

AVOIDING DISAFFECTION IN THE MATHEMATICS CLASS AT SECONDARY SCHOOL: THE ROLE OF TEACHER GENDER*

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Disaffection in the mathematics class is shown to be a good predictor of dropout intentions and to have a considerable impact on enrolment decisions taken before entering tertiary education. We explore a database containing information from 2,200 high school students in Catalonia enrolled at 91 schools. Apart from obvious effects, such as personality traits, pupils' gender and satisfaction with their current teacher in that subject, we provide evidence in the form of higher satisfaction scores that students prefer female maths teachers. This finding is robust to the inclusion of school fixed effects, pupils' features, household characteristics and other teacher characteristics. Although the teacher gender effect is more relevant for girls, it is also apparent among boys.

Key words: disaffection, mathematics, teacher's gender.

JEL classification: I20.

Disaffection in the mathematics classroom has been largely ignored by the literature as Nardi and Steward (2003) point out. Yet, such analyses can be considered important for three principal reasons. First, this variable is a good proxy for general school aspirations since it correlates closely with academic achievement - disengagement in mathematics strengthens dropout intentions [Finn, Gerber and Boyd-Zaharias (2005)]. Second, tertiary enrolment preferences (the Sciences, Engineering and even those fields of study with a considerable content of mathematics such as Economics) are also affected by a fall in the number of students continuing with mathematics in late secondary education [Holton, Artigue and Kirchraber (2001); Rask (2010)]. Consequently, either "steeper" career profiles [Joy (2006)] or regrets regarding short-term educational decisions [Gilovich, Medvec and Kahneman (1998)] are conditioned by these decisions. Third, and finally, disaffection in this subject is particularly relevant as a precursor

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of subsequent gender gaps in curricula choices and occupations [Dee (2008)]. Gender attitudes towards mathematics are commonly cited as an explanation for the marked percentages of student disaffection with mathematics. Although, in most developed countries, girls outperform boys academically and present lower dropout rates, they show lower satisfaction scores for this subject. Since tertiary education is undergoing a feminisation, and considerably higher admission grades are required for Science studies, university choices are changing.

The present paper explores student engagement with mathematics during secondary education in Catalonia (Spain). Spain is no exception as regards the high percentage of students expressing a low degree of satisfaction with the subject. Here, two additional factors are worth mentioning: (i) Catalan high school dropout rates are particularly high when compared to those in other Spanish regions and other OECD countries; and, (ii) Spanish results in studies such as TIMSS and PISA lie at the bottom of the distribution. Moreover, the preference rates expressed by Catalan students for enrolling in Science subjects in higher education have slumped notably during the last decade (6.3% to 4.6% between 1999 and 2007) and the rates of regret regarding their chosen field of education are higher among Catalan (Spanish) university graduates than among their peers in the chosen field of education in other economically developed countries [Mora (2010)]. Likewise, only 18.8% of Catalan freshwomen have applied for technical studies in recent years.

Here, we present new evidence regarding the effects of teacher gender. We use information regarding student perceptions of the subject and of their current teacher, in addition to other relevant dimensions of satisfaction. We should highlight that, besides some obvious effects (such as personality traits, a pupil's gender and individual satisfaction with their current mathematics teacher), a teacher's gender presents an important impact that is relevant, although we did not observe significant individual differences in the characteristics of male and female teachers. Indeed, regardless of the econometric procedure implemented, secondary students prefer female mathematics teachers. This effect becomes significantly higher for female pupils when differentiating between pupil gender in the sample. These findings contrast with those published previously, which provided evidence that coincidence in gender increases academic performance [Dee (2008)] and slightly diminishes college dropout rates [Hoffman and Oreopoulos (2009)]. Here, we draw on a database at the high school level where teachers are only responsible for teaching mathematics. Arguably, as at the college level, the effects are likely to be from teacher to student rather than the other way around. Likewise, performance is not the only explanatory factor for disaffection in the mathematics class. Our identification strategy relies on school fixed effects and random teacher assignment over which students have no control.

Furthermore, and by carrying out a sensitivity analysis, we sought to determine whether female and male teachers consistently apply different methodologies or whether they have different motivational perceptions. At this juncture, and drawing on our sample data, we provide evidence of significant statistical differences in the beliefs and motivational strategies of male and female teachers when managing a classroom. However, even when this information was included, a teacher's gender still showed an impact on satisfaction rates for mathematics.

