masculine" or "feminine" (Friedler and Tamir 1990) hence was omitted from this study.

A central assumption behind arguments for same-sex schooling is that an all-female environment may diminish the impact of masculine stereotypes associated with these academic subjects. In their reviews of research on same-sex schooling, Mael (1998) and Haag (1998) conclude that girls in all-female settings express more positive attitudes to subjects such as math and physics, which they perceive as less masculine than do girls at coeducational schools.

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Same-Sex Schooling and the Math and Science Gender Gap

Same-sex education is not common in the industrialized world. Social, economic and legal forces have caused governments to prefer coeducation to same-sex education, so the latter mainly exists in the form of religious, private and independent schools. Comparative research on mixed- and same-sex education is limited, and incurs the confounding effect of selection mechanisms. In the United States, Lee and Bryk (1986) used the High School and Beyond (HSB) database to compare Catholic private same-sex and coeducational schools. They found that when students were matched by several background variables, girls attending same-sex schools were less affected by gender stereotyping and had higher aspirations and higher outcomes, especially in science. Marsh (1989), who reanalyzed the same data, found no advantage attributable to same-sex schooling. In response, Lee and Bryk (1989) claimed that Marsh over-controlled for background variables, eliminating any possibility of finding significant differences. LePore and Warren (1997) addressed a similar question using the National Educational Longitudinal Study (NELS: 88). Similarly to Marsh, after controlling for SES, prior achievement, and self-concept, no evidence of an advantage was found for same-sex education.

In England and Wales most same-sex schools are grammar schools that select their students based on higher ability. Bell (1989) attributed the higher science test scores of both girls and boys from same-sex schools to pre-selection on the basis of ability and social class. More recently, Spielhofer et al. (2004) found, after controlling for students' background and prior attainment, that girls in all-female schools took more science courses than girls in mixed schools, but still less than boys in all-male schools. They also report that girls in same-sex comprehensive schools performed better than girls in mixed comprehensive schools. In another recent study from England, Daly and Defty (2004) found a moderate advantage for girls attending all-female schools in both achievement and attitudes to math. By contrast, in Northern Ireland McEwen et al. (1997) used longitudinal data to study science participation in same-sex and coeducational schools and found that students in the latter were more likely to enroll in advanced science courses regardless of gender. In New Zealand, Harker (2000) compared same-sex with coeducational schools in public education. Controlling for differences in the student populations in the two school types, he found that any advantage for girls in the same-sex schools diminished to non-significance.

Several studies have examined the effect of intervention programs that created same-sex classes within coeducational schools. However, as Shapka and Keating (2003, p. 933) note, "much of this limited research can be questioned because students were self-selected into programs and no controls were used to account for pre-existing differences." In their own study, which was conducted in Canada, Shapka and Keating (2003) used longitudinal data to evaluate an intervention program that introduced same-sex classes for math and science into coeducational schools in Canada. After controlling for previous achievement, social background, and other personal characteristics, significant post-intervention effects were found for math and science achievement and for course enrollment, but no significant effects were found for perceived math competence or math anxiety. Still, non-random assignment of girls to single- and mixed-sex classes can be an alternative explanation for the study's results. As the authors indicate, "it is possible that the program effects were due to the absence of low achievers and not the absence of boys" (p. 955). This well designed study seems to demonstrate the limitations of intervention case studies in reaching general conclusions on the benefits of same-sex classes within coeducational schools for girls' participation and achievement in math and science.

The Israeli Education System

The education system in Israel consists of five main types of schools: Jewish state secular schools, Jewish state religious schools, Arab state schools, Arab independent Christian schools, and independent Jewish schools; most of the last-named cater to the ultra-orthodox communities. Same-sex education can be found in state religious schools and in the independent Jewish and Arab Christian schools. The present study focuses on Jewish state education and compares mixed-sex education in secular schools with same-sex education in state religious schools. Students in religious schools comprise about 20% of the study population. Independent Jewish schools are not included in the analysis because they teach different curricula, focusing primarily on religious subjects, and many of their students do not take the matriculation exams. Most Arab students study in Arab state schools which are coeducational. The very few independent same-sex Arab schools tend to select their students on the basis of scholastic ability.

