



Gender differences in willingness to compete and answering multiple-choice questions—The role of age

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HIGHLIGHTS

- Women are less willing to enter competition and to guess in multiple-choice tests.
- We shed light at what age both gender differences arise.
- Gender differences in competition preferences emerge in early teenage years (years 12–13).
- Differences in skipping multiple-choice questions exist in all school levels (grades 3–12).

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ABSTRACT

Using a large and unique data set of a German wide voluntary mathematical school competition, we examine at which age gender differences in the willingness to compete arise. We use the data of more than 1,3 million pupils, ages 8 to 18. We find that the share of girls participating in the competition starts to decrease in the early teenage years (12–13). Furthermore, girls answer fewer multiple-choice questions than boys at all age levels. This is interesting as previous findings have identified skipping in multiple-choice tests as one reason for men outperforming women inter alia in university entrance examinations.

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1. Introduction

Entering and performing well in competitive environments is highly related to career choices, wages and promotions (Buser et al., 2014, 2017). When there are structural differences between gender in any of these attributes, the gender wage gap may partly be explained. Both attributes have been studied widely in laboratory situations (Niederle and Vesterlund, 2007) and in framed field experiments (Almás et al., 2016; Booth and Nolen, 2012; Cárdenas et al., 2012). However, only a few studies report on the role of age for entering competition (Andersen et al., 2013; Flory et al., 2017; Sutter and Glätzle-Rützler, 2015). Sutter and Glätzle-Rützler (2015) is – to the best of our knowledge – the only study reporting on the origins of gender differences in developed countries. The

authors find that boys are more likely to compete than girls as early as kindergarden age.¹

In this paper, we provide evidence from a real world math contest (*Känguru-Wettbewerb*), that gender differences in the willingness to compete emerges at the early teenage years at the age of 12–13. Our data set covers a broad sample of at least 1,3 million German pupils, aged 8 to 18. Participation in the *Känguru-Wettbewerb* is voluntary, allowing us to examine the preference for entering a competitive environment in nearly all school grades. Thereby, we shed light on the external validity of the willingness to enter competition.

The *Känguru-Wettbewerb* also allows us to contribute to the literature on structural biases in multiple-choice tests. University entrance examinations and international standardized assessments of educational attainment (PISA, TIMSS, PIRLS) often rely

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¹ Sutter and Glätzle-Rützler (2015) test for gender differences in running, picking cylindrical items from a basket and adding three two-digit numbers.

on multiple-choice tests. A downside, however, is that this testing format tends to favor males over females, *inter alia* because of girls' reluctance to guess if they do not know the answer (Pekkarinen, 2015; Baldiga, 2014; Riener and Wagner, 2017). We are not aware of any study investigating the origins of the gender gap in skipping test items. We start filling this gap by providing evidence that gender differences in guessing exist over all school years.

2. Background information and data

The multiple-choice test. Our data originate from the *Känguru-Wettbewerb* from the years 2013 and 2017. This competition test is administered throughout Germany and it aims at popularizing the subject of mathematics.² Participation in the competition is voluntary for pupils of all school types in grades 3 to 12 and pupils have to pay a small participation fee of 2€ (approx. 2.36\$). The test consists of multiple-choice questions and the organizers design the questions with the aim to achieve gender neutrality in the wording.³ Each grade level has age-appropriate tasks, which have to be solved within 75 min. Test items are divided into three difficulty levels, and are rated with 3, 4, or 5 points for correct answers. Omissions count zero points and starting points and penalties for incorrect answers are chosen such that the lowest possible score is zero.

The test is implemented simultaneously in all schools. Besides getting a certificate of participation, the best 5% of participants win a prize. We will refer to these participants as “top-performers”.

Data. For each question in the *Känguru-Wettbewerb*, we received information about (i) the number of pupils who gave an answer, (ii) how many pupils gave a correct answer, and (iii) how many pupils skipped the question. We know pupils' gender, school grade and whether they are top-performers. The data set includes in total 1,619,363 pupils: 780,085 pupils of more than 9500 schools in 2013 and 839,536 pupils of more than 10,950 schools in 2017.⁴ However, not all observations in 2017 are necessarily independent, as pupils participating in 2013 could have also participated again in 2017. Pupils participating in grade 3 in 2013 are in grade 7 in 2017. Thus, pupils in grades 3 to 6 in 2017 could not have taken part in 2013, and are therefore new and independent observation. If we assume that all participants in grades 7 to 12 in 2017 already participated in 2013, leaves us with data from at least 1.3 million individual pupils.

