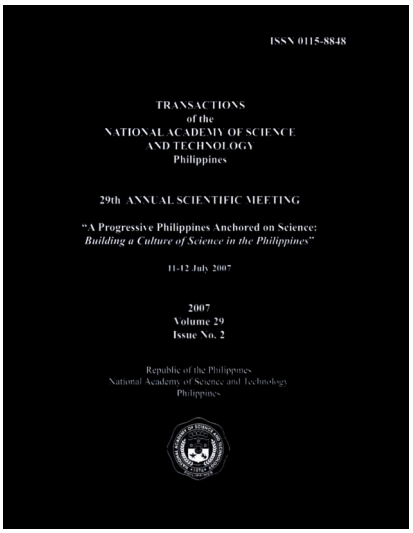
TRANSACTIONSNASTPHL
ISSN 0115-8848 (print)
ISSN 2815-2042 (online)
https://transactions.nast.ph
Vol. 29 Issue No. 2 (2007)
doi.org/10.57043/transnastphl.2007.4492



Roadmap for Developing a Culture of Science Through Effective Basic Math and Science Education

Evelyn Mae Tecson-Mendoza

Chemical, Mathematical and Physical Sciences Division
National Academy of Science and Technology and
University of the Philippines Los Baños

Citation
Tecson-Mendoza EM. 2007. Roadmap for developing a culture of science through effective basic math and science education. Transactions NAST PHL 29(2): 341-347. doi.org/10.57043/transnastphl.2007.4492

Trans. Natl. Acad. Sci. & Tech. Philippines 29: 341-347 (2007)
ISSN 0115-8848

Roadmap for Developing a Culture of Science through Effective Basic Math and Science Education

Evelyn Mae Tecson-Mendoza
Chemical, Mathematical and Physical Sciences Division
National Academy of Science and Technology and
University of the Philippines Los Baños

Culture of science has been defined in different ways. One definition says that people with a culture of science, including the young ones, are more exploring and not passive in getting information and ideas. Another says that these are people who have become not only qualitative but quantitative as well in describing and explaining things and are more creative and innovative. They are a problem-solving people. A country has imbibed a culture of science when decisions of institutions including government are based on evidence and science, and when science has become a way of life for its people.

Towards building a culture of science in the country, our division has focused on the basic math and sciences for the elementary and high school since these are the foundation of higher science and technology education. Even students who eventually major in other fields should have a strong foundation and appreciation of basic science and mathematics and should have been exposed to the analytical and critical thinking involved in such subjects. The CMPSD held four pre-Annual Scientific Meeting (ASM) round table discussions (RTDs) on mathematics and science initiatives, mentoring, science careers and strategies in science and math education and held a technical session during the 2007 NAST ASM.

We hereby summarize the challenges and strategies and possible solutions to the strengthening of basic math and sciences in the country towards building a culture of science.

Increasing Competency and Science Content

It was a recurring observation that many teachers are not majors of the courses they teach, for example, a biology teacher teaching physics or chemistry and vice versa. Competency in the subject matter is weak or

worse, lacking. Among the suggested solutions are:

(1) Increasing the science content in the pre-service. During one of the round table discussions, a representative from the Commission on Higher Education said that the science content of education curriculum is going to be increased. This has to be to be confirmed.
(2) Inservice training should be further promoted for those who are already teaching.
(3) There are also many students who take up BS in various science fields (Math/Biology/Physics/Chemistry who can be encouraged to teach in high school and, thus, education courses should be made available to them.

According to the report on the TEEP (Third Elementary Education Project), significant improvement in math in the National Achievement Test was attributed to the Math Teachers' Lesson Guide series which was prepared by DepEd and Ateneo and printed/distributed by TEEP). We hope we can replicate this success with teachers' lesson guides for chemistry, biology and physics. We have thus linked up with colleagues in chemistry, physics and biology to see if similar lesson guides can be prepared for their disciplines for high school teachers. According to Prof. A. Cuyegkeng of Ateneo, a chemistry guide has already been prepared. This should be reviewed again if needed and efforts be made to distribute this guide to chemistry teachers with the appropriate accompanying training on its use as has been done with the math lesson guide.

On Pedagogy—from Vertical to Inquiry- and Discovery-based Method

Presently, the common method of teaching is the vertical type, concepts and facts handed directly from teacher to student. It is recommended that inquiry- and discovery-based method of teaching be adopted in the country and this should start from primary and nursery schools. Scientific evidence shows that this inquiry- and discovery-based method of teaching stimulates creativeness and innovativeness.