Jewish state secular and state religious schools have several similarities. Both types are financed primarily by public funding. They coexist in most cities, towns and rural areas in Israel, and they serve students of diverse socio-economic levels. On average, the socio-economic characteristics of state religious school students are somewhat inferior to those of state secular school students (Schwarzwald 1990; Dagan 2006). Both school types share similar curricula in most subjects. Not surprisingly, religious schools place more emphasis on Jewish subjects, and their students are expected to take advanced courses in these areas (Ayalon and Yogev 1996; Dagan 2006).

Formally, as public education, neither school type exercises selection policies on the basis of parents' socio-economic status or student's previous achievement. Yet religious schools are selective in one important aspect: the observance of religious codes in the student's home. State religious schools expect parents to provide a religious environment at home that harmonizes with the school's. Moreover, state religious schools can legally refuse to accept, or can expel, students whose behavior does not conform to the school's religious norms. This admission policy of the religious schools in Israel differs, for example, from that of American Catholic schools, where religious affiliation is not an important criterion (Bryk et al. 1993). In Israel the selection mechanism results in about 75% of the students at the state religious schools being from religiously observant families; most of the remainder are from less observant families (also known as 'traditional' families), and rarely from secular ones (Leslau and Rich 2001; Schwarzwald 1990). At the state secular schools, most students are from secular families and the rest are from the less observant religious families (Schwarzwald 1990). As noted above, the strictest religiously observant families in Israel, who belong to the ultra-orthodox community, send their children to independent schools, which are not part of state religious education.

Secular and religious secondary state schools also differ in their policy on gender segregation. While almost all secular schools are coeducational, religious schools separate girls and boys, either in same-sex classes within coeducational schools or in same-sex schools. As a result of developments in the religious sector of education, which are beyond the scope of this paper, the trend over the last three decades has been movement from coeducational schools to same-sex schools. In the mid-1990s about half of the students in the state religious sector studied in coeducational schools; today most students study in same-sex schools. Generally, same-sex schools cater to more privileged parts of the population than coeducational schools. Moreover, the variety of schools in the state-religious sector and the opportunity to choose a school (which is not common in the secular sector) have created selection mechanisms that have widened the achievement gap between same-sex and coeducational schools (Dagan 2006).

The Israeli Matriculation Examinations

The matriculation examinations are administered by the Ministry of Education and are taken during the last years of high school, mainly 12th grade. The matriculation system is based on study units. Exams can be taken at the basic level (two to three units) or at an advanced level (four to five units). To be eligible for a basic matriculation certificate the student must accrue at least 20 units, and sit for exams in all compulsory subjects and in at least one advanced subject. One failure is allowed. However this basic diploma is not sufficient for admission to a university, or to most academic college programs. Most higher education institutions require a pass in math (at least at the basic level), advanced English and at least one additional advanced-level subject. The high school curriculum consists of a core of compulsory subjects (civics, Hebrew, basic math, basic English, Bible studies, history, and literature) and advanced courses in a variety of optional subjects in the humanities and the natural and social sciences.

The Gender Gap in Math and Science in Israeli High Schools

Previous research in Israel has revealed substantial gender differences in participation and attainment in math and science. In a review of studies which compared achievement in science and attitudes to science, Friedler and Tamir (1990) found large differences between male and female high school students. In particular, girls on average took fewer advanced science courses than boys and tended to specialize and attain higher achievement levels in biology, whereas boys tended to specialize and excel in physics. Chemistry achievement lay midway between biology and physics. Ayalon (1995) found the same gendered pattern in physics and biology: boys tended to take physics while girls more often chose biology. Furthermore, Ayalon reported that in schools in which advanced math was taken by a larger proportion of students ("math-oriented schools") the gender inequality in science course taking increased. In another study, Ayalon (2002) found greater gender discrepancies in advanced math and physics course taking among Jewish students than among Arab students. Ayalon attributed the higher level of gender equality among Arab students to a more restricted curriculum, resulting from discrimination in government allocations. Zohar and Sela (2003) found that in advanced physics course taking for matriculation, the ratio of girls to boys was about 1:3, and it remained stable from 1988 to 2000. In advanced computer science placement, gender inequality proved even larger and the ratio of girls to boys was about 1:4 from 1995 to 2003 (Eidelman and Hazan 2007).

