Effectiveness and Spillovers of Online Sex Education: Evidence from a Randomized Evaluation in Colombian Public Schools[1]

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Abstract

Sexual health problems cause negative externalities from contagious diseases and public expenditure burdens from teenage pregnancies. In a randomized evaluation, we find that an online sexual health education course in Colombia leads to significant impacts on knowledge and attitudes but no impact on self-reported behavior, on average; although fewer STIs are reported for baseline sexually active females. To go beyond self-reported measures, we provide condom vouchers six months after the course to both treatment and control groups and estimate a 9 percentage point treatment effect (52% increase) on the likelihood of redemption. Using knowledge of friendship networks, we document a strong social reinforcement effect: the impacts of the course intensify when a larger fraction of a student's friends is also treated. In particular, when full sets of friends are treated we find significant reductions in sexually active, frequency of sex, and number of partners. Throughout the analysis we fail to find evidence of cross-classroom spillovers.

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1. Introduction

As young adults marry at older ages, they are more likely to have sex before marriage, increasing exposure to unwanted pregnancy risk and sexually transmitted infections (STIs). In the United States, more than 30% of teenage girls become pregnant at least once by the age of 20, and more than 80% of those pregnancies are unintended (Finer and Henshaw, 2006). Because teenage pregnancy is one of the strongest correlates of dropping out of school (Ambrus and Field, 2008), this has long-term impacts beyond timing of fertility. STI risk is especially high for young adults: one-third of sexually active young people in the U.S. become infected with an STI by age 24, with consequences ranging from discomfort to infertility, cancer, and AIDS (Kirby, Laris and Rolleri, 2007).

In developing countries, adolescents face the same complex choices around sexual activity, with the added constraints of lower availability of information about safe sexual practices and restricted access to reproductive health services. In Colombia, only 55% of sexually active females aged 15-17 used a condom in their first sexual encounter (DHS, 2010). This level of risk-taking is reflected in the fertility rate among adolescents in Colombia of 74 births per thousand, compared to 41 per thousand in the U.S., 14 in Canada, 6 in Japan and 5 in the Netherlands (U.N., 2004). By age 19, 20% of female adolescents in Colombia have been pregnant while 16% are already mothers.[2] As Fortson (2009) has argued, sexual risk-taking in developing countries has graver consequences because governments lack the resources and health systems to treat diseases such as HIV.

Acknowledging the public health importance of this issue, substantial amounts of research have focused on understanding how school-based sexual health education can improve students' knowledge, attitudes, and behavior. Recent comprehensive reviews of this literature include Kirby, Laris and Rolleri (2007), Kirby (2008), and Chin et al. (2012), which find evidence that a plurality of these programs are effective at improving knowledge, attitudes, and behaviors such as self-reported condom use.

Until now, the literature has mostly focused on the evaluation of human-led interventions (by adults or peers). In recent years, however, the rise of information and communication technology (ICT) programs has changed school-based sexual health education.[3] Some research suggests that teenagers may learn less from computer-based instruction than from conventional teacher instruction (*c.f.* Angrist and Lavy, 2002; Krueger and Rouse, 2004; Barrera-Osorio and Linden, 2009). However, recent evidence suggests that the opposite may hold true for sexual health programs. Kiene and Barta (2006) evaluated a computer-based

[2] All figures in the international comparison are for ages 15-19.
[3] Early work using new technology focused on videos (Downs et al. 2004) and found encouraging results.

program for college students in the U.S. using a randomized control trial and found that condom use increased significantly one month after the intervention. Roberto et al. (2007) studied a six-session online program targeted at rural adolescents in the U.S. and found a reduction in the number of sexual partners and a delay in the initiation of sex five months after the intervention. Noar et al. (2009) review recent computer-based interventions focused on HIV prevention and find similar efficacy as with human-delivered interventions.

Online sexual health education has become an increasingly attractive option for three main reasons. First, online programs may prove easier to scale-up than human-led programs, especially in countries that have already invested in Internet-equipped computer labs in schools. Second, computer-based courses can be used by students in settings where teachers, health workers or peers refuse or are unable to provide in-person instruction. Third, human-led group settings may not be the ideal learning environment for topics such as sexual health. The sensitive nature of the material can create discomfort and lead students to avoid engaging with the material or participating at all. From this perspective, the anonymity and privacy associated with computer-based learning may actually be better suited to teaching adolescents about sexual health (Barak and Fisher, 2003). For example, Paperny (1997) concludes that a computer sexual-risk assessment program was perceived as nonjudgmental by adolescent users, while an in-person risk assessment was perceived more negatively.

We implement a randomized control trial to evaluate an online sexual health education course designed by the Colombian non-profit organization Profamilia (a member of Planned Parenthood International) and implemented among adolescents in Colombian public schools. The course involved the use of five separate modules covering the topics of sexual rights, pregnancy/family planning and the use of contraceptives, STIs/HIV and the use of condoms, objectives in life and the role of sexuality (empowerment), and prevention of sexual violence.[4] The program was implemented over the course of an academic semester and involved scheduled sessions in the school's computer lab with teacher supervision. In addition, students had access to the course from any Internet-enabled computer using a password-protected account. Students were also assigned an anonymous remote tutor in the central Profamilia offices who would answer questions related to the material individually and confidentially. The sample consisted of 138 ninth-grade classrooms from 69 public schools in 21 Colombian cities. Pre-intervention characteristics were assessed using a baseline survey before students knew they would be taking a sexual education course. We conducted an initial follow-up survey one week after course

[4] Silverman, Raj and Clements (2004) show that dating violence is a relevant pregnancy risk among adolescents.

completion to measure immediate changes in knowledge and attitudes, and a second follow-up survey six months after the course to measure medium-term impacts.

Beyond the developing country context, there are three main innovations in this study. The first tries to address the problem of self-reported outcomes in the sexual health literature by augmenting standard self-reported measures with administrative data on the redemption of vouchers for condoms at a local health clinic six months after the end of the course. This objective outcome addresses the criticism of self-reported data and is arguably as close as we can come to measuring the actual use of condoms in a credible manner. The emphasis on this particular outcome is attributable to the fact that condom use is the key policy target typically employed to prevent STIs and pregnancy among teenagers.

Second, by randomizing treatment across schools, and then across classrooms within schools, we utilize an experimental design that not only allows for an assessment of direct impacts for treated students, but also allows for the measurement of spillovers from treated to untreated classrooms in the same school.

Third, we present an analysis of the role of friendship networks in sexual health outcomes. We are able to assess the extent to which the sexual education course has a differential impact depending on the percentage of a student's friendship network that gets treated (network level complementarities, or what Manski, 2011 calls reinforcing interactions). Knowledge of a student's friendship network also allows us to determine if the fact that a given student receives the course has an indirect impact on outcomes for a friend that did not take the course (network level spillovers).

In the baseline and follow-up surveys[5] we obtain measures on sexual health knowledge, attitudes, and behavior. We create standardized indices to determine the effectiveness of the course on sets of related outcomes. We find that Profamilia's course caused improvements in sexual knowledge and attitudes along most measured outcomes among intent-to-treat students. These students are better able to identify safe and risky sexual practices, STI symptoms, and violent or abusive sexual situations. In the literature, for this type of sexual education course — targeted at teenagers around sexual initiation, where the majority of the sample is sexually inactive — knowledge and attitudes have been the most common outcome indicators.

[5] The surveys were paper and pencil so that the effects would not be confounded with familiarity with a computer. They surveys were self-administered in the classroom.

The overall sexual behavior index (defined for the whole sample, regardless of sexual initiation) does not reveal significant differences in self-reported sexual practices. Although we do not observe significant impacts of the course on many outcomes on average, we do find a reduction in STI presence (-5.2 percentage points, p=0.01) for females who are sexually active at baseline (relative to females that are sexually active at baseline in the control group). Because STI prevalence six months after the course among sexually active females at baseline in the control group is 6.3%, this estimate means that STI prevalence among sexually active females is substantially reduced and brought much closer to zero.

For condom voucher redemption, we find that 27% of treatment students redeem them, compared to 18% of control students, a 52% increase in redemption (p=0.05). We put substantial weight on this result as it provides objective evidence of an increase in condom demand. Although the treatment effect is large and statistically significant for the full sample, it is noticeably non-existent for sexually active females relative to sexually inactive females as well as both active and inactive males (for which treatment effect equality for all three of those groups cannot be rejected). So why do sexually inactive at baseline females redeem vouchers, but not sexually active females? One simple reconciliation, that also is consistent with the STI result, is that sexually inactive at baseline women redeem condoms as a precautionary measure, whereas sexually active at baseline females demand that their boyfriends provide condoms, not them. The fact that sexually active at baseline males do not report an improvement in STI presence, as the sexually active females do, could be a by-product of heterogeneous response within the set of males sexually active at baseline, with some becoming more promiscuous and others less (see Jamison et al. 2013 for similar evidence of sexual sorting from a sexual health campaign in Uganda).

Under the assumption that the only channel through which the training had an impact on sexual behavior is through knowledge and attitudes as taught in the course, we can take advantage of the random assignment to treatment to obtain an instrumental variable estimate of the effect of knowledge and attitudes on self-reported sexual behavior. We find that a one standard deviation (SD) increase in the index of knowledge and behavior leads to a one-fifth SD increase in the sexual behavior index, a larger effect than the one obtained from a standard OLS estimation. Naturally this exercise requires that the exclusion restriction holds. If, for example, the program also led to increased social interaction (e.g., class discussions) that led to behavior change, concurrent with the observed increase in knowledge and attitudes, the IV approach would be invalid. We do not have a direct test of the exclusion restriction, and caution the reader on the necessary assumption for causal interpretation.

We address spillovers in two key ways. First, we observe non-treated classrooms in treatment schools as well as classrooms in pure control schools. Second, we gather data on social networks within and across classrooms. In our first approach, we do not find clear evidence of spillovers from a treated classroom to a non-treated classroom in the same grade and school (which we refer to as a spillover classroom).[6] In our second approach, we find strong evidence of reinforcement: treatment effects are largest when those treated are friends with people who were also treated (after controlling for number of friends overall). For someone who took the course but whose best friends were not in the same classroom (taking the course), the estimated effect size of the course was approximately half of the size as someone who took the course and whose full set of best friends was in the same classroom (also taking the course). In particular, when whole networks of friends take the course, we not only find much stronger effects in terms of knowledge and attitude indicators, but we also observe significant improvements in sexual behavior indicators: reductions in the number of sexual relationships, frequency of sex, and number of partners.

These results complement recent literature on peer effects in sexual health. Dupas (2011) finds positive information spillovers across cohorts of secondary school students in Kenya from an HIV information campaign. Fletcher (2007) and Richards-Shubick (2011) provide evidence that peer group norms have a first-order effect in explaining sexual health outcomes. Our results show that not only do peer groups matter for explaining behavior in equilibrium, but also that the treatment effects of interventions are influenced by social networks.

In terms of cost-effectiveness, we find that $1,000 spent[7] allows Profamilia to provide services to 68 students. We estimate averted STIs per $1,000 spent using two strategies. The first uses the direct estimate on STI reductions among the sexually active at baseline. Assuming a generous rate of decay of the effect of the course (25% annual decay), and accounting for sexual initiation patterns with age, we estimate that $1,000 spent on the course averts 5.3 STIs. The second strategy uses the condom redemption result. We interpret the 9.4 percentage point increase in condom demand as indicating increased condom use by adolescents, which, when combined with estimates of the response of STIs to condom use from the medical literature (Gallo et al. 2007), implies a reduction of 2.0 STIs per $1,000 spent on the course.

