DEVELOPING MATHEMATICS AND SCIENCE IN THE PHILIPPINES AND SOUTHEAST ASIA

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Introduction

My talk will be on my personal experience of developing mathematics and science, mainly in the Philippines, but also for Southeast Asia through the Southeast Asian Mathematical Society. It will divide into 3 parts:

1) Developing PhD programs in mathematics, physics, and chemistry in the Philippines from around 1977 to the late 1980s. This period also coincided with work for and with the Southeast Asian Mathematical Society and the establishment of strong linkages with other countries, especially Singapore, Australia and Japan.

2) Expanding the graduate and research programs with larger government support particularly through the Engineering and Science Education Program of the Philippine Department of Science and Technology (DOST) 1992-98.

3) From 2000 on, concentrating more on building up public elementary and high schools (where over 90% of Filipino children go) and connecting mathematics, science, and engineering to business and industry.

Context: Different situations in Southeast Asia

The situation is different in different countries of Southeast Asia. What differentiates countries are 1) the strength of the environment and culture encouraging serious, disciplined study and a high value for mathematics and science; 2) support and resources from government and private sector.

Very roughly, our countries divide into:

Strong culture and tradition for mathematics and science: Singapore, Vietnam – coming mainly from the shared Confucian culture and tradition

Middle Level: Malaysia (mainly ethnic Chinese) and Thailand (which has been moving up since the 1970s)

Weaker level: Philippines, Indonesia – mathematics and science tradition is weak and support from the environment is also not strong

Countries with special needs – Cambodia, Laos, Myanmar, East Timor (they have very serious problems with their educational system)

I. Building PhD programs in the Philippines in mathematics, physics and chemistry from late 1970s through the 1980s

In 1970 when I returned from graduate studies, our situation in the Philippines was as follows:

a. We had good BS programs at UP and Ateneo – at least in the sense that our good graduates would do well in PhD programs abroad

b. But graduate programs were weak, there were no significant PhD programs nor research

c. The students who went abroad for PhD's did not return. We had only 3 PhD's in mathematics and a few in statistics.

Mathematical Society of the Philippines and Southeast Asian Mathematical Society

We realized we had to do something. One of the first things we did was to organize. In 1972 we organized the Mathematical Society of the Philippines (MSP). It was a fortunate coincidence, that in the same year, July 1972, the inaugural conference of the Southeast Asian Mathematical Society (SEAMS) was held at Nanyang University in Singapore. I was able to attend the conference and this allowed us to connect with mathematicians in the region. Several Singapore mathematicians came soon after to give mini-courses, among them Lee Peng Yee, Koh Khee Meng, CC Chen and others. We also met French mathematicians and Claude Berge came in 1975 to give a summer course in graph theory. Together with this summer course, we organized a Southeast Asian Mathematics Conference. I remember Prof. Kano visiting from Japan.

In 1974 I attended a summer school in logic at Monash hosted by John Crossley. I knew John from his books and did not realize he had moved to Australia. It was a wonderful conference for me. But more important, John together with Anil Nerode of Cornell University and others became aware of the Southeast Asian Mathematical Society and the Mathematical Society of the Philippines and became frequent visitors to Southeast Asia.

The Mathematical Society of Japan began to take an interest in the work of SEAMS and Japanese mathematicians would regularly attend SEAMS conferences and workshops.

MSP and SEAMS Regional Conferences with participation from Australia, Japan and other countries

From the foundation of MSP and SEAMS in 1972, regular mathematics conferences began to be held in the Philippines and the region. There would be at least two important conferences every year. Support came from the host university/country and from universities and mathematical societies abroad. Japan and France played strong roles, especially in the early conferences. For young graduate students in the Philippines, Indonesia and Thailand, these conferences played a very strong role by introducing them to research mathematics and to mathematicians in the region and in Europe and the United States.

UP-Ateneo-De La Salle PhD Consortium

Colleagues in physics and chemistry shared the same situation and concerns and in 1975 the University of the Philippines-Ateneo de Manila University-De La Salle University consortium was formed. Among its first goals was to develop local PhD programs in mathematics, physics and chemistry.