Ayalon and Yogev (1996) emphasized the importance of curricular policy for the explanation of variations in the gender gap in math and science course taking in Israel. They compared gender and ethnic inequality in advanced course taking in Jewish secular and religious state schools in Israel. Overall, they found that state religious schools exhibited less social inequality than secular schools in assigning students to scientific subjects. This apparent egalitarian pattern is the result of the religious sector's different worldview of education, which finds expression in a different curricular policy. State religious schools are

highly committed to Jewish studies (Bible, Jewish oral law-Halacha, and Jewish history) but also to providing their students with relevant skills for the modern labor market. Accordingly, the prevalent distinction between the sciences and the humanities in secular education is less important in religious education. The more able students in the religious schools are encouraged to specialize in both Jewish studies (which are part of the humanities in the secular sector), and the sciences. In addition, that Jewish studies are considered the most prestigious subjects helps to make the sciences less selective and thus more accessible to females and members of less advantaged ethnic groups.

Hypotheses of the Current Study

Assuming that same-sex schooling does affect gendered stereotypes in respect of math and science in high schools, one would expect to find smaller gender differences, or none at all, in students' enrollment in these subjects in same-sex schools. In addition, girls in same-sex schooling are expected to tend more to choose "masculine" subjects, and less to choose "feminine" subjects, than girls in coeducational schooling. More specifically, the following hypotheses were tested in this study:

H1. Girls and boys in same-sex schooling take advanced-level math courses at similar rates.
H2. Girls in same-sex schooling tend to enroll in advanced-level math courses more than girls in coeducational schooling.
H3. Girls and boys in same-sex schooling take advanced-level physics courses at similar rates.
H4. Girls in same-sex schooling tend to enroll in advanced-level physics courses more than girls in coeducational schooling.
H5. Girls and boys in same-sex schooling take advanced-level computer science courses at similar rates.
H6. Girls in same-sex schooling tend to enroll in advanced-level Computer science courses more than girls in coeducational schooling.
H7. Girls and boys in same-sex schooling take advanced-level biology courses at similar rates.
H8. Girls in same-sex schooling tend to enroll in advanced-level biology courses more than girls in coeducational schooling.

Method

Data

The analysis is based on a 20% representative sample of all Israelis born in 1977 and 1978. Information on these people was obtained from the Israeli population census of 1995 (CBS 2001) and from the Ministry of Education's matriculation files (see Ayalon and Shavit 2004 for a study that used similar data). At the time of the census most of them lived in their parents' households so relatively reliable data were obtained on their families' socioeconomic status. The students' national identification numbers were used to merge this information with Ministry of Education records of students' schools and matriculation exams. The analysis was carried out for all students who completed their schooling at state secular and state religious high schools. Jewish independent schools and Arab schools were not included in the analysis. New immigrants to Israel after 1989 were also excluded, to avoid confounding effects related to prior education or to immigration itself.

Measures

Dependent Variables

Enrollment in Advanced courses (five units) in math, physics, computer science and biology: these were coded as dummy variables, each receiving a score of 1 for enrollment or 0 for non-enrollment.

Independent Variables

A series of dummy variables was computed for the combinations of gender and school types (i.e. girls in religious all-girl schools, girls in religious coeducational schools, girls in secular coeducational schools, and so on). The rare cases of girls and boys who studied in same-sex secular schools were omitted. In some cases of small religious schools it was not clear whether the school was same-sex or coeducational, and students in these schools were therefore also omitted. Altogether 1.3% of students were excluded from the analyses for these reasons.

As explained earlier, previous literature indicates that proper control for possible pre-selection is crucial when analyzing same-sex schooling effects (e.g. Marsh 1989; Harker 2000). The dataset analyzed here allows control for three social background variables that were found important in relation to educational achievement in Israel and elsewhere (see e.g. Ayalon and Shavit 2004). These control variables are:

Father's education: measured as the total number of years of schooling. Father's education was chosen because the percent of missing cases for this variable (3.6%) was much lower than the percent of missing cases for mother's years of schooling (10.2%). Missing values were excluded from the analysis.

