DISCUSSION PAPER SERIES

IZA DP No. 18226

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OCTOBER 2025

I Z A Institute of Labor Economics

Initiated by Deutsche Post Foundation

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ISSN: 2365-9793

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ABSTRACT

Stereotypes, Awareness, and STEM Major Choice*

This study examines whether awareness of implicit gender-science stereotypes influences university enrollment in STEM fields. We designed a randomized controlled trial involving 566 Italian high school seniors, combining surveys with an Implicit Association Test to measure unconscious biases. Before students finalized their university enrollment, a treatment group received personalized feedback on their IAT scores, while a control group received no information. Results show that revealing implicit stereotypes significantly reshapes educational choices, but with sharply contrasting gender effects. For women—who initially exhibited stronger stereotypes—feedback increased the probability of enrolling in STEM majors. Conversely, men with strong stereotypes who received feedback became less likely to choose STEM fields. These results highlight that awareness of implicit biases can be a powerful yet double-edged tool for addressing gender gaps in STEM education.

JEL Classification: J16, I20, I24

Keywords: gender stereotypes, STEM disciplines, gender inequality, randomized control trial

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* We are grateful to Orazio Attanasio, Camilla Borgna, Michela Carlana, Antonella Ferrara and Vincenzo Scoppa for insightful discussions. We also thank participants at the Third Workshop on Gender and Education at the Collegio Carlo Alberto in Turin and at the Advances in Economics of Education Workshop in Honor of Ekaterina Skatova at the University of Calabria for valuable comments. All remaining errors are our own. The usual disclaimers apply.

1 Introduction

The gender disparity in Science, Technology, Engineering, and Mathematics (henceforth STEM) has been extensively studied and discussed, revealing persistent imbalances despite efforts to promote gender equality. In many OECD countries, including the United States, Canada, France, Germany, the United Kingdom, Sweden, and Spain, women constitute the majority of college graduates but represent less than half of those graduating in science or engineering (Card and Payne, 2021). In Italy, only 16.5% of young female graduates come from a STEM faculty, compared to 37% of men (ISTAT, 2021).[1]

As discussed in detail in the next section, a large body of research shows that stereotypical beliefs about gender and aptitude in specific scientific or technical domains contribute significantly to the persistent gender gap in STEM.[2] These beliefs—deeply rooted in cultural assumptions about the abilities, interests, and social roles of men and women—operate through multiple channels. For example, stereotypes suggesting that women are less capable in mathematics or science can discourage girls from pursuing STEM-related studies. Teachers, consciously or unconsciously, may hold biased views about students' abilities in these subjects, thereby influencing the encouragement, feedback, and opportunities they provide. Peer dynamics can also reinforce gendered expectations: when peers share stereotypical beliefs, they may undervalue girls' abilities, further widening the gender gap. Moreover, the lack of visible female role models in STEM reinforces the notion that women are neither naturally suited nor successful in these fields, deterring girls from considering STEM careers.

Being immersed in a stereotypical environment can lead individuals to adopt and perpetuate gendered views. The perspectives of teachers, parents, and peers—shaped by social norms—are closely intertwined and likely correlated with individuals' own implicit stereotypes. When these influential figures hold stereotypical beliefs about gender-specific aptitude or interests, students may internalize such views, which can influence their educational trajectories and career aspirations.

This study investigates how high-school students' implicit gender stereotypes affect their choice of STEM disciplines at university, and whether making students aware of their un-

[1] In Italy, there is a strong gender differentiation across disciplinary areas, confirming women's greater propensity to choose humanities-related fields rather than scientific ones, particularly those in the STEM area. According to AlmaLaurea [2023], women make up a large majority in certain education-related fields—training (93.2%), languages (85.0%), psychology (81.8%), medical and health sciences (76.0%), and art and design (71.8%). Conversely, they are a minority in computer science and ICT (14.5%), industrial and information engineering (27.0%), and sports sciences (33.4%).

[2] In a recent paper, Ahn et al. [2024] discuss how grading policies in STEM courses may also contribute to gender disparities, representing an alternative channel to gender stereotypes.

conscious biases can reduce the influence of these stereotypes on their academic decisions.[3] We rely on data from a sample of 566 high-school students in Calabria—a southern Italian region characterized by traditional gender norms—and conduct an experiment consisting of two survey waves: a pre-enrollment questionnaire administered before university choices and a follow-up survey after enrollment, collecting information on students' actual field of study.

In the pre-enrollment questionnaire, in addition to gathering personal and family information, students completed the gender–science Implicit Association Test (IAT) to measure the extent to which they unconsciously associate males with science and females with humanities.[4] Our findings reveal that female students exhibit higher levels of implicit stereotypes than their male peers. These stereotypes are strongly correlated with students' high-school track, math performance, and intentions to pursue a STEM degree.

Subsequently, we implemented a randomized controlled trial in which only students assigned to the treatment group received personalized feedback about their IAT results. Treated students were informed via email about their score and its interpretation—classified as Null, Low, Medium, or High according to standard thresholds used in the literature (Greenwald et al., 2009). Students in the control group received a neutral email that did not disclose their results. Both groups were advised to base their university major choice on their genuine interests and abilities.

Following the intervention, students were re-interviewed after finalizing their university enrollment. Our main finding is that awareness of one's own implicit stereotypes significantly influences university field choices. The treatment effect varies by gender and by the strength of students' initial biases. Treated women with strong stereotypes were more likely to revise their intended paths toward STEM disciplines, suggesting that feedback on implicit bias may have motivated highly stereotyped girls to pursue fields with higher labor-market returns. As far as treated boys are concerned, we find a small effect of the treatment on highly stereotyped ones who appear to have opted more for non-STEM majors. Overall, our results indicate that increasing awareness of implicit prejudices can help mitigate biased decision-making in educational choices.

The remainder of the paper is structured as follows. Section 2 reviews the literature on

[3] The distinction between explicit and implicit stereotypes is clearly described by Copur-Gencturk, Cimpian, et al. [2020]: "explicit biases are discriminatory attitudes and stereotyping behaviors that individuals are consciously aware of, intentional, and under their control. Implicit biases, by contrast, operate below the level of consciousness, are beyond the individual's control, and tend to surface in ambiguous situations, where missing information is inferred from social cues such as gender or race."

[4] Among the various methods to measure implicit stereotypes, the IAT is considered one of the most reliable (Carlana, 2019).

gender stereotypes and student outcomes. Section 3 describes the data collection process, while Section 4 presents the design of the randomized controlled trial. Section 5 discusses empirical regularities between stereotypes, student characteristics, and university choices, as well as the experimental results. Section 6 concludes.

2 Studies on Gender Stereotypes

In the last years a growing number of studies has placed increasing attention to the analysis of the effects of stereotypes across various research domains, including economics, sociology and psychology sciences (Bertrand and Duflo, 2017; Guryan and Charles, 2013). The notion of stereotype, defined in the Oxford English Dictionary as a ”widely held but fixed and oversimplified image or idea of a particular type of person or thing”, is ubiquitous in various societal contexts, shaping perceptions and influencing interactions. Therefore, stereotypes can be conceptualized as cognitive constructs that arise from overgeneralized and simplified perceptions of differences between groups (Bordalo et al., 2016; Bordalo et al., 2019). These mental constructs often involve preconceived notions about the characteristics, behaviors, and roles associated with particular groups. While these generalizations facilitate information processing, they can also give rise to biased judgments and even discriminatory attitudes toward particular groups. Furthermore, discrimination has the potential to trigger self-fulfilling prophecies by influencing the behavior of marginalized groups to align with the stereotypes attributed to them.

The literature has examined the existence of stereotypes towards different groups, including race (Alesina et al., 2024) and political affiliation (Beaman et al., 2009). In recent years, an expanding body of research has delved into the role of gender stereotypes, attempting to assess their impact on the educational and labor market environment (Bordalo et al., 2019). This surge in interest is motivated by the phenomenon known as gender segregation in higher education, which is a significant contributor to labor market inequalities. Women often graduate in fields associated with higher unemployment and overeducation risks, resulting in less lucrative job opportunities (Azmat and Petrongolo, 2014; Barone and Assirelli, 2020; Mann and DiPrete, 2013; Stier and Herzberg-Druker, 2017).

Within the realm of education, research has found that stereotypes' indicators are correlated to students' achievement (Antecol, Eren, and Ozbeklik, 2016) and their specific performance in STEM and/or humanities subjects (Ertl, Luttenberger, and Paechter, 2017). Some works add stereotypes to the possible reasons of the gender gap in mathematics (Good, Aronson, and Inzlicht, 2003) on top of family (Gunderson et al., 2012), biological (Benbow et al., 2000) and cultural (Nollenberger, Rodríguez-Planas, and Sevilla, 2016) factors. Audit and correspondence studies link discriminatory effects to stereotypes, providing descriptive evidence to understand in which situation, for example in high-skilled jobs (Moss-Racusin et al., 2012) or in academia (Milkman, Akinola, and Chugh, 2012), gender discrimination occurs and whether this occurrence may be related to the existence of stereotypes.

Researches show that unconscious bias, caused by implicit stereotypes, could affect gender inequalities either through external (e.g. teachers, employers, parents) or internal factors (e.g. self-confidence). These stereotypes, typically measured by the gender-science IAT score, have been found to correlate with lower female performance in math during college, decreased interest in STEM careers (Cvencek, Meltzoff, and Greenwald, 2011; Kiefer and Sekaquaptewa, 2007; Nosek, Banaji, and Greenwald, 2002) and to predict employer bias against female math performance (Reuben, Sapienza, and Zingales, 2014).

