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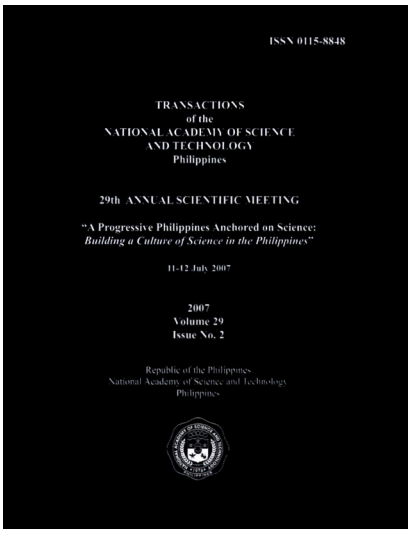

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This presentation is by no means a roadmap with a clear-cut layout of the road ahead and the street network of which it is a part. Neither is it a map drawn from welldefined, compass-based directions and agreements on how the distance traveled at whatever point the Philippines is on the map will be measured. That we are only drawing roadmaps now says much about our condition. Some of our neighbors drew such maps many decades ago, explaining in part why they have achieved what they did. The experience of Vietnam at the height of the war is particularly instructive.

In a collaborative project in 1999, Vietnamese colleagues from my generation, who themselves obtained doctoral degrees from England or Germany quietly but persistently rejected our proposal to bring into the team Vietnamese scholars with doctoral degrees from Europe or the US, who were recommended to us by respected European and American colleagues. We did not understand the resistance at first because the team they eventually constituted consisted of Western-trained Vietnamese social scientists. To get our project moving, we just resigned ourselves to the idea that our Vietnamese partners were simply more comfortable with those from their own networks.

Only when our relations warmed in the course of the project did our Vietnamese counterparts explain their initial stance towards the scholars in our list. Every year since Vietnam established relations with Russia, after the United States accordingly refused to support its nationalist war against the French, the 500 high school students from all backgrounds who excelled in the national examinations each year were sent either to Russia or the Eastern European nations for higher education. They were ordered to excel in the fields they were in---the natural and yes, even the social sciences. They were expected to learn the language of their schools within

six months and, even tougher than this requirement, were not allowed to obtain grades lower than the highest grade in the university where they were assigned. Their collective task was to ensure that everyone in their cohort made the maximum grade. They could not possibly get lower marks when their countrymen were dying.

At the height of the Vietnam War, their nationalist leader, Ho Chi Minh, sent the best and the brightest Vietnamese out of harm's way and told them that they ought to see themselves as soldiers at war for Vietnam (our colleagues claimed their brothers did not die for communism during the war but for their nation). They had to aspire to be great scientists because their mission was to rebuild Vietnam when (not if) they win the war. These Russian-trained scholars went on to study in Europe (now they also study in the United States) for their postgraduate degrees. They returned to Vietnam to build the research institutes of their country. Against this backdrop, it was easy to see why our project partners refused to even consider our list of Western-educated Vietnamese who did not go through the route of the country's best. They admitted feeling superior to those from the same generation in our list who merely obtained doctoral degrees abroad but did not go through the "Russian hardship post".

Interestingly for these colleagues, the war they are fighting now is global competitiveness. Our project with the Vietnamese in 1999 aimed to assess a new mode of donor-supported research, a symmetric North-South model where the donor had no say in the choice of projects as opposed to the usual asymmetric university-based research capacity building program. The only requirements under the new mode were for the science community to formulate a research agenda relevant to the development of Vietnam and for this agenda to be developed in close collaboration with other stakeholders. There is no question that our Vietnamese colleagues appreciated this participatory, development-oriented mode of research capacity building. They, however, told us on the side that their personal adherence to a symmetric and participatory donor supported research capacity building would not stop them from accepting grants under a more traditional asymmetric mode of North-South research collaboration. All they cared about at this point of their history they said, is to upgrade their research capacity regardless of how it is to be done or what kind of relations they would have with the donors. They know, after all, what they want to get out of them and did not foresee the possibility of being vulnerable to Northern domination. As far as they were concerned, Vietnam has vowed to use science to propel it to win the global economic war and its leadership will use all the means to get there.