The benefits of averting an STI are estimated in the literature to be between $634 and $785 (Ebrhaim et al. 2005; Brent, 2011), and this helps us benchmark the cost-effectiveness of the course. Using the condom voucher result, averting an STI is estimated to cost $501, resulting in a benefit to cost ratio of

[6] Both treatment and spillover groups are chosen at random within schools.
[7] All figures in 2012 U.S. dollars.

1.56. If we use the STI reduction result from the survey, we estimate the cost per averted STI at $188, resulting in a benefit to cost ratio of 4.18.

The paper proceeds as follows. In Section 2 we describe Profamilia's online sexual health education course. Section 3 explains the experimental design and econometric strategy. Section 4 presents the results, and Section 5 concludes.

2. The Profamilia Internet Sexual Health Education Course

Profamilia is an internationally recognized non-profit provider of family planning and reproductive health services in Colombia, with over 33 clinics and 1,800 employees. A member of the International Planned Parenthood Federation since 1967, Profamilia is Colombia's largest non-governmental organization focused on sexual health and reproductive health. Profamilia's education branch, Profamilia Educa, developed the online sexual education course. Development of the online course was motivated by the deterioration of some important adolescent sexual health indicators, such as teenage pregnancy rates (DHS, 2005), as well as legal changes, which mandated the introduction of a sexual health curriculum in Colombian public schools. Legislation establishing sexual education as obligatory in public schools was passed in 1994, and national public policy was drafted by 2003 (Ministerio de la Protección Social, 2003). In practice, however, sexual education in public schools remains limited. For most adolescents, lectures on anatomy during biology class cover the extent of sexual education currently being implemented (DHS, 2010).

Rooted in Profamilia's 40 years of experience in providing Colombian youth with services and counseling for sexual and reproductive health,[8] the online course provides a comprehensive curriculum aimed at shaping adolescents' understanding and perceptions of sexuality, risks, reproductive health, sexual rights, and dating violence. All modules have a human rights approach to pregnancy and teen sexuality. They focus on helping the student recognize herself as a person endowed with rights, such as the right to say no to sex, to access basic health services, to access family planning services, and to live without sexual violence.[9]

Profamilia's course takes full advantage of Internet connectivity to provide an interactive experience and responsive, anonymous counseling. The modules can be accessed any time of day, and there is a remote

[8] See Miller (2010) for a study of long-term effects of Profamilia family planning services in Colombia.
[9] Examples from the course modules can be accessed at www.profamiliaeduca.com/profamilia/index.php

tutor available to answer questions and support the learning process. These features aim to create a safe social environment for adolescents to discuss sensitive topics.

Treatment consisted of five modules of Profamilia Educa's course. Students worked on the course for a total of 11 weeks. Each group of treated students was initially given three weeks to become acquainted with the platform and complete activities in the first module. After the first three weeks, each group was given two weeks per module to complete activities in the remaining four modules. Each school dedicated at least one session of 1.5 hours per week to allow the students to complete the course in the school's computer labs. The students were also allowed to continue working on modules at home, at a public library, or at an Internet café.

In school, each group worked on the course in the presence of a teacher, who was tasked with helping the students resolve questions about use of and access to the platform but not questions related to the content of the course. Every student was directly assisted and monitored by an online tutor, who was a trained Profamilia counselor that dedicated part of his or her day to overseeing students during their completion of the course. The tutors have two main roles: answering students' questions about the course contents and monitoring the students' performance.[10]

At the end of every module, the tutor provided the teacher responsible for the group with a grade for each student, based on the results of a test. Each school participating in the course included these grades as a component of the grade of one subject, typically computer education. Each student had to complete module evaluations individually, which was the basis for his or her individual performance report. Participation in the course was mandatory for students.

3. Experimental Design and Estimation Strategy

Sexual education courses must ideally be targeted at children of the appropriate age to benefit from them. Very young children may not yet be interested in sexuality issues, which points towards the benefits of targeting an older age range. On the other hand, sexual education should in principle be provided before sexual initiation to convey its full benefits. In Colombia, 13.5% of adolescents have sex before age 15, and 60% have sex before age 18.[11] For this reason, Profamilia's course targets 14-15 year olds.

[10] Unfortunately, we did not get access to records of the interactions between tutors and students.
[11] In the U.S., 15% of adolescents have sex before age 15 (Flanigan et al. 2006). In our sample of 15-year-old urban Colombian public school students, 33% had sex prior to beginning the course.

The sample frame consists of ninth-grade students in Colombian urban public secondary schools. Given our interest in cross-classroom spillovers, we required enrolled schools to have at least two ninth-grade classes. Schools were also required to have at least one computer room with Internet access.[12] All participating administrators of the schools had to consent for their school to participate in the field experiment before knowing the results of the randomization. Schools agreed to facilitate data collection and coordination, to make a computer lab available for the prescribed time every week (if selected to implement the course), and to not substantially modify their sexual and reproductive health education for ninth-graders during the study. A short questionnaire for school principals at baseline revealed that sexual education in our sample was either non-existent, a topic covered in biology class, or consisted of one or two visits per year by a health professional. Schools in the control group received a sports equipment package as compensation at the end of the study.

The sample consists of 69 public secondary schools recruited in 21 cities with a Profamilia clinic presence.[13] From each school, two classrooms of ninth-graders were selected to participate in the study. If the school had more than two classrooms of ninth-graders, a pair was randomly selected to partake in the study.

Six months after the end of the study, we offered students a voucher for six condoms with a total market value of about $5 dollars at the local Profamilia clinic. The offer was made via an email for all students and additionally via an SMS message for those who provided us with a cell phone number (86% of the sample). To assess whether voucher redemption was hindered by transportation costs to the local clinic, we randomly offered reimbursement for the cost of a bus trip (about $1.50 USD) to half of the students, payable at the clinic when they redeemed the voucher. Profamilia then recorded which students redeemed their voucher at the local health clinic.

Randomization Procedure

Because the sexual education course was part of the curriculum of a computer education (or similar) course, treatment was at the classroom level. Hence our randomization unit is the classroom (also referred to as group). There are three types of classrooms: treatment, spillover and control. The randomization is

[12] We selected schools with a functioning computer lab connected to the Internet with at least one computer for every three students. On average schools had 38 computers with a ratio of approximately one participating student per computer.

[13] The sample excludes rural public schools. In urban settings, it is common for schools in Colombia to have two shifts per day (morning and afternoon). A student is offered a place at a certain shift before the beginning of the school year and once a school is selected, he/she cannot take classes in other shifts or switch shifts. Given the lack of interaction among children of different shifts, we treat different shifts in our sample as different schools. We use both shifts for 13 schools in our sample.

done in two stages. First, schools are randomly assigned to either treatment or control. Then, within treatment schools, classrooms randomly are assigned to either the treatment or spillover condition. A spillover classroom does not receive the treatment, but is in the same school as one which does.

Table 1 shows the partition of schools and groups in the study. We study 138 groups spread over 69 schools. Our total sample size is 4,599 students, with an average of 33 students per group. 46 groups were assigned to control (across 23 schools), 46 groups (across 46 schools) were assigned to treatment, and 46 groups (across the same 46 schools) were assigned to the spillover condition.

Randomization of treatment was performed before the baseline survey. We obtained some basic information about participating school characteristics, reported in Panel A of Table 2. After randomly assigning groups to different conditions, we verified that assignment to treatment was not correlated with any of the available variables.[14]

Implementation

The sexual education course was implemented from August through November 2009 in schools that began their school year in January[15] and from November 2009 through March 2010 in schools that began their school year in September. As expected for a middle-income country, it was not difficult to recruit schools with computer labs. However, it proved more difficult to recruit schools with workable Internet connections. In three of the 46 groups assigned to treatment, lack of Internet access prevented implementation of the online course.[16] In some treatment groups, students were unable to complete all five modules due to unforeseen events such as teacher strikes. Grades on the tests at the end of each module were on average 4 out of 10, with a large mass at zero (48%). Excluding those students with a score of zero, the average was 8 out of 10, suggesting an acceptable degree of understanding for those actually taking the course and the tests. The high proportion of scores equal to zero highlights the challenges of student compliance associated with online education.

[14] Specifically, we drew randomizations with different starting seed values, testing each one for orthogonality on the set of covariates listed in Panel A, and then stopping when a randomization yielded no t-stat larger than 2.0. As discussed in Bruhn and McKenzie (2009), a better approach, rather than what we did, defines a set number of randomizations (e.g., 10,000) and then chooses the one with the most orthogonal assignment.

[15] The school year in some regions of Colombia begins in January (Calendario A), whereas in other regions it begins in September (Calendario B).

[16] For the statistical analysis, these classrooms are still in the intent-to-treat group.

Panel B in Table 2 shows summary statistics by treatment condition. The average age is 15 years (mid-adolescence) and 43% of the sample is male. 44% of students in the sample are sexually active and 32% have a computer at home.[17]

Baseline Balance

Panels A and B in Table 2 show that there are no statistically significant differences across treatment, spillover and control groups except for gender: the control group has 7.6 percentage points and 8.8 percentage points more males than the treatment and spillover groups, respectively. Furthermore, an F-test from a regression of treatment assignment on a full set of baseline characteristics does not reject the null hypothesis that all baseline coefficients are jointly equal to zero (reported in the final row of each panel).

Econometric Specification

Randomization allows for identification of reduced form intent-to-treat effects. Let Y_{ijt} denote an outcome of interest at follow-up (t =1,2) for individual i in classroom j. Treatment and spillover classroom assignment dummies are denoted by T_j and S_j respectively. Treatment classrooms were selected for online sexual health training whereas spillover classrooms were not selected for the training but are in a school that has a treated classroom. We also include the baseline dependent variable as control for precision. We estimate the following regression model via ordinary least squares as our main specification:

$$Y_{ijt} = \alpha_1 + \beta_1 T_j + \beta_2 S_j + \beta_3 Y_{ij0} + \varepsilon_{ijt}, \tag{1}$$

where the error term ε_{ijt} is assumed to be uncorrelated across schools but not within them. Hence, we cluster standard errors at the school level. Because T_j and S_j were randomly assigned, the estimated coefficients are unbiased estimators of the intent-to-treat effects of the course, which we argue are the policy coefficients of interest.

We have multiple measures of sexual health knowledge and attitudes in the survey. However, testing multiple outcomes using (1) for each measure independently increases the probability of rejecting a true null hypothesis for at least one outcome above the significance level used for each test (Duflo, Glennester

[17] Summary statistics for every question used in the survey are reported in Appendix 1.

and Kremer, 2007). Hence, we follow Katz, Kling and Liebman (2007) and define a summary measure Y^* as the unweighted average of all standardized outcomes in a family. That is, we obtain:

$$Y^* = \frac{\sum_k Y_k^*}{k}\text{, where } Y_k^* = \frac{Y_k - \mu_k}{\sigma_k}.$$

For standardization of each variable we use the estimated mean and variance at baseline. Thus, the mean and standard deviation of β in (1) allows us to test whether treatment had an overall positive effect on the corresponding family of outcomes. Furthermore, because the index is standardized, the estimate is easily interpreted as the effect of the course in terms of standard deviations of the outcome variable at baseline.

For sexual behavior outcomes which are of interest on their own (Tables 5 and 10), many are binary outcomes, and hence are not standardized (except for the behavior index column, which aggregates multiple variables, we use the method above to standardize). For interpretation of the sexual behavior outcomes we also report the mean of the dependent variable for the control group.

