The Filipino as Scientist

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Science and Technology Information Institute
DOST Complex, Bicutan, Taguig, MM, Philippines
www.stii.dost.gov.ph
2003

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In behalf of the Filipino people, STII acknowledges with gratitude the following authors for sharing their knowledge in the interest of public service:

1. Mr. Ambrosio Brian F. Enciso of Quezon City Science High School for his article, "Scientific Rizal," published online by Advanced Science and Technology Institute (ASTI).

2. Ms. Josette Talamera Biyo of Philippine Science High School Western Visayas, Jaro, Iloilo, for her speech, "The Scientist as Teacher."

3. Dr. Elizabeth M. Torres of Philippine Science High School, Agham Road, Quezon City, for her research paper "Characteristics of Selected Filipino Scientists" funded by the National Research Council of the Philippines (NRCP).

4. Prof. Stephen Hill of UNESCO Jakarta, for his talk "The Remaking of Scientists" in NRCP Scientific Session, 2002.

We hope this book serves best the needs of students, researchers, professionals, and general public.

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Thank you for interest in our information products.

Jose L. Guerrero, PhD
Director

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Contents

The Filipino as Scientist is produced by the Information Resoures and Analysis Division - Science and Technology Information Institute (IRAD-STII), DOST Complex, Bicutan, Taguig, Metro Manila, Philippines.
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Scientific Rizal

by Ambrosio Brian F. Enciso
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Have you ever heard of the *Draco rizali, Apogania rizali,* or the *Rhacophorus rizali?*

In case you haven't, well hey are the scientific names of animals and insects which our National Hero Jose Rizal discovered – yes, discovered – during his exile in Dapitan. The naming of these fauna after their discover is the greatest tribute to Rizal's scientific endeavors and expertise.

Rizal venerated almost solely for helping form a national consciousness and for fighting for reforms in the Spanish rulers governance in the hope for a better life for his people. Unfortunately, his scientific accomplishments largely remain in the shadow of his writings, travels, supposed amorous affairs, and of course, martyrdom.

Aside from having been a linguist who mastered five languages, a prolific writer of numerous essays, letters, poems, and two novels, and a stubborn nationalist who died for what he believed in, Rizal early on displayed intellectual capabilities in the sciences as well.

Rizal was first educated by his mother and then by private school teachers in his hometown Calamba, and in Biñan, Laguna Rizal's entrance into the Ateneo signaled the start of his streak of scholastic excellence.

Rizal as a Physician

After impressing the Jesuit friars and finishing his Bachelor of Arts with highest honors at the Ateneo, Rizal tranferred to the University of Santo Tomas where he simultaneously took up Medicine and Philosophy and Letters.

In 1882, Rizal sailed for Spain and enrolled at the Universidad Central de Madrid. He received his licentiate in Medicine in 1884 and his licentiate in Philosophy and Letters the following year.

Because of his mother's failing eyesight, Rizal chose to specialize in ophthalmology and worked in the eye clinic of Dr. Louis Weckert, a famous French ophthalmologist. After his four month training with Weckert, Rizal left for Heidelberg, Germany in February 1886 to work under the tutelage of Dr. Otto Becker, an eminent German ophthalmologist. Rizal completed his studies in ophthalmic surgery in this city.

Rizal himself became a skilled ophthalmologist, later making quite a name for himself in Hong Kong. His most famous patient was of course his mother, Doña Teodora, whom he saved from impending blindness.

Rizal as a Geographer

As a keen student of countries and races, Rizal realized the value of skills in geography. He knew that geography is an important shaper of history for it affects a people's way of life and events that take place around them.

Rizal acquired his extensive knowledge of geography through his numerous travels abroad; by pouring over geography books and maps; and by mingling with the famous geographers of Europe, including Dr. W. Joest of Berlin. In recognition of his geographical expertise and his deep interest in geography, he was submitted in February 1887 as a member of the renowned Geographic society f Berlin. He was the first Asian scholar to become a member f the society.

As a geographer, Rizal rendered valuable to his Austrian friend, Professor Ferdinand Blumentritt. He furnished Blumentritt with vital information on Philippine geography that the latter needed in his ethnographic and linguistic studies. Fro instance, in November 1886, Rizal corrected Blumentritt's map of Mindanao in southern Philippines by adding Lake Lanao to it.

Rizal considered geography as one of the more useful discipline and believed that it should be a required subject in school. In the curriculum he made for his proposed college in Hong Kong, he included geography as one of the main subjects together with mathematics, chemistry, physics, history, economics, law, religion, ethics, languages, and physical education.

While in exile in Dapitan, he taught a group of bright boys a wide range of subjects including geography. It is interesting to note that Rizal planned to write a school textbook on geography for children. This was one of the more ambitious projects he failed to realize because of his execution in 1896.

Rizal's expertise in geography aided him in his historical, anthropological, and political researches. Among his writings which require a good grasp of geography were "Ma-yi" (December 1888), "Tawalasi of Ibn Batuta" (January 1889), "The Philippines a Century Hence" (February 1890). "The Indolence of the Filipinos" (September 1890), The People of Indian Archipelago" (no date), and "Notes on Melanesia, Malaysia, and Polynesia" (no date).

Rizal as a Naturalist

Upon his arrival from Europe in 1892, Rizal was promptly arrested and incarcerated at Fort Santiago. Soon after, he was exiled to Dapitan where he lived for four years. During this period, Rizal immersed himself in the study of nature.

Rizal was a dedicated naturalist. With the help of his Dapitan pupils, he collected numerous species of birds, insects, butterflies, shells, snakes, and plants. His collection of shells was said to be the richest private collection of conchology in the Philippines during his time. It consisted of over 340 shells representing more than 200 species.

Driven by curiosity and an eagerness to contribute to the pool of scientific knowledge, Rizal sent many specimens of animals, insects and plants for identification to the museums of Europe, particularly the Antropological and Ethnographical Museum of Dresdan.

He however never accepted money for these specimens, only scientific books and magazines and surgical instruments which he needed in Dapitan. In October 1893 for instance, he sent Director A.B. Meyer of the Anthropological and Ethnographic Museum of Dresdan 12 snakes, one sea horse, two scorpions, and several butterflies. IN subsequent months, he sent more specimens for the museum, including various kinds of insects, birds, and lizards. In payment for these specimens Rizal shipped to Dresdan, Meyer sent him scientific books and journals, artificial eyes, microscopes, and surgical instruments.

Three rare specimens of animals discovered by Rizal earned him high praises from European scientists who named them in his honor: the Draco rizali, a small lizard popularly known as a flying dragon; *Apogania rizali*, a rare kind of beetle; and the *Rhacophorus rizali*, a peculiar frog species.

Rizal as an Inventor

Rizal was not an inventive wizard like Thomas Edison but he did have a certain talent for invention. He invented a cigarette lighter, which he called *sulpakan* and sent it to Blumentritt in 1887 as a gift. The lighter used a compressed air mechanism.

While in Dapitan, Rizal also invented a wooden machine for making bricks which turned out about 6,000 bricks daily.

Although Rizal spent much of his adult years in foreign lands, the Philippines remained his consuming passion. From this burning patriotism and love for his countrymen were born two novels, Noli Me Tangere *and its sequel* El Filibusterismo*. These were the two novels for which Rizal paid the ultimate price – his life. Rizal is not revered because he fought in the battlefield and carried a gun – he was a pacifist to the very end Rizal is the Philippine National hero and the Greatest son of the Malay race because he was a great man who used his great heart for great purposes.*

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The Scientist as Teacher

by Josette Talamera Biyo
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At the outset, I thank the organizers of this activity for bringing me to thousands of committed teachers if the country. I am overwhelmed by your presence, It's so inspiring to see you here today. You are supposed to be home because this is a Saturday. But you are here today because you want to renew your commitment to teaching. For this, let's give ourselves a big round of applause.

