ACHIEVING SCALE in S&T HUMAN RESOURCES

LOOKING BACK, LOOKING FORWARD
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LOOKING FORWARD: What is our MAIN S&T HUMAN RESOURCE CHALLENGE

- The major bottleneck to our moving forward in scientific research, at least in mathematics and natural science (which I know best), but probably also in other scientific and technological fields, is:
- **NUMBERS. We simply do not have enough high-level mathematicians and scientists.**
- This is felt in R&D and MS/PhD programs such as ERDT or PCARI or DOST Research Councils
- We also cite UN norms for numbers of scientists for developing countries.

So WE NEED PhD programs in more cities and universities

- We have still very few Universities with departments that have good PhD programs in Mathematics & the Natural Sciences.
- In Mathematics, they are not very different from the departments that emerged in the 1980 – 1995 period (which is 20-35 years ago): UP Diliman, UPLB, Ateneo, De La Salle, MSU-IIT, UP Baguio and a few others.
- We need to develop or strengthen PhD programs and research in university cities: Cebu, Iloilo, Davao and expand in Baguio

What FORCES lead to DEVELOPMENT of MORE PhD/ RESEARCH DEPARTMENTS/PROGRAMS?

The development of science & mathematics in other countries came from 2 FORCES:

Force 1: A committed group of academic scientists determined to build their disciplines.

This is the story of the UP-Ateneo-De La Salle PhD Consortium beginning in the late 1970s

Force 2: Support from the larger society, notably from universities and the government.

The story of the Consortium tells us that earlier support was hard won. First, from NEDA and later from NSDB/NSTA/DOST.

External Support is needed: but INTERNAL DRIVE comes first

- We usually cite the second force: support from society, from the government and from the private sector.
- But my assessment is that we need to look more closely at the first force: committed groups of scientists, who will work to build their disciplines.
- It is not just a question of getting more funds for PhD students or for research.
- If equivalent funds were offered to our colleagues in Vietnam, there would be more takers.
- It is also interest and culture: **INTERNAL DRIVE**

So we begin with:
1) ORGANIZED GROUP OF SCIENTISTS;
then 2) WORK FOR SUPPORT

This proposal is then two-fold:

1) For scientists in other cities/universities to organize themselves to develop PhD programs.

2) To get the support of their universities
For CHED and DOST to create a PhD Development Fund

But the key driver *(as in the UP-Ateneo-DLSU consortium)* >> a determined CORE GROUP of scientists and academics.

SUPPORT FROM OTHER UNIVERSITIES: LOCAL AND FOREIGN

- There is also need for assistance from other universities, local or international.

  In the consortium, this came first from Nanyang University in Singapore, then from the Japan Society for the Promotion of Science (JSPS) and the Australian University International Development Program (AUIDP)

- This assistance is particularly needed for PhD mentoring and research

  Today a program starting, for ex. in Cebu or Davao, can look for initial support from a local university and then get connected to the international network through the local university

BUT MOST IMPORTANT >> GOOD STUDENTS

- Identify and recruit good students
- The most important starting point for a PhD program:
  NOT the curriculum BUT capable, talented students
- It is particularly important that the first batches should be strong, since they will set the culture and standards for the future of the program
- They must study FULLTIME
- There is more funding available for fulltime studies today

BEGIN with the END in MIND: RESEARCH AREAs

- The PhD program should start w determining the research areas for the PhD
- Not like the usual way: begin with setting up the coursework and the comprehensives.
- In the consortium, we determined the areas in:
  > MATHEMATICS (graph theory&combinatorics, algebra, functional analysis)
  > CHEMISTRY (organic chemistry),
  > PHYSICS (laser physics).
- In time, they expanded to other fields.
- From the beginning, we identified the research mentors: local & foreign
- As Covey says: BEGIN WITH THE END IN MIND.

HOW ABOUT COURSEWORK & COMPS

- Common coursework should be "What every mathematician, physicist, chemist, biologist should know" and should be basically done in the FIRST YEAR
- SECOND YEAR should already include:
  - > courses geared towards research,
  - > seminars on possible research topics, and
  - > preparation for the comprehensives
- COMPS should be finished by end of second year.

All the above ASSUMES that one has GOOD students – with GOOD PREPARATION

CONDITION of POSSIBILITY: TALENTED & WELL-PREPARED STUDENTS

- Students should have two (2) full years for the PhD thesis research
- With a year abroad, through sandwich program grants from CHED and DOST as well as funding from partner departments abroad.