We also report heterogeneous effects by sexual activity status at baseline and gender, using the following fully saturated specification:

$$\begin{aligned} Y_{ijt} &= \alpha_2 + \beta_4 A_{ij} + \beta_5 M_{ij} + \beta_6 T_j + \beta_7 S_j + \\ &+\beta_8(A_{ij} \times T_j) + \beta_9(A_{ij} \times S_j) + \beta_{10}(M_{ij} \times T_j) + \beta_{11}(M_{ij} \times S_j) + \beta_{12}(A_{ij} \times M_{ij}) + \\ &+\beta_{13}(A_{ij} \times M_{ij} \times T_j) + \beta_{14}(A_{ij} \times M_{ij} \times S_j) + \beta_{15} Y_{ij0} + \varepsilon'_{ijt}, \end{aligned} \tag{2}$$

where A_{ij} is a binary variable that equals one if the student was sexually active at baseline and M_{ij} is equal to one if the student is male. This allows us to differentiate between effects of the course by gender and for students who were reached pre-/post-coital initiation.

4. Results

We present the first set of results in Tables 3-5, using aggregate standardized indices on knowledge (Table 3), attitudes (Table 4) and behavior (Table 5).[18] Table 5 also reports the results on the condom voucher experiment. All tables consist of two panels. The first panel includes estimates from equation (1), while the second panel reports heterogeneous impacts by gender and sexual activity status at baseline from equation (2). For each indicator, we include the results from both follow-ups, the first taken one

[18] The tables include the definition of the individual variables used in the construction of each index. For space reasons, we do not report results on every individual outcome but they are available upon request. As mentioned before, the Behavior table does not standardize the dependent variable except for the Behavior index in Column 8.

week after the end of the intervention and the second one taken six months after the end of the intervention. We focus more on the results of the second follow-up; however, the comparisons of effects between the short- and medium-run give us an indication of the durability of the effects.

Knowledge

Table 3 presents the impacts on five standardized indices which measure knowledge of the identification of STI symptoms and causes, recognition of sexual violence, prevention of STIs, prevention of undesired pregnancies, and proper condom use. Column 6 is an index of all the variables used in the table. The aggregate knowledge index suggests a 0.37 SD increase in overall knowledge one week after the intervention and a 0.38 SD increase in overall knowledge six months after the intervention. On an index-by-index comparison, the lowest impact is found on the identification of situations of sexual violence - we find that treated beneficiaries are 0.11 standard deviations (SD) more likely to correctly identify a situation of sexual violence. The largest impact is found on the knowledge about STI prevention, where treated teens are 0.52 SD more likely to correctly identify proper condom use as the safest method to avoid acquiring an STI six months after the end of the intervention. The impact on the identification of sexual violence was larger when the questions were asked one week after the end of the training, suggesting that knowledge vanishes gradually with time. This knowledge decay pattern, however, is not found in all indices. Indeed, the opposite pattern appears in the cases of pregnancy prevention knowledge and STI prevention knowledge. The second row in Panel A shows that we do not find clear evidence for cross-classroom spillover effects on average on knowledge about sexual and reproductive health.

Panel B in Table 3 presents evidence that knowledge effects are not heterogeneous across gender and baseline virginity. We cannot reject the null hypothesis that the effects are the same for those sexually active at baseline compared to those sexually inactive.

Attitudes

Table 4 presents the results on three attitude subindices: attitudes towards the use of condoms, conservatism with respect to age of initiation of sexual activities, and attitudes toward denouncing and seeking help in the event of sexual abuse. Column 4 presents an overall index of attitudes, containing all variables used in the table. We find significant effects of 0.24 SD in terms of attitudes one week after the intervention and 0.17 SD six months after, which suggests some decay in attitude impacts over time.

Significant effects were found for each subindex six months after the intervention. The training was effective in generating a more positive attitude towards condom use, a more conservative attitude towards sexual activity, and an increased awareness regarding sexually abusive situations among participating teenagers. Indeed, trained teens scored 0.13 SD higher in the sexually conservative attitudes subindex composed of the following variables: a) indicates that individuals their age should not have multiple sexual partners in the same month; b) thinks it is too early for individuals of their age to engage in sexual activities; and c) feels confident he/she will be able to wait to have sex until emotionally prepared to do so. Treated teens are also 0.11 SD more likely to agree with the need to report cases of sexual abuse to the authorities and the need to seek medical attention in such situations. The training was also successful in generating more positive attitudes towards the use of condoms at the first follow-up (0.17 SD) and at the second follow-up (0.10 SD). For attitude indicators, we again find no consistent evidence of spillovers across classrooms.

These results on knowledge and attitudes are important because these two factors have been shown to be the strongest protective factors in preventing STIs, HIV and pregnancy among teens (Kirby, Lepore and Ryan, 2005). Furthermore, recent research has documented the important role that social norms play in responsible sexual behavior (Munshi and Myaux, 2005; Ashraf, Field and Lee, 2009). By changing knowledge and attitudes in youth attending school, sexual education can ultimately play a fundamental role in achieving desirable aggregate changes in sexual behavior. We return to this point after presenting reduced form evidence of program impact on behavioral outcomes.

Sexual Behavior

In Columns 1-8 of Table 5, we show self-reported sexual behavior outcomes measured six months after the intervention. We report individual outcomes in Columns 1-7 and an overall index of behavior in Column 8 (average of standardized outcomes). The estimation reveals that the course did not change the average number of partners, frequency of sex, or rate of abstinence over the six months following the course. An often-made argument against sexual education in early adolescence is that that it will result in increased sexual activity. Our results reject this, which is consistent with results from other studies (Chin et al. 2012).

In terms of risky sex indicators, we find a reduction in the incidence of STIs among treated girls that were already sexually active at baseline (-5.2 percentage points,[19] p=0.01). Because STI prevalence six months after the course among sexually active females at baseline in the control group is 6.3%, this estimate means that STI prevalence among sexually active females is substantially reduced and brought much closer to zero (the prevalence of STIs among the non-sexually active).

Our summary of self-reported behavior (in which a negative sign signifies a reduction in risky sex and an *increase* in contraceptive and condom procurement) is reported in Column 8, which shows that although the point estimate is suggests an improvement in average self-reported sexual behavior, it is not statistically significant.

Condom Vouchers

The validity of self-reported sexual behavior among adolescents has long been a limitation in the literature (Brener, Billy and Grady, 2003). By measuring the percentage of students who redeem vouchers for condoms at the local health clinic, we address the possible lack of reliability in self-reported outcomes via an objective safe-sex practice metric. Condom availability is important for adolescent health given the sporadic nature of adolescent sexual activity.

Column 9 in Table 5 reports the results of the voucher experiment. The administrative data from voucher redemption shows statistically significant and important effects. We find that 27% of treatment students redeem them, compared to 18% of control students, a 52% increase in redemption (p=0.05). We put substantial weight on this result as it provides objective evidence of an increase in condom demand. Although the treatment effect is large and statistically significant for the full sample, it is noticeably non-existent for sexually active females relative to sexually inactive females as well as both active and inactive males (for which treatment effect equality for all three of those groups cannot be rejected).

Why do sexually inactive at baseline females redeem vouchers, but not sexually active females? One simple reconciliation, that also is consistent with the STI result, is that sexually inactive at baseline women redeem condoms as a precautionary measure, whereas sexually active at baseline females demand that their boyfriends provide condoms, not them. The fact that sexually active at baseline males do not report an improvement in STI presence, as the sexually active females do, could be a by-product of heterogeneous response within the set of males sexually active at baseline, with some becoming more

[19] This is the sum of coefficients on *Treatment* and (*Treatment* * *Sex active*) in panel B of Table 5.

promiscuous and others less as, in Jamison et al. (2013) who find evidence of sexual sorting from a sexual health campaign in Uganda.

The distance from the school to the clinic and bus reimbursement coefficients are of the expected sign: for those offered reimbursement of bus fare, the redemption rate was 3.5 percentage points higher, and similarly those who live further are less likely to redeem.

The Effect of Knowledge and Attitudes on Behavior

The established literature has long argued that there exists a causal effect of knowledge on health behavior (*cf*. Kenkel 1991). In doing so, researchers have been aware that an OLS regression of behavior on knowledge does not provide consistent estimates due to the presence of unobserved factors which can influence both variables, such as parental education or expectations about the future (Kearney and Levine, 2012). Reverse causation may also contribute to the lack of consistency in OLS estimates. For example, a risky sex event may trigger a search for information and hence an increase in knowledge.

Kenkel (1991) in particular posits a structural relationship between knowledge and behavior, where knowledge is an endogenous variable, and then uses an instrumental variables approach to estimate the impact of knowledge on behavior. A requirement for the consistency of this strategy is that the sole mechanism through which behavior can be affected is knowledge. We use the randomly assigned sexual education course as an instrument for an index of knowledge and attitudes, and then estimate the effect of knowledge and attitudes together on sexual behavior. The exclusion restriction requires that the course only affects behavior through its effect on knowledge and attitudes. As long as this condition holds, we can estimate the effect of knowledge and attitudes on sexual behavior for those affected by the course (a local average treatment effect, or LATE). This exercise is valuable because it provides a credible estimate of the effect of sexual knowledge and attitudes on future sexual behavior. It can also help interpret estimates from studies which are limited to knowledge and attitudinal outcomes because it establishes a quantitative relationship between these measures and sexual behavior. However, caution is advised. For instance, perhaps the course also has an impact on behavior due to an authoritarian effect, or through increased social interactions and shifting social norms, which would happen concurrently with the shifts in knowledge and attitudes captured in the index. This would be a violation of the exclusion restriction necessary to interpret the IV regressions as causal from the knowledge and attitudes index to behavior.

Table 6 presents OLS and IV estimates of behavior on an index of knowledge and attitudes.[20] Columns 1 and 2 are presented without controls, while Columns 3 and 4 control for gender and sexual activity at baseline. The F-statistics reported in the table rule out weak instruments. The OLS estimate is small in both columns (-0.028 and -0.039, respectively), while the IV estimates are much larger.[21] While the IV estimate in Column 2 is imprecisely estimated, Column 4 suggests a large effect of knowledge and attitudes on behavior. For every standard deviation increase in the knowledge and attitudes index, the IV estimate predicts a 0.23 standard deviation improvement in the behavior index. This magnitude is broadly consistent with the reduced form estimates, which showed a relatively large effect of the course in terms of knowledge and attitudes (0.38 SD for knowledge and 0.17 SD for attitudes), and a smaller effect in terms of behavior (approximately one-fifth of the size, at 0.04 SD).

Beyond interpreting these results as evidence that the effects of knowledge on behavior are economically and statistically significant, the reader can also take away from these results that the individuals who improved their knowledge and attitude scores by the course were also those that presented improvements in terms of sexual behavior.

Friendship network interactions and spillovers

In this section, we analyze treatment and spillover effects, differentiating between students for whom a small or a large percentage of friends was also treated. In the surveys, students were asked to identify their closest friends by name, and indicate if they were in the same school and/or classroom. We used this information to match each student's social network to the list of students in the treatment and spillover groups. Table 7 presents summary statistics about the network treatment distribution. The table shows substantial variation in the number of friends that are located in the same classroom as a treatment student. For students in a spillover classroom, there are very few links to students taking the course (in the treatment classroom). Indeed, 89% of spillover students have no best friends in the treatment classroom - this affects the precision of the spillover estimates.