The gender stereotype literature also focuses on beliefs and behaviors of teachers. Indeed, there is evidence that attitudes of teachers towards boys and girls strongly influence educational and labor market outcomes (Copur-Gencturk, Thacker, and Quinn, 2021; Lavy and Sand, 2018). These studies also show that the gender of the teacher is an important variable to be considered in all school grades since it is a significant predictor of long-term STEM success (Carrell, Page, and West, 2010; Kukla-Acevedo, 2009). Particular attention has been devoted to teacher stereotypes. Carlana [2019], comparing students randomly assigned to teachers with different level of bias, shows that exists a strong cause-effect relationship between the potential stereotyped behavior of teachers and the outcomes of their students. The gender gap in math performance significantly increases when students are assigned to teachers with stronger stereotypes. This effect is particularly pronounced in female students, with no significant impact on their male counterparts. A notable consequence of teacher bias is the inclination of female students to opt for less challenging high-school tracks, aligning with biased teachers' track recommendations. This suggests that teacher bias not only affects immediate academic performance but also shapes long-term educational trajectories (Lavy and Sand, 2018). When examining the mechanisms underlying the adverse effects of teacher bias on student achievement, the study reveals that biased teachers can activate negative self-stereotypes, leading female students to perceive themselves as less proficient in math than their actual accomplishments would suggest. As personality development takes place at an early age, the gender stereotypes held by teachers (and/or family members) can shape self-confidence, influencing future choices. In this context, Ertl, Luttenberger, and Paechter [2017] assert the importance of implementing didactic measures, such as hands-on activities or research clubs, that are student-oriented and support their decision-making regarding their choice of field of study. Alesina et al. [2024] and Carlana [2019] argue that it would be necessary to introduce a series of policies aimed at informing people about their prejudices or training them to ensure equal behavior towards all students.

Our study closely aligns with research conducted by Carlana [2019] and Alesina et al. [2024], which primarily examines implicit stereotypes revealed through the IAT. While these works investigate how implicit biases among teachers, related to gender and race, respectively, affect their grading behavior, and whether revealing these biases prompts behavioral change, our study takes a different approach by focusing on students rather than teachers. Specifically, we examine how informing high school students about the existence of gender-science stereotypes influences their subsequent university major choices. This shift in focus is important and underexplored: by targeting students at a critical decision-making stage, our study offers insight into whether awareness of societal stereotypes can shape educational paths. Students who have been exposed to a stereotypical environment are prone to internalize gendered views, potentially influencing their educational decisions and career aspirations. This influence can operate regardless of the guidance they receive from teachers or parents. At the end of high school, when students in many countries, including Italy, must select their university degree program, they may not readily accept explicit advice from teachers. For instance, around 47% of students in our study responded with 'I don't let anyone advise me' when asked, 'Who do you think could advise you in choosing your university path?', while about 30% mentioned parents and 13% mentioned teachers. Then, to address the underrepresentation of women in STEM disciplines, it could be crucial to make students aware of these stereotypes. To the best of our knowledge there are no studies evaluating if by rendering salient to students their unconscious level of gender-science stereotype can lead to more genuine majors' choices, off-siding the impact of prejudices. Our randomized control trial experiment is targeted to provide an answer to this research question.

3 Description of the Study

Our study focuses on a group of final-year students enrolled in the Italian high school's general tracks, commonly referred to as Lyceum. These schools are set on specific tracks based on various disciplines, including humanities (Classic Lyceum), sciences (Scientific Lyceum), and other fields such as languages and arts (in this paper simply grouped in a unique category indicated as Other Lyceum).[5] These senior students are at a pivotal juncture in their lives, confronted with the decision of whether to pursue higher education after high-school graduation, selecting a specific degree program, or entering the workforce directly.

We have chosen to concentrate only on Lyceum due to the higher likelihood of students attending this type of high school to enroll in universities. In Italy in 2019, about 66% of students who have attended a Lyceum pursue higher education compared to a 28% rate for those with a technical diploma and a 19% rate for individuals with a vocational diploma (AlmaLaurea, 2020). This strategic focus enables us to better investigate individuals' field of study preferences and choices.

In January 2021, we identified eligible schools (all of them are public schools) in Calabria, an Italian region situated in the southern part of the country, known for its adherence to traditional gender norms. In general, Italy is positioned at the bottom edge of the scale measuring the *Gender Role Attitudes* (GRA). GRA refers to the beliefs concerning the perceived appropriateness of social roles for men and women, in particular about the division of paid labor, childcare, and housework, on the basis of a gendered separation of tasks and responsibilities.[6] Using data from the European Value Study, Lomazzi [2017] shows how in the last decades the modernization processes varied across Italian regions and different gender patterns developed accordingly, leaving behind southern areas. By strategically focusing on this region, we make sure that we are considering students who are likely to show gender-science stereotypes and, consequently, an environment where students' behavior is likely to be shaped by these specific prejudices.

We included in the experiment the first 15 schools that answered our invitation to participate in a general research project aimed at investigating the relationship between characteristics of students and university choices. All participating schools had the approval of their ethics committee. We reached out to these schools via a phone call followed by a staff meeting with the school principal. The meeting for the presentation of the project took place according to the *vademecum* reported in the Appendix. In this Appendix, Table A1 reports the names of the participating schools, along with the number of students and classes involved in the survey. Figure 1 displays their geographic distribution across the region, showing that most

[5]The Other Lyceum category includes the curricula known as *liceo artistico* (art high school) and *liceo linguistico* (language high school). These terms refer to specific types of Italian secondary schools that specialize in the arts and languages, respectively.

[6]According to Luijkx, Reeskens, and Sieben [2022], who analyze data of 34 European countries from the European Value Study of 2017, Italy is positioned at the 28^{th} position in the Domestic Domain GRA index, showing very traditional attitudes towards gender roles.

of the participating schools are located in the province of Cosenza. In order to investigate if the high schools involved in the experiment are comparable to other schools in Calabria, we follow the approach used by Moti et al. [2023] and look at their performance as measured by the Index of School Quality developed by the Fondazione Agnelli (Fondazione Agnelli, 2015). The index is derived from the performance of each school's graduates in their first year of studies at university.[7] For the fifteen schools under consideration, the index is 59.22 (standard error 6.7) on a scale from 1 to 100. Instead, the average for all schools in the region is 57.65. This indicates that there is no apparent basis for anticipating that the schools included in the sample possess any noteworthy distinctions.

For each participating school, all the classes of the last high-school year were selected. The data collection process was implemented in two distinct phases and involved 566 students—359 women and 207 men—who are enrolled in the following scholastic fields: Scientific Lyceum (283), Classical Lyceum (230), and Other Lyceum (53). At the pre-enrollment stage, which took place between April and May 2021, online meetings were organized with schools with the aim of administering to students, via IT platforms, both the IAT and the pre-enrollment questionnaire.

The IAT provides an implicit measure of the strength of gender–science associations, capturing unconscious biases that students may not explicitly report. This measure is crucial for our analysis, as it allows us to identify heterogeneity in how awareness of stereotypes affects educational choices. The questionnaire, reported in the Appendix, was administered through the Google Forms platform and was designed to obtain information about each student's personal traits (e.g., residence, gender) and some family characteristics (e.g., parental job position and years of parental education). We also collected information on the educational performance and post-school prospects of each student. In particular, each participant was asked to indicate the evaluation reported at the end of the previous school year in certain subjects, such as Italian language and mathematics.[8] With regard to university prospects, each student was asked whether or not he/she intended to enroll at university after obtaining the diploma and, if the answer was positive, to express a preference regarding the course of study. We also proposed a number of questions investigating students' beliefs about factors affecting the choice of university degree (costs, returns, individuals giving advice, etc.).

Table 1 contains the definition of the variables used in our analysis, while Table 2 provides

[7]For details see https://eduscopio.it/.

[8]In the case of the evaluation reported at the end of the previous school year, the students had the possibility to choose a number between 6 (pass) and 10 (distinction).

descriptive statistics of the data acquired during the pre-enrollment stage. Table 3 indicates the name of the degree courses and, for each of them, the number of students who have indicated the intention to enroll in each program. In this table, it is also reported the number of students who intend to enroll in a STEM major according to three different STEM definitions. The most restrictive one is Core STEM, which considers among STEM majors only Chemistry and Pharmacy, Engineering and Architecture, Mathematics, Physics, and Computer Science. Expanded STEM adds to the previous ones Biological Sciences, Geology and Natural Sciences, while Broad STEM is a wider (and also weaker) definition since it also includes Economics, Business, and Statistics. We consider this last alternative definition to evaluate if the relevance of any prejudice is actually only related to merely scientific fields rather than to a set of non-humanistic majors.

From Table 3, it appears that the share of women who intend to enroll in Engineering and Architecture, Mathematics, Physics, and Computer Science, relative to the total women who intend to enroll at university, is less than half of that of men, and this was actually expected. Instead, the share of women who intend to opt for Chemistry and Pharmacy, and Biological Sciences, Geology and Natural Sciences, is larger than that of men. This is also not surprising in our case since these scientific fields are often selected by women as they offer preferential tracks for jobs that are family compatible, such as assistant pharmacists and high-school teachers.[9] However, from this table it clearly appears that, overall, the share of women who intend to enroll in a STEM discipline is nearly half that of men, and this holds true across all three definitions of STEM.

As far as the IAT score is concerned, we obtained 551 valid responses and 15 missing values. Based on the test results, students were categorized into four levels of implicit gender stereotypes: High for IAT scores greater than or equal to 0.65; Medium for scores in the range $[0.35, 0.65)$; Low for scores in the range $[0.15, 0.35)$; and Null for scores strictly lower than 0.15. Following the guidelines of Greenwald et al. [2009], we set 0.15 as the threshold of the IAT score to identify students with low prejudice. To increase granularity, we further distinguished between medium and high prejudice within the category that Greenwald et al. [2009] broadly classified as severe bias. Students with IAT scores below –0.15 are excluded from the main analysis, as such values indicate the presence of the opposite stereotype (i.e., that women are better suited for mathematics and men for the humanities), a bias that was not targeted by our intervention. Consequently, when evaluating the effect of the treatment,

[9] Indeed, we note that data from AlmaLaurea [2023] indicate that in Italy, the differentiation in the gender composition of various disciplinary areas is not significant in the fields of biology and medical-health disciplines.

the Null stereotype group consists of students with IAT scores between –0.15 and 0.15, in line with standard practice in the literature.[10] Table 4 shows the different IAT score categories and the corresponding number of students in each group, while Figure 2 displays the kernel density estimate of the IAT scores, along with the thresholds used to define our four classes.

