

# Taking the challenge

Vijay A. Singh

The Olympiads, like the Olympics, are international competitive events. However, these are related to academics and not sports and the Olympiad events are organized annually and separately for each subject. Teenage students, reputedly the best young minds of their nations, from across the globe, assemble for about ten days at a pre-determined location every year. They are presented with challenging problems of sterling academic standards. In many ways the Olympiads represent a celebration of the best in high school and pre-college science.

The Homi Bhabha Centre for Science Education is the nodal centre for the Olympiads. It organizes the participation in the six Olympiads, namely, astronomy and astrophysics, biology, chemistry, junior science, mathematics and physics every year. It has also hosted International Olympiads: mathematics in 1996, chemistry in 2001, astronomy in 2006, and biology in 2008. Hundreds of students from across the globe gathered in Mumbai for these events. In December 2013, it hosted the International Junior Science Olympiad in Pune and hosted the International Physics Olympiad in July 2015 in Mumbai.

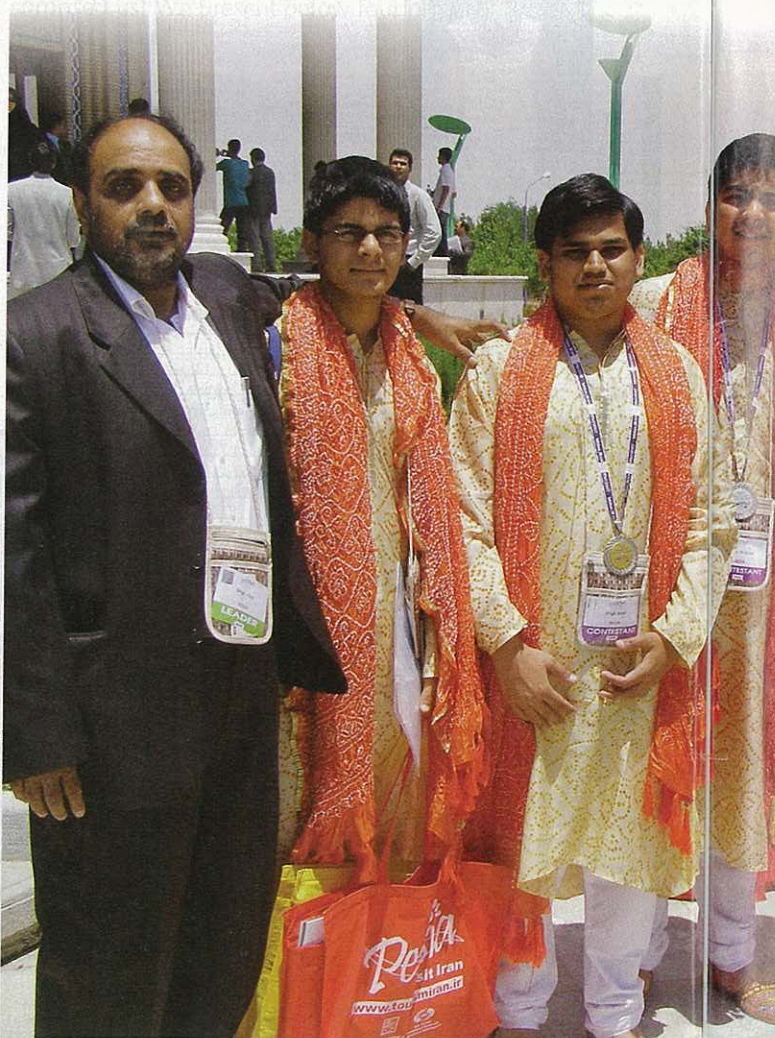
The Olympiads for physics, chemistry, biology, mathematics, astronomy, and astrophysics are pitched at the higher secondary school level. There are age limits and conditions that the participating students should not have entered the University system. The Junior Science Olympiad is open to high school students. Based on their performance they are awarded medals: gold, silver, bronze, or some honours/special prizes. The science and mathematics Olympiads are conducted in a very democratic and transparent way. All the participating countries have equal rights in the international jury sessions for approving the tests just before they are administered to the students.

