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## “Gender Gap in Performance in Competitive Environments: Evidence from a Real Competition on Spelling”

Author: *Tuğba Özacit*

Tutor: *Prof. Nagore Iriberry*

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## **ABSTRACT**

This Master's thesis examines the gender gap in performance in a real contest. The data from a contest for children on spelling and vocabulary in English, named National Spelling Bee, offers the opportunity to study the gender gap as competition advances. The contest offers a unique opportunity to study gender differences in a prominent contest on a language task where the contestants compete in multiple eliminatory rounds. Two main findings should be highlighted. In the six editions I study, I do not find evidence for girls and boys showing different likelihood for being among the semifinalists or among the winners. However, there is a gender difference in the dynamics along the multiple rounds in the contest. Boys show, relative to girls, better performance in later rounds compared to earlier rounds. There are also interesting heterogeneous effects regarding the age, school grade and ethnic origin.



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## 1. Introduction

The existence of gender gaps in labour market outcomes, such as in wages, has been an important object of study for economists. Even if the gender gap in wages has shown a decreasing trend over time, it is still persistent in developed countries (Blau and Kahn, 2000, and Cuberes and Teignier, 2015). Gender difference in wages not only plays an important role in the efficiency of the economy, but the gender gap in labour force participation also affects negatively the economic performance of countries (Klasen and Lamanna, 2009; Thévenon et al., 2012). These are the main reasons why economists aim to understand the sources of gender gap in labour market outcomes.

In the previous decade, two important studies have proposed an alternative and complementary explanation for men and women obtaining different outcomes in the labour market: that of gender differences in *competitiveness*. Gneezy et al. (2003) show that men and women show different performances under competitive environments, even though under piece-rate incentives they did not show any such differences in performance. Niederle and Vesterlund (2007) further show that men and women show different preferences when choosing among a competitive and a non-competitive incentive scheme, women shying away from competition. As labour markets are inherently competitive, these two explanations indeed contribute to explaining why men and women might get different outcomes in labour market outcomes.

The main goal of this study is to explore whether girls and boys show differences in performance in a real contest as the competition advances. The contest is on a language task, that of spelling and vocabulary of English, called National Spelling Bee, which is placed in the United States of America.

The contest offers important features in order to advance in the understanding of gender differences in performance in competitive environments. First, it is a real and prominent contest in the United States of America, where about 300 students participate every year. It is a highly recognized contest in the United States. Second, the contest has multiple rounds, which many of them being eliminatory, such as the best contestant is the only one, out of 300 initial participants, who survives until the last round. This offers the opportunity to study gender differences as competition advances. Third, it is a novel task, that of spelling and vocabulary in English, which have not been analyzed previously. The type of task has been shown to be important in the gender differences both in performance and in entry decisions in competitive

environments (see for example, Gunther et al., 2010, and Iriberry and Rey-Biel, 2011). Finally, the data offers some heterogeneity in interesting dimensions such as age, ethnic origin and the type of school the participants come from.

I find that girls and boys have the same likelihood to be at semifinals as well as to be among the winners. I also use historical data on the winners, to see that boys and girls have been equally present among the winners. However, we do find that girls and boys show different performances as they advance into later rounds in the contest: boys perform better than girls as the competition advances. Finally, I carry out the heterogeneity analysis in the gender difference in spelling performance exploiting the variation of four dimensions: Ethnic Origin, Age, Grade, School Type. The results show that the detected gender difference is mainly driven by Indian and relatively younger participants.

## **2. Literature Review**

Gneezy et al. (2003) examined the performance differences of women and men in competitive environments. They proposed a between-subject design with a control and a treatment group. The male and female individuals in both groups were asked to perform a real effort task, solving mazes, for 15 minutes. In Treatment 1 (piece-rate payment), men and women were paid according to piece-rate scheme, where they obtained 0.50 euro approximately per correctly solved maze. The earnings depend on participants' own performance and participants would not know how much others' earnings. They find no differences in performance between men and women (the  $p$ -value of two sided Man-Whitney U test is 0.2023). In Treatment 2 (competitive pay), men and women were paid according to a competitive scheme. Performance of 6 individuals was compared and only the highest performing subject was paid, 3 euro per maze, while the remaining participants were paid 0. In the mixed tournament, men and women showed different performances: men showed significantly higher performance (the  $p$ -value of two-sided Mann-Whitney U test is 0.0004).<sup>1</sup> Last, they run Treatment 3 (random pay) to control risk aversion. Only one participant would be paid, and this participant was chosen randomly at the end of maze solving, and participants would not know how much maze solved by other participants (the  $p$ -value of the two-sided Mann-Whitney U test was 0.165) so they do not find

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<sup>1</sup> Additionally, they run Single-Sex Tournaments with groups of women only and groups of men only, and competition rules were the same as Treatment 2. Men did not perform significantly different in single-sex tournament than mixed tournament;  $p$ -value of two sided Mann-Whitney U test is 0.5630. However, performance of women is significantly higher in single-sex tournament than noncompetitive schemes. As a result, women showed equally competitive behavior than men in single-sex tournaments.

a significant difference between men and women with random pay scheme. As the result of their analysis, there is gender gap in performance in tournament, which means women underperform relative to men of identical skill level once competition is involved.

The follow up literature of Günther et al. (2010), Shurchkov (2010), and Iriberry and Rey-Biel (2011), also run laboratory experiments under piece-rate and competitive structure with various types of tasks. Günther et al. (2010) replicate the experiment and extend it to a gender-neutral task and a female task. They find that women react as strongly to incentives than men in the neutral task and women react stronger than men in female tasks, while in male tasks they underperform. Shurchkov, 2010, constituted two distinctive games, one involving verbal puzzles and one involving math puzzles, with the high time pressure and low time pressure under non-competitive treatment (piece-rate), competitive treatment (tournament) and choice treatment added. The result shows that, women underperform men in high-pressure math-based tournaments.<sup>2</sup> Iriberry and Rey-Biel (2011) designed computer-based tasks, Mental Rotation Task, which is perceived as a male task, and Symbol Digit Substitution Task, which is perceived as a female task, under piece-rate incentives and pair-wise tournament in a within-subject design. The main treatment variable in their design is with the information provided after the piece-rate and before the pair-wise tournament. They found that women underperform in competitive environment when men are expected to outperform women, and, the existence of a rival is strongly primed through the information provided. The follow-up studies therefore show that the task is important, in particular, individuals' perceptions about the stereotype behind the task, whether it is a male-female-neutral task. Also, the type of information individuals obtain before the competition is important.