During the post-enrollment stage of the study (carried out between November 2021 and February 2022), students who participated in the pre-enrollment stage were re-contacted by telephone in order to obtain information on whether they chose to continue their studies and their actual major selection. A total of 322 students were successfully interviewed, including 212 females and 110 males. Table 5 presents the percentage of students enrolled by field of study, according to the three STEM definitions considered in this study (Core STEM, Expanded STEM, and Broad STEM, as described in Table 1). The data reveal a pronounced gender gap in enrollment across Engineering and Architecture, Mathematics, Physics, and Computer Science: the proportion of female university students in these majors is less than half the corresponding proportion for male students.

Conversely, the proportion of women who enrolled in Chemistry, Pharmacy, Biological Sciences, Geology, and Natural Sciences exceeds that of men, which is consistent with students' earlier stated intentions. When comparing actual versus intended choices, the only notable discrepancy is observed in the field of Medicine and Health Professions: 6.52% of students actually enrolled in this field, compared to 16.93% who initially intended to. This difference is likely attributable to the national entrance exam required for admission to this program in Italy.[11] All in all, women appear to be underrepresented in STEM disciplines under all three definitions considered in this study. As expected, the most pronounced gender gap emerges under the most stringent definition, Core STEM. In this case, the reported figures align closely with national statistics provided by ISTAT [2021] and AlmaLaurea [2023], as discussed in the introductory section of this study.

At this point, it is important to address the issue of attrition, specifically, whether the students who were successfully re-contacted during the follow-up phase differ systematically from those initially involved in the pre-enrollment stage. In Table 6, we report results from simple regressions showing that the probability of participating in the post-enrollment stage is not significantly associated with most student characteristics, with the only exception being

[10] In any case, the main results reported in paragraph 5.4 fully hold if students with IAT score lower than -0.15 are included. These estimates are available from the authors upon request.

[11] These majors in Italy are subject to restricted enrollment, with the number of available student positions significantly lower than the demand. As a result, the selection process ultimately produces an almost perfect gender balance in terms of the share of students enrolled in these fields.

the type of lyceum attended. Notably, the intention to choose a STEM major does not influence the likelihood of participating in the follow-up, nor does treatment status affect participation.

To further support the claim that attrition does not introduce bias, Figure 3 presents kernel density estimates of the IAT score distributions for students who were and were not reached in the post-enrollment stage. In addition, Table 7 reports the results of two-sample Kolmogorov–Smirnov tests for equality of distributions. The distributions appear very similar, and the tests consistently reject the hypothesis that one distribution dominates the other in terms of larger or smaller values. These findings reinforce our confidence that attrition does not selectively affect students based on their level of implicit gender-science stereotypes.

4 Treatment and Randomization

To assess whether awareness of implicit gender stereotypes mitigates their influence on students' major choices, we conducted a randomized controlled trial (RCT). Participants were randomly assigned to either a treatment or a control group. The treatment group received personalized feedback on their IAT score, whereas the control group received no information regarding their implicit biases.

The intervention was administered via email. Treated students received a message disclosing their IAT result, categorized as Null, Low, Medium, or High. In contrast, the control group received a neutral thank-you email for their participation in the initial questionnaire, with no mention of the IAT or stereotypes. Both groups were reminded that their choice of academic field should align with their genuine interests, aspirations, and expectations. The full text of both communications is available in the Appendix.

Although students in both groups belonged to the same classrooms and could potentially communicate, those in the control group could not access their own bias scores. To further minimize the risk of information spillovers, feedback emails were dispatched only after teaching activities had concluded.

Following the approach of Alesina et al. [2024], who provided stereotype-related information to teachers to examine bias against immigrants, our design informed all treated students of their IAT classification. This enables a robust estimation of causal effects: since only students classified as holding stereotypes are expected to adjust their behavior in response to the information, any observed differences in major choices can be attributed to the treatment effect among these students. Accordingly, we hypothesize that the treatment will have no effect on students without stereotypical associations but a significant effect on those with high levels of implicit bias.

Randomization was stratified by gender, school, and academic performance in humanities and mathematics to ensure balance across groups. As shown in Table 8, 274 students were assigned to the treatment group and 277 to the control group. The randomization procedure ensured comparable proportions of treatment and control participants within each school. Balance tests on baseline characteristics—including gender, IAT score, and school type—confirm that the groups were statistically equivalent (Table 9). Additionally, we regressed treatment status on students' academic performance, finding no significant differences, which further validates the randomization procedure. These results collectively indicate that randomization was successfully implemented.

5 Results

5.1 Correlations between Students' Characteristics and the IAT Score

Prior to examining the impact of implicit stereotype disclosure on university choices, we analyze the principal correlations between gender-science stereotypes and the individual, familial, and educational characteristics of the students in our sample. Specifically, we estimate the following linear regression model:

$$\text{IAT score}_i = \alpha + \text{School}_{FE} + \beta X_i + \varepsilon_i \quad (1)$$

The results, presented in Table 10, indicate that female students exhibit significantly stronger implicit gender-science stereotypes than males across all model specifications. This finding aligns with expectations for high-school students in a region where social roles have been historically shaped by a rigid gendered division of paid labor, childcare, and housework.

We further observe a notable interaction between gender and school environment. Male students enrolled in classical and scientific lyceums tend to express stronger gender stereotypes than their peers in other lyceum types (e.g., artistic, linguistic). Conversely, the opposite pattern holds for female students. This suggests that academically rigid and traditionally male-dominated educational settings may reinforce traditional gender norms among boys, while potentially prompting girls to question them.

Academic performance also correlates with stereotypes in a gender-specific manner. Higher mathematics performance among female students is associated with significantly lower IAT scores. No comparable correlation is observed for male students, implying that boys' implicit biases are largely independent of their mathematical aptitude, possibly because societal norms already align mathematical proficiency with male identity. For girls, however, excelling in a counter-stereotypical domain may mitigate the internalization of prevalent gender-science stereotypes. The robustness of these findings was verified using an ordered logit model with the IAT score categorized into classes, which confirmed the main results (see Column VI, Table 10).

5.2 Stereotypes, Students' Characteristics, and Intended Choices

We now examine the determinants of intended university major choices by estimating the following linear probability model:

$$\begin{aligned} \text{Intended STEM}_i = \alpha + \text{School}_{FE} + \beta X_i + \delta_1 \text{Female}_i + \delta_2 \text{IAT score}_i \\ + \delta_3 (\text{Female} \times \text{IAT score})_i + \varepsilon_i \end{aligned} \tag{2}$$

The dependent variable is a binary indicator equal to 1 if student intends to enroll in a STEM major, and 0 otherwise. We test the robustness of our results using three alternative definitions of STEM majors. As shown in Table 11, the IAT score significantly predicts the intention to pursue a STEM field. This effect is particularly strong for female students: those with more pronounced implicit gender–science stereotypes are significantly less likely to intend to choose STEM, a result that holds across all STEM definitions. The negative and statistically significant coefficient on the interaction term (Female $\times$ IAT score) consistently supports this finding, indicating that stronger implicit stereotypes substantially reduce the probability of female students intending to enroll in a STEM major. Furthermore, as expected, higher mathematics performance and attendance at a Scientific Lyceum are positively associated with the intention to choose a STEM program.

5.3 Stereotypes, Students' Characteristics, and Actual Choices

Our analysis now turns to actual enrollment data. The empirical specification is as follows

$$\begin{aligned} \text{STEM}_i = \alpha + \text{School}_{FE} + \beta X_i + \delta_1 \text{Female}_i + \delta_2 \text{IAT score}_i \\ + \delta_3 (\text{Female} \times \text{IAT\_score})_i + \varepsilon_i \end{aligned} \tag{3}$$

This specification employs a dichotomous dependent variable equal to 1 if student i ultimately enrolled in a STEM major, and 0 otherwise. The estimates presented in Table 12 are broadly consistent with the patterns observed for intended choices, although the coefficients for the key variables of interest generally lose statistical significance. This attenuation is consistent with the treatment directly influencing actual enrollment decisions, thereby introducing noise into the baseline correlations.

Mirroring the results on intentions, female students are significantly less likely to enroll in STEM fields. Furthermore, for women, higher IAT scores remain negatively associated with STEM enrollment, although this relationship achieves statistical significance only for the most restrictive (Core STEM) definition. As anticipated, academic performance and institutional background are strong predictors of final major selection. Students with higher mathematics performance demonstrate a greater likelihood of enrolling in STEM, and attendance at a Scientific Lyceum is positively and significantly associated with STEM enrollment across all three definitions

5.4 The Effect of Rendering Salient Implicit Stereotypes on STEM Choices

Having established a correlation between implicit stereotypes and both academic performance and major selection, this section investigates the causal question of whether awareness of one's own gender prejudices can subsequently alter educational choices. To test this, our experimental design provided treated students with personalized feedback on their IAT score—categorized as Null, Low, Medium, or High—prior to their final university enrollment decision.

To estimate the causal effect of this information, we employ a specification that leverages the intensity of the revealed bias. Our empirical strategy is based on the following equation, estimated separately for female and male students:

$$\begin{aligned} \text{STEM}_i = \alpha + \text{School}_{FE} + \beta X_i + \lambda_1 \text{IAT category}_i + \lambda_2 \text{Treated}_i \\ + \lambda_3 (\text{Treated} \times \text{IAT category})_i + \varepsilon_i \end{aligned} \tag{4}$$

The dependent variable is a binary indicator equal to 1 if the student enrolled in a STEM major. The variable Treated is a dummy equal to 1 for students in the treatment group who received information about their stereotype level. The IAT category is represented by a set of four dummy variables (Null, Low, Medium, High), indicating the intensity of implicit gender-science associations as measured by the IAT. The vector of coefficients λ_3 captures the causal effects of the treatment for each stereotype intensity level.

Tables 13 to 15 present the estimates of Equation (4) for female students under alternative

STEM definitions, while Tables 16 to 18 present the corresponding results for males. Standard errors are clustered at the school level in all specifications. The tables report four progressively saturated model specifications, which sequentially incorporate individual controls (parental education and occupation, risk aversion, economic resources), school fixed effects, and performance in mathematics and language. It is important to note that IAT feedback was provided to all students in the treatment group, regardless of their gender or actual level of implicit bias.