Our problem with the PhD program was funding. We needed sufficient funds so our PhD students could study fulltime. The first source of funds came in 1977 when I received a call that the PhD program in Statistics at the University of the Philippines had extra funds and they were willing to give some for a PhD program in mathematics. It was very modest and would only support a 3-year PhD program. We decided to take the risk and begin with 5 PhD students from the three universities. Because of our situation of few PhDs who could teach, our format was to teach the coursework locally, but arrange that by the end of second year they could work with a foreign mentor either locally or abroad. Four of them finished, three did their research at Nanyang University in Singapore and one under a German mentor, Prof. Heinrich Kuhn, at the University of the Philippines.

Note: I mentioned the challenge of providing a supportive environment. During this period I and my few colleagues had to do almost everything, from teaching the graduate courses, to working out arrangements for lecturers from abroad, to getting the funds for the program and for the studies in Singapore. It was what would be called a bootstrapping period.

After two years, we began to move towards a more stable situation. The National Science Development Board (now the Department of Science and Technology) decided to provide more adequate and more stable funding for the PhD program, at least for the local expenses. This included programs in physics and chemistry. It did not, however, include funding for research visitors nor for research abroad.

International Support from Australia, Japan, Germany

Fortunately, two key links were established in 1977. John Crossley invited me to Monash for a term. During that period, we visited the Australian Vice-Chancellors Commission and asked for support for our programs. This eventually led to the Australian Universities International Development Program, which gave us regular support for visiting professors, external advisers and fellowships in Australia.

The Mathematical Society of Japan had also started inviting the Presidents of SEAMS for a visit to Japan to establish better links. I was President of SEAMS 1977-78 and was invited by Prof. Kawada, who had

moved to Sophia in November 1977. When he informed the President of Sophia University, Fr. Joseph Pittau, he was pleasantly surprised to find out that I was a Jesuit and that Fr. Pittau and I knew each other. During my stay at Sophia, he asked me if Japan had a scientific program with the Philippines. I said no. So he brought me to JSPS, whose offices were near Sophia. This led a year later to a visit of JSPS to Manila and the beginning of the DOST-JSPS program in the Philippines.

The German DAAD also provided long-term visits to the University of the Philippines (UP). Several professors, e.g. Professors Kuhn, Kaballo, and Schultze spent 5 years each at UP. They were very helpful in developing important areas of mathematics at UP.

By around 1980, we thus had a stable framework for the PhD program:

i. Funding from NSDB (DOST) for the local component

ii. Funding from AUIDP and JSPS and others for the foreign component

iii. A system of local advisers and foreign advisers

Even before the start of the JSPS exchanges, we had visitors from Sophia University in mathematics, physics and chemistry under a special program established by then Sophia President, Fr. Joseph Pittau. I remember Professor Kaneyuki coming under that program. The first visitor in mathematics under JSPS was Prof. Koji Shiga from Tokyo Institute of Technology in 1981. Prof. Mitsuo Morimoto from Sophia came in 1983. In 1987 the JSPS exchange followed what was called the "core university model." For the Philippines, the UP-Ateneo-De La Salle consortium was the core university and for Japan, Sophia University. Sophia took charge of organizing the participation of scientists from participating Japanese universities.

Development of Research Networks

Several research networks have formed from the collaboration with Japan and Australia, notably the *Graph Theory and Combinatorics* network. They established the Graphs and Combinatorics Journal, the first international mathematics journal from our part of the world. A second network is in *Algebraic Combinatorics* and a third in *Functional Analysis.* (I will leave a copy of a report of Prof. Mari-Jo Ruiz of Ateneo de Manila with details on the JSPS cooperation and the networks.)

II. Expanding Graduate Programs and Research with greater government funding through the Engineering and Science Education Project (ESEP) 1992-98.