India made a late entry into the Olympiads. It started participating in the International mathematics Olympiad from 1989, whereas the event has its beginnings in Eastern Europe in 1959. The involvement with the science and astronomy Olympiads began a decade later: in physics from

1998, in chemistry and astronomy from 1999, in biology from 2000 whereas these events are being organized since 1967, 1968, 1998, and 1990 respectively.

A happy outcome has been that almost every student selected to represent India has come back with a medal from the international event. Our strike rate is almost 100 per cent. Like the sports Olympics, nations are not officially ranked in the Olympiads. However, based on aggregate scores, India is generally among the top ten nations participating in the Olympiads.

It is imperative also to look at the Olympiads in a critical light. Medals should not be and are not the only goal of this high profile movement. It is a talent search exercise, but has it been a successful talent nurture exercise? How has it impacted quality science



Photos courtesy: Prof. Vijay Singh

education in the country? How have teachers been harnessed to achieve this? We shall take a critical look at the Olympiads in this article.

**The selection process**

The Olympiad selection procedure at HBCSE has now been standardized. Briefly, for science and astronomy Olympiads, it consists of a five- stage process. The Indian Association of Physics Teachers (IAPT) conducts the first stage with support from emerging teachers associations in chemistry and biology, and till 2006, from the National Council of Science Museums (NCSM). This stage, called the National Standards Examinations (NSEs), conducted in over 900 centres all over the country, has mainly objective type questions. The second test conducted in about 15 centres, is descriptive with subjective problems of high difficulty level comparable to the international Olympiads. This constitutes the Indian National physics/ chemistry/biology/astronomy/junior science) Olympiads Examinations (INPhO, INChO, INBO, INAO and INJSO), respectively.

While the participation in the first test runs into almost a 100,000 (in the year 2013-14, about 39,000 in physics, 33,500 in chemistry, 14,000 in

biology, 11,600 in astronomy and 24,500 in junior science), approximately the top 300 students in each subject participate in the second test. About 35 to 40 students in each subject are selected from the Indian National Olympiad examinations and are invited for Orientation-Cum-Selection Camps (OCSC) held at HBCSE. The emphasis is on experimental orientation. Students appear for several rigorous theoretical and experimental tests leading to the selection of Indian teams for the International Olympiads. The selected teams for International Olympiads again go through about two weeks of pre-departure training (IO-PDT) at HBCSE.

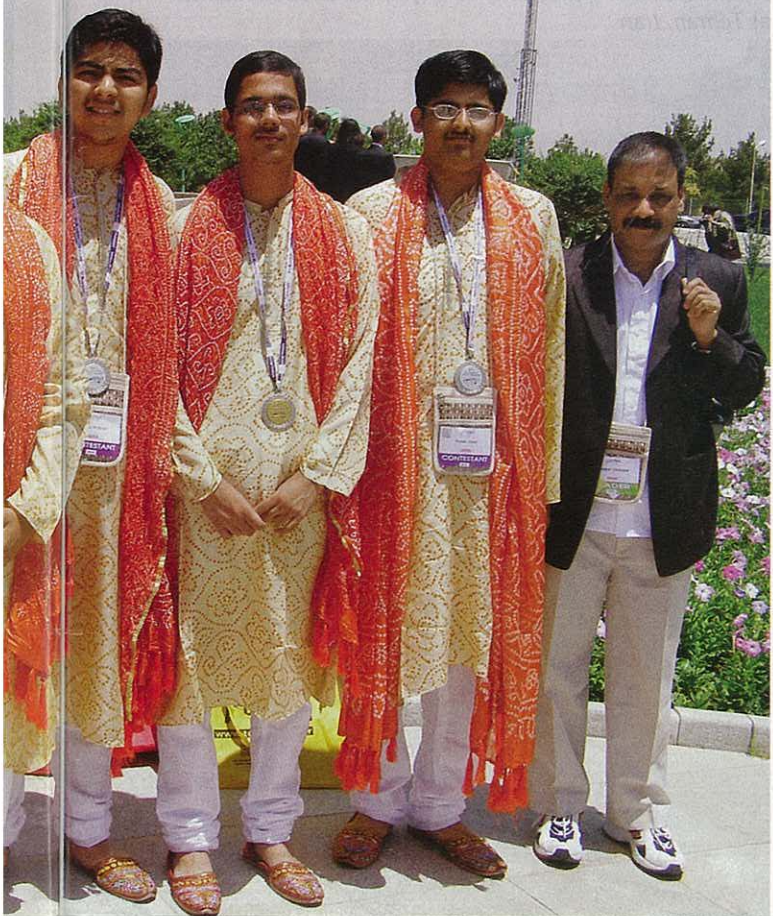
A similar pattern of selection and training is followed by HBCSE in mathematics under the aegis of the National Board of Higher Mathematics. The first stage of the program consists of the Regional Mathematics Olympiad (RMO) where a centrally designed test is conducted at about 24 regional centres in India. The remaining stages are similar to the stages described earlier.