The Vietnamese are already winning! Their stance towards their country's development and their deep love of nation (that our colleagues

claimed would make them fight any force that encroaches into their space, whether it is China, Russia, or the United States) accounts for the value of science and scientists in the minds of the country's general public. It also explains why at the height of the US-Vietnam war, they continued to translate the best scientific books and articles into Vietnamese. No wonder they are topping the Mathematics Olympiads. That the mission for scientists and professionals is clearly passed on to the younger generation is manifested in their performance in international scholarship competitions. In the Asian Scholarship Foundation' review of humanities and social science proposals from young Southeast Asian scholars of which we were a part, the Vietnamese applicants used to be within the ambit of affirmative action just a few years ago; now they are among the best applicants. This remarkable change resonates with the experience of Vietnamese students in our own Asian Institute of Management as told by an AIM professor to a colleague. As a group, they usually start out among the poor performing students but end up among the top, come graduation time.

Unlike Vietnam, we do not have a nationalist visionary like Ho Chi Minh to imbue us with the mission of building this country through science, and the culture that it thrives in. Our visionary, Jose Rizal, the Renaissance Malay who was himself a man of science, has extolled us to greatness, but succeeding generations of leaders have not impelled us to put our act together in the context of a modem era for the sake of our nation. Our impetus to do something about our situation has come from diffused sources. More often than not, it has worked through negative psychology--our dismal performance in math and science competitions and exams; our lack of development despite a misplaced sense of superiority over counterparts in our region (with very little English skills) whose countries have began to develop much faster than us; the economically precarious existence of scientists and the muting of their social criticism because of their status in the hierarchy of public values; the debasing of professional natural and social scientists who, as Czarina Saloma-Akpedonu (1) pointed out in her paper yesterday, are made to answer trivial questions like--" Why do Filipino men urinate in public spaces?" Why are we fond of "tingi" (sachet marketing)?" "Why do starlets not wear underwear?" Why is bayanihan no longer being practiced these days"?; or dire warnings about our future such as that expressed in the Inquirer editorial in 1999 which says:

> "as a nation then, are we forever consigned to backwardness and pre-modernism, bound to commit errors of judgment and short-sightedness because we have failed to develop a scientific attitude that can explain the world and all its vagaries?" (2)

The Vietnamese experience demonstrates the need for a strong resolve to draw for our country, a roadmap for building a science culture in general and science and mathematics education, in particular. More importantly, it highlights the need to focus on formulating and implementing concrete plans of action.

This presentation attempts to draw some of the premises and contours of a roadmap from several sources: the rich and nuanced discussion of various issues in the Social Science Technical Session yesterday, the keynote speech of Father Ben Nebres in this Annual Meeting (3); and the insights from successful projects that include the Bemidos' experiment in Bohol (4) and other ideas about building a science culture that have been repeated in several annual scientific meetings of the NAST.

Let us now move to a few premises that those tasked with drawing the roadmap can draw upon. In discussing the premises, we shall cite developments that augur well for drawing concrete curves and lines in our future roadmap. Indeed, there are other premises but our time is limited so we will just focus on what to us are the more salient ones. Since the relative absence of a science culture is a social problem, we draw on the insights of social scientists in general, social scientists in yesterday's Technical Session in particular, and natural scientists in this forum who have an intuitive understanding of culture as a human condition and appreciate the need to bring "people" into scientific practice.

Premise 1: Science Culture is reflected in a mode of thinking and being that focuses all solving problems

Many of the vagaries we experience are a function of our lack of knowledge of the structures that bring them about. A scientific attitude, as sociologist Raul Pertierra would put it, is likely to result only if the world is perceived in certain ways (e.g. as unambiguous realities that unfold with some regularity and predictability) (2)

A scientific attitude draws from a much broader culture which is still evolving for us. What does it mean to build a science culture?

