

# The Effect of Social Networks on Students' Academic and Non-Cognitive Behavioural Outcomes: Evidence from Conditional Random Assignment of Friends in School\*

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We investigate the impacts of separating students in Israel from pre-existing social relationships during the transition from elementary to middle school on their academic progress. We define several types of friendships using students' self-defined friendship nomination and rely for identification on the random assignment of students to classes within a given school. Our results suggest that the number of friends has positive or negative effects on students' educational outcomes, depending on the type of and on friends' socioeconomic background. These gains might be partly mediated through greater cooperation, reduction in violent behaviour and improvements in social satisfaction in class.

There are many educational programs and practices that separate students from their social network in school or class, from usual transitions of students between primary and middle/high-school to more deliberate policies with different educational objectives. For example, school busing programs and policies that enhance school choice in order to increase school productivity (by introducing competition among schools) often detach students from their childhood social network.<sup>1</sup> Other policies that often lead to students being separated from their friends include educational reforms that redesign school zones or catchment areas<sup>2</sup>, closure of failing schools in high accountability settings<sup>3</sup>, the

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<sup>1</sup> Many countries have pursued this type of policy—for example, the US (Cullen *et al.*, 2005; and Angrist *et al.*, 2013); New Zealand (Fiske and Ladd, 2001); and Colombia (Angrist *et al.*, 2002).

<sup>2</sup> For example, the Wake County school district has moved up to 5 % of the school population in any given year during the 1990s in order to balance schools' racial and income composition (Hoxby and Weingarth, 2005).

practice of reshuffling students among classes in every grade<sup>4</sup>, programs which expand student access to high-performing schools<sup>5</sup>, or reassigning students when they advance to a higher grade in school. Social and welfare programs, such as the US's Moving to Opportunity, also detach, though voluntarily, children from their childhood social environment.<sup>6</sup> The consequences of such social detachment are usually not taken into account in policy making circles<sup>7</sup>, even though it is well documented in social science literature that students' social networks are important for their academic performances and overall development.<sup>8</sup>

In this paper we investigate the influence of social networks on educational attainment of children in school. Our unique contribution is the analysis of the impact of the size of students' social network in class, both in the short and in the long run, while carefully addressing the identification and the causal nature of the relationship. We show that the effect of network size depends both on the 'quality' of friendship ties, measured by the nature of reciprocity of friendships, and the 'quality' of friends, measured by their mean socioeconomic background. We additionally examine several non-cognitive aspects of memberships in a social network assessed by survey questionnaires on students' behavioural outcomes. We discuss our results in relation to predictions from a conceptual framework that embeds three important modelling innovations introduced recently in the peer and social network literature in an educational environment: joint production, social pressure in a network environment, and mutual insurance among network members.

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<sup>3</sup> For example, a 2011 education bill in the UK allows the government to order closure of failing schools [<http://www.theguardian.com/education/2011/jan/27/education-bill-abolishes-four-quangos>].

<sup>4</sup> Classroom shuffles every September are common in many countries, including in the US in many school districts. [<http://www.nbcsandiego.com/news/local/Parents-Protest-Teacher-Shuffling-Combined-Classrooms-in-SDUSD-277828971.html>].

<sup>5</sup> For example, the METCO voluntary desegregation program that allows students from Boston public primary schools to attend public schools in other communities that have agreed to participate (Angrist and Lang, 2004).

<sup>6</sup> For an analysis of the MTO Experiment, (see Katz *et al.*, 2001; Kling *et al.*, 2005; and Kling *et al.*, 2007).

<sup>7</sup> The recently approved Boston Public School's proposal to reallocate facilities in an effort to expand access to high performing schools has faced strong opposition from parents of children who under the new plan will be detached from their childhood environment [<http://www.change.org/petitions/mayor-thomas-menino-stop-bps-superintendent-johnson-s-plan-to-uproot-mission-hill-school-k-8-2>].

<sup>8</sup> In the next section we discuss the literature on social networks and educational outcomes. In addition, the psychology literature also emphasizes the effect of children's peer relationships on multiple aspects of their emotional and cognitive development. It provides evidence linking children's' social acceptance to self-perception which also motivates them to pursue academic goals and improve their educational outcomes. This literature also stresses the important role of friendships in the adjustment process of students during school transitions and even suggests that there are long run implications of adjustment difficulties in middle school to later educational attainments (Wentzel, 1998; Wentzel *et al.*, 2004; Nelson and Debacker, 2008).

We base our analysis on a school choice program that started in Tel Aviv in 1994, which allowed students who completed primary school to choose their middle school.<sup>9</sup> The application process of this program allowed sixth-grade students to designate their middle schools of choice and to list up to eight friends with whom they wish to attend that school. The lists create natural “friendship hierarchies”, identified by the students themselves, that we exploit in our analysis. We designate four categories of social networks of friends that stem from these lists as follows: reciprocal friends (students who list one another), followers (those who listed fellow students as friends but were not listed as friends by these same fellow students), rejecters (those who were listed by fellow students but did not reciprocate by including the same students on their own lists) and second circle of reciprocal friends (reciprocal friends of the student’s reciprocal friends, excluding the first circle of reciprocal friends). We also define, for each friendship type, two additional aspects of the relationship: 1) the geographic distance between friends, living in the same neighbourhood or not; 2) and the length of acquaintance among friends, being together in kindergarten or meeting later in primary school.

Using these data, we examine the consequences of the school transition on the size of a student’s pre-existing (from elementary school) social network according to the different types of relationships defined. Then we estimate the effect of the students' new social networks in class after their assignments in middle schools on their educational outcomes in the short run (8<sup>th</sup> grade external exams) and in the long run (high stakes matriculation exams at the end of high-school) as well as on non-cognitive behavioural outcomes.

Our identification strategy is a conditional random assignment model: in Tel Aviv middle schools, students are randomly assigned to classes within a given school; therefore, conditional on the school and on the number of friends a student has at her/his school, the number of friends she/he attends class with should be random. Since we estimate the impact of friends by type in class, we control for the number of friends by type in school; the school (and in a variation, the class) fixed effect enables us to eliminate all school (class)-level un-observables and compare the impact of friends in class among students who attend the same class, and have the same number of friends in school.

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<sup>9</sup> See Lavy (2010) for a further analysis of the overall effect of the Tel Aviv choice program on student achievements and behavioural outcomes.

To support our identification assumption, we first discuss the practice of random assignment of students to classes within schools. The randomness of class composition results from the fact that students' assignments into classes based on ability, family background or any other characteristics of the students are forbidden by law in Israel and this law is strictly enforced. In order to explicitly test for the randomness of class composition in our sample, we performed a series of Pearson Chi-Square tests. In addition, we note that the assignment of students to classes within school is managed by school administrators who do not receive students' peers' preferences. We then perform balancing tests which examine whether conditional on the class and on the number of friends in school, student's background characteristics are correlated with the number of friends in class. Finally, we also consider the possibility that the allocation process is not completely (conditionally) random. Although school administrators did not receive students' peers' preferences there still could be some cases of students' moving to a different class based on peers' preferences which might lead to a correlation between students' unobserved characteristics and number of friends by type. We thus assess the degree of omitted variable bias by implementing the coefficient stability test developed by Altonji et al. (2005) and further extended by Oster (2015). All these tests provide overall evidence in support of our conditional random assignments estimation strategy.

Our results highlight the importance of students' social networks in class to their educational outcomes in middle school, and its prolonged effect until the end of high school. Simulating how students' academic success would have changed if the transition to middle school would not entail in changing their social network in class, we find a large overall positive increase in academic achievements, as test scores in math, English and Hebrew would rise by about 0.12 standard deviations. This effect persists until the end of high school, leading to gains in several matriculation outcomes, such as the average matriculation scores in the three subjects above, the total number of credit units in matriculation certificates, and the probability of receiving a matriculation certificate.

Furthermore, we are able to test how these educational gains depend on two dimensions of 'quality' of friends. The first dimension of friends' 'quality' suggests that relationships which are of reciprocal nature have the highest positive impact on educational performances. The presence of reciprocal friends in class has a large positive effect on middle school test scores - adding one

reciprocal friend in class raises the student's average test scores by 0.098 standard deviation of the test scores distribution. The impacts of non-reciprocal relationships are lower and depend on the asymmetry of the relation - while the presence of a follower has a positive effect on test scores, the effect of rejecters is negative. The impact of indirect links, as measured by the second circle of reciprocal friends, is small and not significantly different from zero. For each friendship type we also test the effect of two additional aspects of the relationship: 1) the effect of living in the same neighbourhood, by comparing the effect of friends by type living in the same zip code area to those living far from each other; 2) the effect of length of acquaintance, by comparing the effect of friends acquainted in kindergarten to those of friends who meet in later years. Friends who are neighbours have larger effects than other friends but these differences are not precisely measured. The length of acquaintance does not affect the treatment effect of each type of friendship.

The effect of the second dimension of 'quality', which is measured by the mean socioeconomic background of friends, allows us to distinguish between the effects of 'quality' versus 'quantity' of friends. We find that both of these effects are important for students' achievements. Moreover, in addition, we find that the effects of both 'quality' and 'quantity' of friends have interesting patterns of heterogeneity by gender, parental education and age of students.

The effects of these different aspects of social networks may indicate that trust and cooperation among members of the social networks are important, and facilitate the effects on educational outcomes. We are able to test this channel by observing the impacts of these features of social networks on several non-cognitive outcomes. We show that classes that are characterized by more reciprocal friends (especially if these relations are supported, meaning that reciprocal friends have a mutual reciprocal friend) are also characterized by more cooperative behaviour of students toward each other in class.<sup>10</sup> In addition, we find that having more reciprocal friends and followers lowers violent behaviour and improves social satisfaction in class.

This paper is related to a growing body of research on the role of social interactions in shaping economic behaviour (see De Paula (2015) for a recent survey of the literature). The literature has been

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<sup>10</sup> See Jackson *et al.* (2012) for a theoretical and empirical discussion of the concept of 'supported' friendship.

dominated by the investigation on suitable identification strategies for peer effects models (Manski, 1993), which addresses two main concerns: that peers' are self-selected into groups and face the same environment (endogeneity problem), and that individuals and peers' behaviours are simultaneously determined (reflection problem).<sup>11</sup> Furthermore, these identification problems of peer effects have been generally analysed in linear- in-mean models assuming that the outcome of each individual depends linearly on his own characteristics and on the mean outcomes and characteristics of his reference group.

Another strand of the literature focuses on theoretical extensions, each suggesting a different mechanism that might generate such peer effects in the workplace and in schooling environments. The main mechanisms in this literature include: 1) joint production (Kandel and Lazear, 1992; and Mas and Moretti, 2009); 2) social pressure in a network environment (Falk and Ichino, 2006; and Bandiera *et al.*, 2010); 3) mutual insurance among network members (for example, Fafchamps and Gubert, 2007; and Attanasio *et al.*, 2012). These features have been shown to play an important role in shaping individual behaviour and yield predictions about the effect of the size of the social network on individual behaviour and outcomes. De Giorgi and Pellizzari (2014) embedded these three important modelling mechanisms in an educational framework which we use to interpret our findings.

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<sup>11</sup> Several authors solved the endogeneity problem by using random assignment to groups and focusing on the reduced form effect of peers' background characteristics on outcomes. For example, Sacerdote (2001), Zimmerman (2003) and Ammermueller and Pischke (2009) show that randomly assigned peers to dormitories/classes have significant effect on students' outcomes depending on peers' mean characteristics. Addressing the reflection problem, Bramoullé *et al.* (2009) and Lin (2010) developed an empirical framework for identifying the effects of both peers' 'quality' and behaviour on academic outcomes using full knowledge of students' social network structures. These studies make use of self-determined friendships nomination from the Add Health data to show that both friends' mean school grades and friends' mean characteristics have significant effects on a student's educational attainments. Patacchini *et al.* (2011) present evidence regarding the persistency of these effects ten years after the friendships' nomination took place. In another related study Patacchini *et al.* (2017) show that long lived tie relationships have more persistent effect on educational attainments in the long run than short ones. The authors explain this finding by developing a dynamic theoretical model of social interactions which predict the convergence of social norms among peers who repeatedly interact with each other. Exploiting a unique data from a survey conducted in Chinese schools, Lam (2014) estimates the impact of several peer-attributes (cognitive ability, personal traits and behavioural traits) on student's cognitive outcomes. He distinguishes between friends, study mates, emotional supporters, and seatmates, and finds that both the mean cognitive abilities and the mean personal traits of peers (of all types except seatmates) have significant effect on students' achievements. See Blume *et al.* (forthcoming) for a recent survey of this literature, which integrates the theoretical, econometric, and empirical sides of the social interactions literature through a systematic investigation of linear social interaction models.

