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NUMBERPLAY

Breaking the Grip of the Gaokao, China's SAT

By GARY ANTONICK *August 31, 2015 12:00 pm*



Gary Antonick (center front) with the China Math League team outside Wallenberg Hall at Stanford University on Aug. 19, 2015. Gary Antonick

The notorious *Gaokao*, (高考, or “High Test”) is China’s SAT on steroids, with a score on the nine-hour test being the sole criterion for admission to Chinese universities. Preparing for the test is a years-long obsession for both students and parents. (In case you missed it: Brook Larmer’s [Inside a Chinese Test-Prep Factory](#).) And for many, the unfortunate consequence is that the lengthy preparation destroys, rather than enhances, academic ability. Student enthusiasm and curiosity are crushed.

Although many in China are aware of the Gaokao’s impact, the test has a 1,300-year history and will not be easily killed. Instead, perhaps the best way to break the Gaokao’s life-draining grasp is indirectly, through clubs and activities that rejuvenate kids’ sense of curiosity and fun. And two weeks ago I discovered one such extra-curricular activity that’s becoming popular among Chinese math-lovers: The Math League, an organization based in New Jersey committed to having kids worldwide enjoy math and discussions about problem-solving.

The Math League organizes math contests around the world, including an annual China vs. United States event held annually at Stanford University. After this competition I had the opportunity to spend a day with the Chinese team introducing the some of the topics (cognitive bias, critical thinking, mathematical creativity, intuitive problem-solving) the students may find useful if they pursue math or computer science as a career. The team was wildly enthusiastic (see photo at the top of this post), perhaps a bit too rowdy at times, but with an abundance of curiosity and self-expression. Any negative impact from the Gaokao seemed, for the moment at least, to be gone.

Certainly the Math League experience was at the core of this enthusiasm, and this week it's my pleasure to share the questions used for the competition. (The Math League has copyrighted the questions, and they are used here with permission.) There are quite a few questions, so for our main challenge this week we'll consider the following five:

Fourth Annual Stanford Math League Competition (Sample Questions):

1. *If my age 24 years ago was 24, what will my age be 24 years from now?*
2. *What is the minimum number of people needed in a room to be certain that at least 3 of them were born in the same month?*
3. *If the sum of three prime numbers is 20, what is the largest possible value of one of the three primes?*
4. *If my brain weighs 0.90 kilogram plus half its weight in kilograms, how many kilograms does my brain weigh?*
5. *Working alone, a pump fills an empty pool in 3 days. If it works with a second pump, the two pumps together can fill an empty pool in 2 days. In how many days can the second pump, working alone, fill an empty pool?*

These questions will serve as our official challenge for the week. They aren't *too* tough, but how about 60 of them — in 45 minutes? That is the idea behind the Math League's *Speed Test 60*. Is the test actually fun? Give it a try with [this year's test](#).

If your pencil's still sharp and you're up for more, you might consider the following challenges — also from this year's Stanford contest. These have tougher questions, but there are only 10 of them. Time limit: 70 minutes for all 10 questions. Here are the [Grade 6 and 7 test \(10 questions\)](#) and the [Grade 8 test \(10 questions\)](#).

The average score for Chinese Math League team members, by the way, was 30 out of 60 for the speed test and 5 out of 10 for the individual tests. (Speed Test answers posted at the end of this post. Individual test solutions to be posted on Friday, Sept. 4.)

I was impressed by the Math League program and asked its co-founder Dan Flegler about its impact. Here's his response:

I believe that contests such as ours instill a love of mathematics in students and spur them on in their study of mathematics. The best math student I ever taught was getting Cs in the honors ninth-grade math course I was teaching when his father bribed him with a \$5 bill to join the math team. On the first contest he ever took, he missed 5 of the 6 questions, but got the very hardest question correct. I was amazed since the problem he got correct was a geometry question that I thought he lacked the requisite

knowledge to solve. It turned out that he found a novel way to solve the problem that was completely different from the way I thought it should be done. He went on to complete algebra 1, geometry, algebra 2 and trigonometry in about four months, studying independently under my direction. He eventually won virtually every high school math competition in New Jersey and later got his Ph.D. from Stanford University in applied mathematics. But this never would have happened if he hadn't been inspired by a math contest.

I also asked about the speed test. The goal for this test is a fast, correct answer — rather different from the poking and prodding we do on Numberplay. Nevertheless I did enjoy racing through the sixty questions, which are much easier than they look at first. Finding the simple hook for each — in about ten seconds — is exhilarating: a series of sixty bite-sized riddles. At the same time, I didn't get them all right. Do many students score 100%? Here's Mr. Flegler:

The only students who ever got perfect scores on the speed round were two fraternal Chinese twins (a boy and a girl). Neither I nor any of my colleagues can get a perfect score on the speed round when we take the speed round for fun (even when I write many of the questions myself!). Trying to do 60 questions in 45 minutes isn't an easy task for anyone. The speed round is really very different from anything else we do in our competitions — we save it for last since it's like dessert after a heavy meal.

And the Chinese student experience with Math League contests? I asked Rui Hu, coach of the China team (Dr. Hu is at the far right in the photo at the top of this post). Here's his response:

The Math League and the Stanford International Youth Program enable Chinese students to view and learn math and science from a completely different perspective from what is available in China.