While we were able to develop the PhD programs in mathematics, physics and chemistry in the 1980s, we realized that they were only a small beginning. New needs emerged very quickly. For example, we realized the need for better equipment for experimental work. Chemists and physicists would often have to wait for a JSPS or AUIDP research visit to run their experiments in labs abroad. We needed better libraries as well. Thus by the middle 1980s, Fr. Nebres, who led the mathematics group, and Dr. Ester Garcia, who led the chemistry group, began to look for ways to obtain this greater funding. With the new government of President Corazon Aquino in 1986, we had more access to government and

were able to establish the Philippine Council for Advanced Science and Technology Research and Development (PCASTRD) within the Department of Science and Technology. Dr. Ester Garcia became a leader in this council. Because of the situation of government funding in the Philippines, we needed external funding to be able to have the needed resources for sophisticated equipment and other needs. A new DOST Secretary, Dr. Ceferino Follosco, came along and worked with us to eventually put together a package supported by the World Bank and Japan (JBIC). The total project cost was about $100 million, 80% from World Bank and JBIC and 20% from the Philippine government.

The project ran from 1992 to past 1998. It provided larger funds for:

1) MS and PhD programs, both in the Philippines and abroad, post-doctoral fellowships and visiting professorships. The programs extended to other fields of science and to engineering.

2) Library development

3) Laboratories development and acquisition of research equipment

4) Support for high school science laboratories in 110 high schools.

The institutions in the ESEP consisted of 19 colleges of engineering, 10 colleges of science, 110 high schools.

Leadership of Project Advisory Group

A Project Advisory Group (PAG) supervised the ESEP. I was the Chair of the Project Advisory group and with me were Dr. Ester Garcia (UP Chemistry), Dr. Paulino Tan (De La Salle Engineering), Dr. David Booth (Australia, Physics), Dr. Jose B. Cruz, Jr. (Engineering, USA). The whole group met for several days three or four times a year. And the Philippine based group met much more regularly with the management team.

Getting this project started and running it showed the challenges of establishing a science and technology culture in a developing country like the Philippines:

1) We had to work to set up a structure and framework within the national science system, the Department of Science and Technology, for this larger program to be possible. This became possible after President Aquino assumed the presidency, because the science group had more access to decision-making in government.

2) Even then, getting approval for the project involved getting the support of other government departments, some initially strongly opposed to it, as well as from Senate and Congress. This required a lot of lobbying work.

3) The Department of Science and Technology had no experience in managing a project like this. The Project Advisory Group had to help set up the management system in the DOST to manage this complex project. A particular problem was that the DOST culture and the culture of universities were very different and a lot of miscommunication happened. Much needed

expertise had to be provided by the Project Advisory Group, such as in the procurement of sophisticated equipment and in connecting to research laboratories abroad.

For the most part, these problems were overcome and when we visit universities today, we see that so many of the leaders in science and engineering came from the ESEP project and so many of the research laboratories and libraries were established during this project.

Today there are stronger research laboratories in physics, chemistry, and biology in key universities. There are stronger computing facilities in many universities. Our libraries are also much better. The first internet connections were actually done by the Engineering and Science Education Project. The advance from the PhD programs in the 1980s were research labs and research groups, who now do more independent research and run stronger PhD programs. Linkages with labs and research groups abroad are also much better.

However, something we feared as we ended the project did happen. The work of ESEP was not continued. The next steps would have been to develop research laboratories and research teams that generate research on more equal terms with labs and teams abroad. A new project the Engineering Research and Development for Technology (ERDT) led by the University of the Philippines is helping achieve these new levels and I hope they achieve great success.