From a policy perspective, our research highlights the possible negative consequences for educational and behavioural outcomes of detaching students from their social environment. The literature on housing mobility or school choice based on randomized vouchers programs has shown mixed results, perhaps because their overall effect may reflect detachment of students from their childhood social environment. While some school choice programs have been shown to have positive effects on test scores, mainly of students from low socioeconomic backgrounds, housing mobility programs, such as Moving to Opportunity in the US, had no significant impacts on standardized test scores.<sup>12</sup> Some have argued, for example Blume *et al.* (2011), that these programs might have disrupted participants' social ties and as a result have harmed their educational achievements, offsetting to some extent the potential gain from exposure to better schools and communities.<sup>13</sup> In this paper, we are able to isolate the effect of social relationship detachment on student educational outcomes from other environmental changes and highlight the importance of maintaining one's social network throughout middle/high school. The policy implications are that taking students' social networks into account can create a better assignment of students between and within schools in general, and improve the design of these social and welfare programs in particular.<sup>14</sup>

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<sup>12</sup> See, for example, reports of the US Department of Education on “The Evaluation of Charter School Impact” (2010) and of the US Department of Housing and Urban Development on “Moving to Opportunity for Fair Housing Demonstration Program - Final Impact Evaluation” (2011).

<sup>13</sup> Testing the degree of social isolation as one of the possible outcomes of housing vouchers programs, by comparing the amount of social interactions of lottery winners to losers, suggests mixed evidence: while Katz *et al.* (2001) report a similar number of social visits (of friends and family members) for both groups, and Kling *et al.* (2006) finds that job-related social networks improved labour market outcome of lottery winners by a small amount according to the MTO program, other papers have found negative effects of MTO and other programs (e.g., the Gautreaux program and HOPE VI program) on the social relations of lottery winners. Turney *et al.* (2006) found that transportation difficulties and disrupted social networks were barriers to employment in the treatment group. Other papers have reported that lottery winners have fewer close relationships (Kissane and Campet-Lundquist, 2012), fewer neighbourhood social ties (Greenbaum *et al.*, 2008) and reported experiencing lower emotional support in general (Curley, 2009). A recent paper that examines a similar housing voucher program in India (Barnhardt *et al.*, 2014), finds that lottery winners reported facing increased isolation from family and caste networks and lower access to informal insurance. Low level of social integration of lottery winners in schools was also suggested as affecting school vouchers' programs (DeLuca and Dayton 2009; and Blume *et al.*, 2011). For example, Angrist and Lang (2004) show that there is little evidence of socially or statistically significant effects of lottery-winning students on their classmates.

<sup>14</sup> The optimal design of school choice programs is the focus of much recent research. For example, a recent series of studies (Abdulkadiro *et al.*, 2003, 2005, 2011 and Pathak and Sönmez, 2013) analyses the optimal design of admission rules in school choice programs where students take into account strategic considerations when submitting their preferences for schools.

Our paper contributes to the literatures in four dimensions. First, it provides estimates of the impact of the size of social networks on students' educational outcomes, while carefully addressing the causal nature of the relation. Second, it estimates the respective effect of 'quality' of friendships based on two different aspects of relationship quality: friends by friendship type based on the relationship reciprocity and the average socioeconomic background of friends by type. Third, using a unique dataset on non-cognitive outcomes, it measures the effects of these social networks' characteristics on several behavioural outcomes. Fourth, our finding regarding the negative consequences of detaching students from their childhood social environment allows better understanding of puzzling evidence of small or no effect of school choice or housing programs for the poor on educational outcomes of children. Clearly, taking these consequences into account can improve the design of these and related social and welfare programs.

The rest of the paper is organized as follows. Section 1 discusses the conceptual framework. In Section 2, we present our data. Section 3 explains the identification and estimation methodologies. We detail our results in Section 4 and offer conclusions and policy implications in Section 5.

## **1. Conceptual Framework**

The literature on peers effects in the workplace and in schooling environment suggest several mechanisms through which peers effect might be manifested: 1) joint production (Kandel and Lazear ,1992; and Mas and Moretti, 2009); 2) social pressure in a network environment (DeLuca and Dayton 2009; Bandiera *et al.*, 2010); 3) and mutual insurance among network members (for example, Fafchamps and Gubert, 2007; Attanasio *et al.*, 2012).<sup>15</sup> All these new features in modelling social

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<sup>15</sup> There is a vast sociology and economic literature on this channel. The general concept, referred to as social capital, is that individuals can use membership in groups and networks to secure benefits (Bourdieu, 1986; Putman, 1993; Lin, 1999; and Portes 1998). Coleman (1988) introduced the same idea in an educational context. In the economic literature, recent empirical papers tried to characterize social networks in which peers engage in mutual insurance and risk sharing behaviours. These papers show that the number of direct links (the number of members with whom the individual interact directly); the quality of these links (whether these relationships are interpersonal such as close friends and relatives groups); the amount of endowments embodied in the network; and the degree of correlation between incomes of members in the network, are all associated with more access to credit, better risk sharing and higher amount of network's informal favour transactions (Fafchamps and Lund, 2003; De Weerd and Dercon, 2006; Fafchamps and Gubert, 2007; and Attanasio *et al.*, 2012). Other papers have even shown that the amount of indirect links and the degree of closure among direct links helps sustain



interaction have been shown to play an important role in shaping individual behaviour and yield predictions about the effect of the size of the social network on individual behaviour and outcomes. Therefore the evidence we present in this paper on the effect of the size of social networks on individual behaviour and outcomes can be interpreted against the theoretical predictions from models that assume one of these features as deriving mechanism of social interaction. To facilitate the interpretation of our findings we adopt the conceptual framework of De Giorgi and Pellizzari (2014), because it allows to embed the three features discussed above as special cases in an educational environment and to derive their predictions regarding the effect of the size of the social network on students' outcomes. We present this model in the online appendix and we summarize it here.

In this model students interact socially in an educational environment where they exert costly effort to study, learn and obtain grades in academic examinations. The first special case we consider is of joint production, where the learning production of each student depends on the efforts of all group members and the benefit function from academic performance equals to the productivity achieved by all peers. This can be the case, for example, if students undertake teamwork and students choose endogenously their teamwork peers. In line with results presented in Kandell and Lazear (1992), we show in the model presented in the online appendix that having more friends in the group can increase the group's academic performance through two main channels: by directly increasing the productivity (if the learning production is increasing in the number of friends), or indirectly, by increasing the level of effort of each member in the group (if the marginal production of effort increases with the number of friends). The second case we consider is that of social pressure. Following the model presented in Bandiera *et al.* (2010), we assume that the production function exhibits no externalities, but the cost of effort depends on the number of friends. In this case, more friends might increase students' effort if it decreases their marginal cost of effort, which can be the case if studying alongside friends generates contagious enthusiasm or generates incentives to compete. The third case we consider is that of mutual insurance/social learning. Using the theoretical framework presented in De Giorgi and Pellizzari (2014), the main assumption is that friends can mutually insure themselves against fluctuation in their

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favorable exchange between group members (Allcott *et al.*, 2007; Karlan *et al.*, 2009; Krishnan and Sciubba, 2009; Jackson *et al.*, 2012; and Ambrus *et al.*, 2014).

productivity, for example by exchanging classroom notes with friends. In this case, if students are *ex ante* identical they will choose their effort levels on the basis of splitting equally the group's average expected productivities. Thus, the size of friends' group will have an effect on students' average expected performance if friends' interactions involve any form of social learning that will lower the effect of negative productivity shocks. In a school learning environment, for example, exchanging notes can reduce the noise around the material taught.

Our paper cannot fully disentangle these mechanisms and therefore all of them are possible explanations for the dependency of students' educational performances on the size of their social networks. Nevertheless we will show that our results are especially consistent with the joint production and the social pressure explanations. According to these two channels, 'closer' friends may increase student's grades by creating a positive learning atmosphere, especially if these friends are from a high socio-economic background (assuming that 'closer' friends decrease students' marginal cost of effort/increase students' marginal production of effort). On the other hand, rejecters may decrease students' grades by reducing student willingness to study, especially if rejecters are from a low socio-economic background. We will discuss and interpret the findings we present in the forthcoming sections in light of these models and their predictions.

## **2. Data**

### **2.1 Data Sets**

In this paper we use a unique database of friendship networks of students that participated in the Tel Aviv school choice program in 2000–2003. A new school choice program started in Tel Aviv in September 1994. It replaced a busing integration program that assigned some students to schools in the city, but out of their school district. The choice program allowed students who completed primary school a choice of a middle school. Each student could choose from a set of five schools, three of which were outside his/her school district. The school choice program opened the possibility for a better match between students and schools, and the system had the potential to increase school productivity by introducing competition among schools.

Within this framework, each student, at the end of sixth grade, was asked to rank his/her preferred five middle schools, and to list up to eight peers with whom he/she would like to be assigned with in middle school. In case of excess demand for enrolment in one school, students were assigned with one or more of their nominated friends to a subsequent school, so as to maintain a balanced enrollment across schools based on socioeconomic level, educational achievement, gender, and disciplinary record.<sup>16</sup> On average, 93 % of the students received their first school choice and most of the remaining 7 % received their second choice. We note that the process of assigning students to school based on peers' and schools' preferences was administered by Tel Aviv municipality while the assignment to classes within school was done independently by the schools' administrator. Although school administrators did not receive students' peers' preferences and did not assigned students to classes based on peers' preferences there could still have been some cases of students' moving to a different class due to peer preferences leading to a correlation between students' unobserved characteristics and number of friends by type. Thus, we consider the possibility that the allocation process was not completely (conditionally) random by performing a coefficient stability test (Altonji *et al.*, 2005; and Oster, 2015) in order to assess the degree of omitted variable bias.

The empirical analysis presented in this paper is based on the Tel Aviv municipality's administrative records of sixth-grade students in schools that participated in the Tel Aviv school choice program, for the years 2000, 2002, and 2003. The cohort of 2001 is not included in this study because the essential data on school choice and friendships are not available.<sup>17</sup> In addition, the Tel Aviv municipality's administrative records also include the zip code of each student's address in sixth grade and the assignment of these students in kindergarten for the years 1994, 1996, and 1997.<sup>18</sup> Each record contains an individual identifier, a kindergarten identifier, a school and class identifier in the

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<sup>16</sup> Because the system guaranteed that each student would attend school with at least one of his or her nominated friends (if the student nominated eight friends), a strategy that guaranteed getting the first chosen school was to form a group of friends that all chose the same school as first choice but each chose different schools as their other choices. This strategy will work perfectly for all group members if there are only four or five students in the group but it might be less than perfect for some members of the group when the group size is increased beyond five because there are only 13 relevant secondary schools.

<sup>17</sup> We obtained the data from the School Authority of Tel Aviv and the files for the 2001 cohorts were erased from their archive by mistake.

<sup>18</sup> We note that the data on kindergarten assignments covers only three-quarters of the students.

sixth grade, student's zip code and student preferences for middle school enrolment and friend assignments.

In order to test the effect of students' separation from pre-existing social networks during the transition from elementary to middle school on their behavioural and education outcomes in middle school and high school, we combine this dataset with data from two additional sources:

1) The first is GEMS records (Growth and Effectiveness Measures for Schools - *Meitzav* in Hebrew) for the three cohorts that we study. The GEMS is collected by the Division of Evaluation and Measurement of the Ministry of Education.<sup>19</sup> The GEMS is administered at the midterm of each school year to a representative 1-in-2 sample of all elementary and middle schools in Israel, so that each school participates in GEMS once every two years. This dataset includes test scores of eighth graders from a series of tests (in math, Hebrew and English), which were transformed into z-scores for each year and for each subject to facilitate interpretation of the results, as well as responses of seventh-through eighth-grade students to a questionnaire. The proportion of students tested is above 90 %, and the rate of questionnaire completion is roughly 91 %. The GEMS questionnaire records include seventh and eighth graders' responses addressing various aspects of the school and learning environment. We select a section that focuses on student social behaviour and satisfaction from school environment. In this section, students are asked to rate in a 6-point scale—ranging from 1 (strongly disagree) to 6 (strongly agree)—the extent to which they agree with a series of statements. We also examine a set of items in the questionnaire where students report the amount of time allocated to homework in math, Hebrew, English, and science and technology. Each record contains, additionally, the student's class identifier, school identifier, and demographic information (gender, ethnicity, number of siblings and level of parental education).

2) The second is high school matriculation test scores and credit units from the Israel Ministry of Education for the three cohorts that we study, which are available at the Ministry of Education research lab. Matriculation exams are a series of national exams in core and elective subjects taken by

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<sup>19</sup> The GEMS is not administered for school accountability purposes, and only aggregated results at the district level are published. For more information on the GEMS, see the Division of Evaluation and Measurement website (in Hebrew): <http://cms.education.gov.il/educationcms/units/rama/odotrampa/odot.htm>.

the students between tenth and twelfth grade. Students choose to be tested at various levels of proficiency, with each test awarding from one to five credit units per subject, depending on difficulty. Some subjects are mandatory, and, for many, the most basic level is three credit units. Advanced level subjects are those subjects taken at four or five credit units. A minimum of 20 credit units is required to qualify for a matriculation certificate, which is a prerequisite for university admission. The average scores in the matriculation certificate, which are calculated by the higher education Council, are weighted based on the number of credit units taken (advanced level subjects are also given bonuses: four credit units are awarded a bonus of 12.5 points, and five credit units 25 points). All schools in the sample are schools with an academic track leading to a matriculation certificate. We focus on the following matriculation outcomes that are available for all the years: test scores in math, English and Hebrew which were transformed into z-scores for each year and for each subject<sup>20</sup>, matriculation status (=1 if awarded with the matriculation diploma and 0 otherwise) and total number of credit units in the matriculation certificate. The final merged panel dataset consists of data for three cohorts of students: 1994–2006, 1996–2008 and 1997–2009. The dataset includes students' social networks in the sixth-grade, their placement in kindergarten and in eighth grade, eighth-grade student GEMS test scores, seventh-grade and eighth-grade student GEMS questionnaires, high school matriculation exams and student characteristics.