In addition to the laboratory experiments, there are also studies that look at gender differences in performance in the field. Gneezy and Rustichini (2002) run a field experiments with different levels of competition in an elementary school in Israel. Firstly, the children ran once by him/herself. Then, children matched in pairs starting with the two fastest children. Results show that boys and girls ran at the same speed when they run alone, but when competing boys outperformed girls. Namely competition increases the performance relative to a non-competitive environment for boys, but not for girls. Jurajda and München (2011) and Örs et al. (2013) examined gender differences in performance in different university entry exams. Jurajda

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<sup>2</sup> According to entry choice of the participants, the paper shows that women increase their willingness to compete and performance level in low-pressure verbal tournaments.



and München (2011) do not find gender difference in performance for less competitive schools, while they find that men perform better than women for more competitive institutions. Örs et al. (2013) examine performances for each gender in the French Baccalaureat, which is non-competitive, and in the highly competitive entrance exam for the Ecole des Hautes Etudes Commerciales in Paris, they find gender gap in the competitive entrance exam, whilst women perform better in non-competitive setting. Lastly, Azmat et al., forthcoming, study gender gap in performance in school performance in different tests with different stakes in a non-competitive environment and they find that gender differences are also different depending on the stakes of the tests.

Closest to my research question, Iriberry and Rey-Biel (2016) examine the gender gap in a competitive environment at the two-stage Mathematics contest for children between 10 to 16 years. They find that the gender gap in performance increases as the competition increases from stage 1 to stage 2. The increase in the underperformance of female explained by the high competitive pressure, which means women underperformance increases relative to men as competitive pressure increases.

In my Master's Thesis, I contribute to this literature by analyzing performance data from a real competition on spelling and vocabulary among children in the USA, called National Spelling Bee Competition. Distinctively to previous studies I do not consider piece-rate and competition environments, but only competition but with different rounds. Essentially, the contest has similar competitive structure as in Iriberry and Rey-Biel (2016)'s two-stage math contest, but in contrast to the previous study, this contest has rounds. Also, I test for gender differences when performing in a language-related task, which if anything can be considered a female task. One important limitation, which will be further discussed in the Conclusions, is that as competition advances, not only the competitive pressure increases but also the difficulty of the spelling task increases.

### **3. Description of Spelling Bee**

National Spelling Bee is a non-profit basis educational promotion that started in 1925 in the United States. It is contest for children that aimed to improve their spelling, increase their vocabulary, learn the concepts and develop correct English usage for their future, and year by year acquired a worldwide dimension by local sponsors.

Local spelling bee takes place in all 50 states, the District of Columbia, American Samoa, Guam, Puerto Rico, the U.S. Virgin Islands and Department of Defense Schools in Europe. It is also administered in cooperation with local spelling bee sponsors from seven other countries: Bahamas, Canada, China, Ghana, Jamaica, Japan and South Korea. More importantly, only declared champions of the local Spelling Bee qualify as participants of the Scripps Spelling Bee National Competition. The contest runs by one pronouncer, one associate pronouncer, one head judge, three judge members, eleven leadership team members and bee week staffs.

The competition is divided into three distinctive segments: Preliminaries Test, Semifinals and Championship Finals. Each segment includes various competitive games, called rounds. All words used in the Spelling Bee are from previous year's dictionaries.<sup>3</sup> For my analysis, I collected data of National Spelling Bee 2010, and 2012-2016 editions. During the analysis years, tournament format of the National Spelling Bee has changed in 2013 and 2016. Below, I explain the details for each round:

***Preliminaries:*** The preliminaries segment starts with the round one and ends with the round three. After the preliminary segment, there is a 'Maximum 50 Speller Standard'. The 50 spellers who receive highest cumulative point during the Preliminaries can advance to the semifinals segment and the rest of participants are eliminated.

2010 and 2012 Preliminaries

Round 1: 50 multiple choice questions

Round 2: 1 spelling question on stage

Round 3: 1 spelling question on stage

2013, 2014, 2015 Preliminaries

Round 1: 24 computer based questions and 24 multiple choice test

Round 2: 1 multiple choice vocabulary test questions and 1 spelling question on stage

Round 3: 1 multiple choice vocabulary test questions and 1 spelling question on stage

2016 Preliminaries

Round 1: 12 multiple choice spelling test and 12 multiple choice vocabulary test

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<sup>3</sup> A *Dictionary of American English*. Sir William A. Craigie and James R. Hulbert, eds. University of Chicago Press, 1944, a *Dictionary of Americanisms*. Mitford M. Matthews, ed. Univ. of Chicago Press, 1951, Mencken, H.L. *The American Language*. New York: Alfred Knopf, 1938 (suppl. I, 1945: suppl. II, 1948) and final authority and sole resource for the spelling of words is *Webster's Third New International Dictionary, copyright 2002, Merriam-Webster*.

Round 2: 1 multiple choice vocabulary test questions

Round 3: 1 multiple choice vocabulary test questions

**Semifinals:** During the 2013, 2014, 2015 they added a new semifinals part which includes 4 sections of multiple choice tests and 2 spelling tournament without elimination until the end of 6<sup>th</sup> round. After the round 6, there is ‘Maximum 12 Speller Standard’ applied, which means, only 12 spellers with highest cumulative score have the chance to compete in the final rounds. Contrary to this rule, while in 2010, 2012, 2016, semifinals segment is only spelling competition on stage with elimination, that is, the speller who misspell is eliminated.

2013, 2014, 2015 Semifinals

Round 4: 12 computer based spelling test (Section A) and 12 multiple choice vocabulary test (Section B)

Round 5: 1 multiple choice vocabulary test (Section C), 1 unique spelling question

Round 6: 1 multiple choice vocabulary test (Section D), 1 unique spelling question

2010, 2012, 2016 Semifinals

Continuous rounds: 1 unique spelling question for each participant. For these editions, there is no difference between structure of final rounds and semifinals.

**Finals:** The structure is the same for all editions. The pronouncer pronounces a word to the speller, if the answer is correct, the speller continues with the new round, and the speller is out of the competition once he or she misspells the word.

Additionally, Figure 1 shows the eliminatory structure of each edition for each vocabulary and spelling rounds. The empty lines present that those rounds were not existing in the respective edition, and *Yes* represents that the round is eliminatory, *No* represents that round is not eliminatory. As a general pattern, in all editions the later rounds, those from round 4 on, are eliminatory in the spelling task, which will be the main focus of this study.

Finally, in Figures 2, 3 and 4, I show the specifics of the contest structure in each edition.

## 4. Analysis

### 4.1. Descriptive Statistics

The data set I used in the analysis includes data from 2010 edition and 2012-2016 editions from the National Spelling Bee Contest, adding up to 6 different editions with a total sample of 1,683 participants.<sup>4</sup>

Table 1 presents socio-demographic variables overall and by gender for the 1,683 participants. To see gender differences in competition, the independent variable *Male* is set to take the value of 1 if the speller is male and the value of 0 if the speller is female. According to this table, we can see that 49.1% of the total participants are male and 50.9% of total participant are female, the number of participants for each gender are 827 and 856, respectively, showing gender balance. Table 1 presents the main controls variables.

