RECENT TRENDS AND ISSUES IN SCIENCE EDUCATION IN SOUTHEAST ASIA

In Southeast Asia, learning in science, more than in any other subject, is considered to be a prerequisite for modernization and national development. Thus, over the past two decades, which have been characterized by movements towards industrialization and accelerated economic development, science education has been at the forefront of curriculum reform movements.

During the early years the reforms in science education emphasized science for the development of scientific and technical manpower, since there were (and still are in many places) acute shortages of trained manpower in these fields. Rigorous scientific training was emphasized during those years, mirroring reforms in the West during the post-sputnik era, stressing knowledge in the traditional scientific disciplines and an academic approach to learning.

During more recent years, science education in Southeast Asia, once again following cues coming out of the West, has become much more process or discovery oriented, but, in addition, has begun to lay much more importance on relevance to local needs and conditions as well as egalitarian issues, epitomized by UNESCO's "science for all" movement. Under these influences, science educators in this part of the world have begun to present science as a promoter of logical thinking and a developer of problem solving skills, not only among the scientific elite involved with complex problems and high technology but also among the average wage earner and homemaker in their day to day struggles to make a living and provide for their families.
The current review examines some of the trends related to the general situation described briefly above. It will focus chiefly on primary and secondary education, using material gleaned either from written documents or informal interviews. This paper does not present an historical account of reform movements in science education in Southeast Asia and it is not intended to be comprehensive. Instead it is intended to cover, in a somewhat impressionistic manner, trends in six of the mostly frequently discussed areas of science education, namely:

1. Curriculum reform
2. School science equipment
3. Teacher training and retraining
4. Nonformal science education
5. Research in science education
6. Regional collaboration.

In certain of these areas some countries will be featured and others not. This is not necessarily because those countries are particularly representative of the area. It is because their programs are especially interesting or innovative or well known. Inevitably certain of the most interesting innovations will be overlooked simply because I, as a layman in this field, simply did not have access to the appropriate information.
1. Curriculum Reform

   a. Integration. Critics of science education during the 60's and 70's found it to be dull, overly academic and fragmented. It was one of the most unpopular subjects among students, partly because of the way it was presented and because it generally had very little to do with their everyday experiences. The integrated science movement, strongly supported by organizations like UNESCO, was developed to make science more problem and society oriented, and thus, presumably more interesting and less intimidating to children. Two kinds of integration were advocated, that among sciences (to counteract fragmentation) and that between science and social studies (to promote social relevance).

   Examples of this abound in Southeast Asia. In Malaysia, for example, a phased primary school curriculum reform introduced in 1982 will present to pupils in primary 4 a new course entitled "Man and his environment," an integration of various sciences and social studies. The main purpose of that course is to establish an appreciation of science in the modern world, a goal consistent with a recent regional UNESCO conference call for science education which above all would establish and maintain a positive attitude towards science and technology. Malaysia also offers an integrated lower secondary school science course, which is social problem oriented, emphasizing themes like environmental pollution, energy conservation and consumerism.

   In Thailand, the Royal Thai government's Institute for the Promotion of Science and Technology (IPST) has developed an integrated science approach for elementary schools which combines health education with science and social studies. For the lower secondary schools IPST has developed an integrated science curriculum which emphasized the triangular relationships among ENERGY, CHANGES IN MATTER, and the
ENVIRONMENT.

b. Relevance. Advocates of indigenous curriculum reform have insisted that science must be presented in such a way that it is relevant to a country's needs and resources. The position has also been advanced that for science to be attractive and meaningful to most children it must impinge on their daily life experiences and be geared to their level of cognitive development. Besides those who call for relevance to national problems and context, there are those within nations who call for adaptations to local environments and conditions, particularly in nations like Indonesia and the Philippines, where there is wide regional variation.

Examples of this movement are perhaps most plentiful in the Philippines, where the official national curriculum states that science education must be connected to the needs of the country and development goals. The prestigious Science Education Center at the University of the Philippines (UPSEC) has conducted numerous community surveys and made profiles of students and teachers in an effort to develop science learning modules with materials relevant to local problems, needs and resources to supplement national textbooks. Perhaps the best single example of this is a joint UPSEC/UNICEF project called "survival of the family," which started with a community needs assessment and ended with villagers experimenting with different types of traditional medicine and ways of salting fish.4

In Thailand, relevance to national problems and conditions is stressed in every part of the new national curriculum, but perhaps
stressed in every part of the new national curriculum, but perhaps the best examples come from the upper secondary courses, those developed for the science stream students. For example, the course in biology is centered on the examination of the biology in the immediate environment of the learners. Moreover, the chemistry course at the same level puts special emphasis on the chemical industry of Thailand.

c. Process Skills. All of the countries in the region are engaged in a movement to make science education more process skills oriented than it formerly was. More part of an international Zeitgeist than a result of indigenous pressures, and perhaps originating with the Nuffield science curriculum and/or the Scottish Secondary Science course, this movement stresses a move away from a fixation on scientific knowledge towards an emphasis on inquiry skills and discovery learning. Such a focus, accomplished generally through active learning approaches (doing experiments, going on field trips, observing natural phenomena, discussing problems), is expected to produce in students greater capacities for logical or hypothetical thinking, for data gathering and interpreting, and for problem solving.