Table 1 presents descriptive statistics, for the sample size, number of schools, and number of classes for the Panel data set. The sample we use includes elementary and middle/high schools in Tel-Aviv. Elementary schools are all K-6, whereas middle schools are part of secondary schools that include both the three middle schools grades and the three high school grades. In contrast to the transition between elementary school to middle school that was based on the school choice program, there is generally very low mobility between schools and classes during the primary school years and

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<sup>20</sup> These three subjects are compulsory: the number of credits units required in Hebrew is two credit units, and in math and English students have to choose between the most basic level (three credit units) and the advanced levels (four or five credit units). Additionally, students got zero values in matriculation exams scores if they did not take the exam, but did take exams in other subjects (in about 10 % of cases).

middle school years.<sup>21</sup> The proportion of students that change school after completing middle school is about 10 % and over 80 % of the students stay in the same school from 7th to 12th grade.<sup>22</sup>

We use data for the three sixth grade cohorts: 2000, 2002 and 2003. The school choice program included 47 secular primary schools and 13 secular middle schools.<sup>23</sup> Nearly every primary-school student (about 97 %) in those schools took part in the program and listed at least one of the two preferences—the preferred schools or peers.<sup>24</sup> The sample included 1037 students from the 2000 cohort, 960 from the 2002 cohort, and 1012 in the 2003 cohort. The table indicates that the cohorts are similar across a host of variables: parental education, average family size, and ethnicity.

## 2.2 Definition and Measurement of Friendship Types

We are able to distinguish in this study between different types of social networks, such as reciprocal friendships versus non-reciprocal. In particular, our database allows us to map students' social networks in elementary schools and in middle schools (according to their sixth grade social networks and after their new school and class assignments).<sup>25</sup> By using the students' friendship nominations we are able to define four different types of students' social networks: (1) reciprocal friends—the nominated friends who reciprocated with friendship nominations; (2) followers—students who nominated individual *i* but were not reciprocally nominated as friends by *i*; (3) rejecters—students nominated by individual *i* but who did not reciprocate with friendship nominations of student *i* and (4) second circle of reciprocal friends—which includes the reciprocal friends of the reciprocal friends of individual *i* (excluding the first circle of reciprocal friends of individual *i*).

Table 2 lists the descriptive statistics of these social networks at the classroom level (columns 1-3) and at the school level (columns 4-6). The table indicates that on average, students have more

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<sup>21</sup> There is no practice of reshuffling students among classes within school in Israel.

<sup>22</sup> We note that middle schools' curriculum in Israel does not include any elective courses and therefore students study with the same classroom peers at all courses.

<sup>23</sup> The middle (/high) schools included in the sample are only those that participated in the GEMS testing in the given year.

<sup>24</sup> If a student listed his or her preferred school but not his or her preferred peers (about 6 % of the students), we assume that he did not have friends with whom he or she wanted to be with in middle school.

<sup>25</sup> It should be noted that our definition of friendships (based on students' nominations of friends with whom they wish to attend school) differs from the one usually used in the literature, which relies mainly on more direct questionnaires regarding students' social networks.

reciprocal friends than either followers or rejecters across almost all groups. For example, the number of reciprocal friends in class is 3.07 in 6<sup>th</sup> grade while the number of followers is 2.44 and the number of rejecters is 2.41. The range of followers is nevertheless wider (from zero to 13 in class in the sixth grade) than the range of reciprocal friends and rejecters, since students were allowed to list just up to eight peers. The second circle of reciprocal friends in class includes on average more students (3.65 students in class in the sixth grade) than any other form of first circle friendships, and has also the widest range, from zero to 18 students.

We note that since we measure the students' social networks in the 6<sup>th</sup> grade, the table indicates that all types of friendships decline between sixth and eighth grade during the transition from elementary to middle school. For example, the number of reciprocal friends in school drops from 3.46 to 2.7 in the eighth grade and a sharper decline is observed in the count of various friends at the class level. The decline in the number of friends at the school level is due to the fact that the city authority tried to meet students' school preferences, rather than assigning them to school based on friendships' requests. This decline is even sharper at the class level (from 3.07 to 1.48) since classes were formed randomly. We will rely on this significant variation in number of friendships by types in class, which is random once we control for the number of friendships by type in school, when we estimate the impact of the number of friends by type on students test scores.

We also present in Appendix Table A1 a comparison of social networks by subgroups. For example, the table indicates that girls have larger social networks of all kinds, except for second circle of reciprocal friends, than boys. Younger students have fewer friends by type, except for rejecters, than students who are in the same grade but older. Students of highly educated parents have more friends from all types than students of low-skilled parents. These patterns are consistent at the class level as well as at the school level.

### **3. Identification and Estimation**

The main goal of this paper is to estimate the effects of social networks on students' academic progress in middle school and in high school. Our main identification strategy relies on the conditional random assignments of students and teachers in classes within a school. The randomness of class

composition results from the fact that students' assignments into class based on ability, family background or any other characteristics of the students are forbidden by law in Israel and this law is strictly enforced.<sup>26</sup> In order to explicitly test for the randomness of class composition in our sample, we performed a series of Pearson Chi-Square tests ( $\chi^2$ ) that check whether the student's characteristics and the class the student are assigned to, are statistically independent. Appendix Table A2 presents the p-values of these tests based on 13 middle schools (with two or more classes) and nine characteristics (gender, several ethnicity groups, number of siblings, and level of parents' education). Out of all 116 p-values only 12 p-values were equal or lower than 5 %. Therefore, in only 10 % of the cases, we reject that there is a random assignment of student to classes according to one of the nine characteristics at the 5 % level. We note that in three schools we reject non-random composition of classes based on mothers' years of schooling but in the same schools we accept such random composition with respect to fathers' years of schooling. In addition only in one of 13 middle schools, up to three p-values were equal or lower than 5 %. Overall, we conclude that there is no evidence of systematic formation of classrooms with respect to students' characteristics. Similar evidence is presented in Lavy (2015) who shows that there is no evidence of systematic non-random formation of classrooms in all primary and middle schools in Israel. We also note that the process of assigning students to classes within school is done independently of their assignment to school which is based on peers' and schools' preferences and is administered by the Tel Aviv municipality. The assignment of students to classes within school is managed by school administrators who do not receive students' peers' preferences. In order to explicitly test whether student's background characteristics are correlated with the number of friends by type in class, conditional on their number of friends by type in school and class assignment, we perform balancing tests for the number of friends by type in class and report their results in the next section. In addition, we assess the degree of omitted variable bias by

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<sup>26</sup> Numerous publications of the Director General's Circulars at the Ministry of Education note that a specific committee at the Ministry is responsible for the implementation of the integration policy. This committee monitors periodically the integration process between and within schools. (see for example the Director General's Circular publication regarding the integration policy of Ethiopian students: [http://cms.education.gov.il/EducationCMS/applications/mankal/arc/sd9ak3\\_7\\_47.htm](http://cms.education.gov.il/EducationCMS/applications/mankal/arc/sd9ak3_7_47.htm)). See also the Bank of Israel Report No. 2014.07 which examined whether the allocation of students to classes by socio-demographic characteristics was random during the years 2001-2010 and found very little segregation within schools in Israel.



implementing the coefficient stability test developed by Altonji *et al.* (2005) and further extended by Oster (2015). Our identification strategy assumes that conditional on school (class) assignment and on the number of friends a student has at her school, the number of friends she attends class with is random. This motivates the following estimation strategy:

$$y_{icjt} = \alpha + \beta_s + \delta_j + \gamma_t + \sum_n \beta_n FC_{nicjt} + \sum_n \mu_n FS_{nicjt} + u_c + \varepsilon_{icjt} \quad (1)$$

where  $y_{icjt}$  denotes the outcome of student  $i$ , from class  $c$ , subject  $j$  and year  $t$ ;  $\beta_s$  is the class/school fixed effects;  $\delta_j$  is the subject fixed effect;  $\gamma_t$  is the year fixed effect;  $X_{icjt}$  are student characteristics;  $\sum_n FC_{nicjt}$  are the size of the social network of type  $n$  in class, where the types are: first and second circles of reciprocal friends, followers and rejecters; and  $\sum_n FS_{nicjt}$  are the number of friends of type  $n$  in school. The error term in the equation includes a class-specific random element,  $u_c$ , that allows for any type of correlation within observations of the same school across classes and an individual random element  $\varepsilon_{icjt}$ . The coefficients of interest are  $\beta_n$ , which capture the effects of the different types of friendships in class.

For the purpose of comparison, we will first present estimates based on a regression specification that includes only year and subject dummies as controls, and then we will present estimates that include additionally a school fixed effect and number of friends by type in school. With students randomly assigned to classes within schools, any additional controls should not affect the Plim of the estimate of  $\beta$ . However, we also estimate a model that includes a class fixed effect  $\beta_c$  instead of a school fixed effect and also student characteristics,  $X_{icjt}$  (including the mother's and father's years of schooling, number of siblings, immigration status, and ethnic origin). We note that there might be advantages and disadvantages in both specifications (i.e. the specification that includes school fixed effects versus the specification that include class fixed effects). The first specification compares students with the same number of friends in school who were randomly assigned with different number of students in class within the same school, whereas the second compares students within the same class. The class fixed effects estimates might capture spillovers effects if the effects of number of friends in class differ depending on the structure of social relations in class. On the other hand, comparing students who attend the same class and using a class fixed effect estimation strategy

allow to control all class unobserved characteristics. Although our baseline specification is the class fixed effect model, we present evidence based on both specifications.<sup>27</sup>

#### **4. Results: Effect of the Size of the Social Network on Academic Outcomes**

##### 4.1 Main Results

In this section, we present evidence regarding the effect of the number of friends in class by type of friendship on educational outcomes. First, we show the impact of the size of friendship networks in middle school class on 8<sup>th</sup> grade GEMS test scores in math, Hebrew and English. Secondly, we estimate its impact on longer term educational outcomes in the end of high school, in particular test scores in matriculation exams in these three subjects, obtaining a matriculation diploma and total number of credit units in matriculation exams.

##### 4.1.1 Short Term Effect on Academic Outcomes

Table 3 reports the estimated effect of friendship networks, measured by number of friends by type of friendship in class, on pupils' GEMS test scores. The GEMS test scores in all three subjects (math, English, and Hebrew) are stacked together. We report results for four different specifications: the first is a simple OLS regression with subject and year fixed effects; the second is based on the conditional random assignment model and it includes as controls middle school fixed effects and the number of friends by type in school; the third specification includes middle school class fixed effects instead of middle school fixed effects and the fourth specification includes pupil characteristics as well. Each estimate presented in the first four columns comes from a separate regression. We estimate the impact of reciprocal friends (column 1), followers (column 2), rejecters (column 3), and second circle of reciprocal friends (column 4) on 8<sup>th</sup> grade academic outcomes. The next four columns (columns 5-8) show the estimated coefficients from one joint regression that includes the number of reciprocal friends, followers, rejecters, and second circle of reciprocal friends in class together.

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<sup>27</sup> It is important to note that the results of the coefficient stability test of Altonji *et al.* (2005) and Oster (2015) are almost identical for both specifications.

The simple OLS estimates in columns 1–4 are significant for the four types of friendships, indicating that reciprocal friends (in the first and second circles) and followers have a positive effect on pupil academic performance and rejecters have the opposite (negative) effect. The treatment estimates of most types of friends decline in the conditional random assignment specification. The estimate for reciprocal friends declines marginally while the estimate for followers drops by half but remains statistically significant. The estimates for rejecters and second circle of reciprocal friends, in contrast, become not significantly different from zero. We note, however, that these estimates are robust to adding students’ characteristics and including class fixed effects instead of school fixed effects to the regression. The positive estimates of reciprocal friends and followers remain almost identical, while the estimates of rejecters and second circle of reciprocal friends are still not significantly different from zero.

In columns 5–8 of Table 3, we report estimates from regressions that include all four types of friends jointly in the regression. The table indicates that the estimates for the four types of friendships in columns 5–8 are only marginally lower than the respective estimates in columns 1–4, despite some degree of collinearity between the four friendship types. These estimates follow a similar pattern to the estimates in columns 1–4, when adding the number of friends by type in school and school/class fixed effect and are also robust to pupil’s characteristic. The estimate of reciprocal friends declines marginally to 0.098 (se= 0.013) and the estimate of followers drops to 0.035 (se= 0.018). The estimates of rejecters and of the second circle of reciprocal friends are now both negative and remain not significantly different from zero. We view this result as evidence supporting our identification strategy.