I came here to tell you that teaching is a marvelous job; that I Have spent the happiest moments in my life inside the classroom, or doing field work with my students; that I have been teaching for 22 years now, and I will continue to teach for as ling as I am capable of doing so.

A few months ago, I was featured in several local and national newspaper. My husband and two sons were interviewed and shown in one of the primetime television programs. Last December 29, which happened also to be our 18th wedding anniversary, my family was happy to see me featured in the "People of the Year" by the *Philippine Daily Inquirer*.

We are not a showbiz family. It's just that I caused a stir to be the first Asian teacher to win the "Intel Excellence in Teaching Award" in an international competition held at Kentucky, USA. Since its inception in 1997, no Asian teacher has received this award. But I think, what created waves was the fact that I am a Filipino, and I defeated 90 other teachers from around the world, even the American finalists in their hometown. I learned from Intel last October that they have received 4,000 entries to this competition.

Since winning this international award, my life has never been the same. I get a lot of invitations to share my teaching experiences with other teachers. Haring my experiences and methods of teaching with other teachers in the different parts of the country, I have the power to effect change at the national level. But with power, comes great responsibility. Aware of my own capability to make a difference in the lives of my students and other teachers, I feel I have the responsibility to make others aware of their own potentials. Thus, I accepted this invitation even if it meant traveling to different parts of the country in the midst of my hectic schedule in Iloilo.

For most of you who are present here right now, I'm sure you have the same questions in mind.: "What made me in this international competition? What made me stand out from among the best teachers in the world? I cannot give one specific answer. But if you will ask me. "When you joined this competition, did you feel you will win? My answer is, "Yes, I am confident I will win." I believe that the competition did not start in Kentucky. The judging process started the day I started teaching. I am an excellent teacher not because I have received the international award. I received the international award because I am an excellent teacher.

Let me tell you the story of my teaching career…

I finished a Biological Science degree from the University of the Philippines in the Visayas hoping to be a medical doctor one day. For lack of financial resources however, I took the first job opportunity available – teaching. Never did I regret this twist of fate. The day I entered the classroom, I knew I would be a good teacher.

My first eight years of teaching were spent in a rural school in my hometown, January. The school is 30 kilometers away from Iloilo City. St. Elizabeth Academy is a private school managed by the ICM Sisters. Honestly, I am hoping to see some of my mentors here today because I know that the ICM Sisters has a house in Baguio. I want to mention and pay tribute to Sister Angelita Navarro and sister Lourdes Dulay. They are great mentors. I am what I am now to a large extent, because of them. They have played significant roles in my life.

Teaching in my hometown grounded me to the reality of education in a rural setting. My students came from all walks of life, differing in values, attitudes, economics conditions and academic preparations. For lack to teachers in proportion to the number of students, I taught not only Biology but also other subjects outside my field such as English, Music and even P.E. The materials, equipment and facilities for the type of effective teaching I had in mind were nil. These challenges however did not dampen my enthusiasm for the job. In fact, I became more creative innovative.

I remembered the first time I taught "Diversity in the Animal Kingdom." For lack of prepared specimen, I instructed my students to go out of the classroom for ten minutes and look for animals which they can bring in to class. I was expecting them to bring grasshoppers, butterflies and cute stuffs. They came in with frogs, earthworms, spiders and centipedes. One even brought in a snake. I had goose pimples looking at the slimy creatures. But I forced myself to hold them as the students were doing. We had a very lively discussion on the topic. That day, I learned a very important lesson from my students. Never underestimate your students. They can be as creative and as innovative as you."

Teaching English to first year high school students in the rural school is an ordeal. I had a student who for some weird reasons would spell "mountain" as "m-a-n-s-i-o-n." I had students who can barely read a sentence. Teaching them to read an entire paragraph has trained me to be a patient teacher. This also made me appreciate the efforts of teachers in much less privileged schools.

I believe that teaching and learning should not be confined within the classroom. I took an active role in school as moderator of the Rural health and Science Education Committee. I designed outreach programs for students and teachers. Through the program, students were trained to teach primary health care to people in the barangays and encourage these folks to sue herbal medicines. The students taught barrio folks how to make cough syrup from plant extracts and soap from coconut oil. Students gave lectures on environmental protection and conservation.

In the course of teaching, I discovered I have prosperity for the arts. I wrote scripts and helped direct school plays. I got a scholarship from the Philippine Educational Theatre Arts (PETA) and took a summer workshop in theatre arts under the tutelage of the late Lino Brocka. With the new skills acquired. I helped train students and some teachers in community theatre. We produced plays which were presented in Iloilo and other provinces in Western Visayas.

Those eight years of teachings in a rural; school has prepared me for greater challenges ahead. Working with the ICM Sisters has instilled in mew the importance of service, compassion and respect for human dignity. I have learned to love teaching and I see it as an instrument for transforming the person and the community.

The day came however when suddenly, I felt I have nothing more to give to my students. That day, I decided I would resign from my teaching job by the end of the school year, and pursue a graduate degree in the center of research and technology which is Manila. This was quite a decision to make considering that I have no family in the big city, my husband was at sea, and I have a one year old son to take care of.

With guts, determination, I went to Manila and enrolled as a full time M.S. in Biology student at De La Salle University,. I was lucky to get a scholarship from the DSLSU Science Foundation which included free tuition and a monthly stipend.

Being a student again after sometime was a marvelous experience. My mind was absorbing information like a sponge absorbs water. I was so engrossed with my studies that I finished my master degree in less than two years. On top of this, while pursuing my M.S. degree, I was hired as a part time lecturer by the Biology Department, and as a research assistant by one of the senior researchers in the university. After finishing my M.S. degree, DLSU took me in as a full assistant professor.

Teaching college students at De La Salle University was an entirely new experience. With modern and sophisticated equipment at my disposal, my world opened to the wonders of scientific research. However, I still value the importance of nature as a big laboratory such that in my ecology classes, I would bring the students to the seas of Batangas, the rivers of Rizal, and the lahar-affected areas of Pampanga to conduct field studies. As a research adviser, I provided consultancy to students doing theses in diverse fields of environmental science. Pursuing my Ph D. in biology at the same university while teaching also enabled me to conduct researches and present papers in the country and abroad.

Research is very exciting. I means sleepless nights, disappointment, physical and mental exhaustion. But the joy of discovering something in nature makes it all worthwhile.

While Manila has provided me with opportunities for professional growth, I still feel that my heart is in Iloilo. Thus, with two additional degrees and one additional son, I brought back my family to Iloilo in summer of 1995.

In June, 1995 the Philippines Science High School Western Visayas Campos hired me as a Special Science Teacher. Only on its third year of existence, the school welcomed my suggestions and expertise. I helped develop its Science Research curriculum and introduced some innovations for teaching the course.

Barely a year of teaching at the Philippine Science School, I realized that my role was not only to teach students, but to train teachers as well. I have received invitations from other schools to share my teaching methods with them. Spearheading a pool of resource persons from our school, we gave lectures and workshops to other teachers in the region on Science Research, math, and other areas of science.

One day, after a year of teaching at Pisay, I received a letter from the students. The letter said, “Dear Ma’am Josette, we know you are being groomed for directorship of the school, and you would want to be the director some day, given the chance. The thing is, we don’t want you to. We just want you to be a teacher. Pisay needs teachers like you . The Philippines needs teachers like you…” Their letter touched me deeply.