In December 2003, the InterAcademy Panel (IAP), a global network of the world's science academies (www.interacademies.net), issued a statement on science education for the youth which was signed by 68 academies of science, including the NAST. The IAP statement recommended to all national leaders the adoption of teaching based on inquiry-based pedagogy, with a major role assigned to students to ask questions, to develop hypotheses relating to the initial questions, and when possible to conduct experimentation using simple instruments. Further

IAP recommended that acquisition of knowledge by children should be horizontal which connects them with nature, both inert and living, directly and involves their senses and intelligence. Children who undergo inquiry- and discovery-based learning have been shown to be open to, enjoy and appreciate science. They perform better academically. They communicate better and are more creative.

Creativeness and Innovativeness

Development of creativeness and innovativeness among our students was cited as major challenge. As discussed earlier, the use of an inquiry-based and discovery-based teaching method will help develop creativeness and innovativeness among children. We know how well Chinese students perform in mathematics and the sciences. However, to further develop and strengthen creativeness and innovativeness among the young Chinese students, China has adopted the French programme called La Main á la Pâte (LAMAP), a "hands on" science education program. Vietnam, Cambodia and Malaysia have also adopted this programme.

In the Philippines, some schools have adopted various models of the "hands on" and inquiry-based teaching method but their adoption needs to be widened and, preferably, institutionalized. Drs. CC Bernido and MC Bernido have developed the Dynamic Learning Program in the Central Visayan Institute Foundation which consists of five pedagogical maxims: (i) learning by doing, (ii) sound fundamentals, (iii) mastery not vanity, (iv) adaptability, and (v) honesty. "Learning by doing" maxim for their math and science subjects in high school means lectures are given only 20 to 30% of the time while the rest is devoted to pre-designed activities.

One of our technical session speakers, Dr. J. Camacho recognized that the Philippine culture of complaining is reflective of the lack of proper training in problem solving. He discussed TRIZ (Theory of Inventive Problem Solving), a powerful methodology for improving thinking processes that promotes improved problem solving skills producing systematic innovation and creating novel inventions. Dr. Camacho is involved in promoting the integration of TRIZ in the academic setting.

Professor Nelson Cue, retired Professor of Physics at the University of Hongkong shared his experiences in successfully transferring technology to industry. He discussed the commercialization of PRS (Personal Response System) which enables students to think about the question and react immediately and allows the teacher to evaluate whether students have understood the material presented. Prof. Cue has also been involved in the commercialization of biotechnology products of recombinant human growth factors for therapeutic purposes. In his undertakings, he presented three stages which were clearly delineated:

1. "A new marketable idea or concept that came serendipitously, through experience, a systematic study, or a combination of these. Exchanges of ideas with various experts would clearly be helpful in this context.
2. Demonstrate the practicality of the idea or concept. A working prototype is essential, and accessible and affordable resources, both human and material, are required.
3. Implement and market the product or service. A working capital is needed and a good network for this is almost essential." (Cue, 2009)

He added that the bottom line for successful technology transfer is to have "a group of creative, educated, and experienced people working together with a common goal."

It cannot be overemphasized that creativeness and innovativeness are a major foundation of discoveries and inventions.

Financial Support to Education; Building Stronger Institutions

Lack of budget, inadequate facilities, lack of textbooks and the like were often cited as problems in the delivery of quality science education and education, in general.

DepEd Secretary Jesus Lapus announced an increase in the budget for the DepEd from PhP 120 billion for 2007 to 150 B for 2008. The new budget represents 2.7% of GDP, still less than the 4% recommended by UNESCO. Moreover, challenges for timely, cost effective and efficient management of resources, and less corruption, face government and especially the DepEd.

The Department of Science and Technology has ongoing projects on teacher training. The DOST Science Education Institute (SEI) developed the certificate and diploma programs in science and mathematics education offered in 16 Regional Science Teaching Centers where teachers can take the program for two summers and the certificate or diploma is granted by the university in which the program is lodged in that particular region. SEI also undertook a training project especially for the training of Mindanao teachers in collaboration with five universities in the area. Further, SEI has programs on faculty development at the master's and doctorate levels.

We acknowledge the enormous contributions from private sector and NGOs in the building of schoolrooms, teacher training, support to students (scholarships, books and reading materials, food and school supplies aids etc), and many other forms of assistance.

Mentoring and the Promotion of Science Careers and Science

The Division realized that to strengthen S & T in the country, we need to promote science careers among our youth, to mentor them well in their research, and to promote science in general to the general public. These concerns were discussed during the pre-ASM round table discussions as well as by some of our speakers during the ASM itself.

Prof. Dina Ocampo characterized a successful mentoring as follows (Ocampo, 2009): "(1) it should be reciprocal. It is not just one person doing all the talking. (2) It should be creative. It is a thinking process; the two minds must meet. (3) Both mentor and mentee should be connected to a vision. In education, when I mentor, I always think of how to make the teaching good, what will make the learning by the children more fun, more meaningful. (4) The mentoring should be informed by disciplinal understanding. (5) It should be guided by professional and ethical practice. (6) Mentoring should be transformative: the mentor should become a better mentor and the mentee should grow and develop depending on their goals and arrangement. In a transformative relationship, both parties change."