Experimental science is the Achilles heel of school science education. The Olympiads remain the only tests at the pre-university level which have a strong experimental component. The experiments developed for this purpose are novel and a worthy addition to the resources available in the nation. Unlike the Indian Institute of Technology (IIT) entrance exam which is a single stage test, the Olympiad selection is a five stage exercise with filters and checks and balances. At every stage the student has the right to appeal her evaluation. In the third stage (OCSC) for example, the student sits across the table with her evaluators and has the right to argue for higher credit. A related science talent search exam is the Kishore Vaigyanik Prothshahan Yojana (KVPY). This is a two stage exam: written and an interview with no experimental component. The Olympiad pattern of selection is worthy of emulation by other examination bodies.

**The international event**

The International Olympiad is spread over seven to ten days. It is held annually and in a different location every year. It is the obligation of the host country to provide hospitality to the participants. Keeping in mind that the assembled students are likely to be the future scientific leaders, the host country showcases its best in terms of its culture, cuisine, and science. Our students are accompanied by two delegation leaders. For the past few years an additional observer has accompanied the team. The leaders and the observer are subject experts and provide guidance and counselling to the students. They also act as

*International Physics Olympiad 2007 Medallists at Isfahan, Iran*



jury members and partake in deliberations on the competitive tests as well as in policy matters. The students in the science and astronomy Olympiads have to take both theoretical as well as experimental tests typically stretching for several long hours. The tests are of exceptionally high quality and designed to test competence and creativity. Unlike many competitive tests in India these are not "speed" tests.

Every effort is made by the organizers to not let political and religious differences interfere with the proceedings and this has been largely successful. There has been a natural evolution in the exams. In the early days the participants were from Eastern Europe and the atmosphere was informal. But with the participation from the Western block and the developing world, one now has to draw up detailed grading schemes and adhere to them strictly.

The questions for the tests are set by the host country and vetted by the international board consisting of the leaders of all participating countries. The Olympiad Examinations give sufficient weightage for both theory (60%) and experiment (40%) with astronomy and astrophysics assigning equal weightage. The latter has a night sky observation component. Strict guidelines are imposed in chemistry to make the experiments safe. There is no experimental component in mathematics. The unconventional Olympiad problems bring you closer to life and to frontier level research. The experimental component compels you to think with your hands. Both experimental and theoretical questions are interdisciplinary: concepts across diverse areas of the subject have to be understood and integrated in order to suggest a credible solution to the problem. Often only a few questions (say three) are asked and ample time (about 5 hours) is given. The Olympiads probe ability and creativity and not speed.

