RISK, CONFIDENCE, AND EQUITY IN MATHEMATICS COMPETITIONS

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Abstract. This study examines the performance of 1,294 fifth-grade students from 26 schools in a city-wide mathematics contest in Israel, analyzing how socio-economic status (SES), gender, and self-confidence shape strategies and outcomes. The contest, adapted from the international Kangaroo Competition, consisted of 12 multiple-choice problems arranged in increasing difficulty, with differentiated scoring and penalties, requiring students to decide whether to solve, guess, or skip. Higher SES and greater school spending predicted stronger performance, confirming the role of resources. In contrast, students in larger or more diverse classes skipped more questions yet made fewer errors, indicating cautious strategies rather than weaker ability. Gender differences were also evident: boys earned higher total scores, while girls skipped more items but maintained comparable accuracy, patterns consistent with strategic risk aversion. Self-confidence exerted a distinct influence. Highly confident students attempted more questions but were less accurate overall, consistent with the Dunning–Kruger Effect; underconfident students attempted fewer items but answered them more precisely. These findings show that competition performance reflects the interplay of resources, strategy, and confidence, shaped by contest design. The paper concludes with implications for equitable access to preparation,

encouraging informed risk-taking (particularly for girls), and feedback practices that help students calibrate self-perceptions to demonstrated competence.

Key Words: *Mathematics competitions; Socio-economic status; Gender differences; Self-confidence; Educational equity.*

Introduction

Mathematics competitions provide opportunities to assess problem-solving skills, foster creativity, and identify mathematical talent. Unlike standard classroom tests, contests impose time pressure and unfamiliar tasks, requiring not only subject knowledge but also strategic judgment under uncertainty. Penalty-based scoring further amplifies this challenge, as students must decide whether to attempt, guess, or skip.

Student outcomes in such contexts are shaped by factors extending beyond mathematical ability. Socio-economic status (SES) is one of the most consistent predictors of academic achievement. Children from more advantaged families and schools benefit from enriched resources, higher-quality teaching, and extracurricular preparation, while students in disadvantaged settings often face larger classes and fewer opportunities [5, 13]. Without intervention, these disparities risk translating directly into competition performance [12].

Gender differences also emerge in competitive settings. While average mathematics achievement shows minimal gaps [8], contests often highlight differences in strategy. Boys are more likely to attempt uncertain items, whereas girls adopt cautious approaches, skipping more questions while maintaining comparable accuracy [9, 11]. Research in Israel confirms that girls value mathematics as highly as boys yet take fewer risks during contests [1, 2]. Such evidence suggests that gender gaps reflect strategy rather than ability.

Confidence adds another layer of complexity. Self-efficacy can promote persistence [4], but overconfidence often undermines outcomes. The Dunning–Kruger Effect shows that students who overestimate their competence attempt more tasks but perform less accurately, while underconfident students may avoid problems despite being capable [7, 10]. In penalty-based contests, both over- and underconfidence have clear costs: miscalibration reduces scores, while excessive caution restricts achievement.

Against this background, the present study investigates a city-wide mathematics contest for Israeli fifth graders. It addresses three research questions: (1) How do SES and school characteristics affect performance? (2) To what extent do gender differences shape strategies such as guessing or skipping? (3) How does confidence relate to accuracy, particularly in light of the Dunning–Kruger Effect? By combining contest results with demographic and attitudinal data, the study

provides insight into how institutional, cultural, and psychological factors intersect in competitive mathematics.

Methodology

The study analyzed the performance of 1,294 fifth-grade students from 26 schools in a large Israeli city, representing diverse socio-economic backgrounds. The contest, adapted from the international Kangaroo Competition, included 12 multiple-choice problems arranged by increasing difficulty. Scoring followed a penalty-based system: +3/−0.75 for easy items, +4/−1.0 for medium, and +5/−1.25 for hard. Students could skip questions without penalty. Each test lasted 45 minutes, with no calculators permitted. This design required contestants to balance mathematical knowledge with risk management.

Data combined contest outcomes, demographic variables, and school-level indicators. For each student, the number of correct, incorrect, and skipped answers was recorded. Socio-economic status (SES) was measured using the Israeli Central Bureau of Statistics' Madlan index, which ranks neighborhoods on a 1–100 scale. Institutional spending per student was drawn from Ministry of Education reports, providing an additional measure of school resources.

Self-confidence was assessed through two indices from a student questionnaire. The first (SCI) measured general confidence in mathematics, while the second (SCI2) captured task-specific confidence by asking students to rate their certainty on answers. Both indices were standardized before analysis.

Missing data were minimal: 46 students did not report gender, and two omitted confidence ratings. These cases were excluded using listwise deletion, leaving valid samples for all analyses.

Multiple regression models examined predictors of three outcomes: total score, accuracy (proportion correct out of attempted items), and number of skipped questions. Predictors included SES, school spending, class size, immigrant student proportion, gender, and both confidence indices. Models controlled for school-level clustering to account for shared variance. Effect sizes were calculated, with gender differences corresponding to a small-to-moderate Cohen's d (≈0.25). Interaction tests (SES × gender; confidence × gender) were non-significant, indicating consistent patterns across subgroups.