Bright Lining in the Horizon---the Initiatives

In his analysis, Father Nebres concluded that improvement of science and math education in the context of Philippine schools should address the following:(1) "Creating the absorptive capacity of schools and clusters of schools to take in and implement significant reform and improvement (attending to the macro problems); and (2) Targeted and focused interventions to address priority needs (academic and non-academic) (attending to the micro-problems). This means meeting the schools where they are, setting next level targets with them, and moving them to the next level." He cited examples of relative success stories like the TEEP which tackled macro problems (absorptive capacity in the school and community) and micro problems (teacher training, textbooks, lesson guides etc.).

We acknowledge the initiatives of various organizations and agencies, private and public, in various activities towards the improvement of science and mathematics education in the country.

- TEEP(Third Elementary Education Project)
- Project SSPEEd (Sectoral Support for Public Elementary Education) (2001-04)
- ACED (Ateneo Center for Educational Development) (2004-) work in Payatas
- Synergeia Foundation--- Project Josie (Bulacan)
- Synergeia in Lipa City---with Mayor Vilma Santos Recto
- BEAM (Basic Education Assistance for Mindanao) Australia (2002-04; 2004-08)

- EQuALLS Education Quality and Access for Learning and Livelihood Skills) in Mindanao USAID
- DOST
- DepEd

In his keynote speech during this meeting, Ateneo President Fr. Bienvenido F. Nebres said "... The culture of the natural sciences and mathematics is not to bewail or just describe a problem, but to solve them." He emphasized the need "to engage Philippine culture and move it into a problem-solving mode, away from a blaming or complaining mode."

The importance of giving attention to the social environment of our schools if we aim to improve and develop our schools and educational system has been emphasized. This means involving the whole school community—principal, teachers, parents and local government (barangay) officials.

Fr. Nebres added:

The challenge for us then is to ask how we can make progress for the majority of our students.

Reiteration of Recommendations

We reiterate our recommendations on the sustained implementation of concrete measures that can be undertaken to strengthen basic science and mathematics towards building a culture of science:

1. A strong government policy is needed for sustained support to science and technology and larger and substantial budgetary provisions for the development of science and technology.
2. The inquiry- and discovery-based science education should be institutionalized and be utilized in all schools of the country. This kind of science education is already implemented to some extent but only in a small number of schools in the country. In this regard, this inquiry- and discovery-based science education program should be developed in collaboration between the Department of Education, the Department of Science and Technology, the science community and the NAST. Centers for the training of school teachers in the inquiry- and discovery-based method of teaching science should be established. Centers and organizations that nurture talent in science and mathematics should likewise be supported.
3. A policy is needed from industry and private sector that rewards the technology career path similar to the career path in marketing and finance. We also need greater support for the development

of science and engineering in the universities from industry and private sector. Stronger academe-industry-government interactions and linkages should be pushed for the more efficient and effective development and transfer of technologies needed by industry and the general public.

4. From schools and universities, we need policies and measures that will strengthen mathematics and science education. We need to benchmark with our neighboring countries and set goals in terms of achievement in mathematics and science at school and university level.
5. We ask our present leaders in science and mathematics to invest time and effort in mentoring and developing a younger generation of scientists and in building with them stronger institutions mathematics, science and technology.

About the Author: Dr. Evelyn Mae Tecson-Mendoza is the chair of the Chemical, Physical and Mathematical Division of the National Academy of Science and Technology and Research Professor, Crop Science Cluster-Institute of Plant Breeding, College of Agriculture, University of the Philippines Los Baños. She can be contacted at: emtmendoza@nast.ph.

References

Nebres B.F. (2007). Building a culture of science in the Philippines. Trans. Natl. Acad. Sci. & Tech. Philippines 29: 177-196.

Bernido C.C. and Carpio-Bernido M.V. (2007). Teaching high school physics effectively. Trans. Natl. Acad. Sci. & Tech. Philippines 29: 251-260.

Camacho D. (2007). Teaching innovative and inventive thinking: an education imperative towards building a culture of science. Trans. Natl. Acad. Sci. & Tech. Philippines 29: 261-281.

Cuevas J. (2007). Effective technology transfers in academia. Trans. Natl. Acad. Sci. & Tech. Philippines 29: 286-293.

Lee V.-L. (2007). Problems and possibilities at the heart of science education. Trans. Natl. Acad. Sci. & Tech. Philippines 29: 212-225.

Ocampo D.J. (2007). Mentoring mentors explicitly. Trans. Natl. Acad. Sci. & Tech Philippines 29: 240-250.