Prizes (mostly after the KFIP). A total of 56 scholars from 13 countries have been awarded the King Faisal International Prize for Science. Mudumbai Seshachalu Narasimhan is the only Indian to have won the KFIP in the science category (for mathematics in 2006)[12]. Vamsi Krishna Mootha of Indian origin, now based in USA received the Science Prize in the category of biology in 2016 (ref. 13). The other major science prizes instituted by the Middle Eastern region are the UNESCO Sultan Qaboos Prize for Environmental Preservation[14] and the recently launched Mustafa Prize for Science by Iran[15].

The Science Prize for the year 2018 will be awarded in the field of mathematics. The topic for the Medicine Prize is 'Immunotherapy for Cancer'. The deadline for all nominations is Saturday, 1 May 2017 and details are at http://www.kff.com/ and http://www.kfip.org/.

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MEETING REPORT

Teacher training workshops in India*

The International GeoScience Education Organisation, Bengaluru organized three teacher training workshops in Goa, Mangaluru and Bengaluru. These workshops were organized as a pilot project to test the impact of such an approach in an Indian setting.

One of the main challenges to humankind in the 21st century is maintaining the balance between human activities and nature. Unfortunately, human activity can cause imbalances in the natural earth system that put at risk the ability of many species, including *Homo sapiens*, to survive on earth. Earth science connects together all aspects of earth processes and the resources that are needed for our existence (freshwater, air, energy, soil, ocean and earth materials) with the study of natural and human-induced hazards. It focuses on understanding the manner in which this complicated earth system works. Therefore, earth sciences is vital to humans in general and especially to those in India, the second most populated and a rapidly growing country in the world.

Unfortunately, without an understanding of the role of humans within the earth system (environmental insight), people of India and the entire world may face future global crises. Therefore, it is essential that every child in India becomes aware of these aspects and is enabled to grow up to be an environmentally literate and responsible world citizen. Emphasis should be laid on the earth system science approach early in the educational scheme as several issues of concern to humans are either related to or emanate from interactions of the different subsystems of the earth system, such as aspects of the Indian monsoon, ocean productivity, cyclones, tsunamis and sea-level rise. Earth science is a truly multi-disciplinary and integrated science of the 21st century and links economic and environmental aspects with human well-being.

Earth science, unfortunately, is neither a separate subject of study nor is it comprehensively represented in the school curriculum in India. Teachers not from the science stream, but the arts stream, teach earth science topics in schools. Teaching is mainly in the form of lectures without many hands-on and mind-on activities. Inquiry-based learning and teaching skills are inadequate; as a result, students memorize facts and figures and do not observe, analyse and hypothesize. Hence they are unable to relate what is taught in the classroom to what they see in their surroundings. That school teachers are not formally trained in the teaching of earth science, which is a glaring omission, covering both the aspects of content knowledge and interactive teaching skills, using the laboratory, outdoors and computer-learning environments that form the heart of earth science education.

In light of the above, the way earth science is taught in Indian schools needs a radical shift from classroom lectures to field work and hands-on activities, observations and deduction. This challenge can only be met by a systematic professional development of teachers, based on teaching materials especially tailored for the Indian curriculum and circumstances.

*A report on Teacher Training Workshops in Goa, Mangaluru and Bengaluru organized by The International GeoScience Education Organisation, Bengaluru during 2–5, 7–10 and 12–15 July 2015 respectively, jointly with the National Centre for Antarctic and Ocean Research, St Aloysius College (Autonomous) and the Karnataka State Council for Science and Technology.

Table 1. Details of the workshops

Spot that rock workshop – for 11–13-year-olds	This workshop leads you step by step through a series of investigative practical activities that will allow you to teach pupils to investigate and sort most rocks from first principles (and distinguish them yourself). The techniques are then applied in describing and classifying a series of unknown rocks.
The rock and soil circus workshop – for 11–13-year-olds	Join our circus and explore the world. Experience how pupils might tackle an earth-related activity. Then tackle rocks and soils the scientific way. Test the rocks, test the soils – find out what they can tell us about the earth we live on. Try different interactive and hands-on practical activities that spotlight rocks and soils as you may never have seen them before – and enjoy the thrills and spills of 'the rock and soil circus' in your classroom.
How the earth works in your classroom workshop – for 11–13-year-olds	Bring the world into your classroom through a wide range of earth science practical and thinking activities. Consider different practical activities that teach about erosion, transportation and deposition, and help you to pan for gold. Use sand and water to show how rivers work and coasts can crumble – see the grains move, see the banks collapse, think where the safest place might be. Clean up your pond water, create your own mini water cycle in the classroom before taking the ideas back, out into the 'real world'.
Life, the atmosphere and everything – for 13–16-year-olds	This workshop offers a range of activities to help you teach earth-related aspects of the curriculum • Life – aspects of the biology-related fossils, evolution and geological time. • Atmosphere – the carbon cycle and possible effects on global warming. • Everything – well, not quite – but activities that help with understanding the need for quarrying, providing reliable energy supplies and radioactive decay and dating. Try the activities with your students and enhance their lives, their atmospheres and – well – everything.
The dynamic rock cycle workshop – for 11–14-year-olds	Try a series of 'hands-on' activities experimenting on and simulating the processes involved in the rock cycle. Use the integrating model of the rock cycle as a means of encountering common rocks and earth processes in a practical, investigative way.
Earth science around your school–outdoor workshop – for 11–16-year-olds	See how earth science principles can be illustrated out of doors, often without a rock in sight, and how pupils can be engaged in discussions about Earth processes and products.
The earth and plate tectonics workshop – for 13–16-year-olds	This workshop gets to grips with the wide-ranging evidence for the plate tectonics theory that underpins detailed modern understanding of our dynamic planet. The workshop begins with an introduction and progresses through a series of activities that are designed to help students develop their understanding. It uses several independent sources of evidence supporting the theory, including using rock and fossil evidence, seismic records, geothermal patterns, geomagnetism and large-scale topographical features, both above and below sea level. The workshop provides a reconstruction of plate movements over the past 450 million years which explains the record contained in the rocks of the world – involving amazing journeys across the face of our planet. It concludes by investigating some of the earth hazards linked to plate tectonics, and how we can prevent loss of life.
Teaching thinking earth science workshop – for 11–16-year-olds	This workshop uses a plastic tank to model the processes of the earth's oceans and atmosphere, and to discuss these in ways to develop the thinking skills of pupils.