The paper is structured as follows. Section one contains a brief discussion of disaffection in the mathematics classroom, whilst the third section describes our database and the econometric strategy employed. Section four shows our empirical results and the last section concludes.

1. DISAFFECTION IN THE MATHEMATICS CLASSROOM

There is an extensive literature on the relationship between self-concept, including subject-specific self-concept, and student's interest [Guay, Marsh and Bovin (2003)]. Marsh *et al.* (2005) provided evidence of these links and reported that the constructs are invariant over gender. Fullarton (1993) found that boys were consistently more confident of their abilities than girls. Likewise, girls and women have been found to seek connection in mathematics and so respond better to collaborative and open-ended forms of learning and assessment [Mendick (2005)]. Hence, it can be expected that girls will experience a higher degree of disaffection with mathematics as a consequence of the greater challenges posed by this subject. This disaffection is accentuated because girls attribute success to effort rather than to ability as boys do [Hyde *et al.* (1990)]. Consequently, girls are more likely than boys to believe that success in mathematics is actually achievable through hard work. Note that girls work harder than their male counterparts and are likely to attach greater importance to a lack of effort as a factor in their failures than boys do [Dweck and Repucci (1973)].

However, other pupil characteristics condition disaffection scores. Among these, two are worth highlighting. First, ageing is a determinant since pupil disenchantment grows as they proceed through the educational system [Keys and Fernandes (1993)]. Second, affective traits influence individual decisions regarding interest levels for subjects including mathematics. Thus, in conducting an empirical analysis, we need to control for these two factors as well as others that also condition disaffection for the subject (parental background characteristics, schooling characteristics).

Solutions can be found in pedagogical change and the introduction of new methodological strategies since certain pedagogical approaches seem strongly related to underachievement [Boaler (1997)]. Typically, mathematical learning integrates cognitive and affective perspectives in the same way as other subjects do. However, performance in mathematics is more closely conditioned by attitudes and classroom disruption than others. The latter is associated with the fact that this subject is more difficult than others and increments in effort are not gradual, students tend to disconnect and disruptive episodes can occur. To ensure their continued interest, students need to be motivated. If not, absenteeism and increasing disengagement lead to the emergence of increased dropout intentions. Consequently, there is a need to focus more on pedagogical issues and teachers' motivational strategies such as allocating greater responsibility to students for their own learning [Boaler (1998)]. In this regard, teacher attitudes and teacher-student relationships become essential.

However, apart from the relationships between teachers and students, does a teacher's gender have an influence on disaffection for mathematics? That is, take two teachers with similar profiles (age, job satisfaction and number of years of

training and experience) but of different gender. Will this result in different levels of student disaffection for mathematics? If so, which factors result in different teaching behaviours? Arguably, role model effects may explain different attitudes in the conducting of mathematics tuition. That is, analogously to female pupils, female teachers may value a pupil's effort rather than attributing success to a student's ability. We investigate all these questions in our empirical analysis.

2. DATABASE

The data for this analysis come from a sample of secondary school students in Catalonia (one of the richest of the Spanish regions). The data sampling took place between February and December of 2008. The survey was targeted at secondary school students. Late elementary and early secondary mathematics teachers¹ in Catalonia (in four degrees) were approached to participate in the survey and help with student data collection. The final sample contains information from more than 3,200 students enrolled at 91 high schools. The questionnaire was supplied on-line. Since not all the high schools had computer room facilities or enough time schedules, some of those who agreed to participate received the questionnaire in paper format. The questionnaire contained six blocks of questions: personal data, schooling characteristics, mathematics' teaching questions, parental background information, conscientiousness and motivation and lifestyle conditions. An additional survey was carried out to obtain information from mathematics teachers through an on-line application. However, not all the teachers whose classroom pupils participated responded to our survey. Note that the teachers approached only taught mathematics. As a result, we obtained complete information (both from teachers and students) for 2,220 Catalan students. 54.6% of teachers participating were female. This percentage is very close to that of the population (59.5%). After restricting the sample, we tested for any selection bias in terms of student gender participation. The gender division of the students was almost the same as that of the teachers who participated (52.38%) as well as that of those who were not interviewed. In fact, the difference was not statistically significant. Note that nothing else can be said about any additional teacher characteristics.