In Appendix Table A3, we present the results from an alternative specification. The estimates presented are from a joint regression that includes the number of the four types of friendships in class on GEMS test scores, while controlling for the sum of these four types of friendships at school level instead of four separate controls, since it is less correlated with the coefficients of interest. The estimates in the last specification are, in most cases, similar to those in Table 3: The estimate of reciprocal friends resembles the estimate in the previous specification, 0.083 (se=0.009), and the estimate of followers is higher 0.049 (se=0.015). The estimate of rejecters is also negative, as in the

previous specification, but is now statistically significant,  $-0.041$  ( $se=0.016$ ), whereas the estimate of the second circle of reciprocal friends remains small and is not significantly different from zero.<sup>28</sup>

The signs and magnitude of these coefficients are consistent with the social pressure and the joint production mechanisms that we discussed in section 1 in conjunction with the model we present in the online appendix<sup>29</sup>: having more ‘truthful’ friends leads to an increase in learning motivation and improved educational attainments while having more ‘unfriendly’ social ties (rejecters) reduces learning by discouraging study effort. Such negative effect on effort will appear if rejecters increase the marginal cost of effort or if they decrease its marginal productivity. Evidence in the psychology literature offers further support for these potential channels, suggesting that reciprocated friendships have positive effects on emotional and educational outcomes of students, while negative peers’ experiences (for example, rejected friendship offers) have a negative effect on educational outcomes (Gifford-Smith and Brownell, 2003). The mutual insurance/social learning channel might be in effect as well since it suggests that friendships by type may have different effects on students’ social learning depending on the ‘truthfulness’ of friendships. More ‘truthful’ social ties, for example reciprocal friends, are more likely to involve personal and more frequent interaction than other type of friends (followers and rejecters) and the more likely outcome of such social interaction is better learning and higher grades.

The estimates of the second circle of reciprocal friends are small and not significantly different from zero in both specifications. This suggests that the number of indirect links has no

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<sup>28</sup> In Appendix Table A4, Table A5 and Table A6 we test three additional alternative specifications: in Table A4, we present the effect of the number of friends by type on each subject separately, in Table A5 we test for the existence of non-linear effects of the four types of friendships, and in Table A6 we add to the baseline specification elementary school/class fixed effect (Table 3 Last row). The estimates in Appendix Table A4 show that the effects across subjects are remarkably similar: while the subject-specific estimates are naturally less precise than our pooled estimates, each of these three estimates is close to the average estimate obtained in Table 3 (column 5–8, third row) when all the subjects were pooled together. Appendix Table A5 tests for the degree of linearity of the effects of the four types of friendships, by a regression that includes dummy variables for the four types of friendships and controls for their respective number in school. The estimates indicate that the influences of reciprocal friends and followers are only partly linear, while the coefficients of all dummy variables of other types of friendships are not significantly different from zero. Appendix Table A6 reports the estimated effect of the number of friends by type on students’ GEMS test scores based on a model that includes also an elementary school/class fixed effect. The estimates presented in this table are remarkably similar to those presented in Table 3 (last row). We think this similarity implies that the results are not sensitive to adding these additional controls.

<sup>29</sup> We note that although this model assumes that students are identical and there is only one type of friends, we extend the discussion to a more complex setting with different types of friends.

impact on educational outcomes, once we account for the effect of the size of the direct links.<sup>30</sup> However, addressing a different aspect of indirect links, the degree of closure of social relation, reveals that they do matter to some extent for students' educational outcomes. Following Jackson *et al.* (2012) we measure the closure of social relation<sup>31</sup> by testing whether reciprocal friends are supported (meaning that reciprocal friends have a mutual reciprocal friend) or not. By including the two separated groups of reciprocal friends (supported and not supported reciprocal friends) in a regression that includes all other types of friends jointly in the regression, their respective number in school, and class, year and subject fixed effect, we find that the effect of number of reciprocal friends that are supported is higher than those who are not (0.103, se=0.014 versus 0.058, se=0.04) though the estimates are not statistically different between the two groups.

The results we presented in this section imply a relatively large impact of social relationships, especially of reciprocal nature. The effect of reciprocal friends is statistically higher than that of other friendship types. The addition of one reciprocal friend raises average GEMS test scores by 0.098 standard deviations of the test scores distribution (based on the preferred specification, presented in Table 3, columns 5–8, last row). Another way of assessing the magnitude of the effect size is by computing the effect of the decline of 1.6 reciprocal friends in the transition from primary to middle school (based on the summary statistics in Table 2). This change leads to a decline in the average GEMS test scores of 0.16 of a standard deviation. The effect of followers is also statistically higher than the effects of rejecters. The treatment estimate of followers is 0.035 of a standard deviation. Therefore, the decline of 1.8 in the mean number of followers in middle school relative to primary school lowered the average GEMS test scores by 0.06 standard deviations according to the preferred specification. The impact of rejecters is not significant in the preferred specification, but it is more precisely measured in the specification presented in Appendix Table A3. Here, a reduction of 1.7 in

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<sup>30</sup> There are few theoretical papers that emphasise the importance of indirect links and its implications for network structure (Jackson and Wolinsky (1996) and Bala and Goyal (2000)), but all empirical papers that refer to indirect links do not count the number of indirect links as we do: Calvo-Armengol *et al.* (2008) refer to the Katz-Bonacich centrality measure, Krishnan and Sciubba (2009) refers to symmetric versus asymmetric networks, and Ambrus *et al.* (2014) use the expansion measure.

<sup>31</sup> Jackson *et al.* (2012) show in a theoretical model that patterns of exchange that are locally enforceable require all links within the network to be supported. They also provide empirical evidence from rural villages in India regarding the correlation between patterns of favour exchange and the levels of support.

the mean number of rejecters in middle school relative to primary school increases the average GEMS test scores by 0.07 standard deviations. The estimated impacts of the second circle of reciprocal friends are not significantly different from zero in all specifications.

A complementary way of assessing the overall magnitude of these estimates is by simulating how one's academic success would change if the transition to middle school did not entail changing the size of the social networks in class, further to the change occurring due to middle school transition. In other words, we model the dynamics of the circumstances as if students were able to stay with all of their childhood friends in a class that moved with them to middle school. Based on the summary statistics in Table 2, we assume the students would have on average an additional 0.91 reciprocal friends and 0.87 followers (referring to the respective number of friends in middle school multiplied by the ratio of number of friends in primary class to number of friends in primary school). Based on the estimates from the preferred specification with class fixed effects (columns 5–6), this scenario increases their GEMS score by 0.12 standard deviations. If we instead use the alternative specification, where the impact of rejecters is also taken into account, and assuming that a student has on average an additional 0.87 rejecters as well, it would increase their GEMS score by 0.08 standard deviation.

Next we estimate and discuss evidence on the sensitivity of the effect number of friends in class to residential geographic proximity of friends. We distinguish between friends who reside in the same zip code area versus friends who live farther away. We note that a zip code area includes only 2-3 blocks. The distribution of friendships within zip code area reveals that the number of rejecters within this area is practically zero and therefore we cannot allow for this type of social connection variation in treatment effect by residential proximity.

We first estimated the effect of residential proximity on the likelihood of friendship by type. The estimates show that living in the same zip code area does not increase the probability of reciprocal friendship ties, while it does decrease significantly the probability of non-reciprocal friendships.<sup>32</sup> In Table A7 we report the estimated effect on GEMS test scores of number of friends by type who reside

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<sup>32</sup> These results are based on separate logistic regressions for each friendship type. The dependent variable is an indicator of the type of friendship and the explanatory variable is an indicator of whether a classmate resides in the same zip code area. We control in these regressions for subject, year and primary school class fixed effects.

in the same zip code area versus friends who reside in a different zip code area. We present in the table estimates based on a specification that includes the number of all four type of friends. For reciprocal friends, followers and second circle of reciprocal friends we distinguish the number of friends by geographic proximity. In the regression we control for the number of friends by type of friendship nomination in school, and year, subject and middle school class fixed effects. The point estimates of reciprocal friends, of followers and of second circle of reciprocal friends are larger when the student and these friends are close neighbours. This is a remarkable result given that the mean number of neighbouring friends is much smaller than the mean number of non-neighbouring friends. However the standard errors of these estimates do not permit rejecting that they are not statistically different.

In Appendix Table A8 and Table A9, we test for the effect of the length of friends' acquaintance. This aspect of friendship ties is presumed to reflect the probability of parents knowing each other, which is said to affect the degree of intergenerational closure and facilitate the imposition of effective norms by the parents (Coleman, 1988). Using data on kindergarten assignments of these students enables us to examine whether friends by type in primary school class attended the same kindergarten. We show that although longer length of acquaintance increases the likelihood of reciprocity of friendship ties, friendships based on new acquaintance during primary schools have the same effect on educational outcomes as friendships that are based on acquaintance since kindergarten. Appendix Table A8 reports the effect of the length of acquaintance of two primary class peers (=1 if two class peers came from the same kindergarten and 0 otherwise) on the likelihood of friendship nomination by type, based on separate logistic regressions for each friendship type and includes subject, year and primary school class fixed effects as controls. The estimated effect of length of acquaintance is positive and significant only in the case of reciprocal friends (0.027, se = 0.03), while negative and only partly significant for other friendship types. Appendix Table A9 reports the estimated effect of the number of relationships based on acquaintance since primary school versus relationships based on acquaintance since kindergarten, for all four types of friendships in class, on GEMS test scores. As in the last specification of Table 3, we report results based on one joint regression that includes the number of friends by type of friendship nomination and by friendship length in class together, controlling for the number of friends by type of friendship nomination in

school, and including year, subject and middle school class fixed effects. Comparing the estimated effect by friendship length, reveals that the differences between the estimates are not statistically different between the two groups: while the estimates of reciprocal friends who knew each other since kindergarten are higher than primary school acquaintance based relationships (0.111 se=0.019 versus 0.093, se=0.014); the estimates of rejecters have the opposite pattern, those based on primary school acquaintance are more negative (-0.075, se=0.035 versus -0.011, se=0.024); and the estimates of follower and second circle of reciprocal friends are almost identical for both types of acquaintance length.

This dimension of friendship ties was also studied recently by Patacchini *et al.* (2017). In contrast to our focus on the effect of number of friends which differ by the length of acquaintance, this study examines whether the behaviour of friends have a differential impact on educational attainments of schoolmates by length of friendship ties. The authors employ an alternative identification strategy that rely on the non-overlapping properties of peer groups in social networks and address the problem of correlated effects by using network fixed effects. They find that only the behaviour of long-lived friends has a positive impact on their peers' educational attainments in the long run. We view our paper and Patacchini *et al.* (2017) as complementary studies, each addressing a different aspect of friendship ties. While Patacchini *et al.* (2017) emphasize the similarity of the behaviour within social groups and convergence of preference affected by the friendship length, in our paper the effect of the size of the group depends less on the length of acquaintance of its members, given type of friendship group (reciprocal friend, followers, rejecters and second circle of reciprocal friends).

#### 4.1.2 Long Term Effect on Academic Outcomes

Using administrative data, we are able to track students from the end of primary school, through middle school, to the end of high school. In Table 4, we present evidence of the longer term effect of number of friends by type on very economically important end of high school educational outcomes. Panel A reports the estimated effect on high school exit exams (matriculation) test scores in



math, Hebrew and English, which are stacked together; Panel B reports the estimated effect on the probability of receiving a matriculation diploma based on a linear probability regression.<sup>33</sup> Panel C reports the estimated effect on the total number of successfully completed matriculation exams' units.<sup>34</sup> We report estimates from the four specifications presented in Table 3, which include all four types of friendships jointly in the regressions. The estimated effects of each type of friendship are presented in columns 1–4.

Similar to the pattern we found in Table 3, the simple OLS estimates in columns 1–4 are positive for reciprocal friends (in the first and second circles) and for followers whereas the estimate for rejecters is negative. The treatment estimates of most types of friends decline in the conditional random assignment specification, but are robust to adding students' characteristics and to the addition of class fixed effects as a control instead of school fixed effects. Comparing the estimates in Panel A of Table 4 to those in Table 3 (last specification) reveals that the effects of the number of friends by type persist to a large extent through high school. Furthermore, most of the point estimates for high school outcomes are very similar to the estimated effect in middle school. For example, the effect of reciprocal friends on GEMS test scores (0.098, se=0.013) is only somewhat higher than its effect on matriculation test scores in same subjects (0.071, se=0.016); the effect of followers is almost the same (0.035 (se=0.018) in Table 3 versus 0.043 (se=0.022) in Table 4, Panel A). Both effects are statistically higher than the effects of rejecters and second circle of reciprocal friends, which in both cases are negative and not significantly different from zero.

Panel B and Panel C of Table 4 report similar estimated effects of the different friendship types on obtaining a matriculation diploma and on total number of successfully completed matriculation exams' units. Reciprocal friends have the statistically largest effect on this outcome (0.025, se=0.008, and 0.771, se=0.210 respectively), while the respective estimated effect of followers is positive and the estimated effects of the other two types of friendship ties are negative, but none of them are significantly different from zero.

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<sup>33</sup> Appendix Table A10 reports the respective coefficients and standard errors from a logistic regression. The marginal effects at the means are very similar to the coefficients of the linear probability regression in Table 4.

<sup>34</sup> We note here that all these high school outcomes are very good predictors of post-secondary schooling attainment and quality and also of earnings at adulthood (Lavy, 2014).