Drawing from the presentations in yesterday's Technical Session (social science) and Father Nebres' speech (3), a science culture prevails when people are able to

- assess whether or not a personal experience responds to questions of validity and replicabililty (1);
- distinguish the transcendental from the mundane; specialist knowledge from lay knowledge; opinion from fact; fiction from reality (1);

- because they have developed critical thinking (6);
- Keep their minds open to other ideas and, more importantly, pay attention to what others say (6);
- abide by the basic principles that underlie the scientific enterprise-intellectual honesty, sense of excellence, innovativeness, evidence-based conclusions, verifiability (7);
- come together to devise solutions in the form of abstract theoretical formulations and, equally, if not more important for a developing nation, solutions to concrete problems (3)

While analyzing problems towards their solutions is part of the culture of science, many of us think linearly: we think the more applied fields are inferior to the pure and theoretical disciplines, unmindful at times of the potential and actual contributions of practice or application to the development of theory. Dr. Gelia Castillo's inspiring reflections on her work and engagements highlighted a life dedicated to science in the service of ordinary people. Without undermining the importance of "pure" or "theoretical science", her plea is for more interdisciplinary (or multidisciplinary, transdisciplinary) research focused on solving concrete problems of concrete people, e.g. agricultural productivity, health concerns, or even connectivity.

In the 1990s, a team of scientists led by M. Gibbons codified this mode of knowledge production and called it Mode II in contrast to Mode I which we are familiar with. The following describes each mode of research (7):

> Mode I: is university-based with standards of research and evaluation determined by disciplinal concerns and hierarchies; In an ideal depiction of this mode, problems are set and knowledge produced in a context governed largely by the academic interests of specific communities. These communities are organized disciplinally and. lodged in artificially delineated academic departments. Within these homogenous disciplinal communities, knowledge is produced along dominant theoretical and methodological paradigms. Quality is determined through a peer review process, an effective form of cognitive and social control, reinforcing a discipline's definition of what problems and techniques are deemed important to work on. Finally, disciplines are organized hierarchically, with the basic disciplines presumed to develop or discover the theories to be adopted by the more applied fields. In the ideal typification of this mode of knowledge production, research utilization is not of primary interest to an academic. Understandably, within this framework, the user is relegated to the end of a knowledge production process, which researchers often have no compulsion to see through. For, theirs is the singular task of producing theories and concepts and evolving methodologies.

Mode 2: is demand-driven, multidisciplinary and less hierarchical This alternative mode of knowledge production is said to characterize the evolution of research areas at the frontier of science and technology such as computers, materials, biomedical and environmental sciences, fields that essentially produced demand driven knowledge lying in the interstices of academic disciplines. In the social sciences, development studies, which cannot be encompassed by any discipline lends itself more easily to the alternative mode. This mode consists of cognitive and social practices carried out in the context of application to a concrete problem. The practices transcend the theoretical and methodological positions of collaborating research partners from different branches of knowledge and disciplines, are organizationally less hierarchical, and tend to be more transient. In the course of understanding a problem, researchers go back and forth between the 'fundamental and the applied, the theoretical and the practical... the curiosity oriented and mission-oriented research'. Being locally driven and constituted, the alternative mode of knowledge production is sensitive to local contexts, committed to the involvement of users not only in the dissemination of findings but also in the definition of the problems and the setting of research priorities. It recognizes the existence of multiple knowledge sites and views the scientific practices lodged in universities as one of many sites that are brought together in the search of solutions to particular problems. Finally, quality is assessed not only in terms of technical merit but also the usefulness or relevance of the knowledge produced. As a consequence, the emergent research practices are more socially accountable and reflexive (Figure 1).