III. Building the Education Base and Connecting Mathematics, Science and Engineering to business and industry

By the year 2000 my analysis of the situation was that there was a new generation of mathematicians and scientists that was taking the leadership in the graduate and research programs and I turned my attention to two areas:

(1) Strengthening public elementary and high school education. This comes primarily from my belief that the deepest problem of the Philippines is poverty and inequality. It is not possible for the majority of Filipinos to come out of poverty without better education. Over 90% of Filipino children go to the public schools and, because of neglect, the situation here is extremely serious, even tragic in my opinion. About 2.4 million children enter Grade 1 every year. About 20% or close to 500,000 drop out before Grade 3. 35% or about 850,000 do not finish Grade 6. Less than half finish high school. The problem is mainly poverty and neglect. I work through two institutions, the *Ateneo Center for Educational Development*, which now has projects to help improve about 400 schools in Metro Manila and two provinces, Nueva Ecija and La Union. I chair the *Synergeia Foundation*, which works with public elementary schools in about 150 towns across the country, particularly in the Muslim areas in Mindanao. An example of the challenge is that our most recent effort now is how to provide feeding programs or school lunches for the poorest children, because they often go to school hungry. We started with just 40 children in a school. This year we moved up to 400 children in one school. Next year, we will do feeding for 1,000 children in 4 schools and we aim to eventually convince Mayors to do this in all their schools.

(2) However, I also tell my colleagues in mathematics and science that talent is distributed statistically and unless we work with these schools, 90% of that talent is probably lost. We have some initial validation of this proposition. We have started studying the test scores of the children in these poorer schools and find many who score in the top 90^{th} percentile in mathematics, despite their poverty and deprivation. We have provided special help for them and gotten them into the Philippine Science High School and into the University of the Philippines and the Ateneo de Manila. Their outstanding scores in mathematics are particularly noteworthy.

(3) The other major endeavor I am involved in is how to connect our mathematics, science and engineering programs to business and industry, to the "real world". For two years, 2008-2010, I chaired a *Presidential Task Force on Education* and a major part of my work was how to improve the connections between universities and industry. Many of the areas would not be of interest for our conference, as they involve technical-vocational education. However, we also have a serious concern on how to connect our science and engineering programs with the actual needs of business and industry in the Philippines.

For the Ateneo de Manila, for example, the mathematics department was losing the best talent to computer science and to management until we established the program in mathematical finance. Similarly, for physics and chemistry until we introduced dual majors, where they could get an undergraduate degree in physics or chemistry and in another year another degree in an applied area, like computer engineering or materials science. These programs now get some of the brightest students in the university.

For mathematical finance, although the ambition of the majority is to get into the investment and finance industry, they have to study very good analysis, probability and statistics and with some mentoring we are getting some of our future mathematicians from them. When I retire from the presidency next schoolyear, I hope also to strengthen the combinatorics and computing group and convince them that there are a lot of opportunities in industry. It would strengthen our algebra and combinatorics group.

(4) This brings me to a question Prof. Shinoda asked. Where is mathematics (and science) going in the Southeast Asian region. Regarding mathematics culture in Southeast Asia, I think it would be true to say that the dominant mathematics culture in our region leans towards applied areas of mathematics or mathematics that relates to applied areas. The exception is Vietnam, where there is a strong tradition in abstract areas of mathematics. From what I know in the Philippines, Singapore, Thailand and Indonesia, the areas with energy and vitality are those that connect with applied disciplines and with business and industry. Among the areas I know are Finance and Risk Management, Engineering, the medical sciences, marketing (e.g. the work mathematicians and statisticians do for Google), computer-generated visuals for movies and games, etc. In the medical sciences, for example, our mathematics and computer science groups worked at various times with groups in Japan on math and computing for imaging technologies. Mathematics, physics, computer science and arts students work together in projects and competitions.

> All of these applied mathematics areas have to work closely with Computer Science and Information Technology. The mathematics students specializing in them need a certain mastery of computing and partnerships with colleagues in Information Technology are essential.
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> My interest in promoting these areas is that they do create jobs and this is important for a poor country like the Philippines. But also it attracts talent to do serious mathematics, physics and computer science. The young students will spend hours and sleepless nights mastering the needed knowledge – because they need it to create something they like and enjoy. Of course, we still have the challenge of convincing some of them that their real vocation is to be a mathematician or a physicist.