As shown earlier, we can simulate how one's academic success would change if the transition to middle school did not entail changing the size of the social networks in class, further to the change occurring due to middle school transition. This analysis highlights the importance of the friendship network and its prolonged influence on students' chances of receiving matriculation certificates. Assuming as before that students would have, on average, an additional 0.91 reciprocal friends and 0.87 followers, will increase their matriculation scores (in math, English and Hebrew) by 0.102 standard deviations; their probability of receiving a matriculation diploma by 2 percentage point (from 76 % to 78 %); and their total number of successfully completed matriculation exams' units by 0.7 (from 19.5 to 20.2).

#### 4.2 Testing the Validity of the Identification Strategy

In this sub-section we present two additional analyses that provide further evidence on the validity of our conditional random assignments estimation strategy. As discussed in Appendix A2, according to a series of Pearson Chi-Square tests we conclude that there is no evidence of systematic formation of classrooms with respect to students' characteristics. We support this evidence by checking whether the number of friends by type in class is correlated with students' observable characteristics, conditional on the class and number of friends by type in school. In the second analysis we consider the possibility that the allocation process is not completely (conditionally) random and assess the degree of omitted variable bias by implementing the coefficient stability test developed by Altonji *et al.* (2005) and Oster (2015).

In Table 5, we present the results of balancing tests for the number of different types of friends in class. We regress directly the treatment measures on student characteristics, focusing on gender, number of siblings, father's years of education, mother's years of education, new immigrant and four ethnicity indicators (child or parents born in Asia/Africa, Europe/America, Former Soviet Union or in Israel). The estimates presented in the table are the regression coefficients of the number of friends of a given type in class on each of these student characteristics. We include as controls in these regressions the number of friends by type in school (same type as in class), and year and middle school class fixed effects. Each column presents estimates for one of the four types of social networks.

Overall, the table indicates that there is no evidence of systematic relationship between these characteristics and the in number of friends of each type in class after controlling for the number of friends by type in school. First, there are 36 estimates presented in Table 5 and only 3 are significant. Secondly, some of the characteristics switch sign. For example, parental education is positively correlated with reciprocal friends but negatively correlated with followers. We would expect, however, that these two types of friendship would have the same correlation sign with parental schooling.

Next we consider the possibility that the allocation process is not completely (conditionally) random. This could result, for example, where students' move to a different class according to peers' preference and can lead to correlation between students' unobserved characteristics and number of friends by type. We assess the degree of omitted variable bias in our estimated effects of number of friends on educational outcomes by implementing the coefficient stability test developed by Altonji *et al.* (2005) and further extended in Oster (2016). The central point of the method is that in order to evaluate the degree of omitted variable bias one should test not only the coefficient movements after the inclusion of observed controls but also the movements in R- squared.<sup>35</sup>

Appendix Table A11 presents the validation results for the analysis of the estimated effect of number of friends by type on both short term and long term educational outcomes. Panel A presents the effects of number of friends by type on GEMS test scores, Panel B, Panel C and Panel D present the effects of number of friends by type on matriculation test scores, the probability of receiving a matriculation diploma and the total number of successfully completed matriculation exams' unit respectively. The first row reports the estimates and R- squared of the effect of friends by type based

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<sup>35</sup> This method evaluates the possible degree of omitted variable bias under the assumption that the unobservable and the observables are approximately equally related to the treatment. The bias-adjusted treatment is approximately given by:  $\beta^* \approx \tilde{\beta} - (\beta' - \tilde{\beta})(R_{max} - \tilde{R})/(\tilde{R} - R')$ , where  $\tilde{\beta}$  and  $\tilde{R}$  are the coefficient estimate and R- squared from the controlled regression and  $\beta'$  and  $R'$  are the coefficient estimate and R- squared from the uncontrolled regression. In addition,  $R_{max}$  is the R- squared in the regression that includes all observable and unobservable controls, which is unknown. Since we do not have external sources for evaluating  $R_{max}$ , we use several options assumed in the literature: (1)  $R_{max} = \tilde{R} + (\tilde{R} - R')$ , (2)  $R_{max} = \min\{\pi\tilde{R}, 1\}$  where  $\pi = 1.3$  and  $\pi = 2.2$ , (3) and the most conservative case :  $R_{max} = 1$ . Calculating the bias-adjusted treatment ( $\beta^*$ ) based on the different options of  $R_{max}$ , enables to construct the bounding set:  $[\tilde{\beta}, \beta^*]$ . The statistical test suggests that if the inclusion of controls moves the coefficient towards zero and the bounding set include zero, the causality of the treatment is rejected. We also check whether the bound of the set are outside of the confidence interval of  $\tilde{\beta}$  (99.5% confidence interval).

on the specification that includes the number of friends by type in school, and subject, year and school fixed effects. The second row presents the coefficient estimates and R- squared of the effect of the friends by type based on a specification that includes in addition students' characteristics and class fixed effects instead of school fixed effects. The four last rows present the bounding sets under different values of Rmax as suggested in the literature where Rmax is defined as the unknown R-squared from a regression that includes all observable and unobservable controls (the different values are: (1)  $R_{max} = \tilde{R} + (\tilde{R} - R)$  (2)  $R_{max} = \min \{ \pi \tilde{R}, 1 \}$  where  $\pi = 1.3$  and  $\pi = 2.2$  (3) and the most conservative case :  $R_{max} = 1$ ). The lower (/upper) bound of each one of these sets is the coefficient of the effect of friends by type on educational outcomes (from the second row), and the upper (/lower) bound is the bias-adjusted coefficient. These bias-adjusted coefficients are calculated based on the changes in R- squared and coefficient estimates across the two first rows, and the maximum amount of variation that can be potentially explained (each value of Rmax defines a different value of bias-adjusted coefficient).

The values of the bounds are in most cases positive for reciprocal friends and followers and negative for rejecters and the second circle of reciprocal friends. The coefficients are closer to zero in the second row in comparison to the estimates presented in the first row except in the case of rejecters, and the bounding sets do not include zero for almost all Rmax values of reciprocal friends and followers and for all values of Rmax of the second circle of reciprocal friends in Panel D. In addition, all of the bounding sets are included in the 99.5% confidence interval of the coefficients in the second row for the two lower values of Rmax.<sup>36</sup> Similar results are obtained for the analysis of the effects of number of friends by type based on the school fixed effects specification. Since for both first lower values of Rmax the results survive either the confidence interval test or the rejection of zero test, and in many cases both, we view these results as further evidence in support of our identification strategy.<sup>37</sup> Moreover the fact that the correlations between parental education and number of

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<sup>36</sup> We note that replicating this analysis for the case where each treatment is included separately in the regression (as in Table 3 columns 1-4) yields similar results.

<sup>37</sup> We note that the fact that Rmax is unknown and there is no clear cut-off for its bounding value limit the empirical applicability of the coefficient stability test. Nevertheless, Oster (2016) suggests the bound of

reciprocal friends and followers have mixed signs as seen from the balancing tests' results but are positive and significant in the case of reciprocal friends raises the possibility that the allocation process involved cases of students moving to different classes because of their friendship ties. The results of these coefficient stability tests suggest however that the omitted variable bias from the possible correlation between students' unobserved characteristics and number of friends by type is limited.

#### 4.3 Effects of Friends 'Quality' on Cognitive Achievements

Peer effect studies in economics focus largely on the effect of a peer's 'quality'. Few studies have documented that peers from a higher socioeconomic background improve classmates' educational outcomes. In this sub-section, we test the effect of friends' 'quality', whether the impact of the size of the network varies with the 'quality' of friends and whether the effect of the size of a student's friendship network changes once we take into account the 'quality' of friends in this social network. In other words, we test for 'quantity-quality' trade-off in the effect of social network on educational outcomes. Additionally, we explore the heterogeneous effects of friendships 'quality' and 'quantity' across different dimensions of students' characteristics.

##### 4.3.1 'Quality' of Friends and 'Quantity-Quality' Trade-off

In Table 6, we report the effect of the number of friends with lower/higher socio-economic background of the student in class, while controlling for their respective number in school (and it includes middle school class, year and subject fixed effects). We report the estimated effect of friends by type with higher socioeconomic background than the student in odd columns, and the estimated effect of friends by type with lower socioeconomic background than the student in even columns. In Panel A we measure socio-economic background based on father's education, in Panel B we do that

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$R_{\max} = \min \{1.3\tilde{R}, 1\}$  (the second bound discussed) as an appropriate bound based on testing the stability of the results of a series of randomized papers.

based on mother's education, in Panel C based on student's ethnicity and in Panel D we use number of siblings as an indicator of socio-economic background.

The evidence presented in the Table 6 suggest that reciprocal friends and followers with higher socioeconomic background, especially as measured by parental education, have larger positive impact than the respective friendship types who are from lower socioeconomic background. This parental education effect difference is statistically significant mostly in the case of reciprocal friends and follower. Interestingly, in the case of rejecters, those who have lower parental education are the most influential and are found to decrease the student's educational performances.

The different signs of the estimated coefficients by friend's type reinforce our interpretation that these results are driven by the social pressure/joint production mechanisms: friends from higher socioeconomic background create a better learning atmosphere and increase the chances of contagious enthusiasm the 'closer' is the relationship. On the other hand, 'negative' type of friendship such as rejecters from lower socioeconomic background than the student is more likely to have a bad influence on him/her. Such different effects based on either measure of friends' 'quality' (type of friendships or socio-economic background of friends) have been emphasized in the psychology literature as well: 'close' friendships ties among children, especially of reciprocal nature, are said to be a source of emotional support (Crosnoe *et al.*, 2003; Vaquera and Kao, 2008); increase self-esteem (Gifford-Smith and Brownell, 2003); help to deal with problems (Azmitia and Montgomery, 1993); and can also function as academic resources (Cauce, 1986). On the other hand, research examining the effect of 'negative' peer experiences (such as exposure to rejecters) show is that 'negative' type of friendship exacerbate academic difficulties by undermining motivation or by increasing exposure to other marginalized peers who de-value academic success (Buhs and Ladd, 2001).<sup>38</sup> The negative effect of

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<sup>38</sup> Bandiera *et al.* (2010) assumes a workplace environment where there are no externalities through the production function. Their evidence suggests that working alongside friends does not affect worker's productivity. However, when they interact the treatment effect with peers' ability, their evidence suggest that peers who on average are more productive than a given friend, have positive impact on that friend's productivity. Park (2017) also finds that working alongside friends at a similar workplace environment might decrease workers' productivity depending on workers' level of conscientiousness. Hahn *et al.* (2017) show that when students are assigned to working groups at school with either schoolmates or friends, students' performance are affected by the group composition only in the case of low-ability females. They find that low-ability females assigned with friends outperform low-ability females assigned with schoolmates.

rejecters can also be predicted from the mutual insurance/social learning model because it is very unlikely that such individuals will join an informal insurance arrangement with students that they prefer not to be in a truthful friendship.

Further insights regarding the impact of both friends ‘quality’ and ‘quantity’ can be derived from the analysis in Table 7, which presents evidence on the effect of both the ‘quantity’ and ‘quality’ of friends by types on educational outcomes. We use an index of friends’ ‘quality’ that we constructed based on socioeconomic background characteristics of students, in particular parental schooling, Asia/Africa ethnicity and number of siblings.<sup>39</sup> For students with no friends of a given type, the ‘quality’ of friends was set to zero, and a dummy variable that equals one for such a case (and zero otherwise) was included in the regressions.

We report the estimated effect of the number and average ‘quality’ of friends by type in class from one joint regression that includes the number of friends by type in school, dummy variables for having no friends by type in class, pupil characteristics, and middle school class fixed effects as controls (columns 1–4).<sup>40</sup> The next four columns (columns 5–8) show the estimated coefficients from one joint regression that includes, additionally, an interaction term between the number and the ‘quality’ index of friends for each type of friendship nomination. In Panel A and Panel B, we present the estimated effects on tests scores in math, English and Hebrew, where the test scores in all three subjects are stacked together: Panel A presents short run effects on GEMS test scores, whereas Panel B presents long run effects on matriculation exams test scores; Panel C reports the estimated effects on the probability of receiving a matriculation certificate based on a linear probability regression;<sup>41</sup> and

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<sup>39</sup> The ‘quality’ index of friends by type in class is equal to the sum of the mean education of the friends’ fathers and the mean education of the friends’ mothers less the proportion of friends from Asia/Africa ethnicity and the mean number of siblings of friends. In Appendix Table A12 we present the estimated effect of each of these characteristics of friends on GEMS tests scores separately: the estimated effect of friends’ ‘quality’ and ‘quantity’ is presented in columns 1-4, and columns 5-8 present their interaction as well. The results of the effects of each category of socioeconomic background of friends are similar to the index of friends ‘quality’: in most cases only the ‘quantity’ and ‘quality’ of reciprocal friends are significantly different from zero. We note that the interaction term of reciprocal friends is significantly different from zero only in the case of number of siblings.

<sup>40</sup> We note that the ‘quality’ of friends by type in school was not included as an additional control due to the high correlation between the ‘quality’ of friends by type in school and the ‘quality’ of friends by type in class.

<sup>41</sup> Appendix Table A10 reports the respective coefficients and standard errors from a logistic regression. The marginal effects at the means (in italics) resemble the coefficients of the linear probability regression in Table 7.

Panel D reports the estimated effects on the number of successfully completed matriculation exams' units.