When I won the Metrobank Foundation Award in 1997 as one of the most outstanding teacher of the Philippines, The Pisay community gave me a poster. The poster was a white cartolina filled with signatures of students, teachers and the non-teaching staff. In the center as a painting of a rose and the message which says, “You are the song that plays so softly in our hearts, that gives us inspiration to aim for greater heights and bigger dreams.. CONGRATULATIONS! We are so proud of you.

In 1998, I won another award as one of “The Outstanding Young Filipino” also known as the “TOTM” in the field of education. By then my friends were kidding me, “What’s next, canonization?” I thought the Metrobank award was the first and the last award I will receive. It’s quite ironic. You see, when I teach, I never think of awards, I just enjoy my work., By then, I was inclined to believe I really do have a lucky streak.

Last year, I won the “2002 Intel Excellence in Teaching Award” in an international competition held at Louisville, Kentucky from May 12-17. Let me tell you about this competition.

This international award which is sponsored by the Intel Foundation and Science Service U.|S.A. is given to deserving Science and Mathematics teachers who are teaching in grades 9-12 (Third Year High school to Second year college), and we actively involved in science fair activities of the school and the community. In the last week of January this year, the Department of Science and Technology in Region 6 informed me that I am being nominated by the department to this competition. I filled up the forms and wrote a paper entitled “ Teaching Science Research to Third Year High School (Grade 9) Students at the Philippine Science High School Western Visayas,” I also wrote a proposal on how to replicate the method and its potential impact in the region. I submitted the requirement t the DOST Office in Taguig, and the rest is history.

In April 10, I received a call from the U.S informing me that I am one of the five international finalists and I will have to go to Louisville, Kentucky for the grand competition. My head was spinning, I can't believe my luck. I learned later that there were 25 of us from the different regions of the Philippines who were nominated. I was chosen from among the 25 teachers to represent the country in the worldwide search for the excellent teacher, and that I competed with 90 other teachers from around the world.

In Kentucky, I presented to the panel of judges and to about 200 teachers from all over the world my method of teaching Science Research to my high school students in Iloilo, I told them that the Philippines is a third world country blessed with abundant natural resources. However, we face problems such as the rapidly declining environment and the general lack of equipment and facilities for scientific endeavors. Faced with this situation, I introduced innovations and strategies which would make Science Research interesting and relevant to my students and the larger community. These innovations included: a) building of scientific library, b) conducting fieldtrips, c) holding of science for a; d) establishing linkages with research institutions, and e) teaching students laboratory and field techniques which would help them in the conduct of their research work.

The judges and teachers from all over the world were amazed that even in the absence of sophisticated equipment, my students were able to produce quality research outputs beyond their expectations.

At this point in time, let me show to you my research students at work..

I went to Kentucky with three high school students form the Manila Science High School who competed for a team project in Physics and a student from the Mindanao State University – Iligan Institute of Technology who competed for the Individual category in the field of microbiology. These students competed with1,200 other students from around the world during the international science and engineering fair which was held back to back with the educators forum where the teaching competition took place.

May 17 was a glorious moment for the Philippine delegation in Kentucky., When it was announced that the student from Iligan won second place for microbiology, we were ecstatic. When it was announced that the students from the Manila Science High school won first place in physics our group was delirious. When the grand award for "Excellence in Teaching" was announced, and for the first time in the history of the event, an Asian teacher won, and a Filipino there was a standing ovation form the crowd at the Philippine flag was waved in the air.

The Philippine delegation's road to success in Kentucky was far from smooth. We almost never made it to the U.S. Our visa interview was scheduled on May 29 when we were supposed to be in the U.S. by May 11. Almost desperate, we asked help from the Department of Foreign Affairs, only to be told by personnel from that office that they will not give an endorsement letter to the U.S. embassy because they could not guarantee that we are coming back.

It was a painful experience for me and the students. We are international finalists to this prestigious competition, judged and trusted by people from other parts of the glove. Yet, our fellow Filipinos did not trust us.. Anyway, we were able to get our visa at the last minute, the most unconventional way, and brought glory to this county in the end.

Let me show to you the scenario during the first day of the teaching competition…

When I entered the judging area, the long table in front was occupied by the board of judges. At the right side of the room, the table was occupied by the finalist from China and her Chinese supporters. At the left side, the table was occupied by the three finalists from U.S. and their friends. The center table for the Filipino finalist was empty, I sat there alone.

I went to the U.S. bringing a CD for my presentation. I also brought transparencies and a white board pen in case my CD wont' work. Coming from a third world country, I was prepared for the worst. It turned out , I was the only finalist who did not bring a notebook computer. I went to the Chinese finalist for help, but she held on to her computer tightly, as if her entire depended on it. One American finalist lend me his computer. But before doing so, with all sincerity and enthusiasm, he gave me a brief lecture on the parts of the computer and its use. As if it were the first time I ever saw one. With all humility and patience, I listened to him attentively.

I was the fourth presenter. When it was my turn to present, a panel member asked if I needed an interpreter. I said, "No, thanks" a personnel from Intel volunteered to run my presentation. I said, "I can do it". After my presentation, they said, "Wow, you're so cool. You know more than us.

What am I telling you? That despite our country's limited resources, Filipino teachers and students can compete globally given the proper training, support and exposure. Our winning at the international scene may not reflect the general condition of science and technology education in the county. But with our concerted efforts, fellow educators, we can move this county forward and let the world see that we are a good people's a good race.

As I look back at my teaching experiences for the past 22 years, I can say that what I had been doing was the embodiment of the Revised Basic Education Curriculum which the Department of Education is trying to implement this year. Integrating activities which touch on real life situations of the learners and the community has trained my students to be analytical and critical thinkers. Furthermore, these experiences have and have developed like skills and values which make them "makabayan", ":makatao"; at "maka-Diyos".

When I went home Iloilo last June 10 after the competition in the US., the city of Iloilo gave me a very warm welcome. At the convocation in our school, teachers and students expressed how proud they are of me. In my speech, I told them, "I am very proud of you too. It is you who has brought me to where I am now. Our experiences together has brought world attention to the fact that hey, there's world-class school out there in Iloilo; a school with world-class doesn't mean going internationally and showing our best out there. Being world-class is passion and commitment to our profession; being world-class is giving our best to teaching. Being world-class starts right inside the classroom.

In winning this international Award, I do not claim to be the best teacher of the land. There are thousands of best teachers out there, working silently, giving their hearts to teaching without thinking of benefits or rewards. I salute these teachers. By winning this award however,

Fellow teachers, money is not everything. I am learning this over and over again form my seven year old son who is a grade one student at SPED School for Exceptional children. He reminded me about this again a few days ago while doing his homework. His assignment was: List ten words to describe your mother and also ten words to describe your father. On the list about me were: allergic, near-sighted, tall smart, famous, kind, loving. When he ran out of words asked: “Mom, can you give me one word to describe yourself?” I said “Beautiful”. He made a sound (the sound of Kris Aquino’s buzzer in “Game Ka Na Ba” when you give a wrong answer). And he said, “Not quite”. But he was quick to add, “But Mom, you are the best mother in the world. And I am happy to be your son. And even if you adopt another child, that child will be very happy too. And I think, all kids who will live in this house will be very happy kids.

I felt such profound joy after hearing this from my son. I did not even feel this kind of joy when I won the international award for teaching in the US. I am very happy that my son did not feel the inconvenience of having to live in a small house. He did not mind the inconvenience of having to take a jeepney rides to school. That last December, when we gave him a 90 pesos worth of bay blade toy, he declared “This is the best gift we gave on TV, in the malls, and everywhere. He is very happy just because we are a family. The day I left for Baguio, he gave me this necklace which he himself made. He said, it is to remind me of him even if I’m far away. And for good luck, so I will deliver a good talk to you. He also added, “And if you can’t sleep in Baguio, you can wear this too in bed.” Fellow teachers, despite our meager income, we can be world-class teachers and parents if we choose to be.