Table 1 shows the descriptive information for the whole sample as well as for the sample used throughout the econometric analysis. Mathematics satisfaction was computed on a Likert scale from 1 to 5, as has been done with other affection measures. Our results showed that 21.73% of respondents were dissatisfied with this subject while 28.14% said they were neither satisfied nor dissatisfied. How-

(1) We are indebted to the Catalan Mathematics Society and especially to Antoni Gomà for providing us with contacts at each high school in which at least one student who has received an international award participates (Cangur 2008). To avoid sample selection bias we decided initially to contact all Catalan high schools. None of the students had access to the questionnaire prior to responding, which ensures that any attrition effects were avoided, but students were free not to respond to some questions if they so chose. However, some bias in the sample selection might be due to the fact that some specific geographical areas or school types, based on their managerial characteristics (state, semi-private or private), might be underrepresented. For this reason, some administrative information was requested from the Catalan Ministry of Education.

ever, 50% of the pupils were either satisfied or very satisfied with mathematics. Additionally, it should be noted that there was hardly any difference between the whole sample and that used for the regression analysis as a consequence of the teacher information constraint.

Next, by disentangling various covariates we can enrich our analysis. First, girls show statistically significant greater degrees of low satisfaction than those reported by their male counterparts. Notwithstanding, this result must be corroborated by the empirical analysis which includes other influential factors. Second, based on the ownership status of the school, semi-private schools (*centros concertados* - that receive some public funding) show a higher degree of satisfaction than that expressed in state schools. However, tuition configuration and school board decisions may well have a greater impact than ownership. This might be the case because, while there are no curricular differences between schools, didactic methodology decisions taken by individual school boards can affect the management of teaching in mathematics. These differences are controlled for in the empirical analysis by the inclusion of school fixed effects. Third, and finally, pupils enrolled in compulsory studies as compared to late secondary studies report lower levels of satisfaction. Note that late secondary students have a more reduced curricular activity in mathematics. However, Table 1 indicates that these differences are not very relevant.

Then, as discussed above, we wish to determine whether disaffection with mathematics is closely associated with an overall poor performance at high school. Some descriptives corroborated this expectation, but bear in mind, at this juncture, that causality cannot be deduced. First, dropout intentions are considerably higher among those disaffected with mathematics. In fact, 31.04% of disaffected students declare having had intentions of dropping out compared with only 15.67% of their non-disaffected counterparts. Second, the maths marks achieved during the previous academic year are notably higher among those not disaffected with maths (3.22 to 2.47 on a scale from 1 to 5). This is further corroborated for those for whom we obtained additional information based on their participation in the 2008 international mathematics competition (Cangur) – an average of 62.64 was awarded to those students that expressed satisfaction with mathematics compared to an average of 51.33 among their disaffected counterparts.

Since satisfaction scores rely heavily on non-cognitive skills or personality traits –as much as 80% of the score is attributable to these two factors [Lykken and Tellegen (1996)]– we included a measure to detect pupil conscientiousness in our survey. This can be considered as constituting the main component of an individual's personality traits influencing his or her ability and satisfaction levels. For this purpose, we introduced seven questions² related to this component. By factorial

(2) Following consultations with psychologists and checking specific surveys for Spanish teenagers (specifically, the adapted Big-Five personality test), the following statements were introduced: (1) I'm precise when doing my work; (2) I follow a plan; (3) I'm responsible when working; (4) I tend to be untidy; (5) I am easily distracted; (6) I do things efficiently; (7) I do not abandon my homework until I finish it. Five were presented in a positive way and the rest negatively. Responses were reported on a Likert scale from 1 (completely disagree) to 4 (completely agree).

Table 1: MATHEMATICS SATISFACTION: SAMPLE DESCRIPTIVE

		Very dissatisfied	Dissatisfied	Neutral	Satisfied	Very satisfied
Sample final regression	[2.237]	7.60 [170]	12.74 [285]	27.76 [621]	37.59 [841]	14.30 [320]
Whole sample	[3.483]	8.41 [293]	13.32 [464]	28.14 [980]	36.06 [1.256]	14.07 [490]
Boys sample	[1.716]	8.62 [148]	11.60 [199]	26.40 [453]	36.71 [630]	16.67 [286]
Girls sample	[1.767]	8.21 [145]	15.00 [265]	29.82 [527]	35.43 [626]	11.54 [204]
Sample (late secondary)	[699]	7.44 [52]	12.59 [88]	23.46 [164]	41.63 [291]	14.88 [104]
Sample compulsory secondary	[2.784]	8.66 [241]	13.51 [376]	29.31 [816]	34.66 [965]	13.86 [386]

Source: Own elaboration.