I find two major problems with current Chinese education. The first is math education. All students are forced to study [Math Olympiad](#) problems, very hard problems, even though a lot of these students have no interest in studying these hard problems designed only for math geniuses. This makes Chinese students the least happy students in the world. But Math League contests are well-known math competitions in North America and in the world, with more than 30 years' history. They present fun and creative problems that promote critical thinking and problem-solving skills, the two most important skills that Chinese students are missing in the current exam-oriented, cram education system in China. It is much more fun working on Math League questions than on extremely hard math problems. Math League contests present a complement to the current Chinese math education. To me, I think the best way is American-style math plus Chinese-style rigorous practice and sound, systematic curriculum.

The second problem is English education. Chinese students spend a lot of time on studying English. But Chinese teachers teach students English with the goal to help them achieve high scores in various English tests, such as the TOEFL (Test of English as a Foreign Language) and SAT, not the goal to use English in daily life. So Chinese students achieve very high scores on English tests, but can't communicate with English speakers. This is true in math education, too. The goal is scoring high in contests like Math Olympiad, not developing students' true interests in math. So ironically, Chinese students hate math and English, although they spend a lot of time studying math and English. And this is where Math League can help as well. Students can learn native English and have fun solving Math League problems.

And do students focused on the Gaokao really want to take time out for activities like Math League? Here's Dr. Hu:

The current Gaokao system, which was restored in the winter of 1977 by Chinese leader Deng Xiaoping, played the most important and critical role in lifting China from poverty and making China the second-largest economy in the world. Thanks to the Gaokao, millions of quality students are able to enter universities in China; most are trained to be the quality engineers who helped create modern China. But the Gaokao and the education system in both K-12 and university levels have their shortcomings. It is basically a cram system. It doesn't really encourage critical thinking, creative thinking or intuitive problem-solving. This partially explains why China is very good at copycatting, but not necessarily good at innovation or creativity.

China has produced many, many quality engineers, but not enough innovators or independent thinkers. The Chinese government realizes this problem, so do Chinese parents and teachers. But it is extremely hard to change the current Gaokao system. No one expects the current Gaokao system will change in foreseeable future. So they (Chinese parents, students and teachers) are looking at alternatives or complementary, and the United States is their first choice, as it is the most powerful and innovative country in the world.

Not all the students who participate in Math League contests in China are planning to go to non-Chinese universities. I would say more than half of them are still planning to go to Chinese universities. But these Chinese students want to try something new, something that is innovative and creative, something that is complementary to the current Chinese education system.

Thank you, Dan Flegler and Rui Hu. For more about The Math League, check out its [website](#), which offers information about contests as well as [books with past problems](#).



The second half of the 2015 China Math League team at Stanford University on Aug. 18, 2015. Gary Antonick

With that final picture of enthusiasm we wrap up this week's challenge. As always, once you're able to read comments for this post, use Gary Hewitt's [Enhancer](#) to correctly view formulas and graphics. (Click [here](#) for an intro.) And send your favorite puzzles to gary.antonick@NYTimes.com.

Solutions

Here's **Ravi** with the solutions to this week's five featured questions:

- 1. If the years mentioned are exact (no fraction of years and/or rounding) and the age is defined as completed year, then the age will be **72**.*
- 2. **25** people will ensure that there are at least 3 of them born in the same month*
- 3. Since the sum is even, one of the primes is even and the other two odd. That means 2 is one of the primes and the sum of the other two odd primes is 18. That largest prime possible is **13**.*
- 4. The statement means that half the weight of the brain in kilograms is 0.90 and the full weight is **1.80** kilograms*
- 5. **6 days** is what the second pump takes to fill the empty pool. It is easier working it out this way – The empty pool's capacity is 3 days of the first pump and also 2 days of first + second pump. This means, 1 day of first pump = 2 days of second pump or the second pump takes 6 days.*

Following are complete solutions to the three Math League tests: the [Speed Test Solutions](#), the [6-7th Grade Individual Problem Solutions](#), and the [8th Grade Individual Problem Solutions](#).

About the Gaokao itself, **Jack Sha** offered this perspective:

I am a Chinese and I also love math in high school, I also hate gaokao, but I want to say that we need a way to measure which is student is better than others. The gaokao system do have shortcomings but it gives equal opportunities to every student in China, no matter you are rich or poor, it also enables schools to measure a student's talent by marks. So the most clever or capable students could go to top universities and do most contribute to the country. I think this is a great system.

Which system is perfect? They all have shortcomings.

Under such an education system doesn't mean you will loose your creativity. Check [universities in China](#) – all those universities cultivate great talents each year. Such as Jack Ma, who graduated from Chinese universities and created top e-commerce website in the world, isn't he creative enough? Plus, as far as I am concerned, there are also many groups or competitions like Math League mentioned in the article in China, it is not a that new idea.

I do think USA has many things that worth China to learn, but talking about gaokao system, I think it is almost the best invention our ancient have done in the past.

Thank you, Dan Flegler and the Math League, and to everyone else who contributed to this week's discussion: Bill, Dan Flegler, Gary, henk, Jack Sha, Mark, Mike O'Connor, Ravi, Seth Cohen and Steven Lord.