Dear teachers, believe in what you are doing no matter how simple. When you do something, do it not because you want to be recognized. Do it because you believe that it can make a difference in the lives of your students, the community, and in your life as well. Believing is improving and maximizing your potential.

And to all educators present here right now, my message is: Let us continue to teach well. There are millions of young minds out there waiting to be nurtured and developed into decent human beings. They are our country’s greatest asset. Let us not fail them. Let us not fail this country.

Yes, teaching may not be a lucrative profession. It cannot guarantee financial security. It even means investing your personal time, energy and resources. Sometimes it means disappointments, heartaches and pains. But touching the hearts of people and opening the minds of children can give you joy and contentment which money could not buy. These are the moments I teach for. These are the moments I live for.

Characteristics of Selected Filipino Scientists

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In the Philippines, the importance of scientists raises the questions of who and what they are and how they are developed. Are there qualities of ability, family background, education and training that make them? What past experiences and environment factors created and sustained their vocation? How do we describe a scientific personality?

Pioneer researchers on creativity and the scientific personality were conducted by F. Galton (1870) Anne Roe (1953) L. Terman and others. The results showed great variability in the characteristics of scientists and their scientific work. These studies however point to some distinctive combination of traits which characterizes the creative person.

A clinical psychologist, Anne Roe, conducted one of the earliest studies over a three-year period in the early 1950's. Dr. Roe's subjects were selected by university committees all over the country as top ranking research scientists. There were sixty-four of them all, averaging 48 years old. The most striking characteristic was a high level of intelligence. They likewise did extremely well on tests of spatial perception, mathematics and verbal reasoning.

As far as habits of thinking, there were some differences among the sixty-four scientists. The biologists and the experimental physicists tended to depend strongly upon visual imagery in their thinking-images of concrete objects or elaborate diagrams or the like. The theoretical physicists and social scientists tended toward verbalization in their thinking. All groups reported a considerable amount of abstract thinking, particularly at crucial points.

In several aspects, the scientists background differed very much from the population at large. There were no Catholics; five came from Jewish homes and the rest had Protestant background. The economic levels were varied, ranging from very poor to well-to-do. Another striking fact is that 53 percent of the scientists were sons of professional men; not one was a son of an unskilled worker. Most of the scientists developed intellectual interest at an early age.

The one thing that all of these sixty-four scientists have in common is their driving absorption in their work.

In his work at the Psychological Service at Pittsburg, Thomas Spencer accumulated a batch of critical incidents describing the characteristics of successful engineers at a major steel company (cited by Taylor and Baron, 1963). He analyzed these and became convinced that creativity involves ideas, work habits and opportunity. Since his subjects were engineers in a big steel company, he believed that the third element, opportunity; is a managerial function in a sense that management provides various opportunities for creativity to flourish to varying degrees.

Kaplan of the University of California interviewed several research directors and scientists of seventeen industrial research laboratories and found out that research atmosphere is related to productivity and creativity in the laboratory. This aspect of Kaplan’s work seems to support Spreechers’ study o n “opportunity” (which is managerial function) as an element of creativity.The comprehensive findings on the personality of men and women who recorded creative achievements is a result of the research done at the Institute for Personality Assessment and Research by Mckinnon, Barron and Gough (Lytton, 1971). The research was done on creative writers, mathematicians, architects, and scientists. Flexibility was one of the attributes in which these groups, were found outstanding. Another variable which proved highly distinctive of these creative groups was a preference for perceptional complexity. This trait is the best predictor of the rated productive powers of a group of research scientists. It would seem that creative persons like scientists are able to accept perceptual complexity in geometric design.

Science is dynamic creative. The scientist is an embodiment of these qualities. This study is an attempt to look into the dynamics of creativity by studying the scientist.

What this study is all about

This study gained insight into scientific creativity by studying the creative and scientific person-the scientist.

Specifically, this study discovered and analyzed the socio-cultural (family, school, community) as well as personally characteristics and events that nurture, nourish and stimulate scientific creativity.

The following are the specific objectives of this investigation:

1. to establish a socio-cultural profile of Filipino scientists by studying the following-- Family background and childhood experiences, Educational background and experiences, Work experiences.

2. to establish an ability and personality profile of Filipino scientists

3. to study and analyze the contribution of the above experiences to the scientists scientific pursuits.

4. to analyze the processes involved in conceiving and producing a scientific work

The subjects of the study were thirty Outstanding Young Scientists awardees recognized by the National Academy of Science and Technology. There were twenty males and ten females.

Research Design and Methodology

The study was ex-post facto and used an interpretive research methodology. The autobiographical-biographical approach was the main research technique. The autobiographical Questionaire was constructed and validated and used as an interview schedule or guide for the autobiographical essays of the scientists.

Significance of the Study

This study contributes to the understanding of the Filipino scientific personality which is significantly absent from research literature. It hopes to add information for the building and formulation of a theory for scientific giftedness in the Philippine setting.

For the science community and the national policy makers, and those interested in the cause of science, this provides an understanding of the socio-cultural (family, school, community) as well as personality characteristics and events that nurture and nourish scientific creativity.

Furthermore, this study is useful in the development of programs and environmental interventions for the training of future scientists.

Discussion of Results

There were thirty autobiographies that were studies and analyzed. The results are presented and discussed below.

Community and Family Circumstances. The type communities varied from the very rural and farming communities to the very urban in Metro Manila. The scientists came from all over the country, from northern Luzon, to the Visayas region to North Cotabato in Mindanao.

Family circumstances likewise varied. Some scientists came from well-off or upper middle class families where in their younger years they trained in the musical instruments such as piano and violin. They went to Baguio or abroad for vacations and had books and encyclopedias in the family libraries in their younger years. Some scientists came from poor families where reading materials consisted of local comic books. They spent their childhood playing with neighbors in the farm. Most scientists however described their families as middle class where the father or a parent was employed.

The parents of the thirty scientists and varied educational backgrounds. Most of the fathers were involved in a profession as lawyer, professor, medical doctors, engineer, accountant, etc. One scientist had a father who had Ph.D. degree. Generally though, most scientists had at least one parent who was in the profession. All scientists had at least one parent who was in the profession. All scientists had at least one parent who was strict and strong-hearted and who emphasized the value of education.

Elementary and High School. Most scientists studied in both public and private schools during their elementary and high school. Some however, had their early education from the private exclusive Schools such as Ateneo and St. Theresa. The scientists performed very well in their elementary and high. Most of them were good, if not excelled in mathematics and science. Many were mathematics and science contestants and won several awards. The scientists reported their interest in reading even in their early years. Several of them reported unusual interest in different subjects like mathematics and physics.

Some scientists had vivid recollections of heir teachers in the elementary and high school and were inspired by some teachers in their studies and even in their personal lives.

College and Graduate School. In college, the scientists studied in varied universities. The universities where they went to were U.P., Ateneo, UST and some state universities in the Visayas and Mindanao. Most of them went to U.P. for their undergraduate degrees.

In college, many scientists have scholarships whether government or private-sponsored. As college students the scientists were serious and diligent in their studies. They performed very well in college. They topped their classes and earned honors and awards as well as scholarship. Most of them, however found the time to join extra-curricular groups such as student government, school paper and even singing groups. As students, the scientists were disciplined, organized and focused in their studies. They read a lot and had questioning minds and the propensity to seek knowledge.