With this information, we obtain the proportion of the student's network of closest friends who were treated (Friends in the same classroom / Total listed friends).[22] If a student and his or her entire network

[20] The knowledge and attitudes index is composed of all the items in the knowledge and attitudes indices of Tables 3 and 4.
[21] The OLS estimates in Columns 1 and 3 are smaller possibly because adolescents who engage in more risky sexual practices become more sexually knowledgeable as a result, biasing the estimates downwards.
[22] One shortcoming of our network analysis is that the questionnaire did not clearly differentiate between friendship and romantic relationships.

of close friends were all in the same treatment classroom, then the proportion is equal to one, but if the network of friends includes students from other classrooms or from outside the school, then the proportion is reduced. We will use variation in the proportion of best friends that are in the student's classroom to estimate a heterogenous treatment effects regression in which the main effects are now interacted with the proportion of friends in the network who were treated (F_{ij}). The specification becomes:

$$Y_{ijt} = \alpha_3 + \beta_{16}T_j + \beta_{17}(F_{ij} \times T_j) + \beta_{18}S_j + \beta_{19}(F_{ij} \times S_j) + \beta_{20}N_{ij} + \beta_{21}Y_{ij0} + \varepsilon''_{ijt}, \qquad (3)$$

where N_{ij} is a control for the number of friends the individual has,[23] and as before, standard errors are clustered at the school level. In Tables 8-10, the interpretation of the main effect (T_j) now becomes the effect of assignment to treatment for someone who has zero friends also treated, whereas the coefficient on ($F_{ij} \times T_j$) is the additional effect of the course for someone whose full set of friends are also treated (analogously for S_j).

We want to make clear that the distribution of a student's network of friends is not a randomly assigned variable (the variation is coming from whether the student's friends are in his or her classroom or are rather neighbors, relatives, etc.). This may lead to bias if, for example, more extroverted students have a larger proportion of their best friends in the classroom and this extrovertedness is related to the outcome beyond the effect stemming from social reinforcement. For this reason, we condition on N_{ij}, the number of individuals that mention a student as a best friend. The necessary assumption hence becomes that the proportion of friends in the classroom is related to the treatment response only through the network effects (conditional on the number of friends).

With this assumption in mind, we present the results for network interactions in Tables 8-10. Table 8 provides clear evidence of a significant reinforcing interaction effect for students in the treatment group in terms of the overall knowledge index (Column 6). We are able to identify an effect of 0.46 SD in knowledge for wholly treated networks, as opposed to a 0.28 SD effect if the student's network is not treated. In contrast, we do not find significant effects for spillover students, even if their network was fully treated. As noted before, we obtain large standard errors for the spillover estimates due to the small number of spillover students with treated networks. At the bottom of each column we report the p-value from a test of equality of the friendship interaction effects for treatment and spillover students. The

[23] This is calculated as the number of people who mentioned individual *i* as a best friend.

reinforcing interaction effect is positive, large and significant for all subindices except for the sexual violence knowledge and condom use knowledge subindices (Columns 2 and 5).

Table 9, on attitude indicators, finds an even starker reinforcing interaction effect. In this case, the effects are significant *only* if the student's friendship network also took the course. For example, if a student's full network was treated, the student is predicted to have a 0.24 SD higher attitude index score, whereas the estimated effect is only 0.04 SD if no one in his or her friendship network was treated. Similar outcomes are observed in each of the subcomponents of the index. As in Table 8, there is no significant network spillover effect for a student that did not take the course.

The effects on behavioral outcomes reported in Table 10 shed light on previously undocumented effects of the role of friendship networks on sexual education program impacts. We had learned in Table 5 that the program had scant effects on individuals' self-reported sexual behavior. However, when examined more closely by degree of intensity within social networks, we find strong reinforcement effects for the overall sexual behavior index (0.19 SD). In particular, the reinforcement effects are significant for number of sexual relationships, frequency of sex, and number of partners over the past six months. This provides evidence that the relevant group for a reinforcement effect is the network of friends, as suggested in Sacerdote (2011). Note that in each of these cases, the straight treatment effect (i.e., the point estimate for those with no friends assigned to treatment) is actually positive (i.e., riskier behavior), and is statistically significant for one of the three outcomes (frequency of sex). While sexual behavior effects could be purely mechanical (i.e. the partner of an adolescent who used a condom during the last sexual encounter obviously also used a condom), the knowledge and attitude effects are not, and hence provide direct evidence of peer interaction effects.

The last column in Table 10 shows that treatment students are 8 percentage points more likely to redeem their vouchers than the control group even if none of their close friends were treated. However, we find no evidence for reinforcing effects when a larger proportion of the student's network is treated. Column 9 also shows a puzzling result in which spillover students whose entire friend networks were treated are 16 percentage points less likely to redeem their condom vouchers than the control group. This is inconsistent with Column 4, in which spillover students whose network was fully treated report fewer STIs six months after treatment. We attribute this instability to the small number of observations in the spillover group with friendship links to treated students.

List Randomization

Following Karlan and Zinman (2012), we implement a list randomization strategy[24] to elicit misreporting in two sensitive questions: (1) "Did you have sex without a condom in the last six months?" and (2) "Did you have sex in the last six months?" The technique is relatively straightforward: half of survey respondents are given a set of three innocuous true/false statements and asked to report how many of them are true. The other half are given the same three innocuous statements, as well as one of the additional "sensitive" statements, for a total of four statements. Column 1 in Table 11 shows the average total number of statements with which students agree in the set of statements which includes the sensitive question (k+1 statements). Column 2 shows the average total number of statements with which students agree in the non-sensitive question set (k statements). Due to randomization, the difference in prevalence presented in Column 3 reflects the proportion of individuals who respond affirmatively to the sensitive question. The list randomization suggests that 17.4% of treatment students had sex without a condom and 29.3% of treatment students had sex in the last six months. These are not statistically different from those in the control group, due to large standard errors. Hence, the list randomization exercise suggests that there were no classroom-level changes attributable to the course in terms of sexual activity and sex without a condom in the last six months, consistent with Table 5.

In Column 4 of Table 11, we present the self-reported answers to the same questions that were asked directly in the survey. We find that treatment students are 8 percentage points *more* likely to report having sex without a condom when asked directly than when asked indirectly. This outcome is the reverse of the expected effect, as individuals may be embarrassed to admit having to sex without a condom and thus may reveal higher prevalence rates when asked indirectly. Interestingly, both treatment and control students are estimated to be eight percentage points (se=5.2 and 5.3, respectively) more likely to report unsafe sex when asked directly instead of indirectly.

Attrition

Attrition is analyzed in Table 12. Attrition was 13% between baseline and first follow-up, and 10% between baseline and second follow-up. Table 12 shows that there is no differential attrition between control and treatment and control and spillover students (Columns 1 and 2).

[24] See Ahart and Sackett (2004), Droitcour et al. (2004), Holbrook and Krosnick (2010), Tsuchiya, Hirai and Ono (2007), and Tourangeau and Yan (2007) for use and reliability of the item count technique for sensitive questions.

We also analyze attrition for the condom voucher offer. Because students had to provide a cell phone number and/or email in order to be offered the condom voucher, the offer could not be made to every student in the study. In fact, the offer could not be made to 31% of students who were missing both pieces of information either due to non-response, misspelled email addresses, or invalid phone numbers. Table 12 Column 3 shows that there was no difference in condom voucher offers between control and treatment groups and control and spillover groups.

Columns 4-6 in Table 12 interact treatment group with socioeconomic status of the family (a score from 1-6 used by the Colombian government for social programs that families are familiar with) and show that there was no differential attrition by socioeconomic status for any of the comparisons. Columns 7-9 and 10-12 perform the same estimation using mother's and father's education with similar results (no differential attrition).

Simulating the worst-case and other sensible scenarios for the non-observed cases, as in Kling and Liebman (2004) and Karlan and Valdivia (2011), we find that the positive effect on condom voucher in Table 5 (0.094** (0.048)) still holds after imputing the mean minus 0.10 standard deviations of the observed treatment distribution to the non-respondents in the treatment group, and after imputing the mean plus 0.10 standard deviations of the observed control distribution to non-respondents in the control group.[25]

Cost-Effectiveness and Cost-Benefit Analysis

The marginal cost of the Profamilia course is approximately $14.60 per student. The bulk of this cost ($10) is accounted for by the remote tutor, and the remainder comes from Internet platform costs and computer depreciation. In this calculation, we do not include opportunity costs of the time of the students (e.g., some alternative educational activity, or leisure or work outside of school).[26] Compared to non-computer-based sexual health interventions in the U.S., which range from $69 to more than $10,000 per student,[27] the Profamilia course is extremely low cost.

[25] Results of these simulations are not presented here but are available upon request.
[26] In our calculations, we also exclude the wage cost of the person supervising students in the computer lab because it is unlikely that a school would hire personnel exclusively for the course. This is in line with guidelines by Dhaliwal et al. (2011), who argue that cost-effectiveness should use marginal costs of adding the program, assuming fixed costs are incurred with or without the program.
[27] Chin et al. (2012), pp280, with inflated estimates to 2012 dollars.

We evaluate the benefits of the course using two approaches. First, we use the direct estimate on STI reductions among the sexually active at baseline. This result suggests that the course is effective in reducing STIs for those who are sexually active. It is also the case that the proportion of teens that is sexually active rises sharply with age. We take this into account using ENDS-2010 data on sexual initiation by age, and we also assume a generous rate of decay of the effect of the course (25% annually). Under these two assumptions (and a 10% discount rate), we estimate that $1,000 spent on the course averts 5.3 STIs.

The second strategy uses the condom redemption result. We interpret the 9.4 percentage point increase in condom demand as indicating consistent condom use by adolescents, which, when combined with estimates of the response of STIs to condom use from the medical literature (i.e. Gallo et al. 2007), implies a reduction of 2.0 STIs per $1,000 spent on the course.

To link the reduction in STIs to disability adjusted life years (DALYs), we use the gender-specific distribution of STIs and the implied DALYs lost per STI incident from Ebrhaim et al. (2005). We estimate that for every STI episode, 0.11 DALYs are lost.[28] Using the estimate of value per DALY of $7,142 in Brent (2011)[29] suggests that the benefit of averting an STI is $785. We obtain a similar estimate ($634) if we use the lifetime costs of an STI presented in Ruger et al. (2012).

Table 13 summarizes our cost-effectiveness and cost-benefit analysis. The first column of the Table presents results using the STI reduction result. We estimate that the course averts one STI at a cost of $188, generating a benefit to cost ratio of 4.18. Using the condom voucher result in Column 2, the cost of averting an STI is $501, indicating a benefit to cost ratio of 1.56, also well above one.

5. Conclusions

The widespread availability of Internet-enabled computers in schools throughout the world and accelerated improvements in software quality make web-based education a plausible alternative in a context of tight budget constrains in public education. Sexual health education is at the forefront of this revolution because it is currently neglected in school curricula, opening an opportunity for low-cost online courses. In societies where teachers may be unwilling or unable to provide sexual education, online courses may also prove a useful substitute for in-person instruction.

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[28] $E(\Delta DALY|STD=1)=\sum_{i=1}^{k} DALY_i \cdot \Pr(STD=i|STD=1)$, where i represents {Chlamydia, gonorrhea, trichomoniasis, syphilis, other curable STDs, PID, genital herpes, cervical cancer, hepatitis B, hepatitis C, HIV}.

[29] Implied by his estimate of $6,300 (2005 dollars) and an inflation rate of 13.3% between 2005 and 2011.