The results in almost all panels indicate that the estimated effects of the number of friends by type (columns 1–4) are not very sensitive to adding the 'quality' of friends variable by type of friendship to the regressions. Namely, the estimates presented in Table 7 are relatively similar to the respective estimates presented in Table 3 and Table 4. Thus, despite some degree of collinearity between the number and 'quality' of friends, the number of friends remains an important factor in students' achievements when adding the 'quality' of friends by type: The estimated effect of the number of reciprocal friends is positive and significantly higher than other friendship types for all educational outcomes. The estimated effect of number of followers is also positive and marginally significant for average matriculation test scores in math, Hebrew and English (0.04,  $se=0.025$ ), but ceases to be significantly different from zero in the case of average GEMS test outcomes; The effects of rejecters and of the second circle of reciprocal friends are still negative and not significantly different from zero in all educational outcomes regressions.

Similar to the peer effect literature, we present evidence on the positive effect of 'quality' of friends, especially that of reciprocal friends, on educational performances. The impacts of reciprocal friends' 'quality' on short term as well as long term educational outcomes are positive and significantly different from zero. Moreover, the impacts of reciprocal friends on both GEMS test scores and matriculation exam test scores (0.016  $se=0.004$  and 0.01,  $se=0.003$  respectively), as well as on the likelihood of obtaining a matriculation diploma and on the total number of matriculation exams' units (0.006,  $se=0.002$  and 0.196,  $se=0.047$ ) are all significantly higher than that of other friendship types. The impacts of other friendship types' 'quality' are also positive (except for the second circle of reciprocal friends) but not significantly different from zero.<sup>42</sup> Comparing the elasticity of the 'quality' of reciprocal friends to that of their 'quantity' at their mean values (the mean value of

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<sup>42</sup> A recent paper by Lam (2014) considers the effect friendship types, such as seatmates, emotional supporters and study mates. He finds that several friendship types improve educational performances through different attributes. While the degree of self-discipline is found to be the most important attribute of friends and emotional supporters, mental ability is found to be the main channel through which study mates influence students' performances.



the ‘quality’ of reciprocal friends is 16.2, while the mean value of the non-zero number of reciprocal friends is 1.5) reveals that the elasticity of the ‘quality’ of reciprocal friends is about twice higher than the elasticity of the ‘quantity’ of reciprocal friends in all Panels.

These findings seem to suggest that both friends’ ‘quantity’ and ‘quality’ are important channels of influence on educational performance. While the ‘quality’ of friends, especially the ‘quality’ of reciprocal friends, has a positive effect on student test scores, as the evidence of the peer effect literature seems to suggest, controlling for it does not affect the ‘quantity’ channel considerably. Adding an interaction term between the ‘quantity’ and the ‘quality’ of friends by type reveals that to some extent a trade-off exists between the ‘quantity’ and the ‘quality’ of reciprocal friends. The estimated effect of the interaction term is negative for all educational outcomes, though significant only for GEMS test scores (-0.004, se=0.002). This trade-off stresses the importance of the previously overlooked effect of the size of friendship networks on educational outcomes in the economic literature, since it reveals that the effect of the mean socioeconomic background of reciprocal friends depends on their number, and declines with the total numbers of reciprocal friends.

The peer effect literature emphasizes largely the effect of a peers’ ‘quality’, as measured by their mean socioeconomic background, and peers’ behaviour effect on students’ educational outcomes. Although we cannot address both of these effects using our identification strategy, we do include the peers’ ‘quality’ channel.<sup>43</sup> Addressing this channel using our identification strategy allow us to compare the effects of the number of friends by type from higher mean socioeconomic background than the student to that from lower mean socioeconomic background. Similar to the peer effect literature we find a positive relationship between socioeconomic background of reciprocal friends and students’ educational outcomes: reciprocal friends from higher socioeconomic background have larger impact on test scores than respective friends from lower socioeconomic background. We note however that addressing other type of friendships than usually addressed in the literature reveals that this effect depends on the reciprocity of the relationship: followers from higher socioeconomic

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<sup>43</sup> The high correlation between students’ socioeconomic background and test scores does not allow us to differentiate between the effects of number of friends by type with higher and lower grade than the student in class given the respective numbers in school and the effects of number of friends by type with higher and lower socioeconomic background than the student in class given the respective numbers in school.

background have also larger impact on test scores than respective friends from lower socioeconomic background while the opposite is true in case of rejecters. In addition, we find that both friends' 'quantity' and friend' 'quality' are important channels of influence on educational performance, and highlight the trade-off between them in the case of reciprocal friends. In the next sub-section we explore the effects of both friends' 'quantity' and 'quality' for different stratifications of the sample.

#### 4.3.2 Heterogeneous Effects of 'Quality' and 'Quantity' of Friends

In order to gain more insight into the effects of social networks on students' test scores, we explore in this sub-section the heterogeneous effects of 'quality' and 'quantity' of friends.

In Table 8 we present estimates based on three different stratifications of the full sample.<sup>44</sup> Panel A reports the effects of friendship types by gender. Panel B presents evidence separately for young and older children of a given cohort. Panel C reports results separately by parental years of schooling (=1 if both parents' years of schooling is above the median – 12 years, and zero otherwise).<sup>45</sup> We report estimates from regressions that include the number and the average 'quality' of friends by type in class, all types included jointly in the regression, and we control for the number of friends by type in school as well as for having no friends by type in class, students' characteristics, class and year fixed effects.

Panel A suggests that the effects of 'quality' versus 'quantity' of friends by type differ by gender. Recent related studies suggest that a higher proportion of girls in class improves educational outcomes (Hoxby, 2000; and Lavy and Schlosser, 2011) by decreasing the level of violence in the classroom and improving inter-student relationships. Since friendship networks are mostly composed of students from the same gender (around 80 % of friendships' nomination are of the same gender), we posit that gender peer effects, as discussed in the literature, characterize small friendship groups as well, and

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<sup>44</sup> It should be noted that an alternative way to measure heterogeneous effects would have been to use interaction terms for these subgroups. However, in this type of approach, the treatment-interaction terms may pick up variations by gender or parental schooling in the effects of other covariates included in the regressions. For this reason, we choose to stratify our sample, although this means our estimates are based on a smaller sample.

<sup>45</sup> Students with missing values in parental education (4 % of the total sample) are excluded from this analysis. The results are not sensitive to the inclusion of these students in the low or high education group. Results based on stratifying the sample by mother's schooling are very similar to those based on father's schooling. These results are available from the authors upon request.

therefore the impact of network would be more pronounced on girls. We nevertheless find the opposite, that social network have stronger effects on boys: We do find that the effects of both the number of reciprocal friends are positive and significant for both gender but they are statistically higher for boys (0.12, se=0.023 versus 0.052, se=0.022). Similarly, the effects of mean ‘quality’ of reciprocal friends are positive and significant for both gender (0.013, se=0.007 for boys , and 0.017, se=0.006 for girls), but the mean ‘quality’ of other types of friendships (except for the second circle of reciprocal friends) are positive and significant only for boys: the ‘quality’ of followers is positive and significant for boys (0.015, se=0.007), and in the case of rejecters it is also statistically higher than that of girls (0.02, se=0.007 for boys and 0.002, se=0.006 for girls).

Panel B of Table 8 presents the estimates for the heterogeneity of effect of social networks of friends by age of pupils. Empirical evidence suggest that “young” students of each cohort have lower scores than “oldest” students throughout their school years, are less likely to attend university (Bedard and Dhuey, 2006), and are more often victims of violence and bullying (Mühlenweg, 2010). Since “young” students relative to their cohort are characterized by lower cognitive as well as non-cognitive outcomes than “old” students, we postulate that both ‘quality’ and ‘quantity’ channels would have stronger impacts on younger students. In order to be consistent with the literature, we stratify the sample so as to include in the “young” group students who are substantially younger than the others. Therefore, the “young” group includes pupils born in the later part of the cohort year (from September to December) while the “old” group includes pupils born in the earlier part of the cohort year (from January to August). However, the table indicates that younger and older students are similarly affected by both number of reciprocal friends (0.067, se=0.024 and 0.089, se=0.019, respectively) and their ‘quality’ (0.018, se= 0.005 and 0.016, se=0.005 respectively). These two groups are being similarly affected by other friendship types as well.

Earlier peer effect studies suggest that students from low socioeconomic backgrounds are more affected by their peers’ ‘quality’ (Hanushek *et al.*, 2003; Gould *et al.*, 2009; and Lavy *et al.*, 2012). The results presented in Panel C of Table 8 suggest that both the ‘quality’ and ‘quantity’ of reciprocal friends have indeed a higher effect on students of low parental schooling than on students of high parental schooling. While this difference is marginally significant in the case of reciprocal friends

‘quality’ (0.022, se=0.005 versus 0.008, se=0.007), the difference between the effect of the number of reciprocal friends for the students with low levels of parental education and those with high levels of parental education is statistically significant (0.113, se=0.021 versus 0.042, se=0.020). The ‘quality’ and ‘quantity’ of other types of friendship have no significant effects for both groups (except for the ‘quality’ of rejecters for student of low parental schooling).

#### 4.4 Behavioural Outcomes

The role of social networks in promoting trust and cooperation between individuals has been the focus of many recent papers. We are able to test this channel by observing the impacts of social network characteristics on several non-cognitive outcomes. Moreover, we view these non-cognitive outcomes as channels through which cooperation and positive learning environment affect students’ medium and longer term educational outcomes.

Using GEMS questionnaires in the 7<sup>th</sup> and 8<sup>th</sup> grades enable us to broaden the scope of the discussion of social networks effects, by examining the effects of friendship on behavioural outcomes as well. The analysis is based on the following five questionnaire items<sup>46</sup>: (1) “Students in class help each other ”; (2) “I was involved in violence (physical fights) in school many times this year”; (3) “Sometimes I’m scared to go to school because there are violent students”; (4) “I feel well-adjusted socially in my class”; (5) “I am satisfied in school”. We note that while the first question addresses the overall social atmosphere in class, the other questions relate to students’ personal feelings and attitudes in the classroom. The students also report the time spent (in weekly hours) doing homework in each of the four subjects, and we use the reported total number of weekly hours spent on homework in all subjects as an additional behavioural outcome.

The first survey question addresses the mutual support of all students in the class (“Students in class help each other”). Since this question refers to the overall behaviour of students in class, we built aggregate measures of mutual support and social network density in class. We focus on several measures of social network density in class: the average number of direct links (reciprocal friends) in

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<sup>46</sup> In these questions, students are asked about the extent to which they agree with a series of statements by using a six-point scale ranging from 1 (strongly disagree) to 6 (strongly agree).

class, the average number of indirect links (non-reciprocal friends) in class and the average number of direct links (reciprocal friends) that are supported. We also refer here to an additional measure that recently was suggested to affect the degree of cooperation among reciprocal ties (Jackson *et al.*, 2012): the proportion of supported direct links versus overall direct links in class. Testing the effects of these social network measures on the average amount of mutual support reported in class (based on separate regressions which includes year and school fixed effects and students' average characteristics in class), reveals that although the estimated effects are all positive, the only one that is statistically different from zero, is the estimated effect of the proportion of supported direct links to overall direct links (0.354,  $se=0.214$ ). These results imply that classes which are characterized by more 'intense' and 'positive' friendship ties have a higher degree of trust and cooperation in class.

Further support regarding the impact of friendship ties on behavioural outcomes can be found at the student level. In Table 9, we report estimates of the effect of friends by type on each of the five additional outcomes. We report estimates from a regression that includes the four types of friendships jointly in the regression, controlling for the number of friends by type in school. The regression also includes students' characteristics, class and year fixed effects. The estimates in Table 9 suggest that the presence of more reciprocal friends in the classroom reduces personal involvement in violence in school ( $-0.091$ ,  $se=0.018$ ) and improves school satisfaction (though this latter affect is only marginally significant,  $0.033$ ,  $se=0.021$ ); while the presence of followers improves social satisfaction in class ( $0.043$ ,  $se=0.023$ ). In contrast, the presence of rejecters and second circle of reciprocal friends do not have significant effect on these behavioural outcomes. We note also that all types of friendships do not affect the time dedicated to doing homework. Comparing the effect of social networks types on behavioural outcomes by gender in Appendix Table A13 suggests that boys tend to be more affected by both the number of reciprocal friends and followers whereas girls are generally more affected by the number of reciprocal friends and rejecters. For example, the table suggests that followers sharply improve boys' social and school satisfaction and reciprocal friends reduces their violent behaviour. In the case of girls, both reciprocal friends and rejecters, reduce girls' fear of school violence and reciprocal friends marginally increase their social satisfaction in class.

In Appendix Table A14 we report the estimated effect of both 'quality' and 'quantity' of friends by type. The regression includes the four types of 'quality' and 'quantity' of friends jointly in the regression, while controlling for the number of friends by type in school, as well as having no friends by type in class, and students' characteristics, class and year fixed effects. The effect of friends by type remains to a large extent very similar when controlling for friends' 'quality'. As before, the

presence of more reciprocal friends in the classroom reduces personal involvement in violence in school ( $-0.07$ ,  $se=0.02$ ), while the presence of more followers improve school satisfaction ( $0.048$ ,  $se=0.028$ ). The ‘quality’ of reciprocal friends and followers affects positively the overall satisfaction from school and social satisfaction in class but these effects are not significantly different from zero. These results highlight the importance of membership in social networks and its positive impact on students’ educational outcomes, and suggest that this positive effect could be partly mediated through higher cooperation, reduction of violent behaviour and overall improvement in student social satisfaction in class.