5.4.1 Findings by Gender and Stereotype Intensity

Female Students: Table 13 uses Core STEM as the outcome. We find that disclosing stereotype levels significantly influences STEM enrollment for women, particularly those with high implicit bias. The coefficients for the treatment-stereotype interaction (λ_3) are positive across all specifications for the Low, Medium, and High categories, though statistically significant only for the High group. This suggests that awareness of strong personal bias may prompt female students to critically reflect on these preconceptions, potentially increasing their motivation to challenge stereotypes and enroll in scientific fields.

Male Students: The treatment effect for males, shown in Table 16, is also significant but operates in the opposite direction. For boys with high baseline stereotypes, being informed of their bias significantly reduces their likelihood of choosing Core STEM majors, suggesting a shift in preference toward non-STEM (e.g., humanistic) fields. However, this effect loses statistical significance after controlling for academic performance (Column IV), indicating that the observed reversal may be partially confounded by subject-specific aptitude.

5.4.2 Robustness to Alternative STEM Definitions

These patterns prove robust when using our Expanded STEM definition (Tables 14 and 17). When adopting the Broad STEM definition (which includes economics and managerial sciences), the results for women remain consistent. For men, however, the treatment effect on Broad STEM enrollment is not statistically significant (Tables 15 and 18), indicating that the intervention primarily affects choices between core scientific and humanistic disciplines rather than dissuading enrollment in quantitative social sciences.

5.5 Some Robustness and Falsification Exercises

5.5.1 Robustness: IAT score as a continuous variable

To validate our findings, we estimate a modified specification using the continuous IAT score and pooling the entire sample. This model incorporates interaction terms to identify heterogeneous treatment effects by gender. The estimated equation is:

$$\begin{aligned}\text{STEM}_i = \alpha + \text{School}_{FE} + \beta X_i + \delta_1 \text{IAT score}_i + \delta_2 \text{Female}_i \\ + \delta_3 \text{Treated}_i + \delta_4 (\text{Female} \times \text{IAT score})_i + \delta_5 (\text{Treated} \times \text{Female})_i \\ + \delta_6 (\text{Treated} \times \text{IAT score})_i + \delta_7 (\text{Treated} \times \text{IAT score} \times \text{Female})_i + \varepsilon_i. \qquad (5)\end{aligned}$$

In this specification, the dependent variable STEM_i is a binary indicator equal to 1 if student i enrolled in a STEM major (according to one of three definitions). The model includes a constant term α, school fixed effects School_{FE}, a vector of individual observed characteristics X_i with associated parameters β, and the error term ε_i. The variable IAT score_i represents the continuous measure of implicit bias, as detailed in Section 3. Consistent with our main specification, we exclude observations with IAT scores below -0.15. The coefficients δ_6 and δ_7 are of primary interest: δ_6 captures the marginal effect of the treatment for male students across the IAT score distribution, while δ_7 measures the differential marginal effect for female students.

Results from this analysis are reported in Tables 19–21. The estimates are consistent with our baseline results. For both Core and Expanded STEM definitions, the treatment significantly affects enrollment decisions, though in opposite directions for male and female students, as evidenced by the opposing signs of δ_6 and δ_7. When considering the Broad STEM definition with a full set of controls, the treatment effect remains statistically significant only for female students.

5.5.2 Falsification: Using pre-intervention intended choices

To further assess the robustness and validity of our results, we estimate Equation (4) using the *intention* to enroll in a STEM major—measured during the pre-enrollment stage, prior to the treatment—as the dependent variable. This serves as a crucial falsification test: since these intentions were recorded before the intervention, they should be orthogonal to treatment assignment. The use of pre-treatment outcomes that are predictive of post-treatment behavior strengthens the causal interpretation of our main findings. A significant effect of the treatment on these pre-existing preferences would indicate spurious correlation and threaten identification; the absence of such an effect bolsters confidence that our estimated treatment effects are causal and not driven by pre-existing differences between groups.

Results from this analysis are presented in Table 22. Estimates, reported separately for male and female students across all STEM definitions and including the full set of controls, consistently demonstrate the null effect of the treatment on pre-treatment intentions. This finding provides strong corroborating evidence for the reliability of our main results.

5.6 Discussion

Overall, our findings support the hypothesis that awareness of implicit gender-science stereotypes can alter students' inclinations to enroll in STEM fields. This shift may occur as individuals become better equipped to distinguish their genuine interests from internalized societal prejudices. Our results align with the work of Alesina et al. [2024], who found that teachers modified their grading behavior upon being informed of their implicit racial biases.

However, a key distinction of our study is that we did not disclose a personally culpable bias, but rather made participants aware of their association with a broad societal stereotype. This allows for a cleaner interpretation of how awareness itself, absent implications of personal misconduct, influences decision-making. Consequently, our findings provide compelling evidence that raising awareness of implicit stereotypes can serve as an effective policy tool to mitigate their influence on critical life choices, even when such stereotypes are reinforced by one's immediate social environment.

Our results, however, reveal a nuanced and gender-asymmetric pattern. Among male students who held strong gender-science stereotypes, the intervention prompted a shift away from STEM fields, potentially enabling a choice more aligned with their intrinsic aptitudes rather than societal expectations. Conversely, for female students, awareness of the same biases had an empowering effect, increasing their propensity to enroll in STEM majors.

This suggests that interventions targeting implicit stereotypes hold promise for reducing the gender gap in STEM. Nevertheless, policymakers should be cognizant of the potential for a simultaneous, countervailing decline in male enrollment, which warrants further investigation.

6 Conclusions

Stereotypes represent a significant determinant of educational choices and a root cause of gender imbalances in the labor market. Prevalent stereotypes regarding female proficiency in mathematics and science can discourage women from pursuing STEM fields, thereby contributing to observed gender disparities in university enrollment and subsequent career outcomes. Concurrently, male students who internalize stereotypes about male aptitude in science may find their career choices channeled in ways that do not align with their genuine interests.

This paper investigated whether raising awareness of these implicit biases could mitigate the underrepresentation of women in STEM. We conducted a field experiment with 566 final-year high school students, measuring their implicit gender-science stereotypes using the IAT score and tracking their intended and actual university choices. Our baseline analysis confirmed that female students exhibited stronger implicit stereotypes than their male counterparts, and that more stereotyped women with lower mathematics performance were less likely to enroll in STEM.

To assess a potential intervention, we implemented a randomized controlled trial where a treatment group received personalized feedback on their IAT scores. The results demonstrate a nuanced impact: students with weak or non-existent stereotypes were unaffected, whereas those with strong stereotypical associations showed significant behavioral changes. However, the direction of these changes was sharply gendered.

For female students with strong stereotypes, awareness of their implicit biases increased the likelihood of STEM enrollment, suggesting that the intervention weakened the stereotypes' constraining effect. Conversely, for male students with similar bias levels, the same awareness reduced STEM enrollment. This may indicate that salience of the stereotype altered men's perception of their comparative advantage or the social identity associated with STEM fields.

This divergence highlights a critical policy challenge: interventions aimed at dismantling barriers for underrepresented groups can produce unintended counter-effects. In our context, the gender gap in STEM may narrow not only through increased female participation but also through decreased male enrollment—an outcome that reduces disparity without necessarily expanding the overall STEM talent pool.

Consequently, the design of stereotype-awareness programs requires careful calibration. The objective of reducing gender gaps must be balanced with the imperative of fostering robust STEM participation across all genders.

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Figure 1: Geo-localization of schools participating to the experiment.

Figure 2: Kernel density estimate of the IAT score with indication of the thresholds used to inform students in the treated group about the level of their gender-science prejudice.

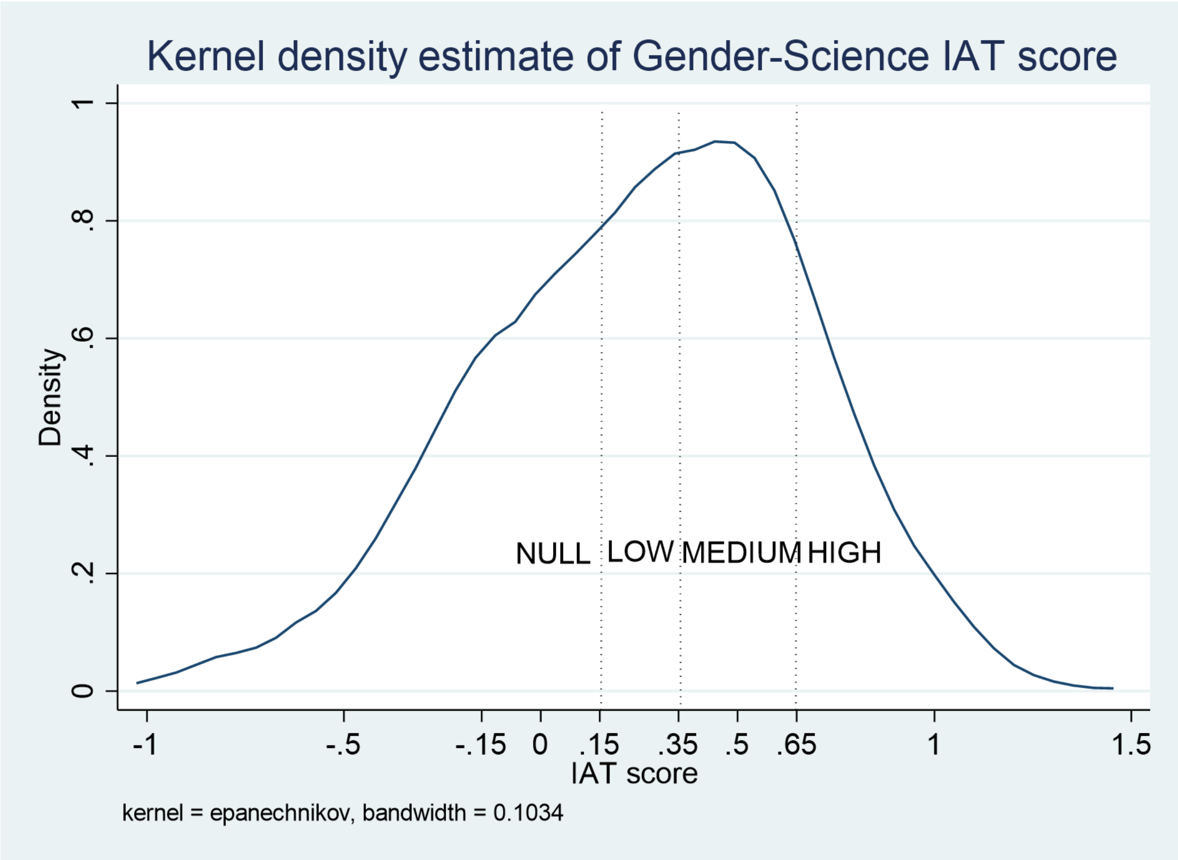

Figure 3: Kernel density estimates of IAT score for students reached by the post-enrollment interview and for those who have been unreached.