Figure 1:

Modes of Knowledge Production

MODE 1

- Research determined by academic interests
- Disciplinal and university-based
- Hierarchical organization following the hierarchy in disciplines
- Quality determined by technical merit through peer review
- Research utilization desirable but not necessary

MODE 2

- Research determined by the need to solve concrete problem/s
- Multidisciplinary; recognizes multiple sites of knowledge production
- Less hierarchical and transient
- Quality determined by technical merit and relevance
- Research utilization is of primary importance

Premise 2: If a problem-solving science culture in the science community will be the focus of our efforts in the next ten years, it is important to note that building a culture of science outside our epistemic community is neither a sequential nor a once-and-for-all event. While a roadmap should connect all the strategies, the process can proceed on various fronts. If the roadmap is clear, the momentum of intended and unintended changes will hopefully move in the direction we wish to take.

Dr Castillo's plea (6) for interdisciplinary approach can be translated into a plea for us to look at our lack of a science culture as a major social problem to solve. As far as developing our roadmap is concerned, we (natural scientists, social scientists, educators) would need-to move into the second mode of knowledge production to thresh the major issues at various levels—basic science education, science education at the tertiary level, science education of the public. All fronts have to be covered.

It is a plea for social scientists, in particular, to be grounded in their disciplines yet to open their minds to developments outside their disciplines. It is a plea for more of us to move easily from one quadrant of Burawoy' s practices of the social sciences that Saloma-Akpedonu (1) cited in her paper yesterday to another but to pay special attention to both policy social science/participatory research/action research. Just to give you an idea of Burawoy's quadrants:

Using sociology as a focal point (although the focus may be broadened to the social sciences), Burawoy posits that the practices of professionals in the discipline can be categorized in terms of audience and the type of knowledge produced. The audience may be academic or extra-academic and, knowledge, instrumental or reflexive. As expounded in Saloma-Akpedonu's paper (1),

> "public social science brings it into a conversation with publics, understood as people who are themselves involved in conversation. Policy social science is in the service of a goal defined by a client. It provides solutions to problems or to legitimate solutions that have already been reached. Professional social science supplies true and tested methods, accumulated bodies of knowledge, orienting questions, and conceptual frameworks. Critical social science examines the foundations - both the explicit and the implicit, both normative and descriptive - of the research programs of professional sociology. It ensures that the stability of sociological frameworks and practices is often subject to periodic rupture or revolutions by making professiona social sciences aware of its biases and by promoting new or alternativ

research foundations" (Figure 2).

The Technical discussion yesterday focused on the public's understanding of social science and how this can be enhanced---through responsible use of the media and more particularly, through effective teaching. Focusing largely on higher education, the discussion touched on the usual structural constraints we have decried about as educators in higher education (the budget for education in general and science education in particular, the low salaries of scientists, the heavy teaching load that constrain research). Surely, these constraints have to be addressed as part of the roadmap.

Audience / Knowledge	ACADEMIC	EXTRA-ACADEMIC
Instrumental	Professional	Policy/Participatory Development/ Action-Oriented
Reflexive	Critical	Public

Figure 2. Typology of sociologies. (modified table of Buramoy, from Bautista, 2004 (8).

Premise 3: At the level of basic science education, there is a wide array of effective interventions to consolidate and learn from as we lay the groundwork for a science culture

In his keynote address, Father Nebres mentioned several bright lights in the dark firmament of basic science education. Let me quickly resonate with his thoughts on the lessons from big programs in education reform. The Third Elementary education Project, which Father Nebres cited in his keynote speech, succeeded remarkably in improving the education landscape of 23 poor provinces (9). Pupils from TEBP schools performed extraordinarily well. Even their weakest schools, the multigrade schools in remote areas, performed better than their counterparts in other parts of the country. The project affected about 1.7 million elementary public school children in all the schools (about 8260) in the 23 Social reform Agenda provinces which were deemed to be the poorest during the Ramos administration and which leads us to say it is the biggest social laboratory