## **5. Conclusions**

In this paper we study how separating from pre-existing social networks during the transition from elementary to middle school affect students’ educational achievement in the short term and in the longer term. For our research, we exploit a unique free school choice framework that also allows students to maintain, in their new school, some of their pre-existing social ties. These unique features of the Tel Aviv school choice program permit an identification strategy that relies on a conditional random assignment model: since students are randomly assigned to classes within a given school, conditional on the number of friends a student has at her school, the number of friends she attends class with should be random. Thus, we estimate the impact of friends by type in class while controlling for the number of friends by type in school. This strategy allows us to contrast the impact of friends by type among students that have the same number of friends by type in school. We further add school/class fixed effects which enable us to eliminate all school/class-level unobservables.

Our results highlight the important effect of students’ social networks in class on their educational outcomes in middle school and its prolonged effect in the long run, as well, affecting several important educational outcomes in high school. To assess the overall magnitude of the effect size of these estimates we simulate how students’ academic success would change if the transition to middle school did not entail changing their social circle in class, beyond the change occurring due to middle school transition. We find that if students kept their childhood friends in a class that moved with them to middle school it would have increased their score in middle school by around 0.1 of a

standard deviation. In addition, it would have improved several human capital outcomes by the end of high school (i.e., matriculation exam scores, the probability of receiving a matriculation diploma and the total number of successfully completed matriculation exams' units) that have meaningful economic consequences for quantity and quality of post-secondary schooling and on earnings in adulthood.

These educational gains are affected by the 'quality' of friends as measured by the nature of friendship ties and by the mean socioeconomic backgrounds of friends. Focusing on the first measure of 'quality' of friends, we show that the presence of reciprocal friends and followers in class has a positive and significant effect on test scores in English, math and Hebrew, while the presence of rejecters has an opposite (negative) effect. However, beyond the first circle of reciprocal friends, the effect of the rest of the social network has no effect on students' academic performance. Addressing the second measure of 'quality' of friends, we find that both 'quantity' and 'quality' of friends are important for students' educational outcomes and that, similar to the peer effect literature, reciprocal friends from higher socioeconomic background improve student's educational outcomes. In addition, we find that these characteristics of the social network affect also several non-cognitive outcomes, implying that the impact of social networks on students' medium and longer term educational outcomes is partly mediated through higher cooperation, reduction in violent behaviour and the improvements in social satisfaction in class.

The evidence we present is relevant for education and welfare policy makers, in particular with regard to the design of school choice programs, and for programs that may lead to relocation of children from their childhood environment. Since our study addresses the importance of students' social networks on academic achievements and general wellbeing, the research has the potential to improve the way students are assigned among and within schools, and to advance our understanding of the social dynamics implicit in school choice programs and welfare programs such as the MTO in the US or immigrant absorption programs in Europe.

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Additional Supporting Information may be found in the online version of this article:

**Appendix A. Tables.**

**Appendix B. Conceptual Framework.**

**Data.**

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**Table 1: Summary Statistics of Students' Characteristics by Cohort**

	<b>2000</b>	<b>2002</b>	<b>2003</b>
	(1)	(2)	(3)
Mean Father's Education	13.36 (3.58)	13.35 (3.43)	12.73 (3.51)
Mean Mother's Education	13.70 (3.16)	13.69 (3.15)	13.08 (3.07)
Mean Number of Siblings	2.06 (1.18)	2.05 (1.05)	2.30 (1.15)
Proportion of Asia/Africa Ethnicity	0.13 (0.34)	0.11 (0.31)	0.10 (0.31)
Proportion of Europe/America Ethnicity	0.19 (0.39)	0.20 (0.40)	0.18 (0.38)
Proportion of Israel Ethnicity	0.57 (0.49)	0.57 (0.50)	0.62 (0.48)
Number of Students	1037	960	1012
Number of Elementary Schools	42	37	43
Number of Elementary Classes	83	69	80
Number of Middle Schools	6	6	7
Number of Middle School Classes	34	30	36

Notes: Each column is based on a different cohort. Standard deviations are reported in parentheses.

**Table 2: Descriptive Statistics of the Social Network: Number of Friends by Type in Class and in School**

	In Class			In School		
	Mean	Min	Max	Mean	Min	Max
	(1)	(2)	(3)	(4)	(5)	(6)
<b><u>Sixth Grade</u></b>						
A. Reciprocal friends	3.07 (2.23)	0	8	3.46 (2.34)	0	8
B. Followers	2.44 (2.33)	0	13	3.08 (2.90)	0	20
C. Rejecters	2.41 (2.14)	0	8	3.02 (2.30)	0	8
D. Second Circle of Reciprocal Friends	3.65 (3.10)	0	18	4.89 (3.99)	0	26
Number of Students	3009					
<b><u>Eighth Grade</u></b>						
A. Reciprocal friends	1.48 (1.52)	0	8	2.70 (2.21)	0	8
B. Followers	0.66 (1.04)	0	8	1.93 (2.38)	0	17
C. Rejecters	0.67 (1.07)	0	7	1.94 (2.00)	0	8
D. Second Circle of Reciprocal Friends	1.08 (1.39)	0	9	3.46 (3.50)	0	21
Number of Students	3009					

**Notes:** The figures in the table denote the number of friends in each category. Reciprocal friends (group A) includes students who listed one another. Followers (group B) includes students who listed fellow students as friends but were not listed as friends by these same fellow students. Rejecters (group C) includes students who were listed by fellow students but did not reciprocate by including the same students on their own lists. Second Circle of Reciprocal Friends (group D) includes only the second circle of reciprocal friends (namely, reciprocal friends of reciprocal friends, excluding the student's reciprocal friends). Standard deviations are reported in parentheses.

**Table 3: Estimated Effect of Number of Reciprocal Friends, Followers, Rejecters and Second Circle of Reciprocal Friends on GEMS Test Scores in Math, English, and Hebrew**

	Treatments included separately				Treatments included Jointly			
	Reciprocal Friends	Followers	Rejecters	Second Circle of Reciprocal Friends	Reciprocal Friends	Followers	Rejecters	Second Circle of Reciprocal Friends
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
OLS	0.117*** (0.012)	0.094*** (0.015)	-0.035* (0.018)	0.047** (0.015)	0.109*** (0.013)	0.061*** (0.017)	-0.014 (0.018)	-0.008 (0.016)
Friends in School and School Fixed Effects	0.107*** (0.014)	0.049** (0.018)	-0.001 (0.022)	0.009 (0.014)	0.112*** (0.015)	0.040* (0.020)	0.005 (0.021)	-0.019 (0.015)
Friends in School and Class Fixed Effects	0.118*** (0.013)	0.049** (0.019)	-0.020 (0.021)	0.008 (0.014)	0.121*** (0.014)	0.034 (0.021)	-0.012 (0.022)	-0.010 (0.016)
Friends in School, Class Fixed Effects and Pupil Characteristics	0.098*** (0.012)	0.050** (0.016)	-0.028 (0.020)	0.007 (0.013)	0.098*** (0.013)	0.035* (0.018)	-0.022 (0.021)	-0.005 (0.015)
Number of Students	7760	7760	7760	7760	7760			

**Notes:** The GEMS test scores in all three subjects (math, English, and Hebrew) are pooled together. These test scores are standardized scores, by year and subject. The first specification is a simple OLS regression with subject and year fixed effects; the second specification includes in addition middle school fixed effects and the number of friends by type in school (Friends in school) as controls; the third specification includes middle school class fixed effect instead of middle school fixed effects; and the fourth specification includes in addition pupil characteristics (gender, parental education, number of siblings, immigration status and dummies for four ethnicity groups). The estimates in each row in columns 1-4 are each from a separate regression. The estimates in each row in columns 5-8 are from the same regression. Standard errors are clustered by class and are reported in parentheses. Significance level of regressions are reported as follows: “\*\*\*”=1% level, “\*\*”=5% level, and “\*”=10% level.

**Table 4: Estimated Effect of Number of Reciprocal Friends, Followers, Rejecters and Second Circle of Reciprocal Friends on Long Term Educational Outcomes**

	<b>Reciprocal Friends</b>	<b>Followers</b>	<b>Rejecters</b>	<b>Second Circle of Reciprocal Friends</b>
	(1)	(2)	(3)	(4)
<b>A. Matriculation Test Scores in Math, English, and Hebrew</b>				
OLS	0.097*** (0.014)	0.037* (0.020)	-0.008 (0.020)	0.018 (0.018)
Friends in School and School Fixed Effects	0.089*** (0.016)	0.032 (0.023)	-0.005 (0.022)	-0.017 (0.017)
Friends in School and Class Fixed Effects	0.066*** (0.016)	0.038* (0.022)	-0.016 (0.021)	-0.011 (0.015)
Friends in School, Class Fixed Effects and Pupil Characteristics	0.071*** (0.016)	0.043** (0.022)	-0.030 (0.022)	-0.010 (0.017)
Number of Students	7599			
<b>B. Probability of Receiving a Matriculation Diploma</b>				
OLS	0.037*** (0.005)	0.009 (0.008)	0.000 (0.008)	0.004 (0.007)
Friends in School and School Fixed Effects	0.031*** (0.008)	0.013 (0.010)	0.000 (0.011)	-0.008 (0.009)
Friends in School and Class Fixed Effects	0.023*** (0.008)	0.014 (0.010)	-0.003 (0.011)	-0.005 (0.009)
Friends in School, Class Fixed Effects and Pupil Characteristics	0.025*** (0.008)	0.015 (0.010)	-0.008 (0.011)	-0.003 (0.009)
Outcome Mean	0.76	0.023		
Number of Students		2609		



**Table 4: Estimated Effect of Number of Reciprocal Friends, Followers, Rejecters and Second Circle of Reciprocal Friends on Long Term Educational Outcomes- Continued**

	<b>Reciprocal Friends</b>	<b>Followers</b>	<b>Rejecters</b>	<b>Second Circle of Reciprocal Friends</b>
	(1)	(2)	(3)	(4)
<b>C. Total Number of Successfully Completed Matriculation Exams' Unit</b>				
OLS	1.092*** (0.160)	0.222 (0.227)	-0.114 (0.225)	0.161 (0.196)
Friends in School and School Fixed Effects	0.941*** (0.214)	0.318 (0.269)	-0.161 (2.770)	-0.082 (0.230)
Friends in School and Class Fixed Effects	0.715*** (0.208)	0.387 (0.266)	-0.242 (0.273)	-0.016 (0.215)
Friends in School, Class Fixed Effects and Pupil Characteristics	0.771*** (0.210)	0.386 (0.268)	-0.380 (0.297)	0.030 (0.228)
Outcome Mean	<i>19.5</i>			

Number of Students

2609

Notes: See Table 3. The estimates in each row in columns 1-4 are from the same regression. The specifications are as defined in Table 3. Long term educational outcomes are: A) Matriculation test scores in math, English and Hebrew, which are pooled together. These test scores are standardized scores, by year and subject; B) The probability of receiving a matriculation diploma according to a linear probability regression; C) The total number of successfully completed matriculation exams' units. Standard errors are clustered by class and are reported in parentheses. Outcome means are reported in italics. Significance level of regressions are reported as follows: “\*\*\*”=1% level, “\*\*”=5% level, and “\*”=10% level.