Note: We report percentages and the number of respondents in brackets.

analysis, we computed a single measure of conscientiousness (the Kaiser-Meyer-Olkin measure was 0.81). Finally, we rescaled this measure in order to obtain a new variable ranging from 0 to 1 which could be considered as a probability measure. Although the survey does not include longitudinal information, this proxy captures unobserved individual heterogeneity substituting student fixed effects.

3. ECONOMETRIC METHODOLOGY

We estimate the latent mathematics satisfaction score through the following reduced form:

$$y_i^* = z_i' \delta + \varepsilon_i \quad [1]$$

where $y_{i,i} = 1, \dots, 5$, represents the ordinal dependent variable, z_i is a matrix containing control variables, δ is a k -vector of k unknown parameters whilst ε_i represents the independently distributed error term. Hence, we conduct our estimation using an ordinal logit procedure. We consider the following covariates within z as conditioning individual scores of satisfaction with mathematics at different levels: (i) pupils' personal data: gender, age, having immigrant status, self-reported health status and state of mind when reporting, usual language for spoken intercourse (Catalan, Spanish or both) and personality traits (conscientiousness); (ii) parental background characteristics: siblings having dropped out of schooling or having successfully graduated, age difference with parents, parental marital status, help received when doing homework, number of books in household, parents' educational attainment levels, parents' health status and appreciation of home environment; (iii) schooling features: had the same teacher previously (for mathematics or other subjects), satisfaction with their current mathematics teacher, school centre ownership, time of arrival at school, number of extracurricular activities enrolled in and their marks in mathematics in their previous academic year³; and (iv) characteristics of their current mathematics teacher: gender, years of experience (in training and at that school), language usually used when speaking, number of books in household and doing further training. Our identification depends on school fixed effects and random teacher assignment over which students have no control. Additionally, random teacher gender assignment can be corroborated, relying on observables, through examining average math grades or dropout intentions by class based on teacher gender since no differences were observed. This means that we were unable to show that there has been no selection of unobservables or disaffection. Notwithstanding, we mitigate any possible bias by including substitutes for student fixed effects (conscientiousness factor) and teacher fixed effects (teacher's job satisfaction).

(3) By adding this variable, we are able to disentangle effects attributable to their previous performance in the subject and which might condition expectations regarding current performance.

4. EMPIRICAL RESULTS

4.1. *Baseline results*

Table 2 shows our main findings. We report the results of the odds ratios for ease of interpretation. Note that we run several tests. We paid special attention to the proportional odds assumption (the covariate effect is the same for the odds of being in the different disaffection categories). In fact, the approximate likelihood-ratio test of proportionality of odds allows us to estimate through an ordinal logit ($\chi^2 = 96.04$, p -value = 0.174). Columns (1) and (2) include the various specifications based on the list of covariates: (1) both pupils' and teachers' characteristics; and (2) school fixed effects. Column (3) excludes pupil satisfaction with their mathematics teacher whilst column (4) report the results based on the pupils' gender. Our results present very little variation.

In terms of the objectives of this paper, we are interested in identifying the influence of the teachers' specific features. Here, two effects require special attention: the teachers' level of satisfaction⁴ and teacher's gender. The greater the teacher satisfaction, the greater the students' affection for mathematics was found to be. For a unit change in teacher gender (i.e. being female), the odds are expected to change by a factor of around 1.4, all other variables being held constant. Note that the standard deviation of our endogenous variable is 1.10 and so this effect is considerably high. If we compute the same effect in other terms, the increase in satisfaction with the mathematics class when being taught by a female teacher was 0.105 standard deviations higher than when having a male teacher (all other variables being held constant). The estimated effect was very high (the second in importance after personality traits). This finding held even after controlling for school fixed effects, which presumably have a substantial effect on a teacher's working environment. Consequently, by enhancing teacher satisfaction we would expect a rise in pupils' affection for mathematics, in the same way that teacher incentives improve student performance [Figlio and Kenny (2007)].