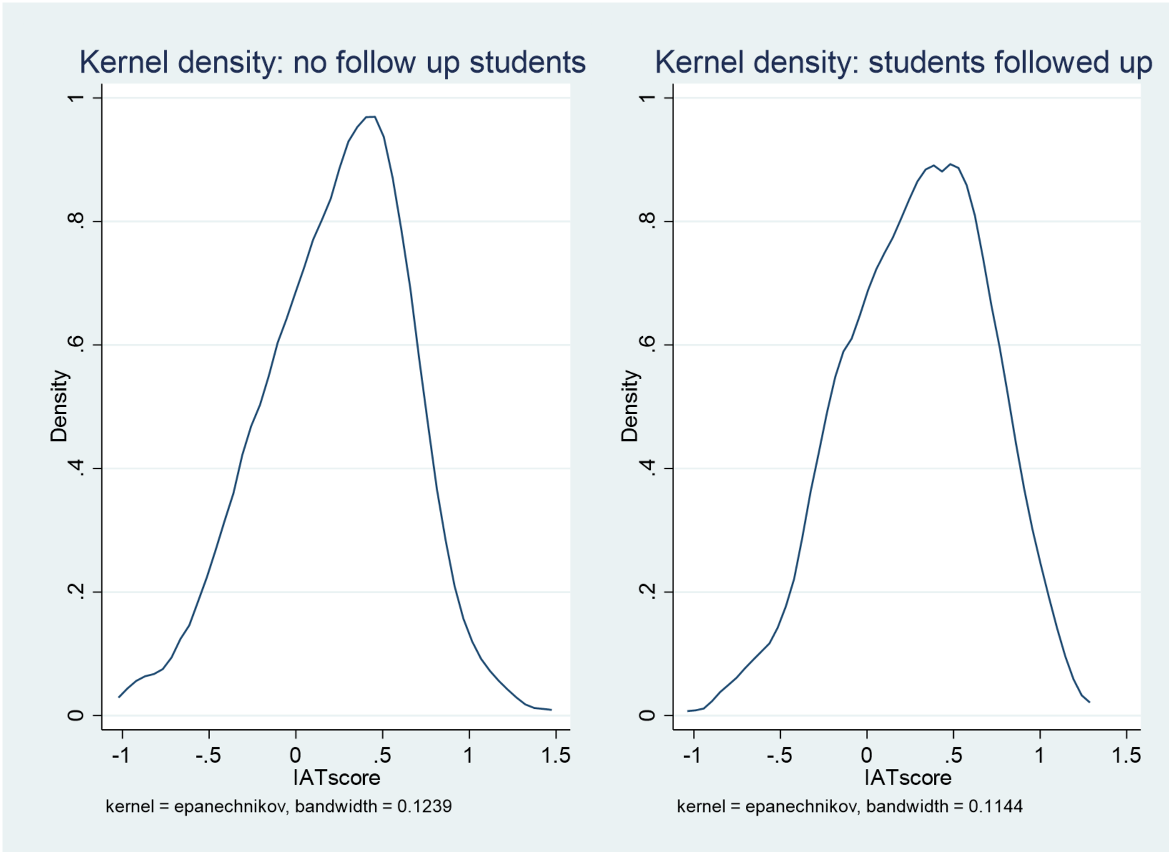

Table 1: Definition of the main variables

Variables	**Definition**
IAT score	Score achieved in the implicit association test
IAT category	Four 0-1 dummies indicating the level of IAT score: High = 1 if IAT score ≥ 0.65; Medium = 1 if IAT score $\in [0.35, 0.65)$; Low = 1 if IAT score $\in [0.15, 0.35)$; Null = 1 if IAT score < 0.15.
Classic Lyceum	Binary variable (1 = enrolled in classical high school)
Scientific Lyceum	Binary variable (1 = enrolled in scientific high school)
Other Lyceum	Binary variable (1 = enrolled in language/art high school)
Age	Student's age in years
Female	Binary variable (1 = female student)
Score Ita	Grade (6-10) in Italian language (last school year)
Score Math	Grade (6-10) in mathematics (last school year)
Hours of Study	Average daily study hours beyond school hours
Father Education	Father's years of education
Mother Education	Mother's years of education
SchoolFE	School fixed effects (binary variables)
Continuing Education	Binary (1 = intends to enroll in university)
Economic Resources	Binary (1 = sufficient family resources for university)
Risk	Risk aversion measure from theoretical lottery. Risk preference scale (1 = very averse to 10 = risk inclined)
Intended Major	Binary variables for planned course of study
Actual Major	Binary variables for chosen course of study
Core STEM	Binary (1 = intends STEM: Chemistry/Pharmacy, Engineering/Architecture, Math/Physics/Computer Science)
Expanded STEM	Core STEM + Biological Sciences/Geology/Natural Sciences
Broad STEM	Expanded STEM + Economics/Statistics

Table 2: Descriptive statistics of variables collected during the pre-enrollment stage

Variable	Obs	Mean	Std. Dev.	Min	Max
IAT score	551	0.263	0.406	-0.922	1.351
Classic Lyceum	566	0.406	0.491	0	1
Scientific Lyceum	566	0.500	0.500	0	1
Other Lycea	566	0.936	0.291	0	1
Age	536	18.78	0.439	17.494	21.171
Female	566	0.634	0.482	0	1
Score Ita	563	8.035	1.102	5	10
Score Math	552	7.675	1.204	5	10
Hours of Study	556	3.537	1.323	2	6
Father Education	539	13.191	3.841	0	18
Mother Education	543	13.612	3.727	0	18
Father Employed	566	0.850	0.358	0	1
Mother Employed	566	0.602	0.489	0	1
Intended Major	566	0.894	0.308	0	1
Economic Resources	543	0.711	0.453	0	1
Risk	543	0.711	0.453	1	10

Table 3: Intended major choices indicated in the pre-enrollment stage

Field	Number of Students			Percentage		
	All	Males	Females	All	Males	Females
Engineering and Architecture	61	34	27	11%	17.98%	7.87%
Mathematics, Physics or Computer Science	24	16	8	5%	8.46%	2.33%
Biological Sciences, Geology, Natural Sciences	22	4	18	4%	2.11%	5.24%
Chemistry and Pharmacy	16	2	14	3%	1.06%	4.08%
Medicine and Health Professions	133	32	101	25%	16.93%	29.44%
Agriculture and Veterinary	10	6	4	2%	3.17%	1.16%
Economics and Statistics	48	32	16	9%	16.93%	4.66%
Law	62	21	41	12%	11.11%	11.95%
Letters, Human Sciences and Languages	77	18	59	14%	9.52%	17.20%
Psychology and Pedagogical Sciences	38	7	31	7%	3.70%	9.03%
Motorial Sciences	21	15	6	4%	7.93%	1.74%
Political and Sociological Sciences	20	2	18	4%	1.05%	5.24%
Total	532	189	343	100%	35.52%	64.48%
Core STEM	101	52	49	19%	27.51%	14.28%
Expanded STEM	123	56	67	23%	29.62%	19.53%
Broad STEM	171	88	83	32%	46.56%	24.19%

Note: Core STEM, Expanded STEM and Broad STEM represent three different definitions of STEM disciplines. Percentages evaluated over the total in each category (all, males, females).

Table 4: Number of students by level of implicit gender stereotype recorded in the IAT score

Stereotype level	Number of Students	Percentage
Null	200	36%
Low	100	18%
Medium	159	29%
High	92	17%
Total	551	100%

Note: High = IAT score ≥ 0.65; Medium = $[0.35, 0.65)$; Low = $[0.15, 0.35)$; Null = < 0.15. Distribution shown in Figure 2.

Table 5: Actual major choices indicated in the post-enrollment questionnaire

Field	Number of Students			Percentage		
	All	Males	Females	All	Males	Females
Engineering and Architecture	28	19	9	8.70%	17.27%	4.25%
Mathematics, Physics or Computer Science	26	18	8	8.07%	16.36%	3.77%
Biological Sciences, Geology, Natural Sciences	39	9	30	12.11%	8.18%	14.15%
Chemistry and Pharmacy	30	5	25	9.32%	4.55%	11.79%
Medicine and Health Professions	21	7	14	6.52%	6.36%	6.60%
Agriculture and Veterinary	1	1	0	0.31%	0.91%	0.00%
Economics and Statistics	38	25	13	11.80%	22.73%	6.13%
Law	35	7	28	10.87%	6.36%	13.21%
Letters, Human Sciences and Languages	62	18	44	19.25%	16.36%	20.75%
Psychology and Pedagogical Sciences	28	0	28	8.70%	0.00%	13.21%
Motorial Sciences	3	0	3	0.93%	0.00%	1.42%
Political and Sociological Sciences	11	1	10	3.42%	0.91%	4.72%
Total	322	110	212	100%	34.17%	65.83%
Core STEM	84	42	42	26.08%	38.18%	19.81%
Expanded STEM	123	51	72	38.19%	46.36%	33.96%
Broad STEM	161	76	85	50.00%	69.09%	40.09%

Note: Core STEM, Expanded STEM and Broad STEM represent three different definitions of STEM disciplines. Percentages evaluated over the total in each category (all, males, females).