**Table 5: Balancing Estimates of Student Characteristics and the Number of Friends by Type in Class**

	<b>Reciprocal Friends</b>	<b>Followers</b>	<b>Rejecters</b>	<b>Second Circle of Reciprocal Friends</b>
	(1)	(2)	(3)	(4)
Gender (Boy = 1)	-0.090 (0.057)	-0.055 (0.037)	-0.056 (0.045)	-0.051 (0.063)
Number of siblings	-0.026 (0.019)	0.006 (0.012)	-0.007 (0.017)	0.004 (0.027)
Father's years of schooling	0.016** (0.006)	-0.005 (0.003)	-0.001 (0.005)	-0.002 (0.005)
Mother's years of schooling	0.018** (0.006)	-0.007 (0.005)	0.006 (0.006)	-0.001 (0.007)
Ethnicity Asia/Africa	-0.040 (0.059)	-0.019 (0.045)	0.028 (0.048)	0.069 (0.055)
Ethnicity Europe/America	0.010 (0.040)	0.006 (0.035)	0.024 (0.046)	-0.025 (0.050)
Ethnicity Israel	0.025 (0.036)	0.015 (0.028)	-0.056* (0.032)	0.003 (0.041)
Ethnicity Former Soviet Union	-0.035 (0.068)	-0.021 (0.035)	0.053 (0.063)	-0.046 (0.068)
Recent Immigrant	-0.025 (0.059)	-0.028 (0.035)	0.093 (0.059)	-0.037 (0.062)
Number of Students	3005			

**Notes:** Each regression controls for the number of friends by type in school and includes year fixed effects and class fixed effects. Standard errors are clustered at the class level and reported in parentheses. Significance level of regressions are reported as follows: “\*\*\*\*”=1% level, “\*\*\*”=5% level, and “\*\*”=10% level

Table 6: Estimated Effect of the Number of Friends by Type on GEMS Test Scores in Math, English, and Hebrew, by Friends Socio-Economic Background

	Reciprocal Friends		Followers		Rejecters		Second Circle of Reciprocal Friends	
	Higher or Equal 'Quality' than the Student	Lower 'Quality' than the Student	Higher or Equal 'Quality' than the Student	Lower 'Quality' than the Student	Higher or Equal 'Quality' than the Student	Lower 'Quality' than the Student	Higher or Equal 'Quality' than the Student	Lower 'Quality' than the Student
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<b>A. Father's Education</b>								
Treatment Means	0.118*** (0.018) <i>1.553</i>	0.066** (0.022) <i>1.032</i>	0.057** (0.025) <i>1.499</i>	0.010 (0.027) <i>0.669</i>	0.014 (0.023) <i>1.254</i>	-0.084** (0.038) <i>0.661</i>	-0.020 (0.023) <i>2.236</i>	0.017 (0.024) <i>0.893</i>
<b>B. Mother's Education</b>								
Treatment Means	0.113*** (0.018) <i>1.525</i>	0.065** (0.022) <i>1.018</i>	0.069** (0.026) <i>1.564</i>	-0.006 (0.028) <i>0.668</i>	-0.013 (0.025) <i>1.233</i>	-0.042 (0.035) <i>0.662</i>	-0.009 (0.023) <i>2.249</i>	0.000 (0.021) <i>0.909</i>
<b>C. Ethnicity Asia/Africa</b>								
Treatment Means	0.103*** (0.014) <i>0.598</i>	0.052 (0.054) <i>0.418</i>	0.043** (0.019) <i>0.528</i>	-0.013 (0.058) <i>0.297</i>	-0.015 (0.022) <i>0.510</i>	-0.072 (0.063) <i>0.284</i>	-0.011 (0.016) <i>0.666</i>	0.046 (0.043) <i>0.366</i>
<b>D. Number of Siblings</b>								
Treatment Means	0.076*** (0.026)	0.108*** (0.017)	0.016 (0.037)	0.044** (0.021)	-0.019 (0.024)	-0.029 (0.040)	0.002 (0.028)	-0.008 (0.019)
Number of Students	7760							

Notes: The test scores in all three subjects (math, English, and Hebrew) are pooled together. The dependent variables are the number of friends by type with higher or equal (lower) 'quality' than the student: A) The number of friends by type with higher or equal (lower) fathers' education than the student; B) The number of friends by type with higher or equal (lower) mothers' education than the student; C) The number of friends by type from ethnicity Asia/Africa (from ethnicities other than Asia/Africa); D) The number of friends by type with higher or equal (lower) number of siblings than the student. The specification includes the number of friends by type with a higher and lower 'quality' than the student in school as controls and includes also pupil characteristics, middle school class and year fixed effects. The estimates in each row in columns 1-8 are from the same regression. Standard errors are clustered by class and are reported in parentheses. Treatment Means are reported in italics. Significance level of regressions are reported as follows: "\*\*\*\*"=1% level, "\*\*\*"=5% level, and "\*\*"=10% level.

**Table 7: Estimated Effect of 'Quality' and 'Quantity' of Friends by Type in Class on Several Educational Outcomes**

	Without Interaction				With Interaction			
	Reciprocal Friends	Followers	Rejecters	Second Circle of Reciprocal Friends	Reciprocal Friends	Followers	Rejecters	Second Circle of Reciprocal Friends
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<b>A. GEMS Test Scores</b>								
Friends' 'Quantity'	0.085*** (0.014)	0.016 (0.022)	-0.030 (0.027)	-0.019 (0.016)	0.200*** (0.058)	0.046 (0.112)	-0.042 (0.112)	-0.038 (0.069)
Friends' 'Quality'	0.016*** (0.004)	0.006 (0.005)	0.010* (0.005)	-0.005 (0.005)	0.025*** (0.006)	0.008 (0.007)	0.009 (0.008)	-0.006 (0.006)
Interaction between 'Quality' and 'Quantity' of Friends					-0.004** (0.002)	-0.001 (0.004)	0.000 (0.004)	0.001 (0.002)
Number of Students		7394				7394		
<b>B. Matriculation Test Scores</b>								
Friends' 'Quantity'	0.062*** (0.018)	0.040 (0.025)	-0.025 (0.024)	-0.014 (0.021)	0.068 (0.061)	0.115 (0.100)	0.036 (0.087)	-0.076 (0.076)
Friends' 'Quality'	0.010*** (0.003)	0.005* (0.003)	0.005 (0.004)	-0.005 (0.003)	0.010* (0.005)	0.008* (0.005)	0.007 (0.005)	-0.008 (0.005)
Regression Estimates of the Interaction between 'Quality' and 'Quantity' of Friends					0.000 (0.002)	-0.003 (0.004)	-0.003 (0.002)	0.002 (0.003)
Number of Students		7404				7404		

Table 7: continued

	Without Interaction				With Interaction			
	Reciprocal Friends	Followers	Rejecters	Second Circle of Reciprocal Friends	Reciprocal Friends	Followers	Rejecters	Second Circle of Reciprocal Friends
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<b>C. Probability of Receiving a Matriculation Diploma</b>								
Friends 'Quantity'	0.029*** (0.009)	0.001 (0.012)	-0.016 (0.013)	-0.003 (0.010)	0.048 (0.041)	-0.028 (0.060)	-0.064 (0.070)	0.051 (0.052)
Friends 'Quality'	0.006*** (0.002)	0.001 (0.002)	0.003 (0.003)	0.001 (0.002)	0.007** (0.003)	0.000 (0.003)	0.001 (0.004)	0.004 (0.003)
Interaction between 'Quality' and 'Quantity' of Friends					-0.001 (0.001)	0.001 (0.002)	0.002 (0.003)	-0.002 (0.002)
Number of Students		2519				2519		
<b>D. Total Number of Successfully Completed Matriculation Exams' Unit</b>								
Friends 'Quantity'	0.821*** (0.243)	0.107 (0.334)	-0.518 (0.315)	0.062 (0.270)	1.300 (1.097)	-0.394 (1.636)	-1.751 (1.709)	0.734 (1.312)
Friends 'Quality'	0.196*** (0.047)	0.062 (0.048)	0.096 (0.071)	-0.003 (0.063)	0.230*** (0.077)	0.042 (0.093)	0.035 (0.100)	0.035 (0.090)
Interaction between 'Quality' and 'Quantity' of Friends					-0.019 (0.038)	0.019 (0.059)	0.047 (0.065)	-0.026 (0.046)
Number of Students		2519				2519		
Treatment Means of Friends 'Quality'	<i>16.162</i>	<i>9.642</i>	<i>9.248</i>	<i>12.580</i>				

**Notes:** The treatments are the number of friends by type in class, the 'quality' of friends by type (set to zero if the student has no friends in class) in class and their interaction. The estimates in columns 1-4 are from the same regression that includes as treatments the number of friends by type in class and the 'quality' of friends by type in class; the estimates in columns 5-8 of each part are from the same regression that includes as treatments the number of friends by type in class, the 'quality' of friends by type in class and their interaction. Each regression includes as controls the number of friends by type in school; a dummy variable that equals one if the student has no friends in class by type; students' characteristics (gender, parental education, number of siblings, immigration status and dummies for four ethnicity groups) and middle school class and year fixed effects. The 'quality' index of friends by type in class is the sum of the mean education of the friends' fathers and the mean education of the friends' mothers less the proportion of friends from Asia/Africa ethnicity and the mean number of siblings of friends. Standard errors are clustered by class and are reported in parentheses. Treatment means of friends' 'Quantity' are reported in italics (the means differ by friendship types because the 'quality' of friends by type was set to zero if the student has no friends in class). Significance level of regressions are reported as follows: "\*\*\*"=1% level, "\*\*"=5% level, and "\*"=10% level.

**Table 8: Estimated Effect of 'Quality' and 'Quantity' of Friends by Type in Class on GEMS Test Scores, By Sub-Groups**

	Reciprocal Friends	Followers	Rejecters	Second Circle of Reciprocal Friends	Reciprocal Friends	Followers	Rejecters	Second Circle of Reciprocal Friends
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<b>A. By Gender</b>								
	<b>Boys</b>				<b>Girls</b>			
Friends' 'Quantity'	0.120*** (0.023)	-0.009 (0.034)	-0.035 (0.038)	-0.016 (0.023)	0.052** (0.022)	0.036 (0.028)	-0.024 (0.034)	-0.031 (0.028)
Friends' 'Quality'	0.013** (0.007)	0.015** (0.007)	0.020** (0.007)	-0.011 (0.007)	0.017*** (0.006)	0.001 (0.007)	0.002 (0.006)	0.000 (0.007)
Treatment Means of Friends 'Quality'	<i>16.204</i>	<i>9.647</i>	<i>9.027</i>	<i>13.126</i>	<i>16.850</i>	<i>10.333</i>	<i>9.554</i>	<i>12.545</i>
Outcome Means	<i>-0.110</i>				<i>0.120</i>			
Number of Students	3818				3576			
<b>B. By Student's Age</b>								
	<b>Young</b>				<b>Old</b>			
Friends' 'Quantity'	0.067** (0.024)	0.026 (0.038)	-0.042 (0.039)	-0.016 (0.028)	0.089*** (0.019)	0.008 (0.029)	-0.019 (0.038)	-0.026 (0.022)
Friends' 'Quality'	0.018*** (0.005)	0.014* (0.008)	0.004 (0.008)	-0.012 (0.008)	0.016** (0.005)	0.000 (0.006)	0.013** (0.006)	-0.001 (0.006)
Treatment Means of Friends 'Quality'	<i>15.910</i>	<i>9.577</i>	<i>9.221</i>	<i>12.040</i>	<i>16.338</i>	<i>9.938</i>	<i>9.015</i>	<i>12.961</i>
Outcome Means	<i>0.063</i>				<i>-0.035</i>			
Number of Students	2793				4601			
<b>C. By Parental Education</b>								
	<b>High Parental Education</b>				<b>Low Parental Education</b>			
Friends' 'Quantity'	0.042** (0.020)	0.038 (0.034)	-0.056 (0.039)	-0.008 (0.027)	0.113*** (0.021)	0.005 (0.033)	-0.015 (0.029)	-0.022 (0.023)
Friends' 'Quality'	0.008 (0.007)	0.011 (0.007)	0.012 (0.008)	-0.009 (0.007)	0.022*** (0.005)	0.006 (0.006)	0.013** (0.006)	-0.011 (0.007)
Treatment Means of Friends' 'Quality'	<i>20.243</i>	<i>11.742</i>	<i>10.655</i>	<i>15.435</i>	<i>14.133</i>	<i>8.600</i>	<i>8.552</i>	<i>11.174</i>
Outcome Means	<i>0.408</i>				<i>-0.227</i>			
Number of Students	2629				4765			

**Notes:** The estimates of each part in columns 1-4 are from the same regression and so are the estimates of each part in columns 5-8. Each regression controls for the number of friends by type in school and includes a dummy variable that equals one if the student has no friends in class by type, students' characteristics, class and year fixed effects. The quality index of friends by type is as defined in Table 6. High parental education is defined as more than 12 years of schooling for both parents. The "Young" group includes pupils born in September-December in the cohort year or later. The "Old" group includes pupils born in January-August in the cohort year or earlier. Standard errors are clustered by class and reported in parentheses. Treatment and Outcome means are reported in italics. Significance level of regressions are reported as follows: "\*\*\*\*"=1% level, "\*\*\*"=5% level, and "\*\*"=10% level.

**Table 9: Estimated Effect of Number of Friends by Type in Class on Behavioural Outcomes**

	<b>Reciprocal Friends</b>	<b>Followers</b>	<b>Rejecters</b>	<b>Second Circle of Reciprocal Friends</b>
	(1)	(2)	(3)	(4)
<b>A. Involvement in School Fights</b>				
Outcome Mean	-0.091*** (0.018) 1.730	-0.019 (0.025)	-0.012 (0.022)	-0.017 (0.020)
<b>B. Fear from School Violence</b>				
Outcome Mean	-0.018 (0.019) 1.604	-0.003 (0.025)	0.028 (0.025)	-0.006 (0.018)
<b>C. Social Satisfaction in Class</b>				
Outcome Mean	0.025 (0.020) 5.184	0.043* (0.023)	0.009 (0.021)	0.019 (0.021)
<b>D. Overall Satisfaction from School</b>				
Outcome Mean	0.033 (0.021) 5.008	0.033 (0.025)	0.004 (0.022)	-0.003 (0.022)
<b>E. Time Doing Homework</b>				
Outcome Mean	0.036 (0.085) 9.137	0.022 (0.092)	0.066 (0.095)	-0.064 (0.080)
<b>F. Behavioural Outcome Index</b>				
Outcome Mean	0.163*** (0.053) 20.878	0.089 (0.065)	0.011 (0.059)	0.035 (0.056)
Number of Students	4529			

Notes: The estimates in each row in columns 1-4 are from the same regression. Each regression controls for the number of friends by type in school and includes pupils' characteristics, class and year fixed effects. The behavioural outcomes index summaries the answers of the previous parts ( C + D - A - B). Standard errors are clustered by class and reported in parentheses. Significance level of regressions are reported as follows: “\*\*\*\*”=1% level, “\*\*\*”=5% level, and “\*”=10% level.