Indonesian science education developers have invested heavily in the process skills development movement. A primary science project in West Java, being developed by the Indonesian Office of Educational Research and Development (Balitbang Dikbud) with help from the British Council, has made process skills development its main objective. This it pursues by focussing on a limited number of scientific concepts which are presented through learner-centered activities, using simple equipment. This system, which is being
developed as a prototype for national use, relies on intensive retraining programs using the school supervisor as a trainer. A secondary science program with a similar focus has already been disseminated nation-wide. Although students at this level are still constrained to cover a discipline-oriented, overly dense curriculum, their learning activities are structured through the use of a series of worksheets, supplements to the textbooks, which call upon them to perform simple tasks and experiments.

In Thailand the inquiry approach to science learning permeates the new IPST curricula. Intended to promote critical thinking and problem solving skills, the new student books place students in the role of discoverer. This is true for science courses geared not only for those who are bound for higher education, but also for those in vocational tracks. For example, in the vocationally oriented upper secondary courses, special science courses have been created by IPST which stress science process skills geared towards problem solving on the job and towards situations in everyday life.

d. Value Orientation. A recent phenomenon, related to the emphasis on linking science study to social problems is the concern for "value-oriented" science. This trend, articulated recently by science educators at a regional meeting at the SEAMEO Regional Centre for Education in Science and Mathematics (RECSAM), results from a concern for the abuses that sometimes accompany scientific and technological development. The meeting held during June of last heard RECSAM officers calling for science for a more humane and caring society and the promotion of global harmony. It also heard Singaporean educators call for "humane rationality" and a Malaysian University
Vice-Chancellor call for more humility among scientists and more awe in approaching the wonders of God's universe. The conference ended by calling for a science education more related to the ethical concerns of man, placing greater emphasis on the social accountability of scientists and technologists and scientific discipline. It also highlighted a need for science to address the issues of drug abuse, energy conservation, consumerism and environmental pollution.

2. School Science Equipment

The active learning models stressed by all of the countries in Southeast Asia require students to work on tasks and make observations of scientific phenomena. This requires laboratory equipment, something extremely scarce in most of the countries in the region because of cost and distribution factors. To make up for this equipment deficit, there have been basically three approaches in the region. Manufactured equipment has been imported from the developed nations, curriculum development centers have fashioned their own equipment using local, low cost materials, and teachers have been encouraged to create their own equipment from locally available materials.

Singapore has embarked on a campaign to equip all of its secondary schools with well equipped laboratories, often using imported materials, at considerable cost. It is estimated that one such lab costs the government around US$350,000, not an uncontroversial sum of money. In Thailand science equipment has been developed and tested by IPST as an integral part of its science curriculum development. For some levels the science equipment has been mass produced with help from the
private sector producers. At others, prototypes have been centrally developed and the sent out where they are produced in greater numbers locally. In Indonesia the process oriented science programs have relied on the production of simple equipment by the teachers themselves, sometimes with aid from a regional science center. In addition, there has been at the national R & D Center a project for the development of a simple, compact science kit. This kit, developed with help from the German government and due to be distributed to 100,000 schools, is considered to be quite ingenious, but since it is not directly related to the science curriculum and since it is a bit intimidating to the teachers, there are doubts about whether it will be used effectively.

The successes with equipment and development and use in Thailand seem to indicate that such equipment needs to be designed and tested in conjunction with actual science lessons. The Thai experience also seems to show that mass production, involving a commercial producer working with the ministry and the curriculum development center, leads to the best materials at the lowest unit costs. Materials can be (and were in Thailand) produced at lower initial costs out of very cheap local materials, but such materials do not last very long. This has also been the case with materials made by teachers themselves. In fact, even the sturdiest of manufactured equipment sometimes needs to be repaired, a fact reported by Thai teachers. Thailand has thus been experimenting with offering training in equipment repair at regional science servicing centers.
3. Teacher Training Support

All of the innovations mentioned above can be a source of bewilderment to the teacher in the field, especially considering that even in relatively wealthy Singapore very few of the practicing science teachers were actually trained in science in the first place. Thus most countries in the region have designed inservice teacher training courses to provide science teachers with special support. In addition, some countries have established teacher science centers serving a cluster of schools, others have produced elaborate training packages and still others have begun to provide special bulletins. Besides innovations in in-service training, there have also been some interesting efforts to upgrade and update pre-service training at teacher training institutions.