Likewise, a teacher's gender seems to influence student levels of disaffection with mathematics. When the teacher was female, the pupils recorded higher satisfaction scores. The magnitude of this effect became more accentuated once fixed effects were included, making this a relevant control since gender-related disparities are linked to school environment. Note that including school fixed effects accounts for the impact of teacher quality variations across schools. Here, two other factors should be highlighted. First, no statistically significant differences were observed between male and female teachers in terms of their age, number of years of experience and teacher satisfaction. Second, the percentage

(4) Several dimensions of satisfaction were considered: work content, promotion, earnings, job security, school climate, teacher and student absenteeism. Measures were collected on a Likert scale from 1 (very dissatisfied) to 5 (very satisfied). Factorial analysis was used to compute a single measure and the factor was rescaled on a range from 0 to 1. The worst average scores were obtained for assigning homework and maintaining attention in class whilst the highest scores corresponded to school climate and work content.

Table 2: ORDINAL LOGIT RESULTS: ODDS RATIO FOR THE CONDITIONING FACTORS

	(1) Not including FE	(2) Includes FE	(3) Excludes satisfaction with their teacher	(4) Boys
Conscientiousness factor	3.672 (1.54)***	3.617 (1.55)***	4.826 (2.05)***	
Pupil's age	0.966 (0.04)	0.971 (0.06)	1.065 (0.07)	3.134 (1.72)**
Being female	0.516 (0.04)***	0.528 (0.04)***	0.589 (0.05)***	0.980 (0.07)
Immigrant pupil	1.114 (0.18)	1.197 (0.21)	1.280 (0.23)	1.266 (0.33)
State of mind during last 2 weeks	1.039 (0.05)	1.062 (0.06)	1.120 (0.06)**	1.157 (0.10)*
Regularly speaking Castilian	0.969 (0.10)	0.872 (0.11)	0.898 (0.11)	1.009 (0.19)
Regularly speaking Castilian/Catalan	1.183 (0.12)	1.099 (0.12)	1.079 (0.11)	1.155 (0.21)
Having dropout siblings	1.057 (0.27)	1.054 (0.28)	1.039 (0.27)	0.818 (0.26)
Having graduate siblings	1.179 (0.11)*	1.176 (0.11)*	1.213 (0.11)**	1.188 (0.17)
Semi-private school	1.035 (0.11)	0.464 (0.21)*	0.631 (0.31)	1.956 (1.36)
Time taken going to school	1.004 (0.00)	1.004 (0.00)	1.004 (0.00)	1.002 (0.01)
Number extracurricular activities	1.080 (0.06)	1.081 (0.06)	1.090 (0.06)	1.229 (0.12)**
Neutral satisfaction with overall teachers' evaluation	1.415 (0.19)**	1.440 (0.21)**	1.813 (0.26)***	1.254 (0.24)
Satisfied with overall teachers' evaluation	1.681 (0.22)***	1.732 (0.24)***	2.516 (0.33)***	1.608 (0.32)**
Parents not being married	0.845 (0.10)	0.834 (0.10)	0.867 (0.11)	0.963 (0.17)
Difference in years with father	0.961 (0.01)***	0.963 (0.01)***	0.965 (0.01)***	0.958 (0.02)**
Difference in years with mother	1.021 (0.02)	1.024 (0.02)	1.014 (0.02)	1.012 (0.02)
Nobody helps with homework	1.201 (0.10)**	1.209 (0.10)**	1.129 (0.10)	1.159 (0.15)
Marks last year in maths	1.550 (0.05)***	1.566 (0.06)***	1.542 (0.06)***	1.564 (0.07)***

Table 2: ORDINAL LOGIT RESULTS: ODDS RATIO FOR THE CONDITIONING FACTORS (continuation)

	(1) Not including FE	(2) Includes FE	(3) Excludes satisfaction with their teacher	(4) Boys
Satisfied with their mathematics teacher	2.552 (0.14)***	2.538 (0.16)***		2.558 (0.23)***
Had maths teacher before	0.974 (0.10)	0.974 (0.11)	1.145 (0.13)	0.992 (0.16)
Had teacher before	0.934 (0.10)	0.882 (0.11)	0.834 (0.10)	1.049 (0.19)
Number of books at home above 100	0.962 (0.09)	1.080 (0.10)	1.082 (0.10)	1.073 (0.14)
Poor father's health	1.062 (0.12)	1.077 (0.14)	1.028 (0.13)	1.257 (0.24)
Poor mother's health	0.848 (0.10)	0.854 (0.11)	0.818 (0.11)	0.769 (0.14)
Satisfied with home climate	1.001 (0.05)	1.013 (0.05)	1.057 (0.05)	1.026 (0.08)
Teacher satisfaction factor analysis	1.878 (0.42)***	1.955 (1.28)	1.078 (0.98)	3.102 (2.65)
Teacher being female	1.274 (0.12)**	1.435 (0.20)***	1.317 (0.21)*	1.442 (0.31)*
Teacher regularly speaking Castilian	1.189 (0.33)	0.774 (0.29)	1.229 (0.59)	0.660 (0.32)
Teacher regularly speaking Castilian/Catalan	1.198 (0.15)	1.061 (0.28)	1.288 (0.37)	0.530 (0.19)*
Teacher doing further training	1.049 (0.10)	1.091 (0.18)	1.607 (0.34)**	0.860 (0.18)
School fixed effects	NO	YES	YES	YES
N	2,224	2,224	2,230	1,095
Wald χ^2	870.43 (0.00)	1,007.94 (0.00)	985.58 (0.00)	479.26 (0.00)
Pseudo-R ²	0.1553	0.1754	0.1147	0.1940

