

International Mathematical Olympiad:

S i n g a p o r e ' s E x p e r i e n c e

*by Tay Tiong Seng**



32nd IMO Sigtuna, Sweden 1991

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29th IMO Canberra, Australia 1988

The pinnacle of all the mathematical competitions open to school students is the International Mathematical Olympiad (IMO). The first IMO was held in Brasov, Romania in July, 1959. Seven countries participated in this olympiad: Romania, Bulgaria, Hungary, Poland, East Germany, Czechoslovakia and the Soviet Union. Each country sent a team of 8 contestants, except for the Soviet Union, which sent only four. The second IMO was held in the following year, again in Romania. The participating countries were again from Eastern Europe. Since then the number of participating countries as well as that of contestants has increased steadily and it has become the most prestigious international mathematical competition. At the 38th IMO which was held in Argentina in 1997, there were a total of 82 countries and regions with 459 contestants. The hosts for the next few years will be: Taiwan (1998), Romania (1999), South Korea (2000), and USA (2001).

The aims of the IMO include:

- the discovering, encouraging and challenging of mathematically gifted school students;
- the fostering of friendly international relations between students and their teachers;
- the sharing of information on educational systems, mathematics syllabi and pedagogy throughout the world.

The competition

Participation in the IMO is by invitation from the host country. Each participating country may send a delegation consisting of a leader, a deputy leader and six contestants. The contestants must be students under 20 years of age who must not have studied at a tertiary institution. They have to write two examinations held on two consecutive days. Each examination consists of 3 problems and the time allowed is 4.5 hours.

The problems are contributed by the participating countries. The host then compiles a short list of 30 to 40 problems. The Jury, formed by the team leaders, then considers the problems and decides on the final six problems for the competition. The official versions in English, French, Spanish and Russian are then formulated and adopted. After that, the team leaders will translate the problems into their own languages. All these are done in two to three days before the deputy leaders arrive with the contestants. The team leaders will meet other members of the team only after the second day of competition.

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The second IMO was held in the following

The answer scripts of each team will be marked by the team leader and the deputy leader. There is a team of coordinators for each question. At an appointed time, the team leader will present the scripts of their contestants to the coordinators for assessment. The leader and the coordinators will then agree on the marks to be awarded. If there is any dispute, the matter will be settled by the Jury. At the final Jury meeting, the cut-off points for the medals are decided. The guideline is that at most half of the contestants will be awarded medals. The number of gold, silver and bronze medals awarded are in the ratio 1:2:3 approximately. Contestants who have a complete solution to one problem and who have not been awarded a medal are awarded honourable mentions. At the 38th IMO in 1997, the number of gold, silver and bronze medals awarded was 39, 70 and 122, respectively.

Singapore's participation

In 1986, Singapore received an invitation from Australia to participate in the 29th IMO which was to be hosted by Australia in 1988. With the support of the Ministry of Education, Singapore International Mathematical Olympiad Committee (SIMO) was formed in 1986 to assist the ministry in the selection and training of the Singapore IMO team. The original committee consisted of Professor Chen Chuan Chong as chairman and the following members: Mr Chan Onn, Prof Koh Khee Meng, Mr Liew Mai Heng, and Dr. Tay Yong Chiang. Since then it has undergone many changes and has grown in size. Since 1988, Singapore has participated in ten IMOs. We have won a total of 1 Gold, 9 Silver and 24 Bronze Medals, and 10 Honourable Mentions.

The national team selection and training

Currently, the national team is selected through a National Team Selection Test organized by SIMO. Since this test is used to select the final candidates for the national team, it is comparable in difficulty to the IMO and are fashioned after the IMO. The test consists of two papers, with 3 problems in each paper, and the time allowed for each paper is 4.5 hours. These tests are held in December each year. Based on the test, a group of 10 to 12 students are selected for national team training. These students undergo rigorous training and after further tests, the final six members of the national team are selected in April. These six will continue to undergo training until they leave for the IMO in July.

