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PERSPECTIVE

Going for Gold in the International Math Olympiad

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In July 2016, two high school students in the Philippine team garnered gold at the 57th International Mathematics Olympiad (IMO) in Hong Kong, capping a three-decade long quest for the top prize in the most prestigious high school math competition in the world. The four other team members also brought home honors, boosting our country to its highest rank ever, 17th out of 109 countries. This article discusses the history of the Philippine participation in the IMO, and examines the critical factors that have led to the victory. For Philippine team participants in general, these include: institutionalized and refined search for and training of potential participants, early exposure to problem solving from family and/or school, mental toughness of the students. Additional factors exist for Filipino-Chinese contestants, including the Confucian tradition of learning, scholastic role models, pattern similarities between math and the Chinese language, and more time spent learning math.

Key words: International Math Olympiad, math learning, Program for Excellence in Math, Philippine Math Olympiad

INTRODUCTION

Last July 6 to 16, 2016, six high school students, selected and trained for the Philippine team, bagged not just one, but two, elusive gold medals at the 57th International Mathematics Olympiad (IMO) held at the Hong Kong University of Science and Technology, finally cementing in reality our three-decades-long dream of getting the top prize in the most prestigious high school math competition in the world.

Each of our students more than held their own against more than 600 students from 109 countries, and returned home with honors. Out of a possible perfect individual score of 42 points, Farrell Eldrian S. Wu of Makati Gospel Church-New Life Christian Academy and Kyle Patrick F. Dulay of the Philippine Science High School-Diliman, scored 30 and 29 points, respectively, to get gold. Clyde Wesley S. Ang of Chiang Kai Shek College and Albert John L. Patupat of De La Salle University Integrated School scored 24 and 23 points, respectively, to win silver medals. Shaquille Wyan T. Que of Grace Christian College and Vince Jan F. Torres of Santa Rosa Science and Technology High School obtained 15 and 12 points, respectively, to garner honorable mention.

With the stellar performance of every member, our Philippine team ranked 17th out of 109 countries, with a total team score of 133—our best performance ever since we joined the IMO in 1989. The year before, the Philippines had ranked 36th out of 104 countries.

"Our victory brought us closer to Asian powerhouses such as Vietnam (11th) and Thailand (12th)," said Team Leader Dr. Richard Eden, a former IMO contestant himself who is now a professor at the Ateneo de Manila University (ADMU) Math Department. "For the first time, we ranked higher than usually strong countries like Bulgaria (18th), Germany (19th), and Romania (20th)."

Though knowledge of calculus is not required, IMO contestants face three complex math problems for 4.5 hours each over two days, in fields that go beyond high school math, such as number theory, combinatorics, geometry, and algebra (polynomials, inequalities, functional equations). Calculators, of course, are not allowed.

Cut-off scores for awards change every year, based on the complexity of the problems. In 2016, contestants who received at least 29 points got gold; 22 points, silver; 16 points, bronze. Those who answered at least one problem (out of the six) correctly and completely, even without meeting cut-off scores, received honorable mention.

SOCIETAL PROBLEMS

\The first IMO was held in Romania in 1959, but it took three decades for the Philippines to join the competition. In 1984, when some Filipino students performed well in the Australian Math Competition (AMC), the then AMC head—the late Professor Peter O' Halloran—was so impressed that he requested their coach, the late Dr. Jose A. Marasigan, an ADMU math professor, to send a delegation to compete in the IMO.

Four years later, four high school students went to Canberra, Australia as observers, and Victor Luchangco, a senior Ateneo de Manila high school student, received honorable mention, missing the bronze by just one point. In 1989, the Philippine team were no longer observers, but full-fledged contestants, and our country has never missed sending a delegation to the IMO since then.

Poor countries that struggle for economic survival generally do not fare as well as wealthier ones in international competitions, including the IMO. In an article about our participation in the IMO, I noted the following facts (Lee-Chua 1999): In 1984, when Dr. Marasigan met with Prof. O' Halloran, statistics showed that five percent of the Philippine population were in the upper socioeconomic class, 15 percent in the middle, and 80 percent in the low income group. Pundits noted that even if Php eight billion were taken away from the wealthiest, they would still be five times richer than the poorest sector (Ibon Facts and Figures 1984).