Table 6: Participation in second stage questionnaire

	(I)	(II)	(III)
Female	-0.015	-0.016	-0.012
	(0.770)	(0.048)	(0.793)
Classic Lyceum	0.180*	0.179*	0.179*
	(0.063)	(0.038)	(0.038)
Scientific Lyceum	0.213***	0.221***	0.211**
	(0.009)	(0.008)	(0.061)
Score Math	-0.024	-0.020	-0.024
	(0.027)	(0.027)	(0.027)
Score Ita	0.025	0.024	0.025
	(0.029)	(0.029)	(0.029)
Father Education	-0.007	-0.006	-0.007
	(0.007)	(0.007)	(0.007)
Mother Education	-0.010	-0.010	-0.010
	(0.007)	(0.007)	(0.007)
IAT score	0.002	0.004	0.002
	(0.055)	(0.055)	(0.029)
Treated	-0.064	-0.065	-0.064
	(0.043)	(0.043)	(0.043)
Core STEM	0.013		
	(0.772)		
Expanded STEM		-0.020	
		(0.046)	
Broad STEM			0.018
			(0.047)
N	510	510	510

Note: Linear regression models. Dependent variable is a 0-1 dummy indicating participation in the second phase. Core STEM, Expanded STEM and Broad STEM refer to intended choices as defined in Table 1. Treated = 1 if student received stereotype information. Standard errors in parentheses. *p<0.10, **p<0.05, ***p<0.01.

Table 7: Two-sample Kolmogorov-Smirnov test for equality of distribution functions

Smaller group	D	P-value
0:	0.082	0.159
1:	-0.009	0.978
Combined K-S	0.082	0.317

Table 8: Treatment descriptive statistics

Variable	Obs	Percent
Treated	274	49.73
Control	277	50.27
Observations	551	100

Note: Treated = students informed of their gender-science stereotype level. Control = students not informed.

Table 9: Balance tests

	Female	IAT score	Classic Lyceum	Scientific Lyceum	Score Ita	Score Math
Treated	0.005	-0.018	-0.001	-0.004	-0.056	-0.064
	(0.041)	(0.035)	(0.041)	(0.042)	(0.093)	(0.103)
N	566	551	566	566	563	552

Note: Linear regression. Dependent Variable = Treated (1 = informed of stereotype level). Standard errors in parentheses. *p<0.10, **p<0.05, ***p<0.01.

Table 10: Determinants of the IAT score

	I	II	III	IV	V	VI
Female	0.166*	0.160**	0.383***	0.401***	0.551***	1.439*
	(0.086)	(0.069)	(0.068)	(0.069)	(0.164)	(0.745)
Father Education	0.003	0.004	0.004	0.004	0.003	0.006
	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)	(0.026)
Mother Education	-0.001	-0.001	-0.003	-0.003	-0.004	-0.001
	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)	(0.027)
Mother Employed	-0.085	-0.090	-0.084	-0.076	-0.073	-0.278
	(0.068)	(0.057)	(0.068)	(0.056)	(0.057)	(0.321)
Father Employed	0.015	0.020	0.006	0.010	0.018	0.012
	(0.066)	(0.056)	(0.055)	(0.056)	(0.054)	(0.216)
Mother Employed × Female	0.029	0.050	0.048	0.031	0.020	0.063
	(0.085)	(0.074)	(0.068)	(0.060)	(0.066)	(0.339)
Risk	-0.002	-0.004	-0.004	-0.005	-0.006	-0.017
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.027)
Economic Resources	-0.011	-0.012	-0.017	-0.026	-0.024	-0.185
	(0.046)	(0.040)	(0.038)	(0.036)	(0.037)	(0.192)
Classic Lyceum		0.143	0.240***	0.241***	0.247***	0.800**
		(0.094)	(0.068)	(0.071)	(0.062)	(0.365)
Scientific Lyceum		0.165*	0.351***	0.362***	0.352***	1.429***
		(0.087)	(0.033)	(0.036)	(0.032)	(0.221)
Classic × Female			-0.159**	-0.169**	-0.161*	-0.626
			(0.071)	(0.075)	(0.075)	(0.465)
Scientific × Female			-0.297***	-0.314***	-0.294***	-1.452***
			(0.077)	(0.076)	(0.080)	(0.431)
Score Math				-0.026	0.035	0.137
				(0.021)	(0.034)	(0.180)
Score Ita				0.045*	0.001	-0.029
				(0.024)	(0.033)	(0.172)
Score Math × Female					-0.099*	-0.415*
					(0.051)	(0.233)
Score Ita × Female					0.074	0.422
					(0.053)	(0.261)
School FE	YES	YES	YES	YES	YES	YES
Observations	506	506	506	496	496	496

Note: The dependent variable in Column I-V is the IAT score achieved by students during the pre-enrollment survey. The dependent variable in column VI is a 0-3 categorical variable which takes the following values: 0 if the IAT score achieved by students during the pre-enrollment survey is strictly lower than 0.15, 1 if the IAT score is within the range [0.15, 0.35], 2 if the IAT score is within the range [0.35, 0.65), 3 if the IAT score is larger than or equal to 0.65. Standard errors clustered at school level in parentheses. *10% significance level, **5% significance level, ***1% significance level.

Table 11: Impact of IAT score on intended major's choice: Linear probability model

Independent Variable	**Core STEM** (I)	(II)	(III)	**Expanded STEM** (I)	(II)	(III)	**Broad STEM** (I)	(II)	(III)
IAT score	0.196***	0.189**	0.138*	0.240***	0.259***	0.216**	0.206***	0.225***	0.198***
	(0.057)	(0.074)	(0.075)	(0.057)	(0.082)	(0.081)	(0.046)	(0.062)	(0.039)
Female	-0.065*	-0.052	-0.134	-0.022	0.012	-0.131	-0.148**	-0.111*	-0.713*
	(0.034)	(0.030)	(0.321)	(0.037)	(0.041)	(0.297)	(0.054)	(0.059)	(0.358)
Female × IAT score	-0.261***	-0.246**	-0.173*	-0.311***	-0.320**	-0.257**	-0.242***	-0.2523*	-0.2341*
	(0.074)	(0.092)	(0.088)	(0.087)	(0.113)	(0.1181	(0.078)	(0.098)	(0.0792
Age			-0.010			0.019			0.051
			(0.033)			(0.024)			(0.034)
Father Education			0.006			0.007			0.003
			(0.005)			(0.006)			(0.006)
Mother Education			-0.000			-0.002			-0.003
			(0.006)			(0.008)			(0.008)
Mother Employed			-0.041			-0.019			-0.025
			(0.030)			(0.038)			(0.060)
Economic Resources			-0.015			-0.039			-0.007
			(0.034)			(0.0387			(0.037)
Score Math			0.114***			0.106***			0.138***
			(0.037)			(0.035)			(0.031)
Scientific Lyceum			0.212**			0.296**			0.337**
			(0.099)			(0.130)			(0.133)
Classic Lyceum			0.059			0.054			0.080
			(0.103)			(0.113)			(0.064)
School FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Observations	551	551	472	551	551	472	551	551	472

Notes: The dependent variable is a binary indicator for intention to choose a STEM major according to three definitions (see Table 1). Standard errors clustered at school level in parentheses. Significance levels: *10%, **5%, ***1%.

Table 12: Impact of IAT score on actual major's choice: Linear probability model

	Core STEM			Expanded STEM			Broad STEM		
Independent Variable	(I)	(II)	(III)	(I)	(II)	(III)	(I)	(II)	(III)
IAT score	0.166*	0.137	0.048	0.110	0.104	-0.031	0.050	0.063	-0.057
	(0.090)	(0.096)	(0.091)	(0.113)	(0.116)	(0.112)	(0.141)	(0.154)	(0.103)
Female	-0.137*	-0.150*	-0.474	-0.069	-0.089	-0.771	-0.259**	-0.253**	-1.735***
	(0.062)	(0.076)	(0.392)	(0.102)	(0.122)	(0.459)	(0.092)	(0.103)	(0.388)
Female × IAT score	-0.266**	-0.223*	-0.146	-0.221	-0.185	-0.030	-0.142	-0.111	0.020
	(0.101)	(0.120)	(0.121)	(0.148)	(0.166)	(0.135)	(0.178)	(0.203)	(0.130)
Age			-0.134*			-0.059			-0.002
			(0.065)			(0.074)			(0.072)
Father Education			0.000			0.000			-0.006
			(0.006)			(0.005)			(0.005)
Mother Education			-0.004			-0.008			-0.010
			(0.008)			(0.006)			(0.008)
Mother Employed			-0.040			-0.005			-0.002
			(0.057)			(0.048)			(0.065)
Economic Resources			-0.085*			-0.099			-0.083
			(0.040)			(0.063)			(0.049)
Score Math			0.134***			0.128***			0.124**
			(0.021)			(0.040)			(0.0460
Scientific Lyceum			0.298***			0.432***			0.440***
			(0.074)			(0.102)			(0.061)
Classic Lyceum			0.294*			0.114			-0.092
			(0.159)			(0.146)			(0.114)
School FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Observations	319	319	288	319	319	288	319	319	288

Notes: The dependent variable is a binary indicator for actual choice of STEM major according to three definitions (see Table 1). Standard errors clustered at school level in parentheses. Significance levels: *10%, **5%, ***1%.

Table 13: Impact of revealed gender-science stereotype on STEM choice: Linear probability model – Core STEM- Females

	Core STEM - Females			
Independent Variable	(I)	(II)	(III)	(IV)
Low	-0.242	-0.299	-0.266	-0.276*
	(0.170)	(0.185)	(0.182)	(0.135)
Medium	-0.235	-0.255*	-0.235	-0.202
	(0.149)	(0.149)	(0.166)	(0.166)
High	-0.308**	-0.309**	-0.322*	-0.311***
	(0.146)	(0.149)	(0.174)	(0.082)
Treated	-0.294*	-0.384**	-0.368**	-0.345*
	(0.160)	(0.155)	(0.161)	(0.187)
Treated × Low	0.338	0.425	0.379	0.314
	(0.240)	(0.262)	(0.245)	(0.242)
Treated × Medium	0.144	0.220	0.194	0.168
	(0.177)	(0.199)	(0.212)	(0.276)
Treated × High	0.279	0.354**	0.342*	0.425**
	(0.174)	(0.162)	(0.170)	(0.155)
Score Math				0.073
				(0.073)
Score Ita				0.000
				(0.048)
N	177	177	177	177

Notes: The dependent variable is a binary indicator for actual STEM choice (definitions in Table 1). Low, Medium, High = IAT score categories (see Table 4). Treated = 1 if student received stereotype information. Standard errors clustered at school level in parentheses. Significance levels: *10%, **5%, ***1%.