Results and Discussion

Analyses showed that contest outcomes reflected the combined influence of socio-economic resources, gendered strategies, and confidence calibration.

Students from higher-SES schools achieved significantly higher scores, and institutional spending per student was positively related to performance. These

results confirm that resources support achievement [6, 13]. In contrast, students in larger classes or in schools with higher proportions of immigrant students skipped more items but made fewer errors. This pattern suggests that such environments encouraged caution, privileging accuracy over risk-taking. Similar dynamics are noted in broader studies of decision-making under incentives, where individuals adjust strategies to perceived risks and rewards [3].

Gender differences were also apparent. Boys obtained higher total scores, yet their accuracy on attempted items was no greater than that of girls. Girls' lower scores resulted from skipping more questions, not weaker ability, indicating risk aversion. At the same time, girls expressed stronger agreement that mathematics is valuable, confirming earlier findings in Israel and internationally that lower female performance in contests reflects strategy, not disengagement [1, 2, 9, 11]. These findings highlight the importance of creating environments that encourage girls to take informed risks without disproportionate penalties.

Confidence further influenced performance. Students with high self-confidence attempted more questions but showed lower accuracy, resulting in weaker scores. Less confident students attempted fewer items but were more precise. This miscalibration reflects the Dunning–Kruger Effect, in which overestimation of competence undermines performance [7, 10]. In penalty-based systems, overconfidence reduces scores, while excessive caution restricts achievement. Effect sizes indicated a small-to-moderate role for confidence, suggesting that while not the strongest predictor, it meaningfully shaped strategies and results.

Exploratory analyses found no significant interactions: SES effects, gendered strategies, and confidence dynamics held consistently across groups. This robustness indicates that the observed patterns represent general features of contest participation.

The contest's structure amplified these differences. With tasks of increasing difficulty and penalties for mistakes, students faced continuous choices between risk and reward. Performance, therefore, depended not only on mathematical knowledge but also on strategy and confidence. As Applebaum argues [1], competitions should be viewed as pedagogical spaces for developing resilience and metacognition, not solely as ranking mechanisms.

In sum, mathematics contest outcomes cannot be understood as measures of ability alone. Institutional resources supported higher performance, gendered differences shaped strategies, and confidence influenced calibration of effort and accuracy. These findings underline the importance of designing contests and learning environments that recognize the interplay of cognitive, cultural, and psychological factors, ensuring that competitions both identify talent and broaden participation.

Conclusion and Implications

This study analyzed the performance of 1,294 fifth-grade students in a city-wide mathematics contest, focusing on the effects of socio-economic status, gender, and self-confidence. The findings show that results cannot be explained by mathematical ability alone but reflect the interaction of institutional resources, strategies, and psychological factors shaped by contest design.

Socio-economic status emerged as the strongest predictor of achievement. Students from higher-SES schools and those with greater funding achieved better results, confirming that inequalities extend into competitive contexts. Students from larger or more diverse classes tended to skip more questions yet maintained accuracy, indicating strategic caution rather than weaker competence. These findings echo international evidence that resource disparities continue to shape achievement opportunities [12, 13].

Gender differences reflected approach rather than ability. Boys attempted more questions and achieved higher totals, while girls skipped more but preserved accuracy. Girls also expressed stronger valuing of mathematics, showing that lower scores do not indicate disengagement. These patterns highlight the importance of encouraging informed risk-taking, particularly for girls, in supportive learning environments.

Confidence added another layer. Overconfident students attempted more items but lost accuracy, while underconfident students attempted fewer but were precise. This aligns with the Dunning–Kruger Effect [10] and underlines the value of feedback practices that help students calibrate their self-perceptions with actual performance.

For educators and contest organizers, the implication is that competitions should not only identify talent but also promote equity, strategic thinking, and resilience. Practice opportunities, reflective activities, and targeted support for disadvantaged schools can ensure that contests foster inclusion alongside excellence.

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Appendix A: Summary of Regression Results (selected predictors)

Table 1. Multiple regression models predicting performance, accuracy, and skipping

Predictor	Total Score (β)	Accuracy (β)	Skipped Questions (β)
Socio-economic status (SES)	0.14*	0.08*	–0.04
School spending per student	0.11	0.07	–0.03
Class size	–0.09*	0.05	0.13
% immigrant students	–0.08	0.04	0.12
Gender (1 = boy, 0 = girl)	0.14*	0.01	–0.14**
Self-confidence index (SCI)	0.13	–0.12**	–0.08
Task-specific confidence (SCI2)	0.07	–0.10*	–0.07

Note. N = 1,246 (reduced due to missing data). Standardized coefficients (β) are reported. Models controlled for school-level clustering. *p < .05, **p < .01, ***p < .001.