Source: Own elaboration.

Note: Standard errors are reported in brackets, whereas ***, **, * denote significance levels of 1, 5 and 10%, respectively. Adjusted robust standard errors for clustering at the classroom level were computed.

of men taking further teacher training in mathematics in our sample (44.87%) was similar to the overall proportion for male teachers in all subjects in Catalan secondary schools (42.17%).

Recent studies report that assignment to a same-gender teacher enhances student academic performance [Dee (2008); Hoffman and Oreopoulos (2009)]. However, Holmlund and Sund (2008) argue that this effect is mitigated once they control for unobserved student characteristics and teacher selection. These latter findings are in line with Carrington *et al.* (2007), who claim that a teacher's gender has little apparent effect on the academic motivation and engagement of either boys or girls. We therefore investigated here whether the same was true for satisfaction scores in mathematics. That is, does a teacher's gender affect female and male students in the same way? We observed that both boys and girls are influenced positively when their teachers are female, with the effect being significantly higher for girls.

Next, when considering the effects of the other covariates, personality traits were found to be the strongest determinant. Interestingly, in addition to the conscientiousness factor, a pupil's gender is statistically significant regardless of the econometric specification. Girls show a lower probability of being satisfied with mathematics, and this result is robust to the inclusion of other covariates that are related to the didactics of mathematics, including the evaluation methods used. The explanation is that female students report their satisfaction intrinsically (interest in the subject) rather than extrinsically (expecting an award) as their male counterparts do. This finding is reinforced by Norwich (1999) who points out that disaffection with mathematics is related to intrinsic individual assessments. Two additional effects resulting from individual characteristics are worth mentioning. The older the student, the greater their disaffection with mathematics, which is in accordance with Keys and Fernandes' (1993) finding that, with time, students become increasingly more disenchanted with their education. In addition, the number of extracurricular activities was a key factor, coinciding with the literature as regards its additional positive effect on academic performance.

4.2. Sensitivity analyses

Then, we carried out several sensitivity analyses. Our findings were robust to the exclusion of conscientiousness (a proxy for ability). Remember that this variable was used throughout the empirical analysis as a student fixed effect, since unobserved student traits may introduce a bias in cross-sectional studies [Dee (2008)].

Likewise, we avoided any sorting influence as a consequence of female teachers being assigned to better performing students of mathematics. This was tested by computing average characteristics by teacher gender considering either conscientiousness or a student's mathematics marks for the previous academic year. Although we assume all other factors of male and female teachers to be equal, we do control for the influence of unobserved teacher traits (e.g., classroom management behaviour) by incorporating a job satisfaction indicator (built up through a factorial analysis that was unique for each teacher).

Additionally, we examined the correlated effects. We introduced pupils' average satisfaction scores in mathematics and other characteristics of the classroom environ-

ment (female students, immigrant pupils, students with divorced parents, pupils with intentions of dropping out, age, Body Mass Index, extracurricular activities, parents' educational attainment levels and lifestyle conditions). In this way, we were able to include class-size controls and so avoid any misinterpretations regarding other classroom variations [Koedel (2009)]. Additionally, we analysed sensitivity when restricting the student sample to classrooms with a certain number of respondents (above 15 and 20). After including all these considerations, our results remained unchanged. In fact, no statistically significant differences were observed in average classroom characteristics once the sample was divided on the basis of teacher gender.