### **The positive fallout of the Olympiad programme**

The students who are selected for the OCSC are some of the brightest in the nation. They are often the toppers of the board and the professional (engineering and medical) entrance exams. It is worth mentioning that despite our late entry into the Olympiads, almost all participating students in the science and astronomy Olympiads have won medals at the international Olympiads including the coveted gold medals.

*Every Olympiad is an individual event and a key aim is to promote goodwill. Officially, there is no ranking of nations. In the year 2008, India ranked 3rd among 80 nations in International Physics Olympiad. We stood 3rd in International Chemistry Olympiad in the year 2012. India has stood first and second several*

*times in the International Olympiad on astronomy and astrophysics and in the International Junior Science Olympiad. When India hosted IJSO in 2013, 9 out of 12 students secured gold medals. It is difficult to quantify the cumulative performance.*

Over the years, the HBCSE has been involved in developing challenging laboratory tasks and problems in physics, chemistry, and biology. A large repertoire of challenging experiments now exists at HBCSE. The experimental expertise has proved useful in a number of ways. The National Initiative on Undergraduate Science (NIUS) launched by HBCSE in 2004, the recently launched national institutes of science education and research, and several undergraduate teaching programs such as the Chennai Mathematical Institute's physics program have benefited from this programme. The theoretical program too has had spin-offs. Olympiad resource persons have been involved in authoring NCERT textbooks at the higher secondary school level for a decade. Several Olympiad related pedagogical publications in Indian and Foreign Journals (e.g. Resonance, Physics Education and American Journal of Physics) have been authored by Olympiad resources persons.

Since 2004, HBCSE has hosted over 40 resource generation camps in which teachers, scientists, and HBCSE personnel gather for a week to prepare lecture

*9<sup>th</sup> International Junior Science Olympiad 2012 Medallists at Tehran, Iran*



notes, devise innovative problems and design new experiments. The camps provide exposure to school and college teachers to state of the art laboratory environment and advanced theoretical problems. At the same time some of India's leading scientists get exposed to the problems of school and college science education. HBCSE personnel routinely visit various parts of the country to give talks and run short camps for students and teachers. A noteworthy aspect is that several of these camps have been held in non-metropolitan and even rural schools.

The Olympiads have generated tremendous excitement among the meritorious students in the country. They have triggered the formation of the Indian Association of Chemistry Teachers and a similar association of teachers in biology, along the lines of IAPT leading to grassroots support for science. They have also invigorated the Centre as a whole and strengthened its links with leading scientific institutions in the country.

The Olympiad programme of HBCSE complements the National Talent Search Scheme (NTSS) of National Council of Educational Research and Training (NCERT) and the Kishore Vaigyanik Protsahan Yojana (KVPY) of Department of Science and Technology (DST), implemented by the Indian Institute of Science (IISc) – but is unique in several ways. First, it focuses on subject specific talent and competence (physics,

chemistry, biology, mathematics and astronomy); second, it involves (in the third stage) rigorous testing and orientation in experimental science – a feature absent in all other talent search and nurture schemes at that level in India; and third, perhaps most importantly, it is not an entrance programme for admission nor a selection scheme for scholarship. The only incentive, as far as the HBCSE is concerned, is to offer students an academic challenge of the highest order suitable at their level, the challenge to go higher and ever higher in terms of subject competence, with a possibility for some to represent India at the international Olympiads and bring glory to our country.

### Critical appraisal

The Olympiads are expected to provide a benchmark for quality education in the country. The second stage INO question papers are of high standard and undergo rigorous scrutiny from some of the best faculty members. However, little effort has been made to disseminate them. The host institution HBCSE has a small publication division and one can find these papers only in its office in Mumbai. Book stores do not store them and they are not to be found in State-sponsored textbooks such as NCERT. It is well-known that there exists a parallel education system in the nation – namely the ubiquitous coaching centers. The more enterprising centers have used the Olympiad questions to train their better students.