The objective of the workshops was to provide the participants with practical teaching and learning strategies and techniques. The participants experienced active learning in the laboratory, outdoor and classroom learning environments with learning materials (worksheets and activities) that can readily be implemented in their schools.

Through the professional development workshops, the participants experienced teaching methods and learning materials that demonstrated the following aspects:

- Inquiry-based learning
- Earth system-based learning
- Differentiation of learning for learners of differing ages and abilities
- Addressing common misconceptions
- Modelling of a range of earth processes and their effects
- Enhancement of knowledge and understanding of earth processes
- Integrating the outdoor environment as an integral component of learning
- Using the schoolyard as a learning resource
- Development of thinking skills
- Integration of emotional aspects of learning as an integral part of the learning process.

Participants were divided into two groups to experience two workshop approaches. The workshop descriptions follow.

'The rock cycle and the earth system' by Nir Orion: The teachers received an inquiry-based booklet that included activities from the 'Thinking science – understanding environment' (TSUE) – an Earth Systems Approach (ESA) programme for middle and high-school levels. After photographs of the local environment of each of the workshops were emailed to Orion in advance, he designed the booklet to follow the local rock cycle story and developed three different short

Table 2. Summary of the main findings of the workshops

Main findings	The way forward	Benefits
The workshops were originally designed and run in Israel and the UK. We found that they worked equally well for school teachers in parts of India. Both geography and Science teachers participated.	These workshops can be run equally successfully in other parts of India (and other countries too) that have a similar earth science education scenario.	Teachers in other parts of India (and other countries) would be well trained to effectively teach earth science to their students.
Many teachers brought to fore the fact that earth science, being a natural science, should be delinked from geography/social science.	All topics related to earth and its environment should be bunched as one subject and may be called earth and environmental science.	This would, without increasing the load on students, (1) enable science teachers (with physics/chemistry/biology backgrounds) to teach earth science; (2) give visibility to Earth science in the eyes of students, peers, parents and the general public; (3) encourage more talented students to pursue earth science in higher education.
Many teachers felt that more workshops like these should be organized so that more teachers could be trained to effectively teach earth science to school students. Sets of samples of rocks and minerals for classrooms should be made available to them. Some suggested that there should be workshops on other aspects of earth sciences as well.	A National Centre for Earth Science Education (NCESE) should be established to produce master trainers, design new workshops involving activities suitable for an Indian setting and produce educational materials and resources for schools. In the meantime, similar workshops should be organized in other parts of the country.	Master trainers will train school teachers across the country to effectively teach earth science with hands-on activities and motivate students. Until NCESE is operational, more teachers should be trained to do the same.
A model earth, and environmental science curriculum should be devised for an Indian setting for use by school educational authorities across the country.	NCESE should be given the task of devising such a curriculum, in consultation with international experts.	The curriculum could easily be incorporated into current curricula and widen incentives for professional development of the teachers involved.
Workshops should be devised to directly address the newly devised curriculum, accompanied by published workshop materials.	NCESE should be involved in devising, making available and publicizing the new workshops, while ensuring that they evolve over time to maintain relevance to Indian and global earth-related issues.	A structured professional development would be widely offered, enabling teachers to update their broad teaching and thinking skills using earth science as a vehicle for this purpose.

outdoor activities for three workshops. The main objectives of these activities were for participants to make observations and raise questions concerning the local earth systems phenomena, together with the collection of rock samples. The teachers' authentic questions initiated the indoor learning sequence; during the indoor sequence they explored their own authentic samples of rocks.

The indoor inquiry-based learning involved a rich material- and equipment-based learning environment that is normally available (or should be available) in schools (e.g. beakers, test tubes, cylinders, slides, spirit lamps, rock and mineral kits, microscopes, binocular microscopes, sand, soil, ice, plasticine modelling clay, etc.).