We evaluate the effectiveness of a six month web-based sexual education course in Colombian public schools. The course improved students' knowledge and attitude indicators in the short- and medium-term. In terms of behavior, the course led to a reduction in self-reported STIs among females who were sexually active at baseline. But we observe no statistically significant impact on average, across an index of all behaviors, for the population as a whole.

A key methodological component in our study is the use of condom vouchers to measure changes in condom demand. This measure provides plausible evidence that the course was effective in changing safe sex practices. A second analytical innovation is the focus on spillovers, through a two-stage experimental design. The results indicate that spillovers from treated to untreated classrooms in the same school are negligible.

We find strong indications that effects of the course were reinforced when treated individuals had larger percentages of their friend networks in treatment classrooms. The evidence is robust across a large set of sexual health attitude, knowledge, and behavior indicators. In particular, we found that students whose networks were more intensely treated had significant reductions in frequency of sex, number of partners, and number of sexual relations, which we interpret as social reinforcement effects or complementarities.

The results presented here have important policy implications. As governments, multilateral aid agencies and non-profit organizations increasingly demand evidence of program effectiveness before providing funding to sexual education and other public health programs (HHS, 2010), our results provide an optimistic assessment of the use of ICT to generate improved sexual health outcomes among youth. Indeed, using an instrumental variables approach, we estimate that a 1 SD improvement in knowledge and attitudes generates a 0.23 SD improvement in sexual behavior. Additionally, the cost-benefit analysis suggests that because online sexual health education programs are extremely low cost, their measurable benefits in terms of medium-term STI reductions actually justify the costs. We find a wide range in cost-benefit ratio estimates, ranging from benefits to costs of 1.56 to benefits to costs of 4.18 (both of which are well above one). In spite of this positive result, we point out that better compliance with the administration of the course has the potential to substantially bolster cost-effectiveness.

Finally, the results demonstrate the positive externalities of the public provision of sex education: when an individual takes a sex education course, this decision has positive effects on sexual health outcomes among his or her close friends. This suggests that without collective action, there is an underprovision of sexual education, given the existence of positive externalities.

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Table 1. Experimental Design

		Schools	Classrooms	Students
Treatment Schools	Treatment Classrooms	46	46	1522
	Spillover Classrooms		46	1600
Control schools	Control Classrooms	23	46	1477
Total		69	138	4599

First, schools were randomly assigned to treatment and control, then two classrooms from each school were randomly selected to participate in the study. In treatment schools one of the classrooms was assigned to treatment and the other one to no treatment (referred to as a *spillover classrooms*). In control schools both (untreated) classrooms are referred to as *control classrooms*.

Table 2. Baseline Summary Statistics and Balance

PANEL A: Variables available at random assignment	Treatment students (1)	Spillover students (2)	Control students (3)	Difference (1-3)	Difference (2-3)
School year begins in January (=1)	0.720	0.731	0.699	0.020	0.032
	(0.01)	(0.01)	(0.01)	(0.12)	(0.12)
Single shift school (=1)	0.606	0.623	0.577	0.028	0.046
	(0.01)	(0.01)	(0.01)	(0.13)	(0.13)
Morning shift (=1)	0.637	0.658	0.652	-0.016	0.006
	(0.01)	(0.01)	(0.01)	(0.12)	(0.12)
City with more than 600,000 people (=1)	0.260	0.239	0.251	0.009	-0.011
	(0.01)	(0.01)	(0.01)	(0.11)	(0.11)
9th grade classrooms in school	3.226	3.258	3.081	0.145	0.177
	(0.03)	(0.03)	(0.03)	(0.32)	(0.32)
Average number of students in each classroom	37.257	37.330	38.296	-1.039	-0.965
	(0.28)	(0.29)	(0.22)	(2.42)	(2.47)
Number of computers in school	37.669	38.246	35.909	1.761	2.337
	(0.44)	(0.45)	(0.52)	(5.17)	(5.19)
School does not teach sexual education (=1)	0.168	0.167	0.135	0.033	0.032
	(0.01)	(0.01)	(0.01)	(0.09)	(0.09)
p-value from F-test of joint significance on all above variables				0.94	0.89
PANEL B: Baseline variables not available at random assignment					
Male (=1)	0.414	0.402	0.490	-0.076	-0.088*
	(0.01)	(0.01)	(0.01)	(0.05)	(0.05)
Not sexually active (=1)	0.617	0.587	0.590	0.026	-0.003
	(0.01)	(0.01)	(0.01)	(0.04)	(0.04)
Age	14.935	15.020	14.977	-0.042	0.043
	(0.03)	(0.03)	(0.03)	(0.11)	(0.12)
Mother's years of education	12.706	12.641	12.584	0.121	0.056
	(0.07)	(0.07)	(0.07)	(0.11)	(0.10)
Father's years of education	12.672	12.579	12.503	0.169	0.076
	(0.08)	(0.08)	(0.08)	(0.13)	(0.13)
Socioeconomic level	2.175	2.170	2.162	0.013	0.008
	(0.03)	(0.02)	(0.03)	(0.13)	(0.13)
PC at home (=1)	0.323	0.305	0.326	-0.003	-0.021
	(0.01)	(0.01)	(0.01)	(0.04)	(0.04)
Cellphone (=1)	0.742	0.737	0.716	0.026	0.022
	(0.01)	(0.01)	(0.01)	(0.03)	(0.03)
Does not use internet in school (=1)	0.447	0.512	0.482	-0.035	0.031
	(0.01)	(0.01)	(0.01)	(0.09)	(0.09)
Does not use internet (=1)	0.238	0.252	0.252	-0.014	0.000
	(0.01)	(0.01)	(0.01)	(0.02)	(0.03)
Religion is important (=1)	0.619	0.601	0.618	0.001	-0.017
	(0.01)	(0.01)	(0.01)	(0.03)	(0.03)
p-value from F-test of joint significance on all above variables				0.79	0.62

Columns 1-3 report means, with standard errors in parentheses. For Columns 4 and 5, each row is one regression of the characteristic on treatment and spillover indicator variables, with the coefficient (standard error, clustered at the school level) on treatment and spillover reported. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Panel A variables were provided by the schools before the baseline survey took place. We randomized treatment assignment repeatedly until no t-test comparing treatment to control for any covariate was larger than 2.0. Variables in Panel B became available after assignment to treatment. The last rows in Panel A and B report the p-value on an F-test of joint significance for all variables in the panel from a regression where the dependent variable is a treatment dummy (Column 4) or spillover dummy (Column 5). Column 4 excludes the spillover group from the analysis, while Column 5 excludes the treatment group from the analysis.

Table 3. Knowledge Indicators

OLS

	Knowledge of Syptoms and Causes of STIs Subindex		Sexual Violence Knowledge Subindex		Prevention of STIs Knowledge Subindex		Pregnancy Prevention Knowledge Subindex		Condom Use Knowledge Subindex		General Knowledge Index	
	One week post intervention	*Six months post intervention*	*One week post intervention*	*Six months post intervention*	*One week post intervention*	*Six months post intervention*	*One week post intervention*	*Six months post intervention*	*One week post intervention*	*Six months post intervention*	*One week post intervention*	*Six months post intervention*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A:												
Treatment students	0.282***	0.202***	0.254***	0.109**	0.067	0.519***	0.299***	0.335***	0.262***	0.166**	0.372***	0.378***
	(0.048)	(0.056)	(0.057)	(0.054)	(0.041)	(0.139)	(0.049)	(0.078)	(0.046)	(0.064)	(0.049)	(0.080)
Spillover students	0.022	0.064	0.034	-0.025	0.024	0.139	0.043	0.061	0.051	0.031	0.015	0.011
	(0.044)	(0.053)	(0.054)	(0.059)	(0.044)	(0.147)	(0.050)	(0.082)	(0.054)	(0.064)	(0.050)	(0.085)
Control for baseline value of dep. var.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,373	3,867	4,354	3,859	4,353	3,836	4,388	3,874	4,384	3,867	4,388	3,903
Panel B: By sexually active at baseline and gender												
Treatment students	0.318***	0.249***	0.204***	0.057	0.090*	0.636***	0.323***	0.335***	0.239***	0.259***	0.384***	0.392***
	(0.068)	(0.091)	(0.066)	(0.065)	(0.051)	(0.200)	(0.056)	(0.098)	(0.074)	(0.089)	(0.060)	(0.108)
Spillover students	-0.021	0.045	0.027	-0.100	0.012	0.110	0.016	-0.085	0.004	0.088	-0.020	-0.078
	(0.063)	(0.089)	(0.070)	(0.072)	(0.051)	(0.220)	(0.068)	(0.102)	(0.083)	(0.087)	(0.065)	(0.115)
Treatment * Sex active	0.060	-0.263	0.064	0.057	0.063	0.207	-0.012	0.081	0.142	-0.157	0.121	0.055
	(0.135)	(0.161)	(0.130)	(0.098)	(0.144)	(0.251)	(0.127)	(0.139)	(0.129)	(0.141)	(0.116)	(0.166)
Treatment * Male	-0.051	-0.087	0.001	0.051	-0.122	-0.275	-0.082	-0.065	-0.019	-0.140	-0.105	-0.113
	(0.094)	(0.132)	(0.106)	(0.103)	(0.095)	(0.240)	(0.076)	(0.117)	(0.099)	(0.106)	(0.093)	(0.138)
Spillover * Sex active	0.095	0.066	0.052	0.018	0.186	0.454	0.135	0.521***	0.118	-0.025	0.143	0.286*
	(0.108)	(0.154)	(0.143)	(0.112)	(0.134)	(0.281)	(0.131)	(0.150)	(0.093)	(0.143)	(0.103)	(0.167)
Spillover * Male	0.125	-0.015	-0.029	0.200*	0.066	-0.085	-0.065	0.163	0.018	-0.071	0.050	0.124
	(0.090)	(0.133)	(0.125)	(0.111)	(0.095)	(0.279)	(0.090)	(0.123)	(0.116)	(0.114)	(0.094)	(0.144)
Treatment * Sex active * Male	-0.220	0.354	0.086	-0.068	-0.003	-0.363	-0.086	-0.058	-0.166	0.127	-0.163	-0.014
	(0.175)	(0.241)	(0.191)	(0.161)	(0.201)	(0.323)	(0.159)	(0.180)	(0.159)	(0.191)	(0.167)	(0.239)
Spillover * Sex active * Male	-0.202	-0.029	-0.030	-0.181	-0.357*	-0.521	-0.108	-0.514***	-0.035	-0.036	-0.252	-0.446*
	(0.167)	(0.225)	(0.202)	(0.186)	(0.195)	(0.362)	(0.149)	(0.175)	(0.129)	(0.191)	(0.160)	(0.233)
Control for baseline value of dep. var.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,906	3,530	3,894	3,523	3,890	3,501	3,919	3,531	3,917	3,529	3,919	3,552