The selection procedure is rigorous and the most talented students qualify. It is imperative to nurture them. The Department of Atomic Energy took a step in this direction in 2004 by launching a scheme called the National Initiative in Undergraduate Science (NIUS). Under this scheme the students who are in the first year of college are invited to attend expository talks and attached to mentors under whom they carry out projects. The students are given a long rope in this matter – they are supported for two or more years so that a worthwhile project is completed. Over 500 undergraduate students have been through NIUS camps. A case in point is Raghu Mahajan, the IIT all India rank one (AIR – 1) and Olympiad gold medalist (2006) who left the IIT Delhi computer science program midway to pursue a career in physics research at MIT. He has publicly acknowledged the positive influence of the NIUS program in his decision-making. Another Olympiad student and NIUS scholar (Akash Kamra) was honoured by his host institution, in this case IIT Kanpur, with a cash award of Rs. 20,000 for the international publications he authored under NIUS. The research work on quantum teleportation of another NIUS scholar,



Sreeram Murlidharan, from Loyola College, Chennai was singled out for special mention by the renowned journal *Nature*. He secured the 2009 Erasmus Mundus scholarship for doing Masters in Europe and is currently at KTH Sweden. A measure of the success of the NIUS program is the presence of undergraduate students at national and international conferences and the scientific publications.

Although a large number of camps for teachers have been held, there has been criticism that these camps are of short duration (3 days) and meaningful training is not imparted. Thus the crucial multiplier effect from which Olympiad resource persons train teachers who then go on to nurture students has not occurred. One reason perhaps is that the nodal institution (HBCSE) has barely a dozen permanent members handling Olympiad programs. Unless this number is increased several fold this multiplier effect will not become a reality.

The Olympiad program labours under several handicaps. For one, the nodal center (HBCSE) is understaffed. Another major handicap is the parallel education system which at best "teaches to the test". In this case the test is the lop-sided objective tests which form the basis of entrance to professional courses. The high fees charged by the coaching centers exclude the rural student population. The Olympiad program has made a few fledgling efforts but this is akin to a drop in an ocean. Rural India continues to be (to use Naipual's quote) "an area of darkness". This is a critical shortcoming of a program which uses public money.

### Conclusion

The Olympiad programme has multiple dimensions. In 2004, HBCSE launched National Initiative in Undergraduate Science (NIUS) to encourage UG students to excel in science. Students who pursue a career in science are encouraged to participate in our NIUS programme. This programme hosts enrichment lectures and supports long-term nurture programme for students enabling them to carry out project work and research. This has led to a large number of publications in international journals by undergraduate students.

Along with the six Olympiads conducted by HBCSE, we participate in the Earth Science Olympiad, the Informatics Olympiad, the Astronomy Olympiad and the Asian Physics Olympiad. These too are supported by government agencies, voluntary teacher associations, and HBCSE. We caution the students and teachers about private Olympiads, which are not

officially recognized by the Government of India. These private Olympiads are expensive to participate in and do not lead to enrollment in International Olympiads.

The Olympiads are not merely competitions. They are a celebration of the very best in pre-university science and mathematics. Our vision of the Olympiads is very broad. We view the Olympiad as a vehicle to promote excellence in science education at the pre-university level and, in our own modest way, we try to achieve this by writing books, designing national level tests, holding workshops and camps for teachers and collaborating with voluntary science teacher associations.

Further information on the national Olympiad programme can be obtained from the following website: <http://www.hbcse.tifr.res.in/olympiads>. You may also write to [physics.sutra@gmail.com](mailto:physics.sutra@gmail.com).

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The author was a faculty member at IIT Kanpur (1984-2004) and Chief Editor of the *Bulletin of the Indian Association of Physics Teachers* (1997-2000). He has been associated with the Indian Olympiad program since its inception in 1998 and was the national Coordinator of the Science Olympiads from 2003-2014 as well as the national Coordinator of the National Initiative on Undergraduate Science, NIUS since its inception in 2004 (2004-2012). He acknowledges support from the Raja Ramana Fellowship. He is currently professor of physics at the Centre for Excellence in Basic Sciences, Mumbai University.