First, I present the socio-demographic characteristics.

(1) Age: Speller's age at the time of the contest. The average participant's age that has an observed value of 13 for both male and female participants.

(2) Grade: Speller's current academic year, which reports that most spellers are in their 7<sup>th</sup> grade approximately.<sup>5</sup>

(3) Time at Bee: the number of times that the speller has participated in the contest.<sup>6</sup> Most participants participate for the first time although some are repeaters and therefore more experienced.

(4) Ethnic Origin: The spellers' ethnic origins are divided into 9 different groups as dummy variables: White, Black, Asian, Hispanic, Indian, Israeli, Middle East, Native American and Polynesian<sup>7</sup>. According to the Table 2, the four more common ethnic origin of participants are those of White, Indian, Asian and Black spellers with mean 0.55, 0.21, 0.11, and 0.04, respectively.

(5) School Type: it is created as a dummy variable for each school type: Public, Private, Parochial, Charter School and Home-School to control the effects of school types on spellers' performance.

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<sup>4</sup> All the participants' personal information and performance results of the different editions of the contest have been collected from the website of Spelling Bee Contest.

<sup>5</sup> In the Edition 2010, I could not access some information regarding contestants' age and grade.

<sup>6</sup> A speller can repeat the Spelling Bee contest several years except the winners. More details are available in Contest Rules.

<sup>7</sup> The reason to add the variable *Ethnic Origin* is the observed outperformance of Indian spellers in the history.

Secondly, I will also have edition or year fixed effects, as well as, geographical divisions fixed effects, which are shown at the end of Table 1.<sup>8</sup>

Table 2 shows the performance data for each of the spelling and vocabulary rounds. For each edition, there are 9, 13, 16, 22, 18 and 39 rounds, respectively. When increasing the rounds in the contest both the competitive pressure and the difficulty of questions also increases. I will be focusing on performance data, both in spelling and in vocabulary, in the rounds where the contestant is presented with one word and where the contestant can be right or wrong. The *Performance* variable takes the value of 1 if the contestant provided the right answer, and 0 if he or she did not. Table 2 shows the mean values for *Performance* overall and separately by gender for every round.

The number of observations for vocabulary is much lower than for spelling. Vocabulary rounds are less common than spelling rounds so even though I will present the results for both vocabulary and spelling, the main focus will be given to spelling. In the initial rounds girls show slightly better performance, although the differences are not significant. Later, boys show slightly better results, although the differences are not significant. The exception is given by rounds 6 and 7, in which boys significantly obtain better results.

#### **4.2. Main regression Analysis and Results**

In the six editions I analyze there have been 8 winners, since in 2014 and 2016 there were co-champions, with 3 girls and 5 boys.<sup>9</sup> Looking at historical data since 1925, available online, I see that girls and boys are roughly equally likely to be among the winners with 51.58 % of male and 48.42 % of female winners.<sup>10</sup>

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<sup>8</sup> Division 1 includes Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont; Division 2 includes New Jersey, New York, Pennsylvania; Division 3 includes Illinois, Indiana, Michigan, Ohio, Wisconsin; Division 4 includes Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota; Division 5 includes Delaware, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, District of Columbia, West Virginia; Division 6 includes Alabama, Kentucky, Mississippi, Tennessee; Division 7 includes Arkansas, Louisiana, Oklahoma, Texas; Division 8 includes Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming; Division 9 includes Alaska, California, Hawaii, Oregon, Washington.

<sup>9</sup> The winners for each edition are: Anamika Veeramani, female (2010); Snigdha Nandipati, female (2012); Arvind Mahankali, male (2013); Sriram Hathwar, male and Ansun Sujoe, male (2014); Vanya Shivashankar, female and Gokul Venkatachalam, male (2015); Jairam Hathwar, male and Nihar Janga, male (2016).

<sup>10</sup> [https://en.wikipedia.org/wiki/List\\_of\\_Scripps\\_National\\_Spelling\\_Bee\\_champions#List\\_of\\_champions](https://en.wikipedia.org/wiki/List_of_Scripps_National_Spelling_Bee_champions#List_of_champions)

In the regression analysis, I estimate two main equations. First, I look at the gender difference in the likelihood to pass to the semifinals (round 4) and to be among the winners (survive up to the last round). The dependent variable therefore takes the value 1 if the participant is present in round 4 or in the very last round and the main independent variable is *Male*, as shown in Equation 1:

$$Y_{ir} = \alpha + \beta * Male_i + \varepsilon_{ir} \quad (1)$$

Where  $i$  represents the speller, and  $r$  represents the round. Table 3 shows the results. The first column for each dependent variable shows the estimates without any controls while the second column includes *Age*, *Grade*, *Ethnic Origin* and *School Type* as well as, *Edition* and *Division* fixed effects.

I see no evidence for male and female participants for having a different likelihood to be among the semifinals or being among the winners. Additionally, the control variable is *Indian*, showing that Indian origin participants show better performance to pass semifinals.

Next, I exploit the panel structure of the data, where each participant has multiple observations in the rounds that he or she participates. For this reason, the Equation 2 is estimated:

$$Performance_{ir} = \alpha + \beta Male_i + \delta Round_{ir} + \theta Male_i * Round_{ir} + \varepsilon_{ir} \quad (2)$$

where outcome variable  $Performance_{ir}$  is the performance of speller  $i$  in round  $r$ . The same as in the previous regression model,  $Male_i$  is a dummy variable for male participants. The variable  $Round_{ir}$  is a dummy variable that takes the value one when the round refers to that of a spelling round, and zero otherwise. Additionally, variable  $Male_i * Round_{ir}$  is generated to see interaction between male participants and the rounds.

Table 4 presents the estimation results. I show three specifications. The first column of each specification shows the estimation results without controls or fixed effects, while the second shows *Age*, *Grade*, *Time at Bee*, *Ethnic Origin* and *School Type* as controls, *Edition* and *Division* fixed effects. The first specification is a probit model, the second and third models instead are linear probability models, with random effects and fixed effects, respectively. The

comparison between the estimated coefficients without and with controls in all models shows very similar coefficients and a slight increase in standard errors.

The variable *Male* is estimated to be negative and significant coefficient with the Probit model and LPM (RE), which means the male spellers underperform in spelling rounds compared to the female spellers. With the standard deviation is 0.01934 and 0.0522 without controls or fixed effects, and, 0.0203 and 0.0571 with controls and fixed effects, respectively. The variable *Rounds* coefficient is also negative and significant. As expected, in the later rounds the performance lowers, showing both girls and boys lower their performance, due to either the increasing difficulty or to the increasing competitive pressure. More importantly, the observed interaction between *Male* and *Round* (*Male\*Round*) is positive and significant for all three regression models. Consequently, the estimated results show that the male spellers have relatively better performance as the rounds increase compared to female contestants. In addition to main results, the control variable *Time at Bee* coefficients shows significant and positive effect, as expected. Regarding to this independent variable we can say that the speller who participates more than once in the contest, in other words, who has more experience, shows better performance.