Standard of living: the population census collected information on an inventory of durable goods in the home such as TV set, air conditioner, personal computer, and so on. The variable measures the number of items in each household. The range is from 0 to 9. Missing cases (about 18%) were replaced by the mean number of items in the study's population. A dummy variable for missing values was computed and added to the multivariate analysis.

Origin: a series of dummy variables was computed according to father's origin for each of the following categories: Ashkenazim (Jews of European or American origin—the more advantaged Jewish group), Mizrachim (Jews of Middle Eastern or North African origin—the disadvantaged Jewish group), and second-generation Israeli born (father born in Israel). Less than 3% of the cases were missing on father's origin and these were excluded from the analysis. Father's origin was chosen because this variable had far fewer missing cases than mother's origin.

Results

The findings are reported in two stages. First, I present descriptive statistics, showing differences in social background between the student bodies in the different school types, and differences in enrollment in the different levels of math and in advanced physics, biology and computer science, by gender and school type. While this descriptive analysis shows actual enrollment patterns in these subjects it cannot be used for hypothesis testing because it lacks any control for family background, hence for possible pre-selection. So second, I test the study's hypotheses by logistic regression analyses of the odds of enrolling in advanced math, physics, biology and computer science courses, while controlling for gender and school type, standard of living, father's education and ethnic origin. This multivariate analysis is employed to clarify whether differences in advanced math and science course taking may be attributed to differences in the students' family background.

Differences Between the Student Bodies in the Different School Types

Table 1 presents differences in social background between the student bodies in the different school types. About 81% of the students in this dataset studied at coeducational secular schools. In the religious sector slightly more than 50% studied at same-sex schools, the remainder at coeducational schools with separate classes for girls and boys. The data confirm that the religious coeducational schools catered to underprivileged students. Mean father's education in these schools was 9.8 years, compared to 12 years in the total study population. Almost 60% of the students in the religious coeducational schools were Mizrachim, the less privileged Jewish group in Israel. Differences between religious same-sex schools and secular coeducational schools on socioeconomic indicators proved relatively small, with a somewhat higher level of father's education in the religious schools.

Table 1 Sample characteristics

School type	No. and percent of students	Mean father's education (in years)	Percent Mizrachim
Religious all-female	975 4.5%	13.0	32.5%
Religious all-male	1,073 4.9%	13.5	31.0%
Religious coeducational	1,606 8.1%	10.2	53.8%
Secular coeducational	17,162 81.3%	12.2	31.9%
Total	20,816	12.2	33.6%

Enrollment in Different Levels of Math and in Advanced Physics, Biology and Computer Science

The findings in Table 2 indicate that gender is associated with placement in the different math level courses in all school types, but the patterns differ. In both same-sex religious and coeducational secular schools the well documented pattern of boys taking higher level math courses was found. In both school types boys took more advanced-level math than girls and more 5-unit level courses in the advanced math courses. In these two school types the percentage of boys taking the 5-unit math exam was about 50% greater than the percentage of girls taking it.

The coeducational religious schools exhibited a different pattern. The main gender difference was found in the category of those who did not take the math exam. For both girls and boys the percent of those not matriculating in math was relatively higher than in other school types. This percent was especially high for boys: almost 40%, compared with 27% percent of the girls. This finding was the result of the policy of coeducational religious schools to assign many boys to vocational tracks that do not offer academic courses such as math (Dagan 2006).