The workshop started with a short introduction followed by a 2.5-h (including 30 min driving time) outdoor activity in the local environment. The remaining 1.5 days of the workshop was conducted in a room that was laid out for team learning for 4–6 heterogeneous teams of no more than five participants each. The teams worked cooperatively, as directed by the inquiry-based worksheet and the teacher moved between the teams and responded to questions and comments. Each part of the workshop started and ended with an introduction and summary respectively.

The participants of all the three workshops showed remarkable enthusiasm during their learning. This involved deep discussion among them regarding the activities, and several questions were raised.

'Teaching the dynamic earth workshops' by Chris King: This series of the workshops involved a range of hands-on, practical activities during which the participants were invited to test the different activities and provide feedback on their educational value and practicability for teaching in Indian classrooms. Each workshop activity was designed to teach earth science knowledge and understanding while developing critical thinking skills in both the participants and the school pupils they teach.

Each of the workshops was self-contained and a free-standing experience, often with starter and plenary activities based on a workshop booklet, a PowerPoint introduction and a range of hands-on activities using readily available materials. Table 1 provides details of the workshop.

Participants were introduced to the Earthlearningidea website (www.earthlearningidea.com) that contains a wide range of earth science-related activities specially designed for teaching in classrooms with minimal resources, and to the virtual rock kit at www.earthscience-education.com/virtual_rock_kit/DOUBLE-%20CLICK%20TO%20START.htm to help them remember the range of rock types they had seen and used during the workshops.

Each participant was asked to provide feedback on the workshops. They were excited about how earth processes could be demonstrated using inexpensive and easily available materials. It was a radically new experience which the teachers said they would use in their teaching. At the end of the Goa workshop, the teachers gave a written request to the State and Central governments to periodically organize such workshops, which would help to equip them to teach earth science concepts better to their pupils. A teacher participant from Goa was subsequently able to convince the principal of her institution to initiate steps to start the earth science stream for 11th standard.

We summarize in Table 2 the main findings of the three workshops conducted in India, the steps that should be taken to improve the earth science education scenario and the benefits that would accrue by pursuing the suggested steps.

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MEETING REPORT

Plant molecular farming*

The third United Kingdom–India Education and Research Initiative (UKIERI)-sponsored international biennial workshop on plant molecular farming was held during 27–28 July 2016. The objective was to introduce the use of plant expression systems for recombinant pharmaceutical protein, to explore its potential for the production of valuable and complex therapeutics, and to provide hands-on training in basic techniques to early career researchers in India.

Twenty-five participants from research organizations across India were selected from among 46 applications. They were Ph D scholars and early investigators, usually but not necessarily already working in plant science. The two-day workshop comprised a series of lectures, case-study discussions, short technical talks and four hands-on practical laboratory sessions. The inaugural ceremony was presided over by P. S. Mohan (Bharathiar University, Coimbatore) who described plants as bio-factories and discussed the urgent need for more research into plant science for a better understanding of its full potential. He appreciated the organizers for taking the effort to disseminate knowledge in their respective specializations and recent techniques to the emerging young researchers. Julian Ma (St. George's University of London) delivered the inaugural address, emphasizing the role and importance of international collaboration in modern science. He shared his memories of the 7-year collaboration with R. Sathishkumar (Bharathiar University) and remarkable achievements in plant-based chikungunya vaccine development project through UKIERI funding since 2007.

The workshop introduced the field of molecular farming and highlighted latest developments in glycoengineering, plant expression system and protein purification from plants. The programme addressed all the major issues from gene design to manufacture and downstream processing. A particular highlight was the presentation by K. Sumathy (Bharat Biotech, Hyderabad), who gave an in-depth account of the pharmaceutical industry's perspective of recombinant vaccine development in India. She highlighted the importance of a bridge between university research and its scope in Indian vaccine industries. Other keynote talks were delivered by Waranyoo Phoolcharoen (Chulalongkorn University), Gina Webster (St George's University of London) and Gowtham Iyappan (Bharathiar University). Plant molecular farming is the most advanced area of plant science which mainly focus on the production of protein therapeutics, including vaccines, antibodies and other proteins in plants systems. According to Ma, even though plants are safe and economic, they have some limitations such as post-translational modification and transgene containments. The advent of technologies in plant science eliminates these limitations by engineering the plants with glycosylation machinery, and environmental concerns have been addressed by following good manufacturing practices in plant molecular farming through transient expression. A case study involving molecular farming of rabies antibodies in the plant system was discussed by Phoolcharoen. A similar kind of study carried out at Bharathiar University, DRDO-BU CLS was briefly discussed by Gowtham, which involves making plant-based recombinant vaccine for staphylococcal food-poisoning agents. Webster discussed about various recombinant protein purification strategies for purification of antiviral peptides from

*A report on the third UKIERI-sponsored Indo-UK joint workshop on 'Plant Molecular Farming' held at the Plant Genetic Engineering Laboratory, Department of Biotechnology, Bharathiar University, Coimbatore.