Students who wish to take the national team selection tests must first get sufficient training (by themselves or from their school, their schoolmates, SIMO, etc.). To prepare students



37th IMO Mumbai, India 1996

for these tests, the committee runs two training courses: Junior and Senior. Students for the Junior level course are selected based on their performance in the Singapore Secondary School Mathematical Olympiad (Junior Section), while those for the Senior level are selected based on the Senior Section of the same competition.

However, the National Team Selection Test is open to all, not just to those previously trained by SIMO. Thus any student who could not or does not wish to attend SIMO training will still be selected if he/she performs well in the test. The present special issue of the Medley publishes the problems and solutions of the National Team Selection Test from 1994/95 to 1997/98.

Starting from this year, training at the junior level will be conducted during the months of July and August. The Singapore Secondary School Mathematical Olympiad (Junior Section) is held in June. Students in Secondary 1 or 2 who do well in this competition will be selected for junior training. The course lasts for eight weeks. The subject covered are elementary number theory and geometry. Students who do well in this course are promoted to the senior course.

Besides those promoted from the junior course, students in the senior course are also selected from those who did well in the SSMO (Senior Section). The duration of this course is 12 weeks, and the course is conducted from January to April each year. Students who competed in the SSMO (Senior) each year will be selected for the course held in the following year. Topics covered in this course include elementary number theory, geometry, algebra, inequalities, combinatorics and graph theory.

In addition to these training courses and the weekly training of the national team, SIMO also organizes a one-week training camp during the June school holidays for the national team as well as for students in the training courses. The programme comprises three main parts. A typical day begins with lectures and problem solving sessions after breakfast. These will continue after lunch. In the evening campers take part in various sports activities. After dinner, there are also talks and other organized activities.

The camp provides a chance for the various groups of trainees to get together, in the spirit of the IMO, and promotes the development of friendship through mutual enjoyment of mathematics. This is also a homecoming occasion for the "x-men and x-women", a term used to describe the SIMO alumni. Through various interactions, the trainees can learn from the x-men and x-women their past experience at the IMO, national service, application of university, scholarships and so on.



35th IMO Hong Kong 1994

Appendix 1: Singapore Teams 1988-1997

Year/Host/Leader/Deputy Leader	Team Members	School	Awards
29th IMO, 1988, Australia Leader: A. Prof Chen Chuan Chong Deputy Leader: Dr Tay Yong Chiang	Chan Hock Peng ★	HCJC	2 Silver
	Cheong Kok Wui ★	NJC	2 Bronze
	Ngan Ngiap Teng ★★	HCJC	
	Lim Jing Yee	HCJC	
	Tang Hsiu Khuern	TJC	
	Yeoh Yong Yeow ★★	RJC	
30th IMO, 1989, Germany Leader: A. Prof Koh Khee Meng Deputy leader: Dr Tay Tiong Seng	Lam Vui Chap ☆	RJC	4 Bronze
	Lee Mun Yew ★	RJC	2 HM
	Ng Lup Keen ☆	RJC	
	Tang Hsiu Khuern ★	TJC	
	Yeoh Yong Yeow ★	RJC	
	Yu Changkai ★	VJC	
31st IMO, 1990, China Leader: Dr Leong Yu Kiang Deputy Leader: Dr Tara R Nanda	Hsi Han Yin	HCJC	2 Bronze
	Jin Zihuai ☆	TJC	2 HM
	Lin Ziwei	CHS	
	Lim Li Woon ★	RJC	
	Tan Chong Hui ★	RJC	
	Yu Changkai ☆	VJC	
32nd IMO, 1991, Sweden Leader: A. Prof Koh Khee Meng Deputy Leader: Mr Ho Foo Him	Lin Ziwei ★★	CHS	1 Silver
	Ng Chee We	CHS	1 Bronze
	Chua Chek Beng ☆	HCJC	1 HM
	Tan Chong Hui ★	RJC	
	Pang Ki Khoon	RJC	
	Lim Li Ying	RJC	
33rd IMO, 1992, Russia Leader: Dr Tay Tiong Seng Deputy Leader: Ms Ng Bee Huay	Chua Chek Beng ★	HCJC	1 Silver
	Pang Siu Taur ★	RI	3 Bronze
	Ben Liang Yongli	RJC	
	Lin Ziwei ★★	HCJC	
	Ng Chee We ★	HCJC	
	Andrew Teng Huei Chong	RJC	
34th IMO, 1993, Turkey Leader: Dr Tara Nanda Deputy Leader: Mr Foo See Bon	Chong Chan Vee ★	HCJC	1 Silver
	Pang Siu Taur ★	RJC	3 Bronze
	Tan Swee Heng	RJC	
	Andrew Ng Yan-Tak ★★	RJC	
	Tan Choon Siang	RJC	
	Wee Hoe Teck ★	ACS	
35th IMO, 1994, Hong Kong Leader: Dr Wong Yan Loi Deputy Leader: Ms Ong Bee Suan	Davin Chor Han Ping ☆	RJC	2 Silver
	Tracey Ho Chui Ping ☆	RJC	3 HM
	Pang Siu Taur ★★	RJC	
	Tan Choon Siang	RJC	
	Tan Swee Heng ☆	RJC	
	Wee Hoe Teck ★★	HCJC	