Table 3 presents the percentages of students who matriculated in advanced-level physics, biology and computer science by gender and school type. For physics and biology, the findings offer no surprise. In all school types

Table 2 Percent of students who took matriculation math courses, by gender and school type

Gender and school type	Did not matriculate in math	Basic: 1–3 units	Advanced: 4 units	Advanced: 5 units
Girls: religious same-sex	10.1	45.1	32.2	12.6
Boys: religious same-sex	16.7	37.1	27.5	18.7
Girls: religious coeducational	27.2	51.1	16.7	5.0
Boys: religious coeducational	38.6	43.5	12.3	5.6
Girls: secular coeducational	25.7	44.8	18.7	10.7
Boys: secular coeducational	29.4	35.8	18.0	16.9
Mean total	26.5	41.2	19.2	13.2

Note that when using large samples, such as in the present study, X^2 tests of significance usually yield significant results
N=20,816, X^2 =703.62, df=15, p<.001

boys took more advanced physics than girls, and girls took more advanced biology than boys. In computer science, however, unexpected gender equality was found in the religious same-sex schools. The percent of girls who took advanced computer science in this sector was close to the respective percent of boys. This finding is even more remarkable when the percent of girls who took advanced computer science in same-sex schools is compared with the figure for girls in secular coeducational schools. In the latter school type it was only 1.7%, compared with 8.7% percent for girls in same-sex religious schools.

In the coeducational religious schools the number of students who took computer science was very low for both girls and boys, so comparison was practically impossible. Apparently this finding is due to the low socioeconomic composition of the student bodies in these schools. Students from less advantaged background are perceived as less capable of coping with scientific subjects (see Ayalon 1994) so they were probably less likely to be offered computer science courses.

Hypotheses Testing by Logistic Regression Analyses

Table 4 presents the results of logistic regression analyses that estimated the probabilities of enrolling in advanced (5-unit level) physics, biology, computer science and math courses. In all regressions the reference category (the omitted category) was girls in same-sex schools. This category was chosen in order to test differences between this category and all the others. Controls for father's education, standard of living, and origin were entered into all equations. For the origin variables, the reference category was Ashkenazim, the privileged Jewish ethnic group. In the estimation of the probability to enroll in advanced computer science, the coeducational religious schools were omitted because only a few students in these schools enrolled in that subject.

H1. *Girls and boys in same-sex schooling take advanced-level math courses at similar rates*

This hypothesis was not supported by the present data. Girls in all-girl schools evinced much lower odds of taking

Table 3 Percent enrolled in advanced physics, biology and computer science courses by gender and school type

Gender and school type	Physics	Biology	Computer science
Girls: religious same-sex	6.4	18.3	8.5
Boys: religious same-sex	14.4	11.7	10.7
Girls: religious coeducational	2.5	14.0	1.1
Boys: religious coeducational	4.8	8.7	1.1
Girls: secular coeducational	4.2	13.2	1.7
Boys: secular coeducational	14.9	9.2	7.5
Mean total	9.0	11.7	4.7

Note that when using large samples, such as in the present study, X^2 tests of significance usually yield significant results
N=20,816
Physics—X^2 =715.86, df=5, p<.001
Biology—X^2 =121.90, df=5, p<.001
Computer science—X^2 =488.04, df=5, p<.001

Table 4 Exponential coefficients from logistic regression analyses of the probability to enroll in advanced physics, biology, computer science and in advanced 5-unit math courses

	Physics	Biology	Computer science	5 unit math
Gender and school type combinations (girls in religious same-sex schools omitted):				
Boys: religious same-sex	2.49**	.57**	1.39	1.61**
Girls: religious coeducational	.67	1.01	–	.65*
Boys: religious coeducational	1.34	.612**	–	.72**
Girls: secular coeducational	.64**	.70**	.20**	.86
Boys: secular coeducational	2.58**	.45**	.877	1.43**
Father's education (years)	1.16**	1.11**	1.12**	1.19**
Standard of living	1.15**	1.07**	1.21**	1.18**
Standard of living missing	.88	.94	.989	.89
Ethnic origin (Ashkenazim omitted)				
Mizrachim	.67**	.88	.713**	.70**
Second generation Israeli born	.82**	.97	.90	.86**
Intercept	.004**	.004**	.006**	.006**
N	19,524	19,524	18,063	19,524
Pseudo R^2	.12	.03	.11	.10

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

advanced courses in math than boys in both same-sex and coeducational schools. The probability of boys in the religious same-sex sector enrolling in advanced math was about 1.6 times higher than the probability of girls in this sector to enroll in this course.