Dependent variable is an index of related questions. All components of the indices are standardized to mean 0 and standard deviation 1, based on the sample frame at baseline. Standard errors clustered at the school level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Panel B specification also includes dummies for sexually active, male, and an interaction between sexually active and male which are not reported for space reasons. Knowledge of symptoms and causes of STI subindex: Respondent knows STI symptoms include: (a) Abnormal discharges from the penis/vagina; (b) Lesions/sores in genitals; and (c) Painful urination; Respondent knows: (d) Vomiting and headache are not STI symptoms; (e) HIV can be transmitted by having sexual intercourse without a condom; (f) HIV can be transmitted by a contaminated blood tranfusion; (g) HIV transmission does not depend on hygiene; (h) HIV cannot be transmitted via food sharing; (i) clothes sharing; or (j) being in a pool with an HIV-positive person. Respondent knows that (k) HIV is not transmitted if a condom is used while having sexual intercourse with an HIV-positive individual. Sexual violence knowledge subindex: Respondent identifies (a) Nonconsensual touching of genitalia, buttocks, breasts, inner thigh as abusive sexual contact; (b) Forcible sex by husband on his wife as a form of sexual abuse; (c) Having sex with a person who is impaired due to alcohol as a form of rape; (d) If an individual changes his/her mind about sex even at the last minute, sex is nonconsensual and hence a form of sexual abuse; (e) The use of threats to obtain sex is a form of sexual abuse; Respondent knows: (f) sexual abuse is more often than not perpetrated by a known person not a stranger. Prevention of STI knowledge subindex: Respondent knows one of the safest methods to prevent an STI is the use of condoms† whereas the calendar-based methods†, hormone injections† and penis withdrawal† are not. Pregnancy prevention knowledge subindex: Respondent disagrees with: (a) Penis withdrawal is a safe method to avoid pregnancy†; Respondent knows: (b) Women can become pregnant in their first sexual relationship; (c) Safe methods to prevent a pregnancy include injections and condoms†; (d) unsafe methods to prevent a pregnancy include calendar-based methods and penis withdrawal†; Respondent knows that (e) emergency post-coital contraception pills have secondary effects. (5) Condom use knowledge subindex: Respondent knows (a) One of the safest methods to prevent an STI is the use of a condom†; (b) Condoms can be used only one time; (c) HIV can be transmitted by having sex without a condom†; (d) HIV is not transmitted if a condom is used even if the person in HIV positive †; (e) One of the safest methods to prevent a pregnancy is by using a condom†. General knowledge index: an index of all the variables used in the subindices of the table. †Question format changed from list at baseline to yes/no at follow-up.

Table 4: Attitude Indicators

OLS

	Condom Use Attitudes Subindex		Sexually Conservative Attitudes Subindex		Sexual Abuse Reporting Attitudes Subindex		General Attitudes Index	
	One week post intervention	*Six months post intervention*	*One week post intervention*	*Six months post intervention*	*One week post intervention*	*Six months post intervention*	*One week post intervention*	*Six months post intervention*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A:								
Treatment students	0.170***	0.100*	0.072	0.133**	0.260***	0.112**	0.240***	0.172***
	(0.051)	(0.051)	(0.046)	(0.058)	(0.048)	(0.054)	(0.053)	(0.056)
Spillover students	0.028	-0.024	0.003	0.075	0.035	0.015	0.026	0.022
	(0.052)	(0.051)	(0.044)	(0.058)	(0.048)	(0.051)	(0.052)	(0.052)
Control for baseline value of dep. var.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,390	3,864	4,389	3,896	4,344	3,854	4,391	3,906
Panel B: By sexually active at baseline and gender								
Treatment students	0.192***	0.113*	0.024	0.074	0.335***	0.144**	0.257***	0.164***
	(0.059)	(0.063)	(0.047)	(0.061)	(0.071)	(0.070)	(0.055)	(0.061)
Spillover students	0.085	-0.001	-0.011	-0.007	0.070	-0.018	0.065	-0.015
	(0.065)	(0.062)	(0.045)	(0.060)	(0.070)	(0.072)	(0.061)	(0.061)
Treatment * Sex active	-0.094	-0.043	-0.014	0.157	-0.081	-0.113	-0.109	-0.012
	(0.103)	(0.148)	(0.086)	(0.120)	(0.105)	(0.119)	(0.093)	(0.149)
Treatment * Male	-0.100	-0.096	0.073	0.124	-0.202*	-0.018	-0.084	0.011
	(0.094)	(0.095)	(0.079)	(0.087)	(0.104)	(0.083)	(0.092)	(0.091)
Spillover * Sex active	-0.025	0.011	-0.137*	0.099	-0.042	0.060	-0.123	0.072
	(0.111)	(0.138)	(0.076)	(0.113)	(0.112)	(0.137)	(0.094)	(0.153)
Spillover * Male	-0.132	-0.033	0.032	0.134	-0.102	-0.037	-0.090	0.043
	(0.104)	(0.104)	(0.086)	(0.107)	(0.108)	(0.090)	(0.102)	(0.097)
Treatment * Sex active * Male	0.181	-0.063	-0.014	-0.316**	0.104	0.060	0.141	-0.151
	(0.160)	(0.171)	(0.134)	(0.138)	(0.148)	(0.168)	(0.150)	(0.172)
Spillover * Sex active * Male	-0.039	-0.319*	0.013	-0.224	0.095	0.048	0.033	-0.282
	(0.173)	(0.167)	(0.150)	(0.168)	(0.147)	(0.176)	(0.161)	(0.184)
Control for baseline value of dep. var.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,921	3,525	3,920	3,553	3,885	3,523	3,922	3,555

Dependent variable is an index of related questions. All components of the indices are standardized to mean 0 and standard deviation 1, based on the sample frame at baseline. Standard errors clustered at the school level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Panel B specification also includes dummies for sexually active, male, and an interaction between sexually active and male which are not reported for space reasons. Condom use attitudes subindex: Respondent disagrees with statements: (a) "It's not right to carry a condom because people may think that I planned to have sex"; (b) "If a woman wants to have sex without a condom, the man must not refuse"; (c) "Only women are responsible for unwanted pregnancies"; Respondent is: (d) Confident of requesting that a condom be used; (e) Willing to delay sex if condoms are unavailable; Respondent thinks (f) he/she will use a condom in his/her next sexual relationship. Sexually conservative attitude subindex: Respondent thinks that: (a) It is not right when people of their age have sex with several partners in the same month; (b) People of their age should wait to have sex; Respondent's answer to (c) Age at which men and women should start having sex. Respondent is: (d) Confident he/she will have sex only when emotionally ready. Sexual abuse reporting attitudes subindex: Respondent thinks that when a teenager is suffering from sexual violence: (a) He/she must tell his/her family; (b) He/she must tell the authorities; (c) In case of rape, the afflicted individual must seek medical help; Respondent disagrees with the idea that in case of rape the person: (d) Must not tell anyone. General attitudes index: contains all variables used in the other columns of the table.

Table 5. Sexual Behavior, Six Month Follow-up

OLS

	Sexual Relationships last 6 months+	Frequency of Sex last 6 months+	Number of Partners last 6 months	STI presence	Pregnancy	Procured Contraceptives last 6 months	Procured Condoms last 6 months	General Behavior Index	Real Measure of Condom Demand: Redeemed Voucher for Free Condoms|*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A:									
Treatment students	-0.003	0.027	-0.009	-0.005	0.000	0.006	0.021	-0.043	0.094*
	(0.029)	(0.047)	(0.031)	(0.004)	(0.005)	(0.030)	(0.025)	(0.059)	(0.048)
Spillover students	0.023	0.051	0.043	-0.001	0.007	-0.013	0.003	0.108	0.040
	(0.031)	(0.051)	(0.031)	(0.004)	(0.006)	(0.031)	(0.023)	(0.068)	(0.042)
Distance									-0.057***
									(0.017)
Distance^2									0.004***
									(0.001)
Bus reimbursed									0.035***
									(0.012)
Control for baseline value of dep. var.	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No
Observations	4,364	3,857	3,881	3,774	4,252	3,833	3,809	4,413	3,358
Panel B: By sexually active at baseline and gender									
Treatment students	-0.010	0.019	-0.000	0.002	0.002	0.056**	0.035*	-0.050	0.122**
	(0.023)	(0.035)	(0.030)	(0.002)	(0.005)	(0.027)	(0.020)	(0.046)	(0.053)
Spillover students	-0.005	0.014	0.001	0.003	0.005	0.018	0.020	0.017	0.048
	(0.026)	(0.039)	(0.032)	(0.002)	(0.006)	(0.027)	(0.018)	(0.059)	(0.043)
Treatment * Sex active	0.073	0.051	-0.077	-0.054***	-0.033	0.029	0.038	-0.393	-0.101*
	(0.069)	(0.120)	(0.093)	(0.020)	(0.029)	(0.061)	(0.057)	(0.249)	(0.060)
Treatment * Male	0.008	-0.025	-0.037	-0.002	-0.003	-0.043	-0.036	0.048	-0.056
	(0.031)	(0.043)	(0.040)	(0.002)	(0.009)	(0.048)	(0.041)	(0.084)	(0.056)
Spillover * Sex active	0.048	-0.015	0.022	-0.018	0.023	-0.004	0.010	0.055	-0.031
	(0.070)	(0.121)	(0.099)	(0.028)	(0.032)	(0.063)	(0.053)	(0.278)	(0.057)
Spillover * Male	0.014	0.022	0.007	-0.003	-0.012	0.040	-0.047	-0.005	-0.038
	(0.034)	(0.053)	(0.048)	(0.002)	(0.008)	(0.054)	(0.036)	(0.090)	(0.056)
Treatment * Sex active * Male	-0.083	-0.001	0.104	0.041*	0.052	-0.068	0.012	0.437	0.129*
	(0.091)	(0.146)	(0.125)	(0.022)	(0.035)	(0.076)	(0.094)	(0.293)	(0.072)
Spillover * Sex active * Male	-0.006	0.064	0.095	-0.004	-0.016	-0.100	0.049	0.071	0.074
	(0.093)	(0.156)	(0.134)	(0.028)	(0.036)	(0.081)	(0.084)	(0.315)	(0.074)
Control for baseline value of dep. var.	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No
Mean of dep. var. control group	0.262	0.363	0.368	0.010	0.021	0.455	0.199	-0.045	0.182
SD of dep. var. control group	0.440	0.660	0.649	0.098	0.143	0.498	0.399	1.254	0.386
Observations	3,965	3,522	3,539	3,443	3,864	3,497	3,477	4,002	3,053

Dependent variables not standarized, except for Column 8, which is a sum of standardized variables based on the sample frame at baseline. All outcome variables are assessed six months after treatment. Standard errors clustered at the school level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Panel B regression also includes dummies for sexually active, male, and interaction between sexually active and male which are not reported. Columns 1 and 5 include students attrited for written survey but later tracked over the phone. + Does not control for baseline value of the dependent variable, because outcome was not measured at baseline. General behavior index: contains self reported data on (a) Number of partners in the last six months; (b) STI presence; (c) Pregnancies; (d) Had sexual relationships in the last six months; (e) Frequency of sex in the last six months (f) Procured contraceptives in the last 6 months (excluding condoms); and (g) Procured condoms in the last six months (f and g enter negatively in the index). |* Profamilia administrative data. 3,358 students of the full sample agreed to be contacted for this part of the study. Per Profamilia policies, condom voucher redemption includes a brief consultation with a social worker. Specification controls for whether individual had a cellphone. Distance in column 9 is in kilometers. The difference in distance between the 25th and 75th percentiles of distance (the interquartile range) is 3km.