Year/Host/Leader/Deputy Leader	Team Members	School	Awards
36th IMO, 1995, Canada <i>Leader: Dr Chua Seng Kiat</i> <i>Deputy Leader: Mr Tai Thiam Hoo</i>	Davin Chor Han Ping ★★	RJC	2 Silver
	Koh Yi-Huak ☆	HCJC	2 Bronze
	Jeffrey Pang Chin How ★	Anderson	1 HM
	Thevendran Sendokan ★	RI	
	Tay Wee Peng	RJC	
	Wee Hoe Teck ★★	HCJC	
37th IMO, 1996, India <i>Leader: Dr Qu Ruibin</i> <i>Deputy Leader: Mr Gui Eng Hock</i>	Thevendran Senkodan ★★★	RJC	1 Gold
	Daniel Tan Kwang Pang	RJC	3 Bronze
	Low Tzer Hung ★	RJC	
	Jeffrey Pang Chin How ★	HCJC	
	Lim Yee Fun ★	RI	
	Yeo Keng Hee	RI	
38th IMO, 1997, Argentina <i>Leader: Dr Roger K S Poh</i> <i>Deputy Leader: Mr Shaw SweeTat</i>	Thevendran Senkodan ★	RJC	4 Bronze
	Jeffrey Pang Chin How ★	HCJC	1 HM
	Yeo Keng Hee	HCJC	
	Lim Yee Fun ☆	VJC	
	Huah Cheng Jiann ★	VJC	
	Lin Shaowei ★	RI	

RJC-Raffles Junior College

NJC- National Junior College

CHS- The Chinese High School

VJC- Victoria Junior College

TJC- Temasek Junior College

ACS- Anglo Chinese School

HCJC- Hwa Chong Junior College

RI- Raffles Institution

Anderson- Anderson Secondary School

★★★ awarded Gold Medal ★★ awarded Silver Medal ★ awarded Bronze Medal ☆ awarded Honourable Mention



Appendix 2: Where are the X-men and X-women?

Chan Hock Peng, 1988:

*Graduated from National University of Singapore,
PhD in Statistics from Stanford University.
Assistant Professor in National University of Singapore.*

Cheong Kok Wui, 1988:

*Graduated from University of California Berkeley,
PhD student in electrical engineering, Stanford University.*

Ngan Ngiap Teng, 1988:

*Graduated from National University of Singapore,
working for Goldman Sachs.*

Lim Jing Yee, 1988:

Graduated from Stanford University.

Tang Hsiu Khuern (Deng Shao Kun), 1988, 89:

*Graduated from National University of Singapore,
PhD student in Statistics, Stanford University.*

Yeoh Yong Yeow, 1988, 89:

*Graduated from Harvard University, working in London
for D. E. Shaw & Co., an American investment bank.*

Lam Yui Chap, 1989:

*Graduated from Stanford University,
working for Kent Ridge Digital Labs.*

Lee Mun Yew, 1989:

*Graduated from Cambridge University,
teaching in Raffles Junior College.*

Ng Lup Keen, 1989:

*Graduated from Stanford University,
working for Silicon Graphics in California.*

Yu Changkai (Er Chang Kai), 1989, 90:

Graduated from MIT, working for National Computer Board.