H2. *Girls in same-sex schooling tend to enroll in advanced-level math courses more than girls in coeducational schooling*

The hypothesis was not supported by the analysis. The probability of girls in all-female schools taking the advanced 5-unit math course was slightly higher than that of girls in coeducational secular schools but the difference was not statistically significant at the .05 level.

H3. *Girls and boys in same-sex schooling take advanced-level physics courses at similar rates*

Again, the hypothesis was not supported by the present data. Girls in all-girl schools showed much lower odds of taking advanced courses in math than boys in both same-sex and coeducational schools. The probability of boys in the religious same-sex sector enrolling in advanced physics was about 2.5 times higher than the probability of girls in this sector doing so.

H4. *Girls in same-sex schooling tend to enroll in advanced-level math courses more than girls in coeducational schooling*

This hypothesis was supported by the data. The probability of girls in all-female schools taking the advanced physics course was about 35% percent higher than that of girls in secular coeducational schools. But additional control for prior achievement would presumably further reduce the difference between girls in the two school types.

H5. *Girls and boys in same-sex schooling take advanced-level computer science courses at similar rates*

In contrast to hypotheses H1 and H3, this hypothesis was supported by the study. In advanced computer science placement, girls in same-sex schools were no different from boys in both religious same-sex and secular coeducational schools. Although the probability of boys in the same-sex sector enrolling in this course was somewhat higher than that of girls in this sector, the difference was not statistically significant at the .05 level.

H6. *Girls in same-sex schooling tend to enroll in advanced-level computer science courses more than girls in coeducational schooling*

Here too the analysis clearly supported the hypothesis. Girls in same-sex schools took computer science much more than girls in coeducational schools. The odds of a girl in a same-sex school taking an advanced computer science course proved five times greater than for a girl in a coeducational secular school, after controlling for differences in social background.

H7. *Girls and boys in same-sex schooling take advanced-level biology courses at similar rates*

H8. *Girls in same-sex schooling tend to enroll in advanced-level biology courses more than girls in coeducational schooling*

These hypotheses were not supported by the data. Regarding biology, girls in all-girl schools took advanced biology courses more than students in all other school types except for girls in religious coeducational schools. This

finding is similar to that of Ayalon and Yogev (1996), who found that girls in religious state schools tend to specialize in biology.

Summary of Results

The logistic regression analyses revealed an inconsistent pattern of gender differences in advanced math and science course taking. In math, girls in same-sex schooling did not make different curricular choices than their counterparts in coeducational schooling. Similarly, the gender gap in enrollment in advanced physics was very large in both same-sex and coeducational settings, although, girls in all-female schools took this subject more often than girls in mixed-sex schools. Regarding biology, this "feminine" subject was very popular among girls in all-female schools, even more than among girls in coeducational secular schools. The only scientific subject in which same-sex schools were different from coeducational schools was computer science. Girls and boys in same-sex schools took this subject at similar rates, and girls in all-female schools took it at a much higher rate than girls in coeducational schools.

Discussion

That girls in same-sex schools display a "non-feminine" pattern only in relation to computer science, but not physics, biology and math, suggests that the all-female environment itself may not be the reason for gender equality in computer science. The explanation seems to be related to differences in the structure of course offerings in the different school types. Although in Israeli high schools students themselves can choose out of a variety of advanced subjects, the schools intervene in assigning students to them, especially in the sciences. This intervention is manifested in determining minimum criteria for enrollment in advanced courses, and in combining different advanced courses into informal tracks (i.e. advanced math and physics, literature and history, etc.).

In secular coeducational schools, taking advanced computer science goes together with the taking 5-unit level math and usually another scientific subject such as physics or chemistry. In these schools about 60% of the students who took advanced computer science, boys and girls alike, also took 5-unit level math; about the same percentage also took advanced physics, or in some cases chemistry. This means that advanced computer science placement is part of a "package deal" that includes the highest level math course and advanced physics or chemistry. Because of prevailing gender stereotypes, this informal tracking probably deters girls from choosing advanced computer science. Possibly because of the same stereotypes, school teaching staffs are also more hesitant to encourage girls to choose this all-scientific combination.