Additionally, when the same analysis is replicated with the vocabulary rounds, I see no significant coefficients. The results are presented in Table 5. This could be either because no such difference exists or because the number of observations is too low to estimate precisely the coefficients.

### **4.3. Heterogeneity Analysis**

In this section, I carry out the heterogeneity analysis in the gender difference in spelling performance, exploiting variation in four different variables: Ethnic Origin, Age, Grade, School Type. I estimate Equation 2 with controls and fixed effects and Probit Model, shown in Table 6.

First, I concentrate on three different ethnic origins (Caucasian, Indian, Asian), mainly because these are the three ethnic origins that are most common among the participants. Table 6.1 shows that the main observed results are driven by Indian spellers, who show strong effects for male participants showing a negative performance compared to girls in early round but showing positive performance compared to girls in later rounds.

Second, I look at the heterogeneity effect with *Age*. The estimation results in Table 6.2 shows that the coefficient with the triple interaction *Male\*Round\*Age* is negative and significant, showing that the main observed pattern also depends on the age, suggesting that it is mainly observed among younger candidates.

Third, the heterogeneity analysis is examined by *School Grade* with the new independent variable *Male\*Round\*Grade*. The results in Table 6.3 show that the triple interaction is negative and significant. This confirms the pattern with age and shows that the main observed pattern, male participants performing slightly better than girls in later rounds also depends on the school academic year, being more prevalent among earlier school years.

Finally, I also perform the same analysis based on *School Type*. The results on Table 6.4 show that the interaction between *Male* and *Round* is always positive and significant. The exception is given by those contestants who are educated at home who show the opposite pattern. However, it is important to note that there are few participants who are educated at home.

## **5. Conclusions**

In my Master's thesis, I use the performance data on a real contest on a language task, that of National Spelling Bee, to measure the gender gap in performance along the different rounds of the contest, as the competition advances. The main research question is to analyze whether there are gender differences in performance across the different competition rounds. The main attributes of the setting I study are the natural setting the real contest offers, the neutral or even female task that is used, as well as the actual eliminatory structure the contest possess.

This study finds two main results. First, looking at historical data, I see that boys and girls have shown equal presence among the winners. Furthermore, in the six editions that I study in this thesis I also find that boys and girls have had the same likelihood to pass to semifinals as well as to be among the winners. Second and more importantly, I have detected an important gender difference in the dynamics of the tournament: in the initial rounds, girls show better performance than boys, while in later rounds, boys show better performance than girls. It seems boys and girls show different performances that depend on the stage of the competition. This is in line with the findings of Iriberry and Rey-Biel (2016), where they see that the gender gap in performance widens with the competitive pressure.



I would like to finish with a cautionary note regarding the interpretation of the results. The gender difference in the dynamics of the contest can be a gender differential reaction to the competitive pressure but also to the increasing difficulty of the test. One can argue that both things go together many times in real contest, the further one advances, the harder is the task, which adds pressure to the contest. So, in this particular setting, the gender difference in the dynamics could be either a differential reaction to difficulty or the competitive pressure.

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Great Schools, School Research Portal, web page <http://www.greatschools.org/>

## Figures and Tables

	2010	2012	2013	2014	2015	2016
Round 1 Vocabulary			No	No	No	No
Round 1 Spelling	No	No	No	No	No	No
Round 2 Vocabulary			No	No	No	No
Round 2 Spelling	No	No	Yes	Yes	Yes	Yes
Round 3 Vocabulary			No	No	No	No
Round 3 Spelling	No	No	Yes	Yes	Yes	Yes
Maximum 50 Standard						
Round 4 Vocabulary			No	No	No	
Round 4 Spelling	Yes	Yes	No	No	No	Yes
Round 5 Vocabulary			No	No	No	
Round 5 Spelling	Yes	Yes	Yes	Yes	Yes	Yes
Round 6 Vocabulary			No	No	No	
Round 6 Spelling	Yes	Yes	Yes	Yes	Yes	Yes
Maximum 12 Standard						
Continous Spelling Rounds	Yes	Yes	Yes	Yes	Yes	Yes