Most scientists crystallized their career choices in college because of interests in the field or because of the influence of teachers and professors.

All scientists went to graduate school through scholarships or fellowships. The scholarships were obtained on the basis of any or all of the following: performance in school, topping exams, exemplary research work and recommendations of administrators and mentors. In graduate school the influence of mentors and advisers were very significant in developing not only their research skills but their vocation in science. All had gone abroad for their graduate degrees or research fellowships. Their training abroad reinforced not only their knowledge but their commitment to their careers.

Career Choice and Development. Interest in Science careers was brought about by the influence of parents, relatives, friends and teachers and even guidance counselors. Interest and abilities however played significant roles. The scientists reported unusual interests and abilities in science and mathematics as shown by these statements:

> "Optics fascinated me; math as well … I knew I had this gift of science when I got a 100 in my physics class for the entire year.."
>
> I discovered my talent in mathematics in my second year high school.. I answered algebra problems even if I didn't study .. I just listened to the teacher…"

> The type of communities likewise had an influence. One scientist took marine science because of the coral reefs in his hometown. For another, entomology..” would be like a playschool” for I already knew so many insects in our farm.”

A very profound influenced in the lives of scientists were mentors, teachers and other scientists who served as role models. The scientists believed that their choice of science careers were due to the teachers who were epitome of good teaching. The mentors who influenced their careers were described as full of energy, adherence to principles, highly motivated, full of genuine curiosity, mastery, clarity and enthusiasm. To the young minds, these qualities brought motivation , enjoyment, discovery, wonder, amazement and inspiration. They also provided moral support. Some quotations to illustrate this are:

> “My teachers in algebra and technology were many impressive. They were the ones who planted the seed in me which is now becoming to be a deeply rooted full-grown plant.”

> “My biology teacher inspired me to study life science because I was amazed by her broad knowledge of subject maters in biology.”

> I attribute my own enjoyment (of science) to my excellent physics teacher … We had home experiments and this made physics come alive.. He was a most demanding man (quizzes everyday) but we did enjoy his class.”

In college and graduate school, professors and mentors were role models who further influenced not only heir careers but also their lives. The scientists saw in their professors and mentors strength of character, dynamism, idealism, solicitousness, concern, the giving of oneself, leadership, vision and discipline.

The characteristics they considered as strong points were:

meticulous	analytical
discriminating	logical
persistent/preserving	intelligent
hardworking	talented
faith in God	perfectionist
do not spouse mediocrity	
idealism	organized
concern for others	creative
ability to relate with others	focused/discipline
hardworking	honest
fair	thinking
	devotion

The characteristics they considered as weak points were:

- shyness, lack sociability
- sensitivity
- impatience
- obsessive intensity/too serious
- easily distracted
- short tempered/impulsive

The characteristics of scientists may be considered as cognitive and affective. The cognitive qualities that characterized them were analytical, logical, creative, talented and intelligent. Affective characteristics are the following: hardworking, enthusiasm, faith in God, some qualities maybe both cognitive and affective. These were: focused, disciplines and organized. Most scientists tended to lack sociability and admitted to be laid back and shy. They were also impatient and want to get things done. Some tended ot be sensitive, moody, short-tempered and impulsive. A couple of quotations illustrates these qualities:

> “Hard work and patience made possible my career success..”
>
> “I found out that discipline which I have developed through the years helped me in .. daily preparations for classes.. and in preserving when one does not see clearly what is at the end of the tunnel in terms of results…”
>
> “The traits I learned early on are diligence and perseverance. I do not procrastinate. I have an itch (strong desire) to do what I have to do immediately. I usually organize things into what’s important and what’s not. It was probably the “*sipag at tiyaga*” rather than unusual intelligence that gave me honors/awards.
>
> “I am strong willed, very independent minded, more of a loner> I consider as strong points my intellectual abilities in languages, science and mathematics. I also have been gifted with some talent and strong appreciation for music, dance and the arts. I tend to give my best, producing work I peg to the highest standards possible..”
>
> This is contrary to the popular idea that inspiration, relaxation and eccentric behavior characterize the scientific person.

His thinking process and conceptualization of research involved the process of association, imagination and the piling up of ideas. Also identified were the process of analysis, verification and confirmation. The scientist likewise explored, extensions and variations n content and methodologies of published researches… He also looked for the missing and filled the gaps. There was no formula in their conceptualization or thinking process. One thing is sure, there was a lot of effort to pin down ideas and bring these to fruition.

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The Remaking of Scientists

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The Science-Technology-Poverty Trap

As far as scientific enterprises is concerned, attention to the core development concerns of poor countries and communities has been a marginalized side-game to the main show for a long time.

There has a course been very noticeable, attention to the core development enterprise to human and sustainable development, notably, for example, in India, a product of Prime Minister Jahawarhal Nehru's founding legacy, or, over the last twenty years, within global research on sustainable development. Meanwhile however, 85 percent of global R&D expenditure is spent in developed countries and only 15 percent in the developing world; and 85 percent of all R&D in the world privately funded. Thus the product of world research – even that intended originally to help disadvantaged communities – is most likely to be captured as an asset supporting developed world private business rather priorities, of for example, new armaments, computer power, genetic engineering, and new materials, and of global respectability of more "basic" published research, what is directed towards the needs of the poor in the first place is a tiny fraction of the world's scientific potential. And much of what is done in developing countries capacity in industry or wider society to absorb the results, and all to often under the pretence of its respectability as basic research. For example,

> *When I was working with the council for Scientific Research (CSIR) in India 25 years ago, I came across a soils research laboratory, which though situated in a critically arid rural zone, imported its soil samples from the United States in order to ensure the scientists research results were published and cited in America.*

Meanwhile, the interests of advanced country science and technology can reach around national research and development priorities with a distorting effect that can deeply penetrate the lives and social worlds of the poor in a way that perpetuates their inequity within in globalizing world rather than reduces it – because of the very problem of underdevelopment, that is, lack of broard ranging access to economic capital and absence of a distributed technical and social capacity to absorb and take charge of technological change.

To take one case I cam across:

> *The introduction of Norwegian-designed, Japanese motor-powered fishing boats into Sri Lankan fishing villages in the 1960s increased the fishing output by a factor of 7 to 8. This appeared a success story. However, by the mid-1970's the down side had also become visible. Only*

those with some capital could purchase the boats, and more importantly afford the cost of bringing in technically skilled people to maintain and repair them when the boats inevitably broke down. The more wealthy and successful boat owners, who could afford repairs and bought up the idle boats of those who could not, uncreasingly move to a financial management position, owning several boats and employing other villages merely as labour – that is, under a contract relationship that replaced previous traditional obligations and sharing. The higher technology of fishing led to a decrease in employment in fishing by 50 percent. With larger catches, it became worthwhile to transport yields to the capital city, Colombo, whereas most of the catch previously was eaten locally. Consequently, a previous village structure comprising a small elite of one or two families and a large class of free peasants, joined together by traditional social obligations, transformed into a large elite of 10 to 15 families, whilst 200 families were newly precipitated into living close to or below subsistence level and were kept alive by government rations of rice and other foodstuffs – and the fish that were caught near the village were not even available locally as food any more.

To extend this observation of the intrinsic technological trap of underdevelopment itself one step further, communication and information movement in the 20002 are at the very heart of economic progress. Tokyo has more telephone than the entire African continent, and there is continuous change in the capacity and multi-media reach of Japan's communications infrastructure. Developing countries have to somehow board the globalization train, not as it is picking up speed leaving the platform, but as it rushes past at 300 km per hour.