Table 14: Impact of revealed gender-science stereotype on STEM choice: Linear probability model – Expanded STEM- Females

	Expanded STEM - Females			
Independent Variable	(I)	(II)	(III)	(IV)
Low	-0.250*	-0.256	-0.258*	-0.242
	(0.129)	(0.149)	(0.144)	(0.141)
Medium	-0.221	-0.226	-0.235	-0.219
	(0.178)	(0.198)	(0.183)	(0.198)
High	-0.383**	-0.341	-0.358*	-0.383**
	(0.171)	(0.205)	(0.174)	(0.177)
Treated	-0.314	-0.346	-0.362	-0.349
	(0.203)	(0.223)	(0.222)	(0.220)
Treated × Low	0.164	0.183	0.185	0.171
	(0.197)	(0.252)	(0.265)	(0.243)
Treated × Medium	0.211	0.237	0.255	0.246
	(0.223)	(0.255)	(0.257)	(0.232)
Treated × High	0.415*	0.451*	0.474**	0.478**
	(0.225)	(0.231)	(0.219)	(0.196)
Score Math				0.067
				(0.088)
Score Ita				0.042
				(0.060)
N	177	177	177	177

Notes: The dependent variable is a binary indicator for actual STEM choice (definitions in Table 1). Low, Medium, High = IAT score categories (see Table 4). Treated = 1 if student received stereotype information. Standard errors clustered at school level in parentheses. Significance levels: *10%, **5%, ***1%.

Table 15: Impact of revealed gender-science stereotype on STEM choice: Linear probability model – Broad STEM- Females

	Broad STEM - Females			
Independent Variable	(I)	(II)	(III)	(IV)
Low	-0.200	-0.209	-0.206	-0.182
	(0.159)	(0.177)	(0.162)	(0.149)
Medium	-0.202	-0.197	-0.211	-0.186
	(0.160)	(0.182)	(0.165)	(0.179)
High	-0.389**	-0.332*	-0.351**	-0.382**
	(0.138)	(0.174)	(0.137)	(0.138)
Treated	-0.293	-0.338	-0.347	-0.323
	(0.215)	(0.227)	(0.215)	(0.206)
Treated × Low	0.093	0.152	0.153	0.125
	(0.264)	(0.297)	(0.302)	(0.271)
Treated × Medium	0.155	0.199	0.219	0.198
	(0.234)	(0.255)	(0.245)	(0.205)
Treated × High	0.441*	0.511*	0.516**	0.521***
	(0.237)	(0.245)	(0.222)	(0.174)
Score Math				0.113*
				(0.060)
Score Ita				0.042
				(0.048)
N	177	177	177	177

Notes: The dependent variable is a binary indicator for actual STEM choice (definitions in Table 1). Low, Medium, High = IAT score categories (see Table 4). Treated = 1 if student received stereotype information. Standard errors clustered at school level in parentheses. Significance levels: *10%, **5%, ***1%.

Table 16: Impact of revealed gender-science stereotype on STEM choice: Linear probability model – Core STEM- Males

	Core STEM - Males			
Independent Variable	(I)	(II)	(III)	(IV)
Low	0.036	0.453	0.586	0.443
	(0.253)	(0.294)	(0.375)	(0.325)
Medium	0.136	0.141	0.124	0.017
	(0.179)	(0.185)	(0.205)	(0.205)
High	0.091	0.190	0.241	0.192
	(0.194)	(0.238)	(0.269)	(0.232)
Treated	0.192	0.284	0.263	0.081
	(0.202)	(0.248)	(0.264)	(0.262)
Treated × Low	0.158	-0.202	-0.300	0.010
	(0.299)	(0.409)	(0.406)	(0.433)
Treated × Medium	-0.275	-0.231	-0.285	-0.151
	(0.164)	(0.142)	(0.218)	(0.190)
Treated × High	-0.646**	-0.675*	-0.671*	-0.401
	(0.250)	(0.357)	(0.346)	(0.340)
Score Math				0.189***
				(0.062)
Score Ita				-0.046
				(0.064)
N	75	75	75	75

Notes: The dependent variable is a binary indicator for actual STEM choice (definitions in Table 1). Low, Medium, High = IAT score categories (see Table 4). Treated = 1 if student received stereotype information. Standard errors clustered at school level in parentheses. Significance levels: *10%, **5%, ***1%.

Table 17: Impact of revealed gender-science stereotype on STEM choice: Linear probability model – Expanded STEM- Males

	Expanded STEM - Males			
Independent Variable	(I)	(II)	(III)	(IV)
Low	0.046	0.366	0.524	0.408
	(0.245)	(0.300)	(0.376)	(0.314)
Medium	0.046	-0.014	-0.027	-0.121
	(0.162)	(0.137)	(0.200)	(0.203)
High	0.091	0.173	0.189	0.154
	(0.169)	(0.185)	(0.189)	(0.198)
Treated	0.323	0.367	0.348	0.189
	(0.200)	(0.212)	(0.234)	(0.213)
Treated × Low	-0.073	-0.294	-0.379	-0.116
	(0.238)	(0.337)	(0.347)	(0.367)
Treated × Medium	-0.407*	-0.265	-0.285	-0.180
	(0.223)	(0.177)	(0.244)	(0.196)
Treated × High	-0.869***	-0.777**	-0.728**	-0.502*
	(0.249)	(0.263)	(0.252)	(0.257)
Score Math				0.167**
				(0.061)
Score Ita				-0.019
				(0.068)
N	75	75	75	75

Notes: The dependent variable is a binary indicator for actual STEM choice (definitions in Table 1). Low, Medium, High = IAT score categories (see Table 4). Treated = 1 if student received stereotype information. Standard errors clustered at school level in parentheses. Significance levels: *10%, **5%, ***1%.

Table 18: Impact of revealed gender-science stereotype on STEM choice: Linear probability model – Broad STEM- Males

	Broad STEM - Males			
Independent Variable	(I)	(II)	(III)	(IV)
Low	-0.027	0.167	0.328	0.218
	(0.169)	(0.144)	(0.196)	(0.143)
Medium	0.023	-0.010	-0.011	-0.068
	(0.163)	(0.145)	(0.148)	(0.145)
High	-0.091	-0.018	0.008	-0.050
	(0.194)	(0.207)	(0.248)	(0.239)
Treated	0.162	0.157	0.141	0.036
	(0.177)	(0.199)	(0.189)	(0.217)
Treated × Low	0.013	-0.028	-0.140	0.061
	(0.177)	(0.187)	(0.202)	(0.226)
Treated × Medium	-0.078	0.038	0.036	0.156
	(0.195)	(0.203)	(0.264)	(0.302)
Treated × High	-0.298	-0.214	-0.155	0.028
	(0.359)	(0.642)	(0.494)	(0.515)
Score Math				0.096
				(0.090)
Score Ita				-0.104
				(0.074)
N	75	75	75	75

Notes: The dependent variable is a binary indicator for actual STEM choice (definitions in Table 1). Low, Medium, High = IAT score categories (see Table 4). Treated = 1 if student received stereotype information. Standard errors clustered at school level in parentheses. Significance levels: *10%, **5%, ***1%.

Table 19: Impact of revealed gender-science stereotype on STEM choice: Linear probability model – Core STEM - Continuous IAT score.

	Core STEM - All			
Independent Variable	(I)	(II)	(III)	(IV)
IAT score	0.064	0.039	0.036	0.034
	(0.164)	(0.172)	(0.197)	(0.193)
Female	-0.011	-0.042	-0.049	-0.066
	(0.150)	(0.164)	(0.182)	(0.190)
Treated	0.318	0.296	0.300	0.282
	(0.195)	(0.206)	(0.212)	(0.208)
Female × IAT score	-0.417	-0.341	-0.358	-0.361
	(0.246)	(0.270)	(0.288)	(0.301)
Treated × Female	-0.586**	-0.572*	-0.598**	-0.573*
	(0.257)	(0.267)	(0.278)	(0.290)
Treated × IAT score	-0.729**	-0.670*	-0.718*	-0.725**
	(0.283)	(0.330)	(0.340)	(0.331)
Treated × IAT score × Female	1.111**	1.043**	1.124**	1.142**
	(0.427)	(0.434)	(0.445)	(0.438)
Score Math				0.093*
				(0.048)
Score Ita				-0.004
				(0.040)
N	252	252	252	252

Notes: The dependent variable is a binary indicator for actual STEM choice (definitions in Table 1). IAT score is the score achieved by students during the pre-enrollment survey. Treated = 1 if student received stereotype information. Standard errors clustered at school level in parentheses. Significance levels: *10%, **5%, ***1%.

Table 20: Impact of revealed gender-science stereotype on STEM choice: Linear probability model –Expanded STEM - Continuous IAT score.

	Expanded STEM - All			
Independent Variable	(I)	(II)	(III)	(IV)
IAT score	0.080	0.071	0.054	0.062
	(0.169)	(0.163)	(0.183)	(0.211)
Female	0.087	0.061	0.062	0.038
	(0.175)	(0.197)	(0.209)	(0.215)
Treated	0.412**	0.407**	0.422**	0.409**
	(0.160)	(0.174)	(0.184)	(0.178)
Female × IAT score	-0.505*	-0.446	-0.448	-0.470
	(0.274)	(0.296)	(0.299)	(0.316)
Treated × Female	-0.737**	-0.758**	-0.787**	-0.764**
	(0.259)	(0.269)	(0.276)	(0.292)
Treated × IAT score	-1.038***	-1.017***	-1.024***	-1.071***
	(0.280)	(0.300)	(0.297)	(0.296)
Treated × IAT score × Female	1.548***	1.566***	1.593***	1.647***
	(0.418)	(0.431)	(0.417)	(0.421)
Score Math				0.084
				(0.059)
Score Ita				0.026
				(0.043)
N	252	252	252	252

Notes: The dependent variable is a binary indicator for actual STEM choice (definitions in Table 1). Treated = 1 if student received stereotype information.IAT score is the score achieved by students during the pre-enrollment survey Standard errors clustered at school level in parentheses. Significance levels: *10%, **5%, ***1%.