With economics at the forefront, the government could barely allocate much for science promotion, much less for math training. In fact, gross inequality was so endemic that two ADMU professors, a physicist and a theologian, wrote: "In a country where the principal problem is the concentration of wealth and power, and access to the benefits of S & T [since and technology] is limited to one small segment of the population, there is urgent need for radical moral and social reform as well as for education towards social justice" (Gorospe and McNamara 1984).

Whether or not national wealth distribution has become more equitable is not the focus of this paper, but suffice it to say that as of 2012, statistics show that the power and the lower income classes still comprise the majority (52.7 percent) but only have less than a quarter share (23.1 percent) of total household national income. The lower middle class, middle class and upper middle classes combined account for 45.8 percent of total households, and two thirds (65.6 percent) of total household income. The upper income (but not rich) and the rich classes make up only 1.5 percent of the total, while having a share of 11.4 percent of national household income (Albert et al. 2015).

The preoccupation with survival, plus corruption and other trigger political issues, have hindered the government from providing free quality education for all (despite the various excellent public schools, there is still widespread perception that the best education is the priciest one, in the poshest private schools) and focusing on STEM pathways for the youth.

Despite these societal problems, our country has managed the almost impossible. How did we get the gold?

PROGRAM OF EXCELLENCE IN MATHEMATICS AND THE PHILIPPINE MATH OLYMPIAD

After the first Philippine team became observers in the IMO in 1988, Dr. Marasigan established the Program of Excellence in Mathematics (PEM), the first formal training program for potential IMO participants. In 1989, PEM started in the ADMU campus, and through the years, branched out into several centers in Baguio, Cebu, Iligan.

The goals of PEM are as follows: to provide intensive and comprehensive training for mathematically gifted secondary students; to encourage and nurture the study of math in the Philippines; to promote cooperation among mathematicians, math education teachers, and different groups in improving the quality of Philippine math education; to promote excellence as a way of life; and to raise our country's standing in the international educational and scientific community.

Qualified high school and college math teachers were encouraged to train their gifted students, who would then be screened as potential participants. The

screening process initially began in this manner: At the start of each school year in June, six challenging problems were distributed to students nationwide, with solutions submitted to the Department of Science and Technology (DOST)'s Science Education Institute (SEI) by September. The top 25 or 30 scorers were invited to undergo PEM training for six months, by which time the next IMO contestants would be chosen.

Potential contestants could also be chosen by another route: doing well in the Philippine Mathematics Olympiad (PMO). In 1984, under the leadership of Professor Josefina Fonacier, then at the Institute for Science and Math Education at the University of the Philippines-Diliman, the first PMO was held in the National Capital Region and the Southern Tagalog Region. The following year, the PMO went nationwide, with the DOST as major sponsor.

The PMO aims not only to identify and motivate mathematically gifted students, but also to stimulate the professional growth of teachers, and promote the development of math education (Fonacier 1996).

In the early years, this selection process, while possibly the best given the constraints, produced uneven results. Sometimes, the Philippines would come home with a couple or even three honors, such as our performance at the IMO in 1991 at Sigtuna, Sweden, where brothers Wyant and Wilbin Chan, then at Uno High School, each brought home the bronze, and Jose Ernie Lope, then at Philippine Science High School, got honorable mention.

But for several years, the most we could bring home was a solitary honorable mention, or no honor at all. With the costs of travelling abroad steadily increasing, the question of continued participation was ever-present.

In 2007, Dr. Ian June L. Garces of the ADMU Math Department became head coach and Team Leader. He decided to refine the selection process. While PEM exists to this day, the sole path to the IMO became the PMO, under the aegis this time of the Mathematical Society of the Philippines (MSP), composed of the country's university mathematicians.

Only the top winners in the PMO, around 20 of them, would be chosen to vie for the honor of representing the country in the IMO.

These top scorers would then undergo the Math Olympiad Summer Camp (MOSC) where for two months, they underwent rigorous training, by MSP members from UP Diliman and ADMU, and former IMO participants.