Hsi Han Yin, 1990:

*Graduated from National University of Singapore,
teaching in Temasek Junior College.*

Jin Zihuai (Chin Chee Whye), 1990:

*Graduated from University of California Berkeley,
PhD student in Mathematics, Princeton University.*

Lin Ziwei (Lim Chu Wei), 1990, 91, 92:

Undergrad in Mathematics, National University of Singapore.

Lim Li Woon, 1990:

Graduated from Stanford, working for Bain.

Tan Chong Hui, 1990, 91:

*Graduated from Mathematics Department,
National University of Singapore, now doing Acc. M. Sc.*

Ng Chee We (Huang Zhiwei), 1991, 92:

Undergrad in electrical engineering at MIT.

Chua Chek Beng, 1991, 92:

Undergrad in Mathematics, National University of Singapore.

Pang Ki Khoon, 1991:

*Graduated from Stanford University,
master degree student there.*

Lim Li Ying, 1991:

Graduated from Harvard, working in London for GIC.

Pang Siu Taur, 1992, 93, 94:

Undergrad in Stanford University.

Ben Liang Yongli, 1992:

Graduated from MIT, national service.

Andrew Teng Huei Chong, 1992:

Undergrad in University of Pennsylvania.

Chong Chan Vee, 1993:

Undergrad at Princeton University.

Tan Swee Heng, 1993, 94:

Undergrad in mathematics at Imperial College.

Andrew Ng Yan-Tak, 1993:

*Graduated in computer science from
Carnegie Mellon University.
PhD student in computer science at MIT.*

Tan Choon Siang, 1993, 94:

Undergrad in economics at MIT.

Wee Hoe Teck (Huang Hede), 1993, 94, 95:

National service.

Davin Chor Han Ping, 1994, 95:

*President's Scholar, undergrad in economics at Harvard
University.*

Tracey Ho Chui Ping, 1994:

*President's Scholar, undergrad in
electrical engineering at MIT.*

Koh Yi-Huak, 1995:

Undergrad in mathematics at Oxford University.

Jeffrey Pang Chin How, 1995, 96, 97:

National service.

Thevendran Senkodan, 1995, 96, 97:

National service.

Tay Wee Peng, 1995:

National service.

Low Tzer Hung, 1996:

Undergrad at MIT.

Daniel Tan Kwang Pang, 1996:

National service.

Reflections of some x-men

From: **Tan Swee Heng** (1993,94)



30th IMO Braunschweig, Germany 1989

Recalling my SIMO days brings back nothing but fond memories...

The early Saturday mornings spent in NUS solving (and failing to solve) mind-boggling problems; the humbling experience when Ziwei illuminates the class with his elegant solution; the inspiring confidence of Siu Taur as he worked out his proofs on the spot; the numerous, verging on excessive, tea-breaks and card sessions during the SIMO camps; and last but not least, the rather silly jokes that we cracked.

If there is one thing I really cherished in SIMO, it was the family-like atmosphere, the open and friendly interactions among trainees themselves and with the lecturers. Never once did the lecturers talk down to us - we were not equals but they treated us like we were. Medals are of secondary importance - the magic lies in the ambience.

My wish for SIMO: That it comes to represent for Singapore what the Scottish Cafe stood for in Poland - a place for fostering mathematical creativity.

From: **Wee Hoe Teck** (1993,94,95)

Just two ideas ... not necessarily something to write about though.

I was at a unit function - a sit-down nine-course dinner - recently, that reminded me of the buffets that we used to have at the Kent Ridge 'restaurant' towards the end of the SIMO camps. Those dinners used to be something to look forward to, an opportunity for interaction amongst the senior team members and the junior team members, usually in the form of a perplexing puzzle of sorts, whereby one has to guess the number determined by either a delicate arrangement of tooth-picks and other dining accessories or a series of mathematical operations involving the face values of cards in a arranged pre-determined layout ...

I decided then that the geometry of the table may make a difference; sitting at a round table tends to be conducive for such interaction as opposed to the rectangular ones we see in Sheares' Hall those days.