Figure 1. The Elimination Structure of Rounds by Editions

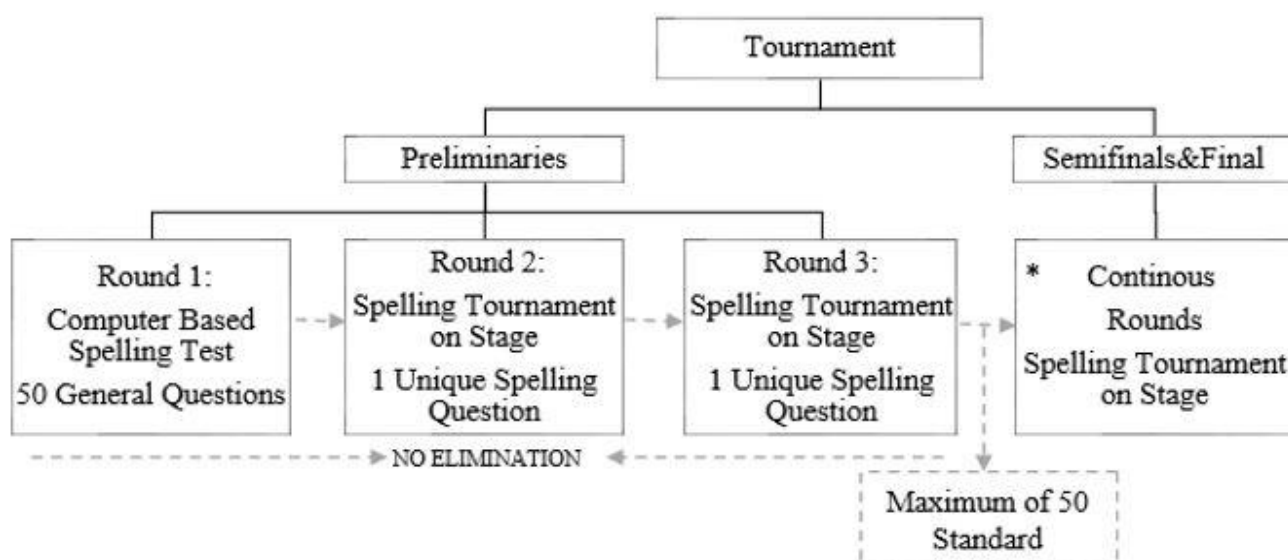


Figure 2. Tournament Structure of 2010 and 2012

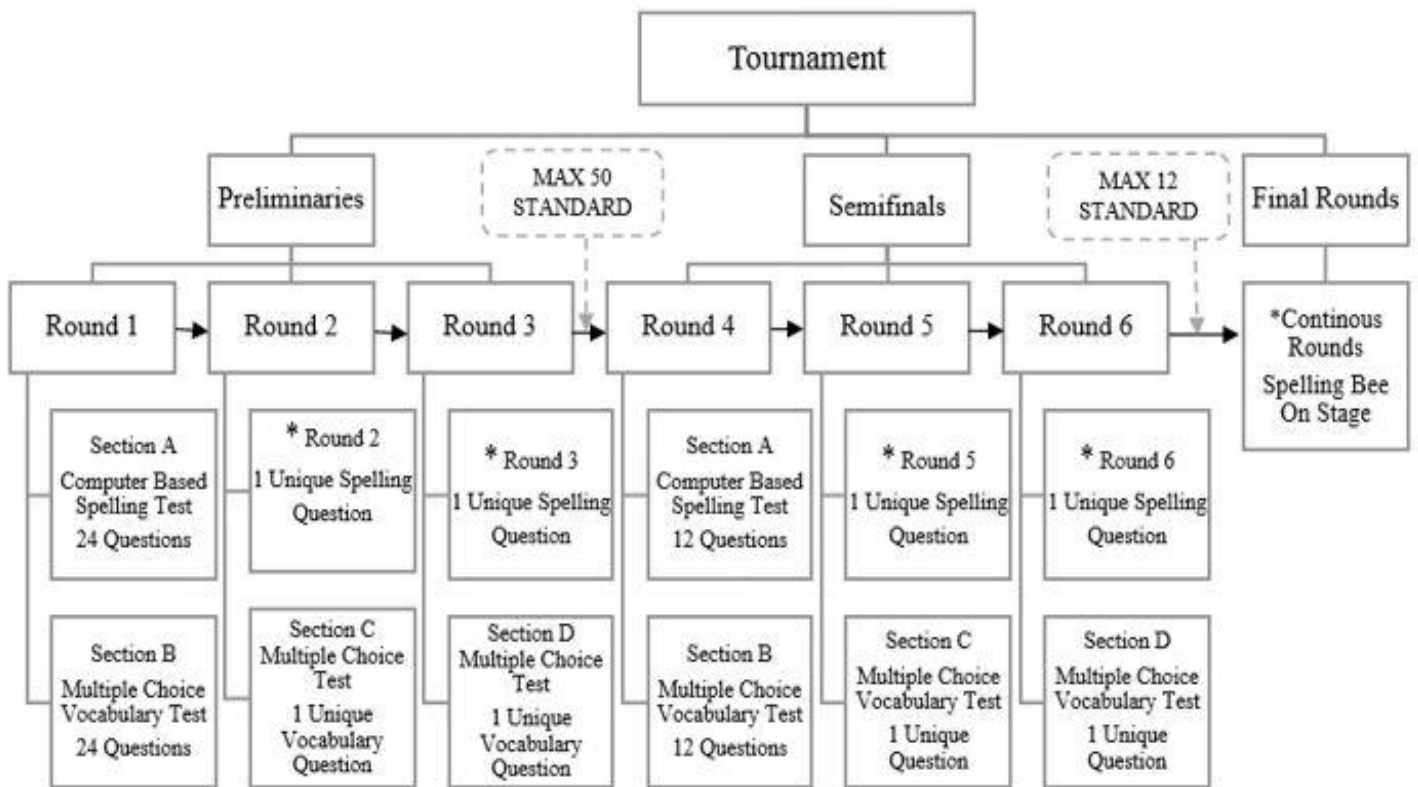


Figure 3. Tournament Structure of 2013-2015

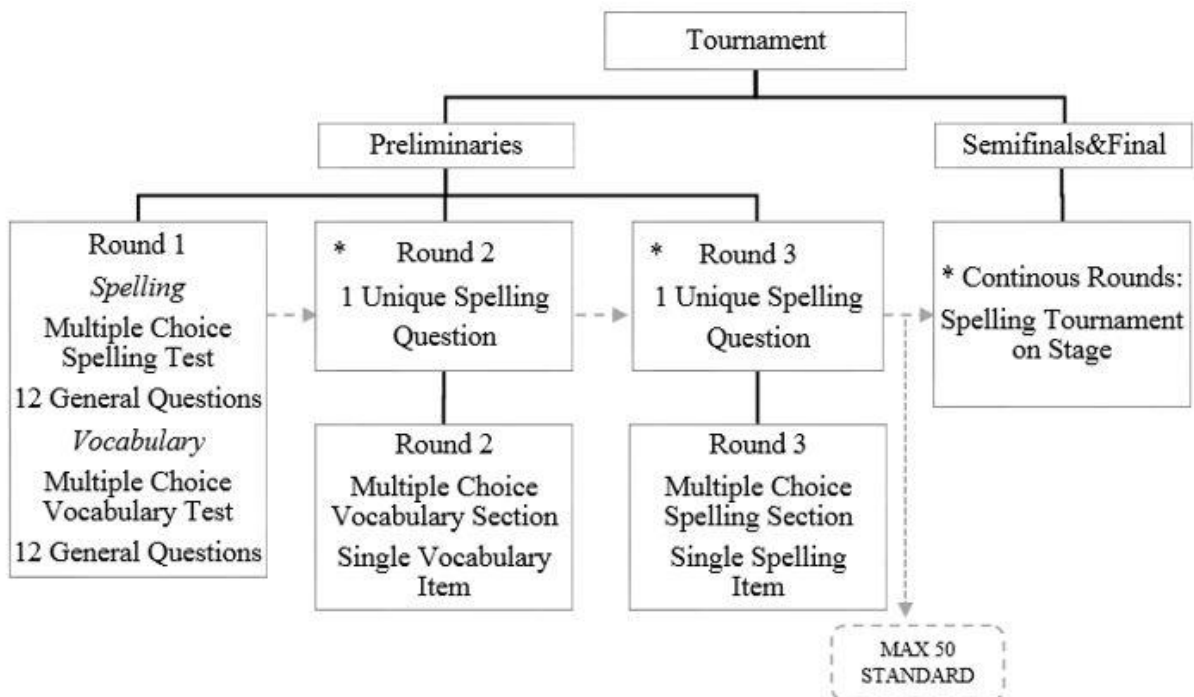


Figure 4. Tournament Structure of 2016

**Table 1. Descriptive Statistics of Spellers**

VARIABLES	Obs	Overall		Male			Female		p-value	
		Mean	Std. Dev.	Obs	Mean	Std. Dev.	Obs	Mean		Std. Dev.
Male	1683	0.49	0.50	827	1	0	856	0	0	
Age	1462	12.70	1.19	707	12.75	1.20	755	12.66	1.18	0.15
Grade	1462	7.06	1.08	707	7.07	1.11	755	7.04	1.05	0.59
Time at bee	1455	1.31	0.66	704	1.30	0.65	751	1.31	0.66	0.83
<b>Origin</b>										
Black	1575	0.04	0.20	771	0.03	0.18	804	0.05	0.22	0.09
Asian	1575	0.11	0.32	771	0.10	0.30	804	0.12	0.33	0.09
White	1575	0.55	0.49	771	0.56	0.49	804	0.55	0.49	0.56
Hispanic	1575	0.03	0.17	771	0.03	0.17	804	0.03	0.17	0.88
Indian	1575	0.21	0.41	771	0.22	0.41	804	0.20	0.40	0.29
Israeli	1575	0.00	0.07	771	0.01	0.10	804	0.00	0.03	0.01
Middle East	1575	0.01	0.13	771	0.02	0.15	804	0.01	0.11	0.00
Native	1575	0.00	0.05	771	0.00	0.05	804	0.00	0.04	0.96
Polynesian	1575	0.00	0.09	771	0.00	0.03	804	0.01	0.12	0.00
<b>School Type</b>										
Public	1462	0.66	0.47	707	0.67	0.46	755	0.65	0.47	0.54
Private	1462	0.08	0.28	707	0.08	0.27	755	0.09	0.28	0.66
Home	1462	0.06	0.25	707	0.05	0.23	755	0.07	0.26	0.15
Parochial	1462	0.15	0.35	707	0.15	0.36	755	0.14	0.34	0.33
Charter	1462	0.02	0.15	707	0.02	0.14	755	0.02	0.16	0.33
<b>Edition</b>										
Year 2010	1683	0.16	0.36	827	0.17	0.38	856	0.14	0.35	0.11
Year 2012	1683	0.16	0.37	827	0.16	0.36	856	0.16	0.37	0.63
Year 2013	1683	0.16	0.37	827	0.15	0.36	856	0.17	0.37	0.42
Year 2014	1683	0.16	0.37	827	0.16	0.36	856	0.17	0.37	0.50
Year 2015	1683	0.16	0.37	827	0.16	0.37	856	0.17	0.37	0.79
Year 2016	1683	0.16	0.37	827	0.17	0.38	856	0.16	0.37	0.51
<b>State-Division-Region</b>										
Division 1	1683	0.04	0.20	827	0.04	0.21	856	0.04	0.19	0.53
Division 2	1683	0.12	0.32	827	0.12	0.33	856	0.11	0.31	0.47
Division 3	1683	0.22	0.41	827	0.24	0.43	856	0.20	0.40	0.06
Division 4	1683	0.07	0.26	827	0.08	0.27	856	0.06	0.24	0.15
Division 5	1683	0.22	0.41	827	0.22	0.41	856	0.22	0.41	0.74
Division 6	1683	0.03	0.18	827	0.02	0.16	856	0.04	0.20	0.08
Division 7	1683	0.09	0.28	827	0.08	0.28	856	0.09	0.29	0.64
Division 8	1683	0.05	0.22	827	0.04	0.21	856	0.05	0.23	0.40
Division 9	1683	0.08	0.27	827	0.07	0.25	856	0.09	0.29	0.05

Notes : This table presents the number of observations and mean values for independent variables and controls by overall and by genders.