In 2016, twenty national PMO finalists joined the MOSC, which took place in April and May at the Institute of Math in UP Diliman and the ADMU Math Department. Aside from Eden and Deputy Leader Dr. Louie John Vallejo of UP Diliman, the other trainers in the MOSC were UP Diliman professors Dr. Jose Ernie Lope (a former IMO contestant), Mr. John Gabriel Pelias, Dr. Jerome T. Dimabayao, and Dr. Maria Carmen V. Amarra; ADMU professors Mr. Gari Lincoln C. Chua, Dr. Job A. Nable and Dr. Timothy Robin Y. Teng (a former IMO contestant); and Mr. Adrian Reginald Sy (a former IMO contestant).

Only after the finalists' performances in MOSC were evaluated would the final six team members would be chosen.

This new approach has borne fruit: female students, notably Carmela Antoinette Lao, then of St. Jude Catholic School, started winning medals; and in the last ten years, at least two, and sometimes even three or four, of the Filipino contestants brought home honors.

"Dr. Garces started a renewal track in our training that produced a consistent increase in our rankings in the IMO for the past decade," says Eden. "Our achievement is the result of the effort and inspiration of those who came before us. He was one of those who made us believe that it is worth participating in the IMO. Thank you, Ian, for convincing us getting the gold is possible."

When Dr. Ester B. Ogena became SEI director, she redoubled efforts to support the Philippine team. "We thank Ester, now Philippine Normal University president, who made available funds for sustained training during her stint at SEI," says Garces.

OTHER CRITICAL VARIABLES

In a previous paper (Nebres & Lee-Chua, 2005), National Scientist and mathematician Fr. Bienvenido F. Nebres and I have identified critical variables in successful high-level problem solving in the Philippines.

Before the top students reach PEM or PMO, many of them, such as gold medalist Farrell Wu, have already benefited from prior training in advanced classes in math starting from grade school, or in other venues such as the Mathematics Trainers Guild (MTG) or the Math Challenge run by the Department of Education, the Math Teachers Association of the Philippines (MTAP), and the Metrobank Foundation.

A non-government organization headed by math teacher Dr. Simon Chua, president of Chong Hua University in Zamboanga City since 1996, MTG has succeeded in developing in eight-to-16 year olds "discipline,

appreciation, innovativeness." These students have won more than 2000 medals and merit awards in non-IMO international math individual, group, and correspondence competitions. MTG has also sought the help of math educators from the People's Republic of China, who help train the trainers.

MTAP, another non-government group composed of grade school and high school math teachers, was created by Sr. Iluminada Coronel, formerly of the ADMU Math Department, and upon her retirement, now in Stella Maris College. MTAP primarily aims to encourage students all over the country to take up mathematics. The contest questions are timed (problems are supposed to be answered within 15 seconds to one minute), and require mental math more than non-routine problem solving, but contestants in the PMO (and the IMO) still find this venue as an opportunity to hone their skills.

CHINESE-FILIPINO CULTURE

According to Dr. Marasigan, many IMO medalists come from Chinese- Filipino schools, and global cross-cultural comparisons have singled out the predominance of East Asians (Stevenson & Stigler 1992). Such performance can be attributed to certain best practices, to wit:

More time is spent learning math in Chinese-Filipino schools. In Chiang Kai Shek Grade School and High School, Grace Christian High School, and several other institutions, students have two math classes per day: one conducted in English, the other in Chinese. They are presented with the same concepts, but taught in different ways and different languages, which augment learning. Moreover, in math, practice makes perfect, leading to a substantial comparative advantage when these extra hours are multiplied by at least ten years (elementary and high school combined).

These exist similarities in pattern recognition of Chinese characters and math symbols. Both seem abstract to the English-bred reader, but forced memorization of Chinese figures at a young age may predispose the child to recognize and retain other symbols later on. (In fact, an interesting reason cited by some US researchers concerning the superior performance of Indochinese and Korean immigrants in US math courses is that math symbols do not depend on prior knowledge of English.) Some Chinese-Filipino students say that they reframe and address certain questions in "ways taught in Chinese math class."