36th IMO Toronto, Canada 1995

Ladders ... Prof CC Chen used to draw some ladder-like structures on the blackboard/whiteboard that supposedly provides a bijection between the trainees and an ordering so that each of us is compelled - in a sense - to solve some problem in the problem set in order to have something to present to the rest of the class. The success of this approach in providing maximum participation and exchange partly stems from an unspoken role whereby the more senior trainees would opt to present solutions to the more difficult problems, whereby the junior ones would merely present whatever solutions they could possibly conceive. Of course I do recall situations whereby in desperation I presented Siu Taur's solutions as I could not solve any of the remaining problems .. :)

From: **Han Ping Davin Chor** (1994,95)

SIMO training was indeed a rather interesting process for me. When I started off in 1992, I was really completely lost. At that time, we still had the junior team and senior team training separately, and I was of course in the junior team, struggling to pick up the very basics of the theorems and techniques needed to attempt olympiad problems. To give you an idea how unprepared I was — I barely knew the formulae for AP/GP and the binomial theorem. But then again, I being one of the youngest members around gave me an excuse (I was still in Sec 2). It may seem like a really early time to get started on Olympiad Math, but the truth with the IMO is — early exposure and consistent practice are the only ways to improvement.

Math has always been a fun pursuit for me. There is always a challenge in staring at a problem that doesn't seem to allow you to lay your finger on its solution for the first few minutes. Then one starts to generate ideas. Have I seen something similar before? Can I adapt a solution to another problem to this one? Is there some unique property in the way the question is set up that should provide the crucial key to unlock the problem? What's unique about the algebraic properties or geometric structure of the problem? And then, bit by bit, approaches suggest themselves to you. You go down the alley that a hunch tells you should lead to the solution... And as you get better, the hunches become more accurate; I guess one calls that mathematical intuition — trying to find what motivates a particular line of thought.

This challenge and interest that I get out of math olympiad problems has never quite left me. And as I've gotten to know over the years, math is never meant to be learnt alone. (This happens to be a favourite quote from one of my present professors.) It's only through bouncing off ideas with other people, other trainees in the SIMO that one improves on one's hunches and hones oneself to find the neatest, most efficient way not just to solve the problem, but to present it's solution. The academic discipline — to be as rigorous as possible — and the desire never to be satisfied with just



31st IMO Beijing, China 1990

solving a few problems, but to tackle harder or newer problems has always left me delighted. It's a form of training that has helped me well in all my endeavours at the university level. Who says math is only for a select talented few who are fortunate enough to be geniuses? (Although, who would begrudge Ziwei's presence?) Even mere mortals (like myself) have gained tonnes from it.



34th IMO Istanbul, Turkey 1993

From: **Pang Chin How Jeffrey** (1995,96,97)

The Math Olympiad had been a unique experience for me. I remembered how much support and guidance I had received from the seniors and X-men when I was in secondary four and how Senkodan and I passed down the "culture" of the IMO to the younger people in the team later on. The IMO alumni is one big family, and X-men often came back to NUS during the residential camp in June to share their experience.

The IMO is lots of exposure too. I remembered that we had two world class professionals, Prof. Chang Geng Ze and Prof. Su Chun from China to train us in 1995. The New Zealand team came to pay us a visit one week before the IMO in 1996. I must admit that India and Argentina are two places that I would most likely not visit if not for the IMO. I also got a nice big chocolate cake in India for my birthday.

In the short history of Singapore's participation in the IMO, I think that I was the one who benefited the most. I was from a simple neighbourhood school and did not win any prizes in mathematical competitions before I took part in the IMO. I must thank the people in SIMO who have given me the chance to prove myself and those who helped me along the way.

The SIMO scale of obviousness

- If the lecturer says it's obvious, everyone saw it ten minutes ago.
- If Davin says it's obvious, it's obvious.
- If Hede says it's obvious, he's seen it before.
- If Andrew Ng says it's obvious, he can't prove it.
- If Ziwei says it's obvious, it'll take us a few days to figure it out.
- If Chan Onn says it's obvious, trust him, you'll never be able to figure it out.
- If Siu Taur says it's obvious, it's wrong.
- If Junxiang says it's obvious, he's either doing an Andrew or a Siu Taur.



38th IMO Mar del Plata, Argentina, 1997