The data set has several limitations. First, the set of covariates is limited and includes only pupils' gender, grade and whether pupils are among the top-performers. Second, the data are at an aggregate level and do not allow to track individual answering patterns. Nonetheless, we can analyze preferences for entering competition because participation is voluntary and entails a participation fee.

3. Results

Entry into competition. Table 1 reports on the number of participants and the share of females separately for 2013 (Panel A) and 2017 (Panel B). More boys than girls sign up for the test in almost every grade. Moreover, the overall number of participants is declining with age. Older pupils might be less willing to take part in the test because they have already participated in earlier years and the prizes might lose their attractiveness. We interpret the difference in the absolute numbers of male participant and female participants as differences in the willingness to enter competition.

The willingness of girls to expose themselves to competition is summarized in column 2 in Table 1 for pupils in grades 3 to 12. The share of females taking part in the competition test is slightly increasing from grade 3 to 6. Moreover, the share of girls taking part in the competition does not seem to differ from the share of females in the population of all German pupils (column 3). However, starting in young teenage years of 12–13, the age when puberty approximately starts, the share of female participants begins to decrease and is lowest in grades 11 and 12. This is remarkable, as the share of females in the overall pupil population increases.⁵ The decline in the willingness to compete is in line with the findings of Andersen et al. (2013). The authors find – similar to our results – that the girls become less competitive in puberty.

Interestingly, the share of girls among the *top-performers* (column 7) is decreasing. This could be due to top-performing girls opting out in later years or due to a compositional change in the relative skill of boys and girls over time. Buser and Yuan (2016) find that girls taking part in the Dutch Math Olympiad, a setting comparable to the *Känguru-Wettbewerb*, are more likely than men to stop competing in subsequent years if they receive a negative signal about their ability.⁶ In light of the finding of Buser and Yuan (2016), columns (6) and (7) in Table 1 suggest a compositional change in relative skills as top-performing girls receive a positive feedback and should therefore be likely to participate in later years. However, this interpretation of our result is suggestive and not definite and it needs further research on possible explanations for the observed pattern.

Result 1. *The share of females participating in the competition decreases at the beginning of puberty, despite that the share of females in the German pupil population increases.*

Skipping test items. Fig. 1 presents the share of skipped questions and the share of correct answers for boys and girls pooling the years 2013 and 2017. Table 2 in the supplementary appendix summarizes the share of skipped questions and the share of correct answers separately for 2013 and 2017 and separately by gender and provides statistical tests. Whether the difference between boys and girls is significant, was estimated by testing on the equality of proportions. For each question, we received data on the number of pupils who gave a correct or wrong answer and the number of pupils who skipped the question. We calculated the share of pupils who answered the question correctly and the share of omitters for each question. Cell entries represent the mean over all shares and the number of test takers is reported in parentheses.

Overall, older pupils tend to skip more questions than younger pupils and girls skip significantly more questions than boys in all grades (except grade 6). Moreover, the gender gap tends to increase from grade 3 to grade 12.

With respect to correct answers, boys seem to outperform girls in all grades, indicating a negative correlation between skipped and correct answers. Gender differences in performance are significant in all grades in 2013 and for grades 5 and 8 to 12 in 2017.

Result 2. *The gender gap in skipping test items exists in all school grades and tends to increase over the years.*

² For further information see <http://www.mathe-kaenguru.de/wettbewerb/>.

³ This information was given in personal conversations by the organizers.

⁴ In our analysis, we excluded pupils in grade 13 as less than 300 pupils in both years signed up for the test. Moreover, pupils in this grade usually prepare for their *Abitur* (High School graduation exam).

⁵ The increase in female share in grades 11 and 12 is due to the fact that more boys leave school after grade 10, the minimum years of schooling.

⁶ In comparison to the *Känguru-Wettbewerb*, the Dutch Math Olympiad draws participants only from two grade, years four and five of the six-year academic track of secondary school.

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