**Table 2. Descriptive Statistics of Performance**

VARIABLES	Obs	Overall		Obs	Male		Obs	Female		p-value
		Mean	Std. Dev.		Mean	Std. Dev.		Mean	Std. Dev.	
Vocabulary Round 2	1132	0.76	0.42	548	0.76	0.42	584	0.76	0.42	0.80
Spelling Round 2	1683	0.95	0.21	827	0.94	0.22	856	0.95	0.20	0.39
Vocabulary Round 3	1132	0.70	0.45	548	0.71	0.45	584	0.70	0.45	0.53
Spelling Round 3	1631	0.82	.038	798	0.82	0.38	833	0.81	0.38	0.85
Spelling Round 4	140	0.67	0.47	66	0.66	0.47	74	0.67	0.47	0.91
Vocabulary Round 5	847	0.12	0.32	403	0.11	0.32	444	0.12	0.33	0.68
Spelling Round 5	230	0.70	0.45	112	0.71	0.45	118	0.69	0.46	0.74
Vocabulary Round 6	847	0.12	0.32	403	0.12	0.33	444	0.11	0.31	0.60
Spelling Round 6	165	0.60	0.49	83	0.67	0.47	82	0.53	0.50	0.07
Spelling Round 7	63	0.79	0.40	35	0.88	0.32	28	0.67	0.47	0.04
Spelling Round 8	50	0.76	0.43	31	0.74	0.44	19	0.78	0.41	0.70
Spelling Round 9	38	0.76	0.43	23	0.69	0.47	15	0.86	0.35	0.23
Spelling Round 10	26	0.76	0.42	14	0.64	0.49	12	0.91	0.28	0.10
Spelling Round 11	20	0.75	0.44	9	1.00	0	11	0.54	0.52	0.01
Spelling Round 12	15	0.80	0.41	9	0.88	0.33	6	0.66	0.51	0.32
Spelling Round 13	12	0.91	0.28	8	0.87	0.35	4	1.00	0	0.50
Spelling Round 14	10	1.00	0	7	1.00	0	3	1.00	0	
Spelling Round 15	10	0.80	0.42	7	0.85	0.37	3	0.66	0.57	0.54
Spelling Round 16	8	0.62	0.51	6	0.66	0.51	2	0.50	0.70	0.72
Spelling Round 17	6	1.00	0	5	1.00	0	1	1.00		
Spelling Round 18	6	1.00	0	5	1.00	0	1	1.00		
Spelling Round 19	4	1.00	0	4	1.00	0	0			
Spelling Round 20	4	1.00	0	4	1.00	0	0			
Spelling Round 21	4	1.00	0	4	1.00	0	0			
Spelling Round 22	4	0.75	0.50	4	0.75	0.50	0			
Spelling Round 23	2	1.00	0	2	1.00	0	0			
Spelling Round 24	2	1.00	0	2	1.00	0	0			
Spelling Round 25	2	1.00	0	2	1.00	0	0			
Spelling Round 26	2	0.50	0.70	2	0.50	0.70	0			
Spelling Round 27	1	0	.	1	0	.	0			
Spelling Round 28	2	1.00	0	2	1.00	0	0			
Spelling Round 29	2	1.00	0	2	1.00	0	0			
Spelling Round 30	2	1.00	0	2	1.00	0	0			
Spelling Round 31	2	1.00	0	2	1.00	0	0			
Spelling Round 32	2	1.00	0	2	1.00	0	0			
Spelling Round 33	2	1.00	0	2	1.00	0	0			
Spelling Round 34	2	1.00	0	2	1.00	0	0			
Spelling Round 35	2	1.00	0	2	1.00	0	0			
Spelling Round 36	2	1.00	0	2	1.00	0	0			
Spelling Round 37	2	0	0	2	0	0	0			
Spelling Round 38	2	1.00	0	2	1.00	0	0			
Spelling Round 39	2	1.00	0	2	1.00	0	0			
Winner	1683	0.00	0.06	827	0.00	0.07	856	0.00	0.05	0.44

Notes : This table presents the number of observations and mean values for variable Performance by overal and by genders. Each round is a dummy variable which takes value 1 if the speller answers correctly, otherwise takes value 0.