4.3. *Teacher and subject satisfaction jointly determined*

Finally, as expected, the pupils that expressed disaffection with their current teacher were more prone to disaffection in the mathematics class. At this juncture, we wondered whether both satisfaction scores might not be jointly determined on answering the questionnaire, reflecting personal psychological traits. Specific appraisals, it is reported, are conditioned by more reflective self-appraisals, even though individuals are not aware of the influence of their self-evaluations on their perceptions [Bono and Judge (2003)]. Individuals questioned about their degree of satisfaction with the subject of mathematics would be conditioned by recent biased memories such as a good or bad classroom experience. Moreover, a 'focusing illusion' may be operating since, according to Schkade and Kahneman (1998), people are more likely to be reminded of a feeling when specifically asked to think about it and so exaggerate the relevance of their feelings. Therefore, while controlling here by using conscientiousness traits, we estimate by means of simultaneous equations since these self-evaluations need to be analysed simultaneously and not in isolation. Note that imposing cardinality or ordinality does not change the nature of the results [Ferrer-i-Carbonell and Frijters (2004)]. For this purpose, we ran a SURE estimation procedure. From these results, it can be concluded that self-appraisals do not have a conditioning effect since a teacher's gender retains its statistical significance⁵.

4.4. *Does the teaching of mathematics differ depending on teacher gender?*

What are the factors, therefore, that point to a pupil's preference for female teachers? Since interrelations are formed within the classroom, one possibility could be the existence of significant differences in the way that male and female mathematics teachers organise their classroom tuition or in the teaching methodologies they adopt. In seeking to answer this question, we compared teachers' methods of assessment and their experience in the classrooms. Teachers were asked about how

(5) We excluded the satisfaction scores from each equation in turn and we considered exclusion restrictions. On the one hand, academic performance in the previous academic year is only condition averse to mathematics but not to the teacher. On the other hand, we excluded from the first equation those covariates representing the number of years of experience a teacher had either at that school or in general. This procedure was carried out using a `cmp` command in Stata. However, for reasons of comparison, we ran an ordered probit instead of an ordered logit. Both coefficients (one equation and both jointly estimated) produced very similar results (0.1316 vs. 0.1132).

often they assess pupils at the blackboard when responding to questions directed at them during the class or in their homework. We also asked them whether pupils were asked to work individually or as a member of a team and whether they used information technologies. However, no significant statistical differences were observed in the teachers' methodologies when separating the sample by gender. In our opinion, this result would seem to be related to the absence of any basic individual characteristics (e.g., age and number of years of training and of teaching experience) within the sample of teachers. Hence, our findings appear to rely on the perceptions that female students have of the relevance of mathematics. Boaler (1997b) argues that mathematics makes little sense to girls when taught in a traditional way and as such serves as a factor that accounts for their underachievement. To a certain degree, therefore, girls that become mathematics teachers will adapt their methodological strategy to this belief. In this manner, it is likely that unobserved, dissimilar tuition beliefs attributable to gender explain our findings.

Finally, differences in teachers' beliefs and motivational strategies may result in classroom disruption or increased rates of failure. To test this, we analysed four specific statements reflecting teacher motivation⁶. Our findings were mixed (see Table 3). On the one hand, no significant differences were detected in response to the following claims: (i) A correct result is not necessary for a student to show that he knows mathematics; and (ii) I create a competitive climate to stimulate students to work and improve. On the other hand, statistically significant differences were recorded between male and female teachers regarding two statements: (iii) Nothing can be done to change students' levels of interest; and (iv) The only way to motivate students is to warn them about failing. Here, male teachers were observed to hold more negative perceptions. Thus, it can be argued that these significant differences in terms of classroom management might influence pupil preferences regarding the gender of their mathematics teacher. Indeed, after including these four additional variables that are shown to influence motivational strategies (see Table 4), a teacher's gender remained statistically significant, with the magnitude being quite similar to our previous findings. Holding all other variables constant, being taught by a female teacher was found to increase satisfaction with the mathematics class 0.127 standard deviations higher than when being taught by a male teacher. This effect is slightly higher than that reported in our previous finding in which the magnitude was 0.105.

(6) These questions are taken from AMOP-E. Medias, a Spanish questionnaire addressed to secondary school teachers which asks about motivational strategies adopted in the classroom. Answers were filled in by the mathematics teachers included in our survey.