Peers who are good in math and science are admired as scholastic role models. It is no accident that many IMO participants are culled from the same high schools, and younger aspirants cite alumni as inspirations. For example, Adrian Reginald Sy, who got silver in the 2013 IMO, cited as his inspiration Carmela Antoinette Sio Lao, who got a silver in 2011. Both of them came from St. Jude Catholic School and are now studying at the Massachusetts Institute of Technology. Some schools consistently produce winners year after year, thus establishing a tradition of excellence in these institutions. In non-Chinese schools, the campus idols are usually sports heroes.

The Confucian tradition of learning, though not as strong in the Philippines as in many parts of Asia, is still adhered to by Filipino-Chinese, who believe that hard work and discipline are the key to success. Education is valued highly by parents, who often supervise their own children's learning at home (compared to Filipino middle-class parents, who more often than not hire professional tutors). Instead of spending time on extracurricular activities such as sports or arts, Chinese-Filipino students traditionally concentrate on math or business.

FILIPINO CULTURE

Though the above factors are prevalent in Chinese-Filipino culture, they are not limited there. Indeed, in an effort to re-create that culture, a counselor and I studied more than 500 (mostly non-Chinese) high-performing the Ateneo High School families and discovered that parents are responsible for many features of the culture of excellence (Lee-Chua & Dionisio 2004).

Parents of top students extensively support their children, and are deemed as important as teachers in school success. These parents consistently supervise homework, provide references, mandate routine and place of study, and have high aspirations and expectations for their children, demanding that they do their best in school. They have also put a good support system in place.

Allied to this factor is early exposure to rigorous problem solving. Many good problem solvers report having been fascinated with math since childhood, and such curiosity has led them to explore harder problems on their own. According to Dr. Marasigan, many IMO winners have parents who had been training them while young. For instance, 1988 silver medalist Jerome Khohayting, then in Xavier School, was fortunate enough to have had a physicist father who exposed him to math problems in grade school, and who supplemented the PEM training with his own.

Parental support is so critical that it can overcome adverse social conditions, such as war and poverty. Prof. Fonacier cites the example of war-torn Cotabato City,

where a teenager from the Albert Einstein School, with extremely supportive parents, once made it all the way to the 1998 PMO national finals, and garnered third place.

Mental toughness, composed of confidence, focus and perseverance, is a trait of good problem solvers. Mentally tough students believe that they are capable of solving the problem, concentrate well on tasks, and have a high tolerance for frustration.

In MTG, students are trained to not give up in the face of challenges, helping them develop a "balance between math skills and character formation," in the belief that academic ability should go hand-in-hand with values, including perseverance.

THOSE WHO CAME BEFORE

Ultimately, the Philippine team's stellar performance in 2016 was the fruit of painstaking, often thankless cooperation, among the local mathematical community, math civic groups, dedicated students, teachers and parents, and the government science education sector, who were all determined to go for gold.

"It hasn't been easy," says Eden. "We struggled. We faced many challenges. But we still gave it our all."

"While only the names of the six contestants and the two team leaders appear in the official records, this achievement is not ours alone," say Eden and Vallejo. "Our stellar performance is the fruit of the labor of various people who came before us. They recognized that the IMO is worth pursuing.

"We thank the Team Leaders of recent years–Dr. Jose Ernie Lope, Dr. Julius Basilla, and Dr. Ian June Garces – for instituting and developing the current training program we have for our IMO participants. We are reaping the fruits of what they started. We thank the Team Leaders of the early years, for devoting their time and effort, when we were still struggling.

"We dedicate this to Dr. Jose Marasigan, our very first Team Leader, who started it all. He did not live long enough to see our first gold medal. Doc Mara, this is for you."

(Left -Right) Dr. Marasigan, Team Leader at the 46th IMO in 2005 at Merida, Mexico, with then Deputy Leader Dr. Eden (at far right). In between were the Philippine team contestants Elvis Chua, Jon Henri Ma, Charles William Ang, Gian Jeffson Chua, John Garret Go, and Daniel Andrew Tan. Go, Ma and Ang each won an Honorable Mention award. This was the last time that Dr. Marasigan led our Philippine team in the IMO.

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