Introduction

Over the past few years, we've witnessed an increasing focus on non-standard examinations as an indicator of student ability, especially as a screening tool for universities looking for students who are able to thrive in their increasingly interdisciplinary, open-ended curriculums. These non-standard contests often take the model of testing a student's ability to adequately and creatively problem-solve.

Problem solving refers to the ability to come up with workable solutions to different problem situations and it involves appreciating the nature of the problem by analyzing the causes and looking for possible solutions. There are studies showing that problem solving skills help young people cope with various challenges and demands in their lives and take responsibility for their actions. Problem solving is considered a coping strategy that increases general competence and adaptation in the real-world setting. Many of our daily activities involve problem solving of some sort, and research suggests that problem solving is fundamental to education; educators are interested in improving students' ability to solve problems. Problem solving is also highly personal and dependent on the knowledge and skills of the problem solver.

Educational institutions have also increased their focus on the role of competition as a predictor of a student's ability to cope with the stress and atmosphere of higher education.

Competition is a key element in many educational tools and is often adopted by educators to motivate and excite their students. Competition based learning, for example, describes an approach characterized by students acquiring knowledge through a structured, competitive environment; where the knowledge gained remains independent of the achievement (or results) of the competitive setting.

Our study is using the annual American Math Competitions as an example of a creative problem-solving competition. These contests have been running since 1950, and now annually serve more than 300 000 students around the world. A typical AMC question will involve all of the key components of creative and critical thinking. For many academically minded students this may be their first extra-curricular example of applying their theoretical knowledge in a stressful, competitive environment.

Methodology

There are two main pools of data being used in this study: an urban, upper-class school of students in New Delhi, India; and a rural, lower-income school in Kerala, India. These disparate groups were chosen to analyze the different effects that the AMC might have on students that differ in key demographic areas, including culture, ethnicity and household income. In all of these pools, the yearly performance data for students who wrote the AMC and those who did not for the

past 3 years were analyzed. Performance data is measured by an annual grade aggregate for every student.

Demographic - details of a student's environment
Performance - annual cumulative GPA, any AMC scores, any SAT/ACT scores, for 2016, 2017 and 2018 academic years
Behavioural - levels of academic self-efficacy, engagement, and motivation
Data Sources:
67 students from Delhi Public School System (DPS), from Delhi, India
76 students from Santiniketan, from Kerala, India.

To answer this, the data of two distinct groups of students who wrote the American Math Competitions ("AMC") in 2016 were collected for the previous three academic years (2016, 2017, 2018), and compared to a control group of their peers who did not write the AMC.
The group of students who wrote the AMC were separated into the 'competitive group and the control group was randomly chosen from students in the same year and class as the competitive group. In this preliminary data set, there were 72 students in the control group and 71 students in the competitive group.

Results

Demographically, there were small differences between the competitive group of students and the control group. The household income varied, with 14.49% of the control group students being in the 50 001 to 100 000 INR household income bracket, while only 1.35% of the competitive students were in that same bracket. Meanwhile, 64.86% of competitive group students were located in the 100 001 to 500 000 INR bracket, while only 43.48% of the control group were in that higher bracket.

The relative education level of student's parents between the control group and the competitive group were nearly identical. 89.12% of the control group students' parents had attended college, while 91.22% of the competitive group students' parents had done the same.

There were more significant differences along gender lines between the two groups. Among the control group, 55.07% were female while 44.93% were male. Among the competitive group, only 36.49% was female while 63.51% was male.
In the performance analysis, significant differences between the control and competitive groups emerged. The control group grade year-aggregates remained relatively constant, hovering just under 80% in all three years of study. The competitive group, in 2016, had a grade year-aggregate of 88.8%, but it grew markedly in the two subsequent years of study, with grade year-aggregates of 93% and 94.5% respectively.

Analysis

This study analyzed two groups of high school students, competitive and control. The competitive group had participated in a creative problem-solving competition, the AMC 8, in 2016. The control group had not practiced in any school-mandated competitions of this nature. The performance results for each group were analyzed by examining grade aggregate scores for every student across three years, 2016 to 2018, inclusive.

The data shows that while the control group grade aggregates across all years examined remained within a range of 1% (with a standard deviation of 0.46), the competitive group grade aggregates rose each year examined by an average of 2.45% (with a standard deviation of 2.40).

There are a number of reasons that this increase in grade aggregate across the years studied in the competitive group can be found. It is possible for example that as the competitive group students began to get closer to graduating and the pressures of entrance exams and college applications began to loom, their intensity and motivation in academics began to increase. However, this is countered by the fact that the control group showed no increase in grade aggregate, and in fact on average showed a worse grade aggregate in the final year studied.

Another strong possibility is that increase in academic performance in the competitive group can be caused by their participation in the American Math Competition, with a subsequent increase in motivation, self-efficacy and confidence in problem solving ability.

To dig into this possibility, subsequent analysis of this sample will investigate the behavioral impact of creative problem-solving competitions, by utilizing non-cognitive predictors. Non-cognitive predictors have been defined as anything but standardized academic achievement, scores on aptitude tests and school-based academic performance (e.g. GPA). Three primary non-cognitive measures will be examined:

Academic engagement has been conceptualized as the amount of intellectual effort that a student puts forth in his or her academic life.
Social engagement is defined in this study as the connection that a student establishes with other students and community.
Academic self-efficacy refers to students‘ confidence in their ability to
perform specific accomplishments necessary for their collegiate academic success.

To this date, as far as we’re aware of, no study has explored the relationship between participation in a non-standard, creative problem-solving competition and success in measures of quantitative academic performance and qualitative student behavior. The complete results of this study could be used by schools to help target resources to maximize benefit and redesign screening and assessment processes.