Table 3: TEACHER STRATEGIES BY GENDER

	Male	Female
A correct result is not necessary for a student to show that he knows mathematics	2.774 (0.08)	2.773 (0.07)
I create a competitive climate to stimulate students to work and improve	2.095 (0.10)	2.079 (0.08)
Nothing can be done to change students' levels of interest	2.048 (0.08)	1.855 (0.07)***
The only way to motivate students is to warn them about failing	1.8095 (0.08)	1.500 (0.06)***

Source: Own elaboration.

Note: Standard errors are reported in brackets, whereas ***, **, * denote significance levels of 1, 5 and 10%, respectively.

Table 4: ORDINAL LOGIT RESULTS: FURTHER TEACHER CHARACTERISTICS

Teacher satisfaction factor analysis	11.361 (8.19)***
Teacher being female	1.368 (0.18)**
Teacher regularly speaking Castilian	0.842 (0.29)
Teacher regularly speaking Castilian/Catalan	1.280 (0.28)
Teacher doing further training	1.326 (0.21)*
A correct result is not necessary for a student to show that he knows mathematics	1.762 (0.22)***
I create a competitive climate to stimulate students to work and improve	1.049 (0.14)
Nothing can be done to change students' levels of interest	0.682 (0.09)***
The only way to motivate students is to warn them about failing	0.803 (0.10)*
School fixed effects	YES
N	2,224
Wald χ^2	968.43 (0.00)
Pseudo-R ²	0.1785

Source: Own elaboration.

Note: Standard errors are reported in brackets, whereas ***, **, * denote significance levels of 1, 5 and 10%, respectively. Adjusted robust standard errors for clustering at the classroom level were computed.

5. CONCLUDING REMARKS AND DISCUSSION

Recently, new evidence has shown that assignment to a same-gender teacher enhances student academic performance [Dee (2008)] and slightly decreases the likelihood of a student dropping a class [Hoffman and Oreopoulos (2009)]. However, Holmlund and Sund (2008) argue that these effects are mitigated once they control for unobserved student characteristics and teacher selection. In our empirical analysis, we have introduced a new question. We explore student satisfaction levels in the subject of mathematics since they are a good proxy for school aspirations in general, as well as conditioning future choices when enrolling in either upper secondary or tertiary education. Using a database containing information for more than 2,200 Catalan students, we provide evidence that both male and female pupils prefer a female teacher for mathematics as they show a greater affection for the subject. This result is robust to the inclusion/exclusion of different effects such as: personality traits, school fixed effects, classmate characteristics and other teacher features. After considering the specific management behaviour of female teachers, these results remained unchanged.

Carrington *et al.* (2007) argue that student preferences regarding the gender of their teachers during the early years of schooling are immaterial. However, this may change when students become adolescents since individual perceptions change as personal matters acquire greater weight. Thus, although students do not show any particular preferences in this regard, they may prefer to be taught specific subjects by teachers that adopt certain kinds of classroom management behaviour. Therefore, a teacher's gender will affect a pupil's preferences since, although they might have quite similar pedagogical skills, male and female teachers present different methods of motivational management and have different failure/success determinants in mind (whereas female teachers place greater emphasis on student effort, their male counterparts stress a pupil's ability). However, such student-teacher relationships based on a teacher's gender are not exclusive to what might be considered the "tough" academic subjects. Marsh *et al.* (2008), for example, found no evidence that boys are better motivated by male than they are by female teachers in high school maths, science, and English classes. Similarly, and in line with expectations, as regards teacher influence, male teachers tend to present a more dominant interpersonal behaviour while female teachers present a more submissive behaviour [van Petegem *et al.* (2005)]. The same authors confirm that female teachers (apart from those without job security) promote greater cooperation amongst students. In addition to these factors, we believe that local characteristics should also be taken into account and, hence, considerably more research is needed on this issue.



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RESUMEN

La desafección por las matemáticas es un buen predictor de la intención de abandono temprano escolar y juega un papel importante en las decisiones del tipo de estudios a cursar en el nivel universitario. En el artículo exploramos una base de datos de unos 2.200 alumnos de secundaria en Cataluña. Aparte de los efectos derivados de la personalidad del estudiante, el género del alumnado o la satisfacción con el profesorado que imparte la materia, reportamos evidencia de que los estudiantes prefieren a las profesoras. Dicho resultado es robusto a la inclusión de efectos fijos escolares, características del alumnado y del hogar, así como otras características del profesorado. Aunque el efecto es más relevante para las chicas, también se da en los chicos.

Palabras clave: desafección, matemáticas, género profesorado.

Clasificación JEL: I20.