In other words the "international' or globalization drives of contemporary science and technology are intrinsically likely to distort the capacity of scientific enquiry to impact positively on the poor at grass roots levels. And, no matter what the national or international intentions may have been to make science and technology work for the poor, the reality is that equity has got wose not beter, Despite all the efforts of the last four decades, poverty and exclusion have deepened and become more pervasive as populations have increased and as demand on finite global resources has intensified. Almost half of the world's population still subsists on less that ywo dollars a day, and a quarter barely survives on less than one dollar a day. The majority of the world's poor are found in the Asia and pacific region. Most tellingly, the income ratio of the richest 20 percent of the world's population to the poorest 20 percent increased from 30:1 in 1960 to 75:1 forty years later in 2000.

The "Boiling Frog' Principle

Meanwhile, over this same 40 year period, there has been a profound change in the nature of the relations between science, technology and society, a transformation that we must understand if we are to do anything about re-directing the pauperization trajectory. This change has appeared continuous, and has been largely unnoticed. However, the biological metaphor of the boiling frog" principle comes to mind; that is, drop a frog in boiling water and it hops out, but put the frog in cold water and steadily heat it up, and it does not notice the difference until it is too late. Whilst apparently continuous, the transformation in scientific enterprise has been fundamental.

Back in the Days of Rock-and-Roll: the “Old” Order of Science

Back in the 1960, “respectable” science was curiosity driven, untroubled by short-term performance reviews or indicators that now plague most universities and government laboratories, “Respectable science’ asserted the democratic ideal that Robert Merton espoused at the time, an open community pooling its knowledge through publication in a disinterested way for subsequent application by others towards public good. “Respectable” science was conducted within the cloisters of universities in which administration was the business of the bursar, and the Vice-Chancellor, rather than being a CEO, was an academic whose main task was to nurture scholarship. “Respectable” science could be conducted in government research institutions, but responsibility for application largely remained outside the institutional walls. And the slightly “grubby” world of mammon represented in industrial research, was desirably conducted in central research laboratories in green parks remote from the factory, but expected to produce applications that could flow out from enquiry into use down on the factory floor.

This was the *contract* between science and society of the 1960s. Society believed in science. Science produced prestige as in the space race. Science produced social advance as through electronics, through nuclear power – potentially capable of delivering energy described at the time as “too cheap to meter”. Science, it was believed, would produce solutions to the illiteracy, grinding poverty and disease of the developing world, as Jahawarlal Nehru, Prince Minister of India, stated in 1964. Scientists were therefore accorded the freedom to pursue their curiosity in the belief that the products would flow, as down a pipeline, to produce public good. With the singular exception of the fear of nuclear war inherited from the dramatic demonstration of the atom bomb in 1945 and revivified every year through the Pugwash Movement of concerned scientists, there was no *debate* about problems caused by application of new science and technology until the very end of the 1960s. The only book before 2965 that I have come across that forewarned a problem in the social contract with scientific and technological enterprise was Rachel Carson’s Silent spring, which a decade earlier observed chemical pesticide residues in the remote reaches of the arctic. Otherwise, science was universally associated with public good.

The Fall from Grace

Today, the gross has gone. What most scientists now confront is a tough world where the research domain is a good ideal more demanding – requiring continuing attention to funding, grants and timelines, to performing on several stages at one – teaching, grant-gaining, publications; where the world of commerce has set up its shingle at the very heart is research institutions and practice. Amongst politicians, science is being called to account and penalized financially where its immediate utility appears to be lacking. And in wider society science and scientists confront a crisis of trust. High is public consciousness are the negative products of an advanced civilization whose productive systems are dependent on contemporary scientific and technological knowledge – producing climate change through greenhouse gases, destroying the food chain in local ecosystems through toxic pollutants, and a globalised .. MacDonalised.. culture through the imposition of technical regularity on social consumption. More accurately, high in public consciousness is the fear that arises from ambiguity of these phenomena – particularly given the increasing distance between the inner workings of science and distribute public knowledge. The [public confront alternative scenarios, for example, today concerning the implication for humanity of cloning not only animals, but humans, where the expert stands in from of scientific enquiries, interpreting and adjusting scientific knowledge to advocacy for alternate interest groups – whether they be a multinational pharmaceutical company or radical ecologists.

This harsher and more ambiguous reality is not just a fall from grace. The social world around science has moved on – partly stimulated by science and its application, but setting a quite new context for the emergence of a quite new order of science, and a quite setting a quite new context for the emergence of a quite new order of science, and a quite new relationship of science with society. We cannot return to the halcien ideals of science practice and organization of the 1960s any more than we can return to the era of gentlemen's science and the Academies of the 17th Century. Instead, science-in-service-of-business is racing ahead of an accepting, largely ignorant and disempowered society and dragging it along behind the technical and market oriented dictates of the closed worlds of the laboratory as translated through the closed worlds of the corporate boardroom. In social consciousness thee has been a move from a vision of knowledge as the liberating builder of futures to one of knowledge as a ephemeral market commodity. Science, meanwhile, is on trail. It will never again be well funded and allowed a long leash by society until the public again has faith.

The social contract of science we confront in the 2000s is therefore confused. The "old" social contract of science of the 1960s has mutated, so that even though many still cherish the idealistic belief that scientific research intrinsically will produce universal good for society, the reality is a good deal more ambiguous. The contract we have entered into has not been consciously debated or negotiated, but has quietly crept into place outside the domain of public attention. The dynamics that drive science-society relations emanate from the market place; the public know little of what happens behind the walls of scientific enterprise, but glimpse primarily what is delivered fro hem by experts in a context of interest and advocacy, or alternatively in finished products that come to hem through the market place. Scientific enterprise is supported in the name of society, that is from the public purse and in universities and government laboratories. However, the criteria for support are now different. Increasingly important are the extent that the enterprise links with commercial advantage and its potential for self-funding. The people are recipients not participants. And the poor are getting poorer.

This is an unsatisfactory contract. Its essence is the short-term, and private interest. Yet we face a Millennial future populated with global warming and environmental degradation, overpopulation, inadequate employment, and an increasingly homogenized world culture – where the richness of social invention from the margins of cultural diversity is increasingly weakened.

What is called for, but is not in place, is a new social contract that aligns science and society in a shared enterprise where the peoples' voice is informed and heard, where there is a return to a trust that is justified. This is not just an academic wish. The World Conference on Science convened in Budapest by UNESCO and the International council of Science (ICSU) in July 1999 brought together the world's to scientists with governments. The world Conference formulated and accepted the necessity of just such a new social contract for science appropriate to human and social development in the 21st Century.

"Being There": Enter the New Order of Science

A new social contract must be realistic however, and indeed capitalize on what is really going on within contemporary science rather than tilt at Quixotic windmills. And when we penetrate a little further behind the commercial face of contemporary science, we find a world of research itself has changed quite radically.

The evidence is now strong that, as John Ziman has observed, there has been building up through the 1990s a "radical, irreversible, world-wide transformation in the way science is organized and performed, - a transformation that is fed by and feeds the commercialization trend I have just described. In my own past life as Director of the Centre for Research Policy in Australia we started to see this trend emerging from empirical evidence were collecting in the early 1990s. Michael Gibbons and his colleagues describe the emerging new mode of knowledge production as :Mode 2", as opposed to Mode 1 where knowledge production is organized along disciplinary lines, characterized by homogeneity, is hierarchical and focused on problems largely set by academic interests or the scientific community. In contrast, Mode 2 knowledge production is carried out in a context of application, tends to be heterogeneous and more transient in its organizational forms. Mode 1 continues to exist, in particular in many developing country research institutions, although government may replace academics is setting the problems. But the Mode is unlikely to be particularly productive any more.