Course offerings have a different structure in religious same-sex schools. Because of the value attached to Jewish studies, most students take advanced courses in these subjects. Consequently, an all-scientific program is much less common in religious than in secular schools. In religious schools, most students combine advanced Jewish studies with an additional advanced science or humanities subject chosen from the various available options. This means that girls in religious schools do not need to choose a "scientific track" but only a science course. Moreover, in these schools less than 30% of the girls who took advanced computer science also took a 5-unit level math course. A 4-unit level math course was sufficient for about 70% of the girls who took advanced computer science.

Computer science was a relatively new subject in the 1990s. Principals of all-female schools probably wanted to introduce it into their curricula because of its prestige and perceived value in the Israeli labor market. Because all-female schools are generally smaller than coeducational schools, and because most girls in these schools take 4-unit level math, it was more reasonable to require 4-unit level math for entry. In contrast, secular coeducational schools had sufficient numbers of students who took 5-unit level math (most of them boys) and were able to use this level as a requirement for entry. In other words, the structure of course offerings made computer science more accessible for girls in same-sex schools than for girls in coeducational schools. This resulted in a much higher rate of girls who took this subject in same-sex schools and elimination of the gender gap in this subject between girls in same-sex schools and boys in both same-sex and coeducational schools. Note that the average score in the advanced computer science matriculation exam was similar for all-female school students and for students from coeducational schools who usually took higher level math. The mean score in advanced computer science was 86.4 for religious all-female schools, 84.8 for religious all-male schools, 82.1 for girls in secular coeducational schools and 86.4 for boys in secular coeducational schools.

Conclusions

This study contributes evidence from Israel to the debate over the advantages of same-sex education. The study's aim was to examine whether girls benefit from same-sex education in math and science, where research shows that they are usually underrepresented. The analysis showed that girls who attended same-sex schools did not dramatically differ from girls who attended coeducational schools in placement in advanced math and science courses. The only

subject in which girls in same-sex schools differed from girls in coeducational schools was advanced computer science. This finding seems to be related to different curricular policy and not to more favorable attitudes to computers.

The Israeli setting is unique in respect to same-sex education because it is part of public education. As such it shares similar curricula, in most subjects, with coeducational schools and is probably less selective than private or independent same-sex education in other countries. Nevertheless, religious education in Israel also involves elements of pre-selection. It draws its students mainly from religious families, and coeducational schools differ considerably from same-sex schools in this sector. Another limitation of the present study is that its dataset does not include information on previous achievement. Yet the fact that similar patterns were found in all school types in most of the analyses implies that pre-selection was not a major problem when control for the family background was employed.

Research on same-sex education often emphasizes the importance of the learning environment for the integration of more female students in math and science studies. For example, in a recent study Logan (2007) examined the learning environment in computer science classes in same-sex and coeducational schools in New Zealand. Girls in coeducational schools were found to be less satisfied with their environment than any other group in the study. The present study could not directly address this issue. A better learning environment is presumably important for all students, especially those who experience stereotype threat (Steele 1997), such as girls in math and science. The findings of the present study, however, indicate that, at least in the Israeli case, same-sex education may not be enough to change educational patterns that are routed in prevailing stereotypes.

As previous research has suggested, curricular policy is associated with inequality in educational opportunities. A policy that matches advanced computer science with the highest level of math and with other "masculine" scientific courses is especially harmful for girls who refrain from choosing these subjects. The religious all-girl school policy of allowing their students to take advanced computer science courses without requiring them also to take the highest level of math and an additional scientific course most probably encouraged more girls to take computer science. This interpretation implies that even without changing gender stereotypes in high school subjects, school administrators can influence gender gaps in math and science course taking and increase the number of girls who choose to specialize in scientific subjects. It might be easier to implement a curriculum which helps girls overcome gender stereotypes in same-sex schools, but it is also possible to implement such a curriculum in coeducational schools. The present study, then, calls for more awareness by teachers, counselors and school administrators of the power of curricular policy in shaping gendered patterns of advanced course placement in high school.

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