**Table 3. Gender Differences in the Probability of Passing to Semifinals and to be among the Winners**

VARIABLES	Semifinals		Winner	
	No controls (1)	Controls (2)	No controls (3)	Controls (4)
<b>Male</b>	<b>-.0216615</b> <b>(.0260731)</b>	<b>.0013991</b> <b>(.0286928)</b>	<b>.0025413</b> <b>(.0033694)</b>	<b>.0018655</b> <b>(.0031353)</b>
Age		.0049573 (.0231561)		.0022312 (.0030906)
Grade		.0440533* (.0266559)		.0000828 (.0040793)
White		-.0048806 (.0650081)		
Black		.0897494 (.0827763)		
Asian		.0015664 (.0727061)		
Indian		.2094819*** (.0666603)		
Private		.0162951 (.0507467)		.0318631 (.0173267)
Home		.0792882 (.0501777)		
Parochial		-.0299694 (.0419382)		.0029912 (.0061807)
Charter		.267569** (.1340853)		
Observations	836	609	1683	1462

*Notes* : The columns 1-3 do not include controls and fixed effects, while the columns 2-4 include all controls and fixed effects. The dependent variable *Semifinals* and *Winner* takes value of 1 if the speller passes to semifinals or winner section, and 0 otherwise. And the independent variable *Male* takes the value of 1 if the participant is male and 0 otherwise. The Probit Model is used in estimation and the standard errors are reported in parentheses with \*\*\* p<0.01, \*\* p<0.05, \* p<0.1



Table 4. Gender Differences in Spelling Performance as the Competition Advances

VARIABLES	PROBIT		LPM (RE)		LPM (FE)	
	No Controls (1)	Controls (2)	No Controls (3)	Controls (4)	No Controls (5)	Controls (6)
Male	-.0974379*** (.0193477)	-.1210119*** (.0203586)	-.2149359*** (.0522188)	-.2998226*** (.057184)		
Round	-.0433122*** (.0052728)	-.0526091*** (.0053094)	-.0967336*** (.0117501)	-.1338667*** (.0130162)	-.251855*** (.0193011)	-.2544918*** (.020474)
<b>Male*Round</b>	<b>.0321368***</b> (.004682)	<b>.0384355***</b> (.0048115)	<b>.077457***</b> (.0127394)	<b>.1040157***</b> (.0138375)	<b>.1796736***</b> (.0215574)	<b>.1829412***</b> (.022822)
Age		.0051553 (.0112428)		-.0212826 (.0319618)		
Grade		-.000417 (.0122315)		.0641938* (.0350059)		
Time at Bee		.0327297*** (.0087762)		.0992803*** (.0220788)		
White		-.0267012 (.025769)		-.0288661 (.0263172)		
Black		-.0039025 (.0386935)		-.0038478 (.038801)		
Asian		.0532988** (.0248285)		.0544868* (.0307432)		
Indian		.0814875*** (.0227009)		.0788664*** (.0278056)		
Private		.0321165 (.0194714)		.0381086 (.0593501)		
Home		.0488346** (.0193176)		.1215467* (.0691289)		
Parochial		.0203294 (.0162365)		.0374379 (.0496205)		
Charter		.0131129 (.0382491)		.0489943 (.1138794)		
Constant			1.003494*** (.015898)	.709864*** (.252499)	1.49413*** (.0398305)	

Observations 4210 3741 4210 3741 4210 3741  
R-squared 0.0194 0.0874 0.0144 0.0144 0.0144 0.0151  
No. Of Participants 1683 1453 1683 1453 1683 1453

Notes: The dependent variable Performance takes value 1 if the speller answers correctly in a Spelling Round, otherwise 0. And the independent variable Male takes the value of 1 if the participant is male and 0 otherwise. The variable Male\*Round presents interaction between Round and Male. The column 1-3-5 do not include controls and fixed effects, whilst the column 2-4-6 include all controls and fixed effects. The Probit Model and Linear Probability Model with fixed effects and random effects are used to estimate and the standard errors are reported in parentheses with \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Table 5. Gender Differences in Vocabulary Performance as the Competition Advances

VARIABLES	PROBIT		LPM (RE)		LPM (FE)	
	No Controls (1)	Controls (2)	No Controls (3)	Controls (4)	No Controls (5)	Controls (6)
Male	-.0077912 (.0346164)	-.002206 (.0339669)	.0943497 (.0837366)	.1059525 (.0807487)		
Round	-.1706631*** (.0045524)	-.1785333*** (.0044436)	-.2929686*** (.014262)	-.3199864*** (.0141022)	-.2970742*** (.0149817)	-.297706*** (.0150338)
<b>Male*Round</b>	<b>.003405</b> (.0087896)	<b>.0024311</b> (.008833)	<b>-.0196797</b> (.0205682)	<b>-.0215791</b> (.0197943)	<b>-.021875</b> (.0216681)	<b>-.0215216</b> (.0217323)
Age		-.0078243 (.0147692)		-.0389581 (.0306646)		
Grade		.0270818* (.015869)		.0958475*** (.033121)		
Time at Bee		.1259554*** (.0128517)		.1965063*** (.024963)		
White		.0126063 (.032298)		-.0072703 (.066482)		
Black		.0490829 (.0477399)		.0506337 (.0994811)		
Asian		.0352361 (.0372549)		.0040633 (.0770688)		
Indian		.1712162*** (.0348676)		.3052055*** (.0716288)		
Private		.0291368 (.0283111)		-.0063552 (.0577317)		
Home		.1045113*** (.0352961)		.1558606** (.0736791)		
Parochial		.0080862 (.0212318)		.0295843 (.0443517)		
Charter		.0279885 (.0445505)		.0511037 (.0895374)		
Constant			1.673913*** (.0582654)	.812603*** (.2362368)	1.738641*** (.043703)	1.74119*** (.0438258)

Observations 4006 3994 4006 3994 4006 3994  
R-squared 0.1782 0.2486 0.1782 0.1763 0.1762 0.1763  
No. Of Participants 1132 1129 1132 1129 1132 1129

Notes: The dependent variable Performance takes value 1 if the speller answers correctly in a Vocabulary Round, otherwise 0. And the independent variable Male takes the value of 1 if the participant is male and 0 otherwise. The variable Male\*Round presents interaction between Round and Male. The column 1-3-5 do not include controls and fixed effects, whilst the column 2-4-6 include all controls and fixed effects. The Probit Model and Linear Probability Model with fixed effects and random effects are used to estimate and the standard errors are reported in parentheses with \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Table 6. Heterogeneity Analysis