Table 21: Impact of revealed gender-science stereotype on STEM choice: Linear probability model –Broad STEM - Continuous IAT score.

	Broad STEM - All			
Independent Variable	(I)	(II)	(III)	(IV)
IAT score	-0.084	-0.082	-0.097	-0.097
	(0.183)	(0.173)	(0.186)	(0.212)
Female	-0.097	-0.122	-0.142	-0.161
	(0.139)	(0.156)	(0.156)	(0.164)
Treated	0.250**	0.226*	0.228*	0.210
	(0.112)	(0.120)	(0.107)	(0.128)
Female × IAT score	-0.377	-0.301	-0.291	-0.299
	(0.240)	(0.263)	(0.251)	(0.265)
Treated × Female	-0.597***	-0.595***	-0.590***	-0.564**
	(0.192)	(0.197)	(0.188)	(0.213)
Treated × IAT score	-0.384**	-0.297*	-0.299**	-0.315
	(0.155)	(0.146)	(0.123)	(0.202)
Treated × IAT score × Female	0.932***	0.883***	0.868***	0.895***
	(0.301)	(0.293)	(0.269)	(0.294)
Score Math				0.097**
				(0.035)
Score Ita				0.002
				(0.033)
N	252	252	252	252

Notes: The dependent variable is a binary indicator for actual STEM choice (definitions in Table 1)I. IAT score is the score achieved by students during the pre-enrollment survey. Treated = 1 if student received stereotype information. Standard errors clustered at school level in parentheses. Significance levels: *10%, **5%, ***1%.

Table 22: Falsification: Impact of treatment on intended STEM choices

	Females			Males		
	Core STEM	Expanded STEM	Broad STEM	Core STEM	Expanded STEM	Broad STEM
Low	-0.150	0.050	0.000	0.096	0.096	0.022
	(0.159)	(0.117)	(0.122)	(0.205)	(0.205)	(0.189)
Medium	-0.139	-0.197	-0.124	0.080	0.080	-0.066
	(0.084)	(0.083)	(0.101)	(0.096)	(0.096)	(0.139)
High	-0.220***	-0.180**	-0.110	0.241	0.429**	0.340**
	(0.101)	(0.087)	(0.136)	(0.176)	(0.149)	(0.128)
Treated	-0.157	-0.086	-0.064	-0.112	-0.113	-0.017
	(0.135)	(0.166)	(0.183)	(0.112)	(0.116)	(0.155)
Treated × Low	0.109	0.283	0.258	0.212	0.212	0.142
	(0.288)	(0.278)	(0.237)	(0.350)	(0.350)	(0.299)
Treated × Medium	0.087	-0.016	-0.044	0.118	0.118	0.094
	(0.147)	(0.165)	(0.176)	(0.188)	(0.183)	(0.126)
Treated × High	0.288	0.183	0.085	-0.113	-0.282	-0.135
	(0.134)	(0.143)	(0.169)	(0.369)	(0.289)	(0.370)
N	188	188	188	107	107	107

Notes: The dependent variable is a binary indicator for intended STEM choice (definitions in Table 1). Low, Medium, High = IAT score categories (see Table 4). Treated = 1 if student received stereotype information. All controls included. Standard errors clustered at school level in parentheses. Significance levels: *10%, **5%, ***1%.

Appendix

Vademecum for School Meeting

- **Step1**: Institutional thanks;

- **Step2**: Provide a brief description of the research whose primary objective is to evaluate how some qualitative and quantitative characteristics of the students can influence the possible continuation of their studies and/or the type of university course chosen;

- **Step3**: Introduce the fact that an online questionnaire will be administered and provide explanations on the operational methods according to which it must be completed;

- **Step4**: Specify that each student will be asked, at the end of the questionnaire, to enter a series of personal information (name, surname, telephone number, email address) for the sole purpose of being contacted in the months of September and/or October (second phase of research);

- **Step5**: Specify the operational ease of the questionnaire, not aimed at any evaluation of the students' abilities/skills, and underline the fact that it is necessary to answer the various questions with "intellectual honesty" and not in a casual manner.

Letter to Treated Students

Dear student,

the test you filled out gave the following result regarding your level of gender-science stereotype: (one of the following items depending on the score)

HIGH LEVEL OF STEREOTYPE

MEDIUM LEVEL OF STEREOTYPE

LOW LEVEL OF STEREOTYPE

NULL LEVEL OF STEREOTYPE

In practice, the test you filled out a few weeks ago regarding your university study choices allowed us to obtain a measure of your level of GENDER-SCIENCE STEREOTYPE, that is, how much you unconsciously think that boys are more suited to studies scientific studies while girls are more predisposed towards literary and humanistic studies. The index we provide you reveals 4 possible levels of stereotype i.e. NULL, LOW, MEDIUM, HIGH. The NULL level indicates the absence of a stereotype of the male-science and female-literature type. The LOW level indicates a slight presence of stereotype, i.e. you tend, albeit slightly, to unconsciously make the associations male-science and female-letters. The MEDIUM level indicates a significant level of stereotype while the HIGH level highlights the presence of a strong gender stereotype. In the presence of LOW, MEDIUM and HIGH stereotype levels, the test reveals that you tend to unconsciously make male-science and female-letters associations. If the indication we have provided you on the outcome of your test reveals the presence of a gender stereotype (LOW, MEDIUM or HIGH LEVEL) we invite you to reflect on whether the university choice you are about to undertake is not actually influenced by the unconscious belief that some faculties are more suitable for men than for women. Choosing university is an important choice that will determine your future. When choosing a university path, you should be careful to consider your genuine abilities, your aptitudes and your aspirations.

With a wish for a happy future

Research Team

Letter to Untreated Students

Dear student, We are writing you this short email to thank you for taking part in filling out the questionnaire relating to your intentions regarding continuing your university studies. Choosing university is an important choice that will determine your future. When choosing a university path, you should be careful to consider your genuine abilities, your aptitudes and your aspirations.

With a wish for a happy future

Research Team

Table A1: Participation by school: classes and students involved

School	Classes	Students
IIS Lungro	1	17
IIS Castrovillari	5	78
IIS Brutium Cosenza	1	22
IIS Praia a Mare	2	20
IIS Roggiano	2	49
ISS Rossano	6	24
IIS San Marco Argentano	2	38
IIS Cassano	2	16
IIS Palmi	5	78
LS Chiaravalle	1	16
LS Strongoli	1	14
LS Mormanno	1	10
LS Trebisacce	4	29
LS Oppido Mamertina	1	12
LC Telesio Cosenza	9	143
Total	**43**	**566**

Survey of High School Students

%subsection*Personal Information

1. **Processing of personal data** – pursuant to and for the purposes of Articles 13 and 23 of Legislative Decree no. 196/2003, with the signing of this form, the undersigned gives consent to the processing of personal data provided following the report submitted.

   Mark only one oval:

   I agree I refuse

2. **School attended**

   Classical high school

   Scientific high school

   Another high school

3. **What is the name of the school you attend?***

   ____

4. **Email address (non-institutional) that you use most frequently, the same one indicated at the beginning of the test**

   ____

5. **SECTION of the school class you are currently attending (ES: A, B, C, etc.)**

   ____

6. **Telephone number (home or mobile)**

   ____

7. **In which municipality do you usually live?**

   ____

8. **Date of birth**

   Example: January 7, 2019

   ____

9. **Sex**

   Male Female

Student Information

10. **What was your assessment at the end of last school year in the following subjects?**

    Mark only one oval per row:

	<6	6	7	8	9	10
Italian						
Mathematics						

11. **How many hours a day do you dedicate on average to studying in addition to school hours?**

    Two Three Four Five More than five

12. **What is your father's educational qualification?**

    University degree or higher

    High school diploma

    Secondary school

    Primary school diploma

    No title

    No reply

13. **What is your father's job position?**

    Employed – Public Sector

    Private sector employee

    Self-employed/Entrepreneur

    Unemployed

    Retired/Inactive/Homemaker

    No reply

14. **What is your mother's educational qualification?**

    (Same options as 12)

15. **What is your mother's job position?**

    (Same options as 13)

16. **Is your father a freelancer in one of the following fields?**

    Engineering and Architecture

    Law

Medicine

Biology

Pharmacy

He is not a freelancer

17. **Is your mother a freelancer in one of the following fields?**

    (Same options as 16)

University

18. **Once you finish school, do you plan on enrolling in university?**

    Yes No I do not know yet

19. **If you intend to enroll, what type of degree course?**

    3-year degree course

    5-year degree course (3+2 or single cycle)

    6-year degree course

    I don't know

20. **Interest in the following disciplines**

    Mark only one oval per row: Very High, High, Medium, Low

    (e.g., Engineering, Architecture, Medicine, Law, Psychology, etc.)

21. **Level of difficulty you believe you would encounter in each path***

    Same structure as above

22. **Which degree course do you intend to enroll in?**

    Options as listed in the original questionnaire

23. **Does distance from your home influence your choice?**

    Yes No I don't know

24. **Will your economic resources be sufficient for university studies?**

    Yes No Partially, I'll need to work

25. **Likelihood of finding a job with each degree**

    Very High, High, Average, Low, Very Low for each field

26. **Expected monthly income 5 years after graduation**

    Ranges from "Less than 1000 EUR" to "More than 2500 EUR"

27. **Is it important to work in your studied profession?**

    Very   Enough   Not much

    Not much, I'm only interested in earning good money

Psychological Traits

28. **I tend to put off decisions or tasks**

    Never   Rarely   Sometimes   Often   Always

29. **If I can choose whether or not to participate in a competition, I prefer:**

    Do not participate   Participate

30. **Are you ready to take risks or tend to avoid them?**

    Use a scale from 1 (very risk averse) to 10 (risk inclined)

    1   2   3   . . .   10

31. **Who do you think can advise you in choosing a university major?**

    My parents   Friends   Teachers

    I don't take advice from anyone   Other

32. **Can you indicate your weight?**

    ____

33. **Can you indicate your height?**

    ____

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