- BUT AS YOU CAN SEE, THIS WILL ONLY WORK IF THE PhD STUDENTS ARE GOOD AND WELL-PREPARED.
- WHICH BRINGS US TO THE MAIN BOTTLENECK IN DEVELOPING HIGH-LEVEL S&T HUMAN RESOURCES IN OUR COUNTRY >>
- **THE QUALITY & PREPARATION OF OUR GRADUATE STUDENTS**

TO HAVE TALENTED & WELL-PREPARED GRADUATE STUDENTS

- We need to have good undergraduates and good BS programs
- BUT to have good undergraduates and good BS programs,
- We need to have a stream of good students coming from High School.

LEARNING from VIETNAM

We cite Vietnam, which we are told sent 2,000 for PhD studies abroad in recent years.

- The lesson we emphasize is to ask our government TO LEARN from VIETNAMand PROVIDE FUNDING for a similar effort.
- BUT: One of the reasons why Vietnam could do that is that it has a very large number of young people who qualify for high level PhD's abroad.
- Consider the performance of Vietnamese high school students in the most demanding international comparative assessment study, namely:
- **PISA: Programme for International Student Assessment**

PISA: VIETNAMESE HS students OUTRANK US, AUSTRALIA & UK

- **2012**: Vietnam first entered PISA (Programme for International Student Assessment) tests in 2012 - coming 17th in maths, 8th in science, 19th in reading
- Higher than the US in all subjects. US was ranked 36th at maths, 28th at science, 23rd at reading
- **2015**: In PISA **global ranking** published by the OECD in May 2015, based on science and maths, Vietnam was ranked 12th, while the US was in joint 28th.
- *Vietnam has outranked the United States, Australia, and the United Kingdom.*
- *In doing so, Vietnam has become an exception to the argument that educational excellence is not possible without a high level of economic development.*

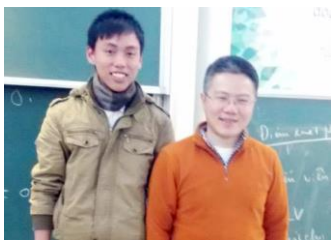
VIETNAMESE MATHEMATICS & SCIENCE CULTURE

- It is not primarily about economic development.
- It is about a culture of academic achievement, of high expectations of student achievement in mathematics and science from parents, teachers, all of society.
- Our performance in TIMSS has been so poor, that we do not even try PISA.
- I have known Vietnamese mathematicians since the early 1970s. They have an outstanding mathematics culture, beginning at the elementary, high school, university level – on to research.
- They carried out this work even during the war with the U.S.

VIETNAMESE awarded the FIELDS MEDAL:
The MATH Nobel Prize

Ngo Bao Chau, (born June 28, 1972)
in Hanoi, North Vietnam
Vietnamese mathematician
(graduate studies and research in France)
who was awarded the Fields Medal
in 2010 (at 38 y.o.)
for his work in algebraic geometry, specifically
"his proof of the Fundamental Lemma in
the theory of automorphic forms."

Two Vietnamese students who won gold medals at the 2015 International Mathematical Olympiad (IMO) are from poor families.



NGUYEN THE HOAN:
GOLD MEDALs in IMO* 2014 & 2015

Hoan was born into a poor family in Thai Binh province. Besides field work, his parents work as assistants to construction workers to support Hoan and his brother, and fund their studies.

Nguyen Thi Thanh, Hoan's mother, said with 1/10 of a hectare of rice fields, the field work is not enough to feed four mouths.

Therefore, Thanh and her husband decided to take extra jobs in Hanoi from which they can earn VND 6-7 million more every month to support Hoan's and their other children's studies.

Hoan passed the entrance exams to three famous high schools, but he decided to study at the Hanoi National University's High School for the Gifted, where his idol, Professor Ngo Bao Chau, a Fields medal winner, once studied.

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*IMO: International Math Olympiad

VU XUAN TRUNG

The second golden boy of the Vietnamese competition team is Vu Xuan Trung, a 11th grader at the Thai Binh provincial High School for the Gifted.

Born into a farmer family with five children in Lich Dong hamlet of Thai Binh province, Trung and his siblings led hard lives. Four of Trung's sisters only finished secondary school and they had to stop learning to help their parents with their work.