DepEd has ever created. It

- **transformed the mindsets** of those who actively participated in the reform experiment;
- **proved the immense wisdom of trusting school heads and teachers,** who possess the best information on what goes on in their schools, with the responsibility of turning them around;
- **awakened and mobilized parents, communities, and local officials** to invest time, energy and resources in the fulfillment of their schools' mission for the future of their children; and
- **produced leaders at all levels of the organization and across functions with the capacity to manage change, providing them a positive, nurturing and liberating environment that allowed for mistakes while innovations bloomed.** By the time TEEP closed, these leaders had proven capacity to plan, organize, and direct components/units with the necessary zeal and flexibility of mind to carry out a gradualist but nevertheless radical approach to education reform;

All told, TEEP was a Low Cost-Reform amounting to only P 806 Per Pupil Per Year Over 8.5 Years. It is also heartening, from the presentations in the 7–8 July 2007 Karunungan Festival, that the TEEP schools are sustaining their efforts despite the end of the project in 2006.

To put educators in poor public schools in a position to begin exploring various methods of teaching mathematics and science and experimenting with them, presupposes that they appreciate change. We would argue for the necessity of large-scale interventions to lay the groundwork, for science and mathematics education of the learner centered, activity-based, science oriented variety espoused by the Bernidos (at the school level), BEAM (at the division-and province levels) or our academicians and scientists. In fact, we are tempted to say, the interventions need not aim for the ideal. Even just stirring the air can do wonders. As Father Nebres remarked in his presentation at the 7–8 July Karunungan Festival, imposing new ideas on teachers, no matter how great, would result in their adopting the ideas initially (for compliance's sake) but returning to their old ways of doing things unless they themselves, as engaged participants in the reform process, see the need for adopting the idea. If there is any lesson from the TEEP experiment, it is that teachers, who because of decentralization, have enjoyed the freedom to experiment in the classroom and discuss their experiences with other teachers in a setting where change is in the air, would have such strong craving for new ideas that they themselves will demand exposure to new ways of doing things.

Abstracting from the TEEP experience, such interventions may be effective if the following features are found:

- it is on a scale that can make a dent
- it is decentralized and school-based (as such opening what Father Nebres calls "open spaces for innovation"
- its starts from where the schools (teachers, principals) are rather than where they ought to be (which was related to an issue raised in the Technical Session yesterday, the need for scientists from imperial Manila to be sensitive to the situation in Mindanao, particularly Muslim Mindanao)
- it gives ample opportunities for these actors to learn by doing and to open their minds to other ways of doing things;
- the best way to develop capacity is to be immersed in the activities that would build it up ... "'learning on the run", "dirtying one's hands", "solving problems" and "reflecting on processes" are the best way for reform programs to move forward.

In conclusion, allow us to reiterate our statements in a paper presented in the OYS Conference two days ago:

> "In the recently concluded Karunungan Conference, Father Nebres and other speakers stressed the need to shift to a problem solving mode, particularly in science and math teaching, that would enhance the learning of important ideas, concepts, and theories in the classroom. This dictum, however, holds as well for the bigger social laboratory of education reform. While existing theories may enlighten the change process, such theories ought to "roll down" through the terrain that has to be transformed, and, if need be, be radically revised. This view presupposes that social transformation cannot be imposed from the outside; the whole point of reform is to enable actors on the ground to participate in the changes that govern their lives.
>
> In light of this perspective, keen interest in the development of a science culture cannot be generated from above by scientists working in elite institutions of higher learning. Nor can it grow out of our conference resolutions, no matter how eloquently expressed. The need for science and the integration of its culture into everyday life must be realized and felt by those who directly shape the mindset of children, especially the majority studying in our public schools. The role of reformist interventions is to cultivate the soil so that more effective theories and pedagogies of learning science and mathematics can be planted and grow. If the soil is tilled, scientists may not even have to tell educators on the ground to adopt new strategies. Teachers and principals will walk the extra mile to look for new theories and methods once the ground is cultivated and they are all fired up. Under these circumstances, the role of scientists like us is to link or expose

these educators to teaching practices that are not only desirable, but that work, unless of course the educators, through their own initiative, have found the necessary links even before we reach them".

As for higher education, the people in this audience have written so much on how to improve the state of science teaching and learning. We have barely touched the surface.

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Endnotes:

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