Table 6. The Effect of Knowledge and Attitudes on Behavior, Six Month Follow-up

	Behavior Index OLS	Behavior Index IV	Behavior Index OLS	Behavior Index IV
Knowledge and Attitudes Index	-0.028	-0.099	-0.039**	-0.233*
	(0.017)	(0.126)	(0.018)	(0.123)
Sexually active at baseline and Male controls	-	-	Yes	Yes
F-stat first stage (p-value)	-	15.00 (p=0.0002)	-	13.31 (p=0.0005)
Observations	2,638	2,638	2,410	2,410

All regressions control for baseline value of outcome. Standard errors clustered at the school level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Behavior index components are standardized to mean 0 and standard deviation 1, based on the sample frame at baseline. Behavior index is composed of self-reported data on (a) Number of partners in the last six months; (b) STI presence; (c) Pregnancies; (d) Procured contraceptives in the last 6 months (entered negatively, so that lower value indicates safer behavior); and (e) Procured condoms in the last six months (entered negatively, so that lower value indicates safer behavior). Knowledge and Attitudes index: Contains all variables in the knowledge and attitude indices of Tables 3 and 4. Instrumental variable for Knowledge and Attitudes index is the *Assignment to Treatment* dummy. Spillover group observations excluded from this estimation.

Table 7. Friendship Networks Summary Statistics

		Cases	Percent
Treatment students with:	No friends treated	366	21.2%
	1 friend treated	277	16.0%
	2 friends treated	266	15.4%
	3 friends treated	227	13.1%
	4 friends treated	286	16.6%
	5 friends treated	183	10.6%
	6 friends treated	123	7.1%
Spillover students with:	No friends treated	1482	88.8%
	1 friend treated	133	8.0%
	2 friends treated	11	0.7%
	3 friends treated	7	0.4%
	4 friends treated	7	0.4%
	5 friends treated	13	0.8%
	6 friends treated	15	0.9%

Friendship link treatment status is established by matching self reported list of friends with list of names of students answering the survey at (either) follow-up survey. The number of friends treated for students in control schools is equal to zero.

Table 8. Knowledge: Network Spillover & Reinforcing Interaction Effects

OLS

	Knowledge of Symptoms and Causes of STIs Subindex	Sexual Violence Knowledge Subindex	Prevention of STI Knowledge Subindex	Pregnancy Prevention Knowledge Subindex	Condom Use Knowledge Subindex	General Knowledge Index
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment student	0.132*	0.083	0.377**	0.201**	0.135*	0.278***
	(0.067)	(0.062)	(0.153)	(0.090)	(0.075)	(0.081)
Spillover student	0.082	-0.023	0.137	0.065	0.035	0.022
	(0.055)	(0.058)	(0.147)	(0.082)	(0.062)	(0.082)
Treatment student * % of friends	0.136*	0.038	0.258*	0.248**	0.056	0.179*
	(0.081)	(0.080)	(0.155)	(0.106)	(0.079)	(0.100)
Spillover student * % of friends	-0.280*	0.170	0.185	-0.154	-0.034	-0.050
	(0.159)	(0.177)	(0.380)	(0.213)	(0.196)	(0.217)
Control for baseline value of dep. var.	Yes	Yes	Yes	Yes	Yes	Yes
Control for number of friends	Yes	Yes	Yes	Yes	Yes	Yes
P-value treatment*(% of friends)=spillover*(% of friends)	0.0387	0.492	0.859	0.0788	0.669	0.334
Observations	3,853	3,845	3,828	3,866	3,853	3,888

Dependent variable is an index of related questions. All components of the indices are standardized to mean 0 and standard deviation 1, based on the control group sample frame at baseline. Standard errors clustered at the school level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. (1) Knowledge of symptoms and causes of STI subindex: Respondent knows STI symptoms include: (a) Abnormal discharges from the penis/vagina; (b) Lesions/sores in genitals; and (c) Painful urination; Respondent knows: (d) Vomiting and headache are not STI symptoms; (e) HIV can be transmitted by having sexual intercourse without a condom; (f) HIV can be transmitted by a contaminated blood tranfusion; (g) HIV transmission does not depend on hygiene; (h) HIV cannot be transmitted via food sharing; (i) clothes sharing; or (j) being in a pool with an HIV-positive person. Respondent knows that (k) HIV is not transmitted if a condom is used while having sexual intercourse with an HIV-positive individual. (2) Sexual violence knowledge subindex: Respondent identifies (a) Nonconsensual touching of genitalia, buttocks, breasts, inner thigh as abusive sexual contact; (b) Forcible sex by husband on his wife as a form of sexual abuse; (c) Having sex with a person who is impaired due to alcohol as a form of rape; (d) If an individual changes his/her mind about sex even at the last minute, sex is nonconsensual and hence a form of sexual abuse; (e) The use of threats to obtain sex is a form of sexual abuse; Respondent knows: (f) Sexual abuse is more often than not perpetrated by a known person not a stranger. (3) Prevention of STI knowledge subindex: Respondent knows one of the safest methods to prevent an STI is the use of condoms† whereas the calendar-based methods†, hormone injections† and penis withdrawal† are not. (4) Pregnancy prevention knowledge subindex: Respondent disagrees with: (a) Penis withdrawal is a safe method to avoid pregnancy†; Respondent knows: (b) Women can become pregnant in their first sexual relationship; (c) Safe methods to prevent a pregnancy include injections and condoms†; (d) Unsafe methods to prevent a pregnancy include calendar-based methods and penis withdrawal†; Respondent knows that (e) Emergency post-coital contraception pills have secondary effects. (5) Condom use knowledge subindex: Respondent knows (a) One of the safest methods to prevent an STI is the use of a condom†; (b) Condoms can be used only one time; (c) HIV can be transmitted by having sex without a condom†; (d) HIV is not transmitted if a condom is used even if the person in HIV positive †; (e) One of the safest methods to prevent a pregnancy is by using a condom†. (6) General knowledge index: an index of all the variables used in the subindices of the table. † Question format changed from list at baseline to yes/no at follow-up.

Table 9. Attitudes: Network Spillover & Reinforcing Interaction Effects

OLS

	Condom Use Attitudes Subindex	Sexually Conservative Attitudes Subindex	Sexual Abuse Reporting Attitudes Subindex	General Attitudes Index
	(1)	(2)	(3)	(4)
Treatment student	-0.020	0.072	0.024	0.043
	(0.064)	(0.074)	(0.070)	(0.073)
Spillover student	-0.021	0.082	0.021	0.032
	(0.049)	(0.058)	(0.051)	(0.051)
Treatment student * % of friends treated	0.213***	0.114	0.166*	0.236***
	(0.075)	(0.071)	(0.093)	(0.078)
Spillover student * % of friends treated	-0.098	-0.059	-0.003	-0.072
	(0.170)	(0.143)	(0.131)	(0.147)
Control for baseline value of dep. var.	Yes	Yes	Yes	Yes
Control for number of friends	Yes	Yes	Yes	Yes
P-value: treatment*(% of friends)=spillover*(% of friends)	0.129	0.279	0.270	0.061
Observations	3,856	3,882	3,840	3,891

Dependent variable is an index of related questions. All components of the indices are standardized to mean 0 and standard deviation 1, based on the sample frame at baseline. Standard errors clustered at the school level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. (1) Condom use attitudes subindex: Respondent disagrees with statements: a) "It's not right to carry a condom because people may think that I planned to have sex"; b) "If a woman wants to have sex without condom, the man must not refuse", c) "Only women are responsible for unwanted pregnancies"; Respondent is d) Confident of requesting that a condom be used; e) Willing to delay sex if condoms are unavailable; Respondent thinks f) he/she will use a condom in his/her next sexual relationship. (2) Sexually conservative attitude subindex: Respondent thinks that: a) It is not right when people of their age have sex with several partners in the same month; b) People of their age should wait to have sex; Respondent's answer to c) Age at which men and women should start having sex. Respondent is d) Confident he/she will have sex only when emotionally ready. (3) Sexual abuse reporting attitudes subindex: Respondent thinks that when a teenager is suffering from sexual violence: a) He/she must tell his/her family; b) He/she must tell the authorities; c) In case of rape, the afflicted individual must seek medical help; Respondent disagrees with the idea that in case of rape the person: d) Must not tell anyone. (4) General attitudes index: contains all variables used in the other columns of the table.

Table 10. Sexual Behavior: Network Spillover & Reinforcing Interaction effects, Six Month Follow-up

OLS

	Sexual Relationships last 6 months+	Frequency of Sex last 6 months+	Number of Partners last 6 months	STI	Pregnancy	Procured Contraceptives last 6 months	Procured Condoms last 6 months	General Behavior Index	Real Measure of Condom Demand: Redeemed Voucher for Free Condoms|*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Treatment student	0.042	0.097*	0.049	-0.004	-0.003	0.041	0.017	0.027	0.078
	(0.036)	(0.056)	(0.039)	(0.005)	(0.006)	(0.035)	(0.028)	(0.074)	(0.051)
Spillover student	0.016	0.036	0.032	-0.000	0.006	-0.014	0.001	0.084	0.048
	(0.032)	(0.050)	(0.031)	(0.004)	(0.006)	(0.032)	(0.022)	(0.062)	(0.042)
Treatment student * % of friends	-0.097**	-0.136**	-0.115***	-0.003	0.002	-0.067	0.007	-0.188**	0.033
	(0.038)	(0.065)	(0.042)	(0.006)	(0.008)	(0.049)	(0.033)	(0.074)	(0.040)
Spillover student * % of friends treated	0.110	0.228*	0.186	-0.012*	0.039	0.006	0.063	0.246	-0.156**
	(0.085)	(0.136)	(0.114)	(0.007)	(0.039)	(0.091)	(0.091)	(0.246)	(0.064)
Distance									-0.057***
									(0.017)
Distance^2									0.004***
									(0.001)
Bus reimbursed									0.035***
									(0.012)
Control for baseline value of dep. var.	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No
Control for number of friends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
P-value: treatment*(% of friends)=spillover*(% of friends)	0.0195	0.0192	0.0170	0.315	0.344	0.472	0.554	0.0932	0.0199
Mean of dep. var. control group	0.259	0.364	0.368	0.00982	0.0201	0.456	0.199	-0.0605	0.181
SD of dep. var. control group	0.438	0.660	0.650	0.099	0.140	0.498	0.399	1.199	0.385
Observations	4,246	3,843	3,868	3,763	4,139	3,826	3,802	4,294	3,334

Dependent variables not standarized, except for Column 8, which is a sum of standardized variables based on the sample frame at baseline. All outcome variables are assessed six months after treatment. Standard errors clustered at the school level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Columns 1 and 5 include students attrited for written survey but later tracked over the phone. + Does not control for baseline value of the dependent variable, because outcome was not measured at baseline. General Behavior index: contains self reported data on (a) Number of partners in the last six months; (b) STI presence; (c) Pregnancies; (d) Had sexual relationships in the last six months; (e) Frequency of sex in the last six months; (f) Procured contraceptives in the last 6 months (excluding condoms); and (g) Procured condoms in the last six months (f and g enter negatively in the index). |* Profamilia administrative data. 3,358 students of the full sample agreed to be contacted for this part of the study. Per Profamilia policies, condom voucher redemption includes a brief consultation with a social worker. Specification also includes as controls has a cellphone, but does not control for baseline values because the voucher was only offered once (6 months after treatment).