Table 6.1. Race-Origin

VARIABLES	White		Indian		Asian	
	(1)	(2)	(1)	(2)	(1)	(2)
Male	.0079904 (.0420962)	-.6323279 (.2099634)	-.094055*** (.1013775)	-.1897951*** (.0438447)	-.0726502*** (.0132853)	-.0679392 (.07092)
Round						
<b>Male*Round</b>	<b>-.0038605</b> (.0123529)	<b>.1550451***</b> (.0379508)	<b>.1027846***</b> (.0206385)	<b>.0262266</b> (.0170518)		
Age	.0020977 (.0184838)	.1599552 (.1070687)	.013064 (.0115079)			
Grade	.0077962 (.0200661)	-.1924103* (.1166669)	.0006432 (.0122105)			
Time at Bee	.0569086*** (.0144334)	.1713717*** (.0807822)	-.0051132*** (.0015743)			
Private	.0474122 (.0303253)	.0152233 (.0330008)	.0359307*** (.0089227)			
Home	.078801*** (.0224627)	-.038448 (.0925842)	-.0533112 (.0535334)			
Parochial	.02004 (.0237407)	-.0060639 (.0349025)	-.0303472 (.0685914)			
Charter	.0467567 (.0532523)	-.0386906 (.086468)	.0326781 (.0501059)			

Observations 1878 1105 394

Table 6.2. Age

VARIABLES	(1)	
	Performance	Performance
Male	-.117084*** (.0203789)	-.1102528*** (.0204104)
Round	-.0534386*** (.0054732)	-.0550842*** (.0055896)
<b>Male*Round</b>	<b>.1027846***</b> (.0206385)	<b>.0919499***</b> (.012264)
Age	.013064 (.0115079)	.0045386 (.0112328)
Grade	.0006432 (.0122105)	.0143549 (.0125448)
Male*Round*Age	-.0051132*** (.0015743)	-.007899*** (.0016054)
Time at Bee	.0359307*** (.0089227)	-.0509838*** (.0533783)
White	-.0533112 (.0535334)	-.0252693 (.0672411)
Black	-.0303472 (.0685914)	.0369584 (.0488763)
Asian	.0326781 (.0501059)	.0645883 (.0471303)
Indian	.0604151 (.047796)	.0400651 (.009036)
Private	.03610080 (.0192706)	.0365674* (.0191956)
Home	.0502539*** (.0192355)	.0504174*** (.0191482)
Parochial	.0232802 (.016077)	.023415 (.0160305)
Charter	.0157361 (.0377293)	.0156833 (.037682)

Observations 3741 3741

Table 6.3. Grade

VARIABLES	(1)	
	Performance	Performance
Male	-.1102528*** (.0204104)	-.1112036** (.05937)
Round	-.0550842*** (.0055896)	-.0513803*** (.0141357)
<b>Male*Round</b>	<b>.0919499***</b> (.012264)	<b>.0520543***</b> (.0150964)
Age	.0045386 (.0112328)	.042825 (.0299979)
Grade	.0143549 (.0125448)	.0237803 (.0373795)
Male*Round*Grade	-.007899*** (.0016054)	.0293027 (.0226936)
Time at Bee	-.0509838*** (.0533783)	-.1292783 (.1263787)
White	-.0252693 (.0672411)	-.0258146 (.1649452)
Black	.0369584 (.0488763)	-.1547578 (.1654211)
Asian	.0645883 (.0471303)	-.0376263 (.1140174)
Indian	.0400651 (.009036)	.073054*** (.053155)
Private	.0365674* (.0191956)	.0989456** (.0487498)
Home	.0504174*** (.0191482)	.073054*** (.053155)
Parochial	.023415 (.0160305)	.0607996 (.1308701)
Charter	.0156833 (.037682)	.2699792** (.0264535)

Observations 3741 391

Table 6.4. School Type

VARIABLES	Public		Private		Parochial		Home	
	(1)	(2)	(1)	(2)	(3)	(4)	(3)	(4)
Male	-.0988521*** (.0256243)	-.1562609** (.0639327)	-.1102528*** (.0204104)	-.1112036** (.05937)	-.1112036** (.05937)	-.1112036** (.05937)	.0602056 (.0949348)	.0602056 (.0949348)
Round	-.0534384*** (.0067336)	-.0554842*** (.0187649)	-.0550842*** (.0055896)	-.0513803*** (.0141357)	-.0513803*** (.0141357)	-.0513803*** (.0141357)	-.0583356*** (.0115534)	-.0583356*** (.0115534)
<b>Male*Round</b>	<b>.0355063***</b> (.0061897)	<b>.0520543***</b> (.0163462)	<b>.0919499***</b> (.012264)	<b>.0315739**</b> (.0150964)	<b>.0315739**</b> (.0150964)	<b>.0315739**</b> (.0150964)	<b>-.0434432**</b> (.0213826)	<b>-.0434432**</b> (.0213826)
Age	-.0087862 (.0145344)	.0237803 (.0373795)	.0045386 (.0112328)	.042825 (.0299979)	.042825 (.0299979)	.042825 (.0299979)	.0642211* (.0348575)	.0642211* (.0348575)
Grade	.013222 (.0157137)	-.033351 (.0377962)	.0143549 (.0125448)	-.0315326 (.0331212)	-.0315326 (.0331212)	-.0315326 (.0331212)	-.0134811 (.0395418)	-.0134811 (.0395418)
Time at Bee	.0400152*** (.0114625)	.0293027 (.0226936)	-.007899*** (.0016054)	.0295 (.0263945)	.0295 (.0263945)	.0295 (.0263945)	-.0585337** (.0264535)	-.0585337** (.0264535)
White	-.0223851 (.0325761)	-.1292783 (.1263787)	-.0509838*** (.0533783)	-.0551752 (.0544057)	-.0551752 (.0544057)	-.0551752 (.0544057)	.2699792** (.1308701)	.2699792** (.1308701)
Black	-.0177807 (.0501445)	-.0258146 (.1649452)	-.0252693 (.0672411)	.0989456** (.0487498)	.0989456** (.0487498)	.0989456** (.0487498)	.4588468** (.199691)	.4588468** (.199691)
Asian	.0735446*** (.0277607)	-.1547578 (.1654211)	.0326781 (.0501059)	.073054*** (.053155)	.073054*** (.053155)	.073054*** (.053155)		
Indian	.0938277*** (.0279849)	-.0376263 (.1140174)	.0400651 (.009036)					

Observations 2444 391 544 275

Notes: The dependent variable Performance takes value 1 if a speller answers correctly in related round, otherwise 0. And the independent variable Male takes the value of 1 if the participant is male and 0 otherwise. The Probit Model is used in analysis and all regressions include controls and edition-division fixed effects. Standard errors are reported in parenthesis, with \*\*\* p<0.01, \*\* p<0.05, \* p<0.1