Indonesia provides some good examples of innovative in-service teacher training for science teachers. In their secondary science program they have instituted an "inservice-onservice" approach, which consists of cycles in which teachers come to the center to learn new approaches and prepare new lessons, return to their classrooms where they apply their new skills under observation, and then come back to the center again for feedback and a new round of lessons. This program also provides a local science center where teachers from a cluster of schools can receive guidance and reinforcement. Indonesia's primary school program uses a similar approach, but in the former the trainers are experienced teachers (who have been through a course at RECSAM and a study tour) and in the latter the trainers are primary school supervisors. Indonesia has also used weekly educational radio broadcasts for in-service
training, but not within the context of the two new science programs.

In Thailand IPST has supervised the retraining of over 25,000 secondary school teachers, based on the reformed curriculum. Since primary school teachers are so numerous and the costs of retraining them judged to be prohibitively expensive, IPST has developed special primary science teaching-learning kits. These kits contained a detailed teachers guide and supporting materials, but it is not certain whether or not teachers are able to follow them with sufficient effectiveness. New plans are now being laid to provide additional support through school cluster centers or science teacher servicing centers.

Singapore has developed a unique form of support for teachers. It is called Research and Evaluation Abstracts for Classroom Teachers (REACT), which is precisely a set of research abstracts sent to teachers twice a year covering various subjects (the most recent edition, December, 1983, covered studies in science teaching and learning and studies in the education of slow learners). At the end of each abstract there is a section which suggests ways in which the findings could be applied in the teacher's own classroom.

Finally, both the Philippines and Thailand have been developing new approaches to pre-service teacher training. In both cases the courses have been based on the competencies required for the delivery of the new curricula. Studies have been conducted in both places to determine what existing levels of competency are, and then the courses are structured to deal with the discrepancy between ideal and actual levels.
4. Nonformal Education

A heightened concern for social issues among science educators in Southeast Asia has prompted them to consider the need and right of people of all walks of life to obtain the tools and benefits of modern science. The UNESCO "science for all" movement (to be described in more detail below), recently convened a seminar in Bangkok to discuss, among other things, mechanisms for promoting scientific literacy and popularizing scientific attitudes and concepts. The suggestions included a number of varieties of nonformal education, many of which are already being used within the region.

For example, in Thailand the country's Science Society has promoted a number of science clubs, science fairs, science awards and a National Science Day. In addition, Bangkok has established a science museum that is so popular that mobile versions have been added to reach enthusiasts in rural areas.

Singapore also possess a popular science center, which uses a number of interactive and operatable displays. In addition, it has in recent years established computer clubs in high schools and community centers, which have grown more and more pppopular with the availability of relatively cheap, locally assembled micro-computers and pirated software.

One of Malaysia's approaches to the popularization of science is the establishment of an off-campus study program at its science university (Universiti Sains Malaysia). This program was originally set up to provide part-time, degree oriented study programs as a "second chance" for those already in the work force. In addition, it was supposed to narrow the
gap in science learning among ethnic groups, by providing a
special "science foundation course" (a degree program with
modified entrance requirements and special preparatory programs)
for ethnic Malays. The sciences courses in this program follow
traditional disciplinary lines. Recently the off-campus program
has also gained in popularity among young high school graduates.
It is now estimated that by the late 1980's the off-campus program
will cater to about 5% of the university population.

Finally, in the Philippines there are a variety of nonformal
education programs in science education. One of the most lively
is that of the science club. As of 1979 there were roughly 2500
science clubs in the Philippines with a total membership of more
than 200,000. Many of these clubs have a practical problem orien-
tation, such as developing food production schemes, developing
new energy sources and conserving natural resources. Another
fascinating example is the "people's school" movement. Supported
by the International Institute for Rural Reconstruction, this
movement in the Philippines introduced new technology into depressed
rural areas through a process of problem identification (using par-
ticipatory research), leadership training, and a two stage technology
transfer (from professionals to village representatives--"barangay
scholars"--and from them to other villagers through demonstration
projects). The processes and the successfulness of these alternative
schools are now being evaluated with the help of IDRC funds.
5. Research in Science Education

It is difficult to tell how much and what kind of science education research has been conducted in the region, especially since so much of it is unpublished and/or in local languages. From the documents available at this time it is apparent that at least the following kinds of research have been or are being conducted within the countries in the region: studies on the cognitive abilities/levels of pupils, curriculum evaluations, assessments of student achievement in science and related attitudes, studies of teaching-learning processes, studies to construct profiles of students and science teachers, community studies and action or participatory research.