Table 11. List Randomization

Means and Standard Errors

	Sensitive and non-sensitive questions	Non-sensitive questions only	List randomization prevalence	Self-reported prevalence	Difference in prevalence
	(1)	(2)	(3)	(4)	(5)
Sensitive question: Had sex without a condom in the last six months†					
Treatment	1.537	1.363	0.174***	0.258	-0.084
classrooms	(0.062)	(0.049)	(0.056)	(0.023)	(0.052)
	[313]	[358]	[671]	[1359]	[2030]
Control	1.646	1.446	0.200***	0.280	-0.080
classrooms	(0.053)	(0.049)	(0.064)	(0.019)	(0.053)
	[308]	[332]	[640]	[1247]	[1887]
Diff: T-C	-0.109	-0.083	-0.027	-0.022	-0.004
	(0.081)	(0.069)	(0.085)	(0.030)	(0.074)
	[621]	[690]	[1311]	[2606]	[3917]
Sensitive question: Had sex in the last six months††					
Treatment	1.656	1.363	0.293***	0.257	0.036
classrooms	(0.047)	(0.049)	(0.062)	(0.023)	(0.057)
	[605]	[358]	[963]	[1505]	[2468]
Control	1.703	1.446	0.257***	0.262	-0.005
classrooms	(0.047)	(0.049)	(0.059)	(0.019)	(0.053)
	[619]	[332	[951]	[1431]	[2382]
Diff: T-C	-0.047	-0.083	0.036	-0.005	0.041
	(0.067)	(0.069)	(0.085)	(0.030)	(0.078)
	[1224]	[690]	[1914]	[2936]	[4850]

Standard errors clustered at the school level in parentheses. Number of observations in brackets. *** p<0.01, ** p<0.05, * p<0.1.

† Literal question was "Did you use a condom in every sexual experience you had for the last six months?"

†† Literal question was "Have you had any sexual relationship in the last six months?"

Column 3 is the difference between Columns 1 and 2. It is the estimated prevalence of the sensitive question using the list randomization technique. The non-sensitive questions asked in Columns 1 and 2 top panel are: I have a bicycle, my favorite color is blue, I live with my father. The non-sensitive questions asked in Columns 1 and 2 lower panel are: I have more than 3 cousins, I have internet at home, I have a dog. Column 4 is the mean prevalence from the self-reported survey, while Column 5 is the difference between Columns 3 and 4. It reflects the difference in prevalence between the list randomization estimation and the direct question estimation.

Table 12. Attrition

OLS

Dep. Var.: Attrited=1	*One week post intervention*	*Six months post intervention*	*Condom Voucher*	*One week post intervention*	*Six months post intervention*	*Condom Voucher*	*One week post intervention*	*Six months post intervention*	*Condom Voucher*	*One week post intervention*	*Six months post intervention*	*Condom Voucher*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Treatment students	0.009	0.012	-0.008									
	(0.020)	(0.019)	(0.040)									
Spillover students	0.013	0.024	0.045									
	(0.024)	(0.018)	(0.046)									
Treatment students *				0.004	0.005	-0.001						
socioeconomic status				(0.007)	(0.008)	(0.016)						
Spillover students *				0.008	0.008	0.015						
socioeconomic status				(0.010)	(0.008)	(0.019)						
Treatment students *							0.001	0.001	-0.000			
father's education							(0.002)	(0.001)	(0.003)			
Spillover students *							0.001	0.001	0.003			
father's education							(0.002)	(0.001)	(0.003)			
Treatment students *										0.001	0.001	-0.001
mother's education										(0.001)	(0.001)	(0.003)
Spillover students*										0.001	0.001	0.003
mother's education										(0.002)	(0.001)	(0.003)
Constant	0.126***	0.100***	0.313***	0.115***	0.098***	0.304***	0.117***	0.150***	0.333***	0.134***	0.143***	0.393***
	(0.016)	(0.014)	(0.030)	(0.017)	(0.019)	(0.035)	(0.019)	(0.029)	(0.040)	(0.023)	(0.024)	(0.047)

*** p<0.01, ** p<0.05, * p<0.1. Attrition=1 for students observed at baseline but not at first follow-up (Column 1), second follow-up (Column 2), or without working cellphone or email for voucher offer 6 months after intervention (Column 3). Columns 4-6 include socioeconomic status variable, Columns 7-9 include father's education variable, and Columns 10-12 include monther's education variable as controls.

Table 13. Cost-Effectiveness and Cost-Benefit Analysis

	STI reduction result	Condom voucher result
Cost Effectiveness		
Marginal cost of course per student[a]	$14.60	$14.60
Averted STIs per $1,000 spent[b]	5.33	2.00
90% Confidence Interval	[1.73, 8.92]	[0.025, 3.75]
Cost Benefit		
Cost per averted STI[c]	$188	$501
Benefit per averted STI[d]	$785	$785

[a] All figures in 2012 U.S. dollars. Marginal costs correspond to remote tutor wage per student ($10), Internet platform costs ($2.10), and depreciation cost of computers ($2.50).

[b] Averted STIs per $1,000 = (Estimated STI reduction per student*1000/MgCost per student)

[c] Cost per averted STI=(MgCost per student/Estimated STI reduction per student)

[d] Column 1 assumes a decay in the effect of the course on STI prevalence of 25% per year. It also accounts for the sexual initiation age pattern which is increasing over time (taken from ENDS-2010), age-specific STD prevalence from National Longitudinal Study of Adolescent Health (Waves I-III), and a 10% discount rate. Column 2 assumes the increase in condom demand reflects consistent condom use by the adolescent, and a reduction in STIs from condom use from Gallo et al. (2005) of 60%, along with the objectively measured STI prevalence from Gallo's data of 54%.

[e] Benefit obtained from STI distribution and DALYs per incident in Ebrhaim et al. (2005), and value of DALY from Brent (2005).

Appendix 1. Summary Statistics at Baseline

INDEX	INDIVIDUAL VARIABLES		MEAN	SD	MIN	MAX	Q25	Q75	N
Knowledge of Symptoms and Causes of STI Index Variables	Respondent knows:	Vomiting is not an STI symptom	0.101	0.301	0	1	0	0	4305
		Headache is not an STI symptom	0.105	0.307	0	1	0	0	4211
	Respondent knows STI symptoms include:	Abnormal discharges from the penis/vagina	0.307	0.461	0	1	0	1	4331
		Lesions/sores in genitals	0.185	0.388	0	1	0	0	4221
		Painful urination	0.320	0.467	0	1	0	1	4334
	HIV transmission does not depend on:	Hygiene	0.665	0.472	0	1	0	1	4512
	HIV cannot be transmitted:	Food sharing	0.907	0.291	0	1	1	1	4512
		Being in a pool with an HIV-positive person	0.924	0.265	0	1	1	1	4512
		If a condom is used while having sexual intercourse with an HIV-positive individual	0.628	0.483	0	1	0	1	4512
	HIV can be transmitted by:	Having sexual intercourse without a condom	0.791	0.407	0	1	1	1	4512
		A contaminated blood tranfusion	0.684	0.465	0	1	0	1	4512
Sexual Violence Knowledge Index Variables	Respondent identifies as abusive sexual contact or abuse:	Nonconsensual touching of genitalia, buttocks, breasts, and inner thigh	0.845	0.362	0	1	1	1	4490
		Forcible sex by husband on his wife	0.758	0.429	0	1	1	1	4490
		Having sex with a person who is impaired due to alcohol	0.759	0.427	0	1	1	1	4490
		If an individual changes his/her mind about sex even at the last minute	0.569	0.495	0	1	0	1	4490
		The use of threats to obtain sex	0.670	0.470	0	1	0	1	4490
	Respondent knows sexual abuse is more often than not perpetrated by a known person, not a stranger		0.181	0.385	0	1	0	0	4343
Prevention of STI Knowledge Index Variables	Respondent knows one of the safest methods to prevent an STI is not:	Calendar-based methods	0.929	0.256	0	1	1	1	4504
		Hormone injections	0.795	0.404	0	1	1	1	4504
		Penis withdrawal	0.905	0.293	0	1	1	1	4504
	Respondent knows one of the safest methods to prevent an STI is the use of condoms		0.737	0.440	0	1	0	1	4504
Pregnancy Prevention Knowledge Index Variables	Respondent disagrees that penis withdrawal is a safe method to avoid pregnancy		0.562	0.496	0	1	0	1	4477
	Respondent knows women can become pregnant in their first sexual relationship		0.723	0.448	0	1	0	1	4506
	Respondent knows unsafe methods to prevent a pregnancy include:	Calendar-based methods	0.875	0.330	0	1	1	1	4516
		Penis withdrawal	0.791	0.407	0	1	1	1	4516
	Respondent knows safe methods to prevent a pregnancy include:	Injections	0.471	0.499	0	1	0	1	4516
		Condoms	0.759	0.428	0	1	1	1	4516
	Respondent knows that emergency post-coital contraception pills have secondary effects		0.143	0.351	0	1	0	0	4477
Condom Use Knowledge Index Variables	Respondent knows condoms can be used only one time		0.608	0.488	0	1	0	1	4485
	Respondent knows one of the safest methods to prevent an STI is the use of a condom		0.737	0.440	0	1	0	1	4504
	Respondent knows HIV can be transmitted by having sex without a condom		0.791	0.407	0	1	1	1	4512
	Respondent knows HIV is not transmitted if a condom is used even if the person is HIV		0.628	0.483	0	1	0	1	4512
	Respondent knows one of the safest methods to prevent a pregnancy is by using a condom		0.759	0.428	0	1	1	1	4516
Condom Use Attitudes Index Variables	Respondent disagrees with statements:	It's not right to carry a condom because people may think that I planned to have sex	2.894	1.168	1	4	2	4	4500
		If a woman wants to have sex without condom, the man must not refuse	2.835	1.176	1	4	2	4	4525
		Only women are responsible for unwanted pregnancies	3.516	0.931	1	4	3	4	4514
	Respondent is confident of requesting that a condom be used		1.552	0.716	0	2	1	2	4533
	Respondent is willing to delay sex if condoms are unavailable		0.678	0.467	0	1	0	1	4518
	Respondent thinks he/she will use a condom in his/her next sexual relationship.		0.805	0.396	0	1	1	1	4438
Sexually Conservative Attitudes Index Variables	Respondent thinks that:	It is not right when people of their age have sex with several partners in the same month	3.683	0.729	1	4	4	4	4520
		People of their age should wait to have sex	3.395	0.904	1	4	3	4	4544
	Respondent's answer to:	Age at which women should start having sex	19.577	3.296	10	30	18	20	4501
		Age at which men should start having sex	18.449	3.248	10	30	16	20	4509
	Respondent is confident he/she will have sex only when emotionally ready		1.411	0.776	0	2	1	2	4525
Sexual Abuse Reporting Attitudes Index Variables	Respondent disagrees with the idea that in case of sexual violence the person must not tell		0.983	0.131	0	1	1	1	4481
	Respondent thinks that when a teenager is suffering from sexual violence he/she:	Must tell his/her family	0.713	0.452	0	1	0	1	4502
		Must tell the authorities	0.741	0.438	0	1	0	1	4502
		In case of rape, must seek medical help	0.596	0.491	0	1	0	1	4502
		Must tell someone such as teachers, friends, etc.	0.021	0.144	0	1	0	0	4502
Behavior Index Variables	Had any sexual relationship in the last 6 months+		0.269	0.443	0	1	0	1	4364
	Frequency of sex last 6 months+		0.390	0.688	0	2	0	1	3857
	Number of partners last 6 months		0.430	0.768	0	3	0	1	4530
	STI presence		0.006	0.078	0	1	0	0	4432
	Has been pregnant or girlfriend has been pregnant		0.019	0.135	0	1	0	0	3647
	Procured contraceptives last 6 months (excludes condoms)		0.519	0.500	0	1	0	1	4494
	Procured condoms last 6 months ++		0.109	0.312	0	1	0	0	4528

+ Not available at baseline. Refers to second follo- up data statistics which correspond to the values used to standardize variables for the index.

++ Question at baseline asked for last month instead of last six months