Trung's father is a lock repairman, while his mother runs a small grocery. Their income is enough to feed the seven family members.

However, Trung has always been an excellent student. When Trung was a fifth grader, he won the first prize at the national math competition for children.

When he was at secondary school, he got first prize at the provincial math competition. He won the second prize at the national math competition when he was in the 11th grade and then the gold medal at the 2015 IMO in Thailand.

We can emulate Vietnam in the INTERNATIONAL MATH OLYMPIAD

- From 2011 to 2015, Philippine ranking has improved: 54, 73, 53, 45, 36
- Vietnam 2011-2015: 31, 9, 7, 10, 5
- We have yet to win a Gold Medal. Vietnam has won 54.
- From Vietnam's experience we can see that many of our future gold medalists will come from poor pupils in the public schools
- **BUT we have to face the reality that in the National Achievement Tests in High School, the high school average over the last many years in math, science and English has been about 40%.**

So we need to IDENTIFY TALENT at the GRADE SCHOOL LEVEL EARLY & NURTURE IT

- The major challenge in developing future mathematicians and scientists at the grade school and high school level is not so much lack of high level courses, as lack of fundamentals.
- For mathematics, fundamentals means doing **real problem-solving, not just exercises**
- For physics or chemistry or biology, it means doing **real experiments, not just demonstrations**

PROBLEMS vs. EXERCISES

- *An **exercise** is a question that tests a student's mastery of a narrowly focused technique, usually one that was recently "covered." Exercises may be hard or easy, but they are never puzzling, for it is immediately clear how to proceed….*
- *In contrast, a **problem** is a question that cannot be answered immediately. Problems are often open-ended, paradoxical and sometimes unsolvable, and require investigation before one can come close to a solution. Problems and problem-solving are at the heart of mathematics."*
  - Paul Zeitz, "The Art and Craft of Problem-Solving".

PROBLEM-SOLVING & EXPERIMENTs

- In Mathematics: we usually give Exercises, meaning problems that can be solved using techniques we have taught. Real problems are those where we do not know what to do – we have to try several things, experiment, make mistakes – and often they take hours or days.
- In the Sciences: it is the difference between demonstrations and experiments. We usually do demonstrations. Experiments, like problems in math, demand trying various approaches, making mistakes and taking a lot of time.

ATENEO SUMMER PROBLEM-SOLVING SEMINAR; COACHING GRADE SCHOOL & HIGH SCHOOL

- Dr. Queena Lee- Chua and I started a Summer Problem-Solving Seminar with Freshman and Sophomore Ateneo College students over 10 years ago. There is an excellent book, "The Art & Craft of Problem-Solving" by Paul Zeitz which we have been using.
- We then get the students who have taken this course to coach Ateneo Grade School and High School students. And over the years they have developed a collection of challenging problems which can be used at Grade School and High School level.

A MODEST PROPOSAL

- It would be wonderful if we could develop a **cadre of High School mathematics teachers** who could be teachers and coaches for problem-solving.
- To get there, we have to help teachers overcome the fear of not knowing how to solve a problem.
- I tell them that I sometimes go through problems in our summer class, where I do not know how to solve them either.

Caring for the ROOTS & TRUNK of the S&T TREE

- As I said in my paper in your kits, we tend to focus on support for the leaves and the fruits of our S&T tree : PhDs, research, publications.
- We need to look as well and care for the roots and the trunk: the identification and development of a stream of talent from grade school, high school onwards.
- This will not happen without determined effort.
- Philippine culture in general puts high value on learning English well (I think that sometimes we value fluency even if the quality of thought is not particularly good).
- We are rather accepting of weakness in mathematics and science (*reinforced in media by entertainers who further devalue this trait by always laughing about it rather than working to improve it.)*

TO SUM UP: the NEED to BUILD a SYSTEM

THAT WILL:

- Identify talent at least by intermediate grades (5 & 6) and through high school.
- Have a program for mathematics problem-solving with them.
- Have a program for experiments in the natural sciences for them.
- Inspire them to pursue science and engineering in university.

BUILD A SYSTEM

THIS SYSTEM WILL REQUIRE:

- A cadre of teachers who will make it a mission to carry out 1 to 4 above
- career path for these teachers with recognition and reward
- But the **FIRST STEP** is to have a group of mathematicians and scientists dedicated to developing these teachers