Within Mode 2:

- Discipline appear to have increasingly less relevance in driving research fields, with the majority of research now being published across disciplinary boundaries and cross-disciplinary research centres increasingly replacing the single discipline university department as site of research production: in Australia, for example, university research centres account for at least 50 percent of Australia's tertiary education research.

- In spite of the massive expansion of electronically mediated data bases and information access, personal networks and immediate personal relations appear to be of crucial importance at the leading edge of new fields – which, as with, for example, membrane technology or intelligent materials, emerge and dissolve through network relations rather as do “self-organizing systems” described in “chaos theory”. Personal networks and immediate personal relations, rather than commercial institutional arms of academic institutions, are of central importance also in relations between university research and industry. The basic reason is that multidisciplinary research, and even more, trans-disciplinary research, requires teams and transfer into the teams of tacit informal knowledge of solving “this kind of problem” rather than just technical knowledge drawn down from specific disciplinary shelves. Richard Nelson demonstrated at the end of the 1980s in a survey of 600 US industrial companies for example, that three-quarters of the most important contributions of academic research to technological development were in the form of uncodified (or tacit) knowledge and skill transfer, and only one-quarter in the form of codified knowledge, that is patents, machines, research papers and so on. A secondary reason that personal networks are increasingly important is trust. An industrialist talking about university research links offered me the metaphor of an Olympic high jumper to emphasize this point. If you want to win the Olympics you send one person who can jump 2.6 metres, not two people who can jump 1.3 metres each.

- Modes of communication and organization have changed. Speed of information transfer and complexity of required knowledge are the guiding dynamics. As a consequence, the most productive multidisciplinary teams are relatively small, between five to twelve members. Publications are less the leading edge of ideas transfer than electronic communication and conferences in fields that mode fast, like electronics. Indeed, it can well be argued that reliance of academics in many fields on the “discourses” represented in contributions to the literature is more a sign of marking one’s territory or maintenance of the province of those whose thinking and contributions are far from the centre of what is currently shaping the field and its questions and who count publications to gain local promotion. Patents simply slow down industrial application in fast-moving fields where complexity makes the patent of limited applicability anyway, and tend to be most relevant in straightforward traditional industries such as chemicals and steel. At the core of the new order of science is communication immediacy.

The impact of communication immediacy is that where leading edge research is successfully joined to innovative enterprise, the “game” of innovation is rather more that of a “basketball” or “soccer” match than a relay race. In other words the traditional (1960s) view of the application of knowledge was that basic research could lead to applied research, thence development and economic wealth with the “idea” passed on as it were like a baton in a relay race. The new order involves many actors, researchers, firms, universities, governments and so on, where the ball of the idea is passed backwards and forwards between he various players until it finally reaches the end-goal. Basic research if often a product of highly focused applied research rather than the other way around, and most leading edge research is likely to be team-based and multidisciplinary or transdisciplinary. Traditional institutional boundaries, for example, between universities, government and industry, either are dissolved, or desirably can be dissolved, as in the case of Australia's Cooperative Research Centres. In the new order the key is networking and immediacy – "being there!. Driving the agenda has been the emergence for the sake of global competitiveness of the drive for speed in application of research to specific market-contextualised demands.

The Mode 2 order is one where science is more intimately connected into private market advantage. It is also one where movement of scientists and new (small) organizational forms are key dynamics in the competitive capture of scientific and technological.

Capitalizing on the New Order: Building a New Social Contract of Science

These dynamics provide new opportunities, not just for advanced economics, but also for enhancing national competitiveness in developing countries. However, national strategy, with ,limited resources, has to be one of "nesting" into the global market scene and into strategic alliances with large companies and developed country institutions. "Smallness" can be an advantage, because large organizations are likely to be bemired in procedural bureaucracy and long communications linkages.

No strategy will work however unless the scientific enterprises of the developing country revamps its public system to make it fast on its feet and attentive to "capture" rather than creation of knowledge. "Creationism" or building basic research institutions as a national strategy in this context has limited relevance unless the institutional walls are re-invented to bridge the research-application nexus at the start. Attention to world-class quality in a small number of fields is crucial, as is attention to training of scientists to foster team-enterprise and connection into international networks.

For science to benefit the poor directly however rather than national competitive advantage more generally, the re-design of information flows and engagement must stretch much further. The New Social Contract of Science comes of age through re-establishing relevance to those otherwise "unconnected" into the benefits of globalization, and in the re-establishment of public trust.

It follows then that the key to unlock and spring out of the science-technology-poverty trap for the Philippines, is not just more expenditure on science, although the lessons of Japan, the Republic of Korea and now, China, show the importance of such an enhanced commitment. More importantly what maters is to create a paradigm shift in how science is practiced and in the dialogue that links scientific enquiry and technological application with the people.

It is very encouraging to see that DOST's Medium Term Plan endorses this idea of a "new social contact" – inscribed with a vision of a competent and competitive science and technology community with a social conscience.

I strongly endorse this strategic position, but stress that it implies new thinking not just new priorities. The idea is a new social contract does not involve simply moving the pieces on the established chess board. Instead, the game itself has to change. There are fundamental consequences for human resource development strategy in the Philippines.

Trust and empowerment: connecting scientific and technological advance with the social world of the poor.

At the heart of a change strategy stands the engagement of scientists with the local communities they seek to serve. This engagement is critical, apart from any other reason, to escape the trap that is evident in the case 1 presented earliest concerning the introduction of modern fishing boats into Sri Lankan villages. Scientists must understand the community as a whole and not assume that introduction of an apparently simple new technology or technique is unproblematic. New technologies, new technical practices, interact with the whole of a community's life and social relationships, not just change one element. Furthermore, through engagement, the scientists can see what is needed next, not always obvious at the start of an application programme, no matter how carefully designed.

A current UNESCO project in Indonesia offers an example:

We have been working with the village people around Jakarta bay for seven years Now, focusing on introducing waste recycling for profit – for we learnt some years ago the no conservation programme works in developing countries unless the people directly make a profit or benefit from it. The community programme originated with the need for action that was demonstrated from 10 years of scientific monitoring of Jakarta's impact on coral reef in the Bay. Action focused on producing and marketing comport from recycled organic material- effective in reducing the waste produced from traditional markets by 30 percent; and in paper recycling for profit by youth – where, through the advice of a Japanese designer, decorative paperware and boxes were sold directly to Japanese stores. With economic collapse of 1997 the market for compost also collapsed. So, based on ideas of the community, we assisted the use of compost to grow medicinal plants and plants for hire in office blocks. The new business flourished and the kampongs "greened". Banjasari, one of the communities, has now been designated as one of the city's ecotourism sites. Further, the women of the kampong decided to use the medicinal plants to develop a herbal-based health service for the very poor – and research support was provided. When a kampong-wide recycling system was introduced, both the community members and the local rubbish collectors were involved – with external technical experts. – in designing the rubbish bins and collection trolleys. Research and community therefore interact, and the result is a working community system that is both *environmentally friendly and income generating whilst at the same time is fully "owned" by the people as they basically designed it.*

Scientific research therefore must fit within its a social and community context and offer real opportunity for the voice of the people to be heard. UNESCO has found this particularly important in the development of eco-tourism on the island of Palawan in the Philippines.