In his talk, John Crossley noted the areas of research in the Sophia Mathematics Department: "Algebra (especially group representations), Analysis, Geometry, Statistics, Biomedical Mathematics (to me this subject has at least two meanings: biomathematics and statistics, but now also embraces string matching), Manufacturing Systems Engineering, Information Systems, Library Science, Neuroscience, Pharmacology, Computer Networks, Databases, Educational Technology, Perception & Robotics."

It does seem that the Sophia University Mathematics Department has the research groups to connect with this interest in mathematics connected to applied areas. I did not include Educational Technology in my earlier list. But Dr. Mercedes Rodrigo of the Department of Information Systems and Computer Science (DISCS) of Ateneo de Manila is leading a research group in educational technology and I am sure she would be very interested in collaborating with colleagues at Sophia.

Following some of the lines of thought in John Crossley's paper, I wonder if we could explore work with Sophia University in the areas of mathematics/science and computing. In some of the strategic planning meetings of the Ateneo de Manila science groups, we have explored *computational science* as an area of specialization. It is a practical consideration for us. For example, the Philippines does not have the resources to do a lot of first-hand research in, say, neuroscience or medical imaging. But we could take the data obtained by research groups in Japan and do the computational work. We actually did some of this type of work some years ago. Some colleagues at the University of the Philippines have done initial work with colleagues in Vietnam on, for example, inverse problems and imaging. The general direction follows from the thoughts in John Crossley's paper. My experience is that a lot of young people would find interest in these areas.

Some Concluding Thoughts

The report of Dr. Mari-Jo Ruiz entitled "Networking through the Japan Society for the Promotion of Science" relates how much has been achieved through collaboration with Japanese colleagues made possible by the JSPS. Sophia University, as the core university for this exchange, played a very key role in these important developments. Allow me to quote from her conclusion:

Success Factors and Measures

From 1987 to 2000, a total of fifty-two short term visits were made by Filipino mathematicians to Japan while Japanese mathematicians made sixty-one visits to the Philippines (Appendix 1). A complete documentation of the exchange from 1979 – 1986 was not available. The list of publications arising from the exchange and the volumes of lecture notes published since 1984 (Appendix 2), the networks formed, the conferences organized, the working relationships and personal friendships that developed, the joint work between Filipino and Japanese mathematicians that continues by way of papers, projects and conferences, - - all these attest to the success of the exchange. The records show similar success stories in the other areas served by the exchange - - Biology, Chemistry and Physics.

There were minor problems encountered during the exchange, but the objectives of the exchange were achieved inspite of them.

Among the factors that contributed to the success of the mathematics exchange, I would include the following:

1. *The vision and personal care of those who administered the exchange at the start - - Kawada, Shiga, Nebres, Morimoto.*

2. *The judicious choice of participants from both countries - - the established Japanese professors, the mature and focused Filipino mathematicians.*

3. *The convergence of the goals of the JSPS Exchange Program and the UP-ADMU-DLSU Consortium.*

4. *The personal interest of the participants - - their openness to working in a different culture and their appreciation of that culture.*

The graph theory network and the algebraic combinatorics network came together for the ***Conference on Algebra and Combinatorics*** *in March 2006. The comments from Japanese participants at that conference show that the exchange has remained faithful to the vision of Kawada. Mathematics cooperation began, survived and continues to flourish with friendship: Shinoda, commenting on the conference itself said*

> *"I realize that this conference is all about love and friendship."*

Akiyama, commenting on long-term interaction said

> *"I learned . . . not only mathematics, but life - - kindness, faithfulness, and above all, care for others."*

REFERENCES

Nebres, B.F. & Intal, M. G. (July 1998). *Science and technology policy and program innovations and the social sciences: The case of the Engineering and Science Education Project (ESEP)*. Plenary address at the National Academy of Science and Technology Annual Scientific Meeting.

Nebres, B.F. (November 1998). *The University of the Philippines – Ateneo de Manila University – De La Salle University consortium in science and mathematics*. David C. Lam Institute for East-West Studies (HKBU-LEWI) International Workshop on Academic Consortia. Hong Kong.

Ruiz, M. P. *Networking through the Japan Society for the Promotion of Science*, 11-12. Quezon City, Philippines.