RECSAM has for many years sponsored a program to assist countries in the region to assess the intellectual development of their children, especially as it relates to concept formation in science and mathematics. RECSAM's instructors in this program have promoted the use of clinical methods (sometimes called group task approaches), which were pioneered at the Geneva school under Piaget. The RECSAM project has involved developing, pilot testing and revising appropriate instruments in all ASEAN countries.

Three of the countries in Southeast Asia have been involved in the IEA network for the evaluation of science achievement (the Second International Science Study), namely, Thailand, Singapore and the Philippines. Besides assessing conventional areas of science knowledge and comprehension, the study is covering process skills of scientific inquiry (as far as they can be measured through a paper and pencil test). In addition to internationally coordinated
analyses, Thailand expects to use the results as a sort of summative evaluation of its new curriculum. The Philippines, on the other hand, expects to use its results to ascertain whether or not its students are sufficiently prepared to meet the country's science and technical manpower needs.

In addition to the above, IPST in Thailand has made formative evaluation a strong component of all its curriculum development efforts. Using qualitative (direct observation) and well as quantitative methods (teacher questionnaires), IPST has produced over 50 research studies, which it has used in continuous curriculum renewal and improvement.

The Science Education Center at the University of the Philippines has turned out an impressive array of research studies, using a variety of methodologies. Its monograph series includes 5 studies on student characteristics related to science learning, 5 on science teacher characteristics and roles, 3 on the science curriculum, 3 on learning-teaching processes, 3 on student outcomes and one community study. In its work on the "survival of the family," UPSEC used participatory research to assess community needs and to experiment with new village-level technologies.

In Singapore the Curriculum Development Institute (CDIS) encourages teachers to work as "coagents" in continuously renewing the science curriculum. In addition, the Institute of Education has developed a unique institution referred to as TREP (Teachers as Researchers and Evaluators Project), which encourages teachers to conduct research in their own classrooms, e.g., performing simple learning experiments and assessing their results. Findings are then reported to IE which uses or disseminates them as appropriate.
Finally, in Indonesia some in-house evaluations of the two major science education projects have taken place. In addition, a major summative evaluation of the secondary science project is underway drawing on prominent national researchers as well as Dr. James Eggleston of Great Britain. Besides that some interesting dissertations on science education have or are being written, like Beverly Young's (British Council) "illuminative evaluation" of science teaching and Ratna Wilis' (IKIP Bandung) forthcoming research into teachers' understanding of science process skills.

6. Regional Collaboration

A resurgence of interest in science education during the early 1980's has led to the proliferation of regional activities and exchanges. Unlike the first big post-independence surge in science education, which was tied to the concerns and problems of the Europe and the United States, the movement in the late seventies and early eighties is based on a concern for national and regional development.

At RECSAM 1980 was the culminating year of SEASAME (South East Asia Science and Mathematics Experiment) an eight year effort to work cooperatively in the development of "indigenous curriculum reforms," in the spirit of "interdependent independence." Since then scores of conferences and workshops have been held at RECSAM, one of the most recent of which, the regional seminar on "Problems and Issues in the Teaching of Primary and Secondary Science for Development" (June 6-10, 1983), resulted in the call for "value-oriented" science as mentioned above.

The latest series of regional UNESCO activities in the science education field can be traced back to the UNESCO/ESCAP Conference of
Ministers Responsible for the Application of Science and Technology to Development and those Responsible for Economic Planning in Asia and the Pacific (CASTASIA II). This conference produced the so-called Manila Declaration which contained 25 recommendations, including the need for member states to build up science and technology and R & D management capabilities and to integrate science and technology development with national economic planning and policies.

A direct follow-up to that conference was a meeting held last month (Dec. 12-15) at the ESCAP Regional Center for Technology Transfer in Bangalore (sponsored by the UNESCO Regional Science Office in Jakarta) to plan training programs to assist policy makers in transforming economic development requirements into science and technology programs and in finding appropriate applications for the results of research in science and technology.

Related to the CASTASIA declarations but also drawing from global strategies and plans are two other UNESCO initiatives, first the "Science for All" movement, spearheaded by the UNESCO Education Office, Bangkok, and second the recent meeting concerning the "Popularization of Science and Technology in Southeast Asia," organized by the Science Society of Thailand in cooperation with the UNESCO Regional Office for Science and Technology, Jakarta.

A meeting on "Science for All" was recently held in Bangkok (September 20-26, 1983) to consider ways in which science concepts and attitudes could be "delivered" to four specific target groups, namely, the formal school population, out-of-school children and youth, the work