> *In the UNESCOProject we have been implementing around Ulugan Bay in Palawan, the communities were trained in simple research to monitor and manage their own fishing stocks and care for the environment to these and other productive assets, and were assisted in converting their boats to tourist boats in such a way that they could be reconverted for fishing in one hour. Geological knowledge was built up amongst the people of one of the barangays to allow them to take tourists spelunking through a local rock formation. But all the ideas about building on the original scientific inputs came from the community.*

Together, these dimensions – of recognizing and supporting multi-disciplinary team-based research, capitalizing on tacit or informal knowledge flows, re-establishing trust, incorporating social and community engagement within scientific enquiry, fitting scientific intervention into its social and community context and recognizing that technical application within communities may well involve social innovation – would seem to be the dynamics to address in pursuing the Department of Science and Technology's vision of a competent and competitive science and technology community with a social conscience. Such a social contract capitalizes on the interactive, local and "tacit" knowledge strengths of the new order of science – whether it be in participation of the Philippines in global science, or in application of science to community needs.

Action

Following then are a number of starting points that might be considered in seeking to apply the idea of a new social contract in the Philippines.

S&T Education Reform: Educational reform is clearly implied in putting the substance of this vision of a new social contract of science into place.

(1) *Scientific Training*: We have to produce a different kind of scientist – one who from their earliest experience of science and technology training is brought into direct contact with communities and community needs within their education; who is taught to participate within a team environment, who, whilst focused and disciplined areas and to applied problems. In my own personal experiences teaching interdisciplinary curses in Chicago, Sussex and Australian universities, students must also develop a solid disciplinary grounding from which they

have the confidence to ask interdisciplinary questions. But this is a matter of staging of coursework, not of teaching either traditionally or by the principles of the new social contact.

(2) *Absorptive Capacity*. A national government needs also to pay attention to ensuring that any programmes to introduce new technologies or techniques to local communities, adequate attention is paid to the community's technical capacity to absorb and cope with the change – through upgrading local technical capacity to absorb and cope with the change – through upgrading local technical knowledge to maintain, repair and even look beyond the specific technical innovation. Background to community technical capacity is their familiarity with the thinking of science – a significant target for interactive science popularization programmes.

2) *Institutional Reform*. Development of human resources to meet the demands of the new social contract does not stop however in the graduation halls of school and university. We must also look beyond formal schooling to transforming the institutional structures that support the current way of doing things – including within government research. For example:

1) Mobility Inside Institutions: Organizational walls around science in the public sector often seem to resemble the characteristics of a barrier reef – preventing, or at least mediating, interactions of an internally calm lagoon with the turbulence of the public ocean outside. But the new social contract of science calls forth institutions the metaphor for which is more appropriately described as an open ocean that washes nutrient over human need. The walls around research enterprise must be broken down. Movement of scientists is to be encouraged – between universities and industry, and between research laboratories in the Philippines and leading edge research laboratories internationally. Indeed, the Philippines may even wish to look in a fresh way at the "brain drain" that has drawn so heavily on the scientific capacity of Philippines people. It is useful to the nation for Philippines scientists to reside in leading edge laboratories overseas – as long as there is a conscience national strategy to ensure their continuing contact with the Philippines national science system, for example, through return visits and effective counterparting. At the leading edge, and in application of science, we must now capitalize on the significance of "tacit" or informal knowledge that can only be learn by ":being there". As I observed earlier, of all the dynamics that led to application in industry of public sector research in Australia, the most important was personal contacts, networks ad flows of people between the institutions.

Furthermore, at the leading edge of many fields of scientific enquiry today, notably, electronics for example, basic and applied research embrace each other in such a way that it is impossible to tell which one placed the first kiss.

2) *Mobility Outside Institutions:* Movement of scientists outside of formal institutional so that they interact with and listen to want communities want (their own local "tacit" knowledge), is to be encouraged, as the parameters of government and academic based research enquiry. For scientists to contribute to poverty alleviation human development and equity within a developing country within the framework of the new social contract of science, they must engage in the overall life and development issues that the communities confront rather than deliver results of research conceived at a distance or within the closed realm of commercial interest.

3) *Bridging Science and Governance:* Scientists need to be institutionally brought into planning, development and governance situations as part of their career progression. In China as it opened up its public research system in the late of 1980s, one mechanism introduced was to encourage scientists to volunteer to serve as science deputies to governors in local provinces. This had a tremendous two-way influence – assisting local administrators to see the potential contribution of science to their governance and development priorities, whilst at the same time, providing a practical real-life perspective of governance priorities for the scientists to take back into their subsequent research.

4) *Teams.* The organization needs to pay attention to bringing the different disciplines (and Tacit knowledge) together into teams, and rewarding team-based contributions to sustainable development and community empowerment, rather than just individuals.

5) *Shared Decision Making.* The way in which decisions about research direction are made needs to ensure that local communities are really involved, not merely consulted or revisited. This does not mean building liaison nits – for here rarely work and largely keep scientists safely at a distance from the interactions needed. Similarly, whilst community-focused advisory boards can provide overall direction, they cannot represent the richness or complexity of the actual situation in specific communities. For it to work, scientific research must be set in context. Scientist – even those

working on the more basic end of sustainable development and community empowerment issues – need to have direct contact in the communities.

> In Uttar Pradesh, for example in a project I monitored in 1979, the Lucknow Research Institute built a spinning machine to increase the quality of cotton produced by local village women, and so allow the cotton to meet the input requirements of new semi-automated weaving factories recently built. To be sustainable in the village environment, the machines needed to be able to operate by peddle power or small electric motors. The design solution of spinning twice as fast however cold not be achieved as he level of human energy required was exhausting. Instead a mathematician at Reading University in England was contracted to design node characteristics that would cast specific mathematical curves n the spinning cotton. This worked and the machines are now introduced,. One cannot imagine a mathematician at a distance even thinking of such an application without the context being formed first.

6) *Evaluating Application Potential.:* Research results, even in areas that may not immediately appear relevant to poverty alleviation goals, should be evaluated – perhaps through multi-disciplinary teams – for their potential application to locally empowering sustainable development. For example, designation of biosphere reserves and many conservation decisions are based on scientific evaluation. But, the results may be employed to both maintain conservation and generate income. Not only for biosphere reserves offer security for genetic diversity of the future; with sensitive zoning, they also offer economic opportunity for ecotourism related local production and so on.

7) *Performance Review:* Criteria for performance need to be reviewed to reward those who create change within the framework of sustainable development and community empowerment goals rather than who simply do research or produce reports.

> *When I was working in India in the late 1970's one way of my tasks was to review the output of the governments research institution, the council of Scientific and Industrial Research. In the one year I found something of the order of 340 applications in local communities or industry – this was from the entire national system. One year later, only one*

remained in operation. The basic problem was that the scientists were evaluated positively for their production of reports about research applications, not for ensuring their research results were fully bedded in an sustainable.

8) *Accountability:* Finally, public institutions need to be accountable for their contribution to locally empowering sustainable development. In fat too many cases in my experience of developing countries research institutions and universities, the product of research consists almost singularly of reports in the library which are no even easily available to the public. No mechanism is built to cross the bridge to the public. Here, an immediate step can be taken to build a public-oriented home page that publices the products of institutional research and which could be monitored for "hits" to see what captures interest. Success in building such bridges and demonstrating results – in particularly towards locally empowering sustainable development – should then be reviewed as a criterion in allocation of research budgets both internally and externally to public research institutions.

A Final Word

I have been sketching out some of the dimensions of what it means to implements a "new social contract of science" in the Philippines. There is much more to be done, and I do not pretend the task is easy. But, I do contend that the task is essential. If, we, and I include myself and UNESCO explicitly, who are working to make science a real force for equitable and sustainable development, continue to re-arrange the educative and institutional pieces towards seeking relevance, but by "old order" and "old contract" criteria, we must surely fail. For the world of science we would recognize the basic dynamics of the "new order of science", and "re-design the game to capitalize on tacit and informal knowledge transfers, to build into being the "new social contract of science", to build a fresh house for scientific enquiry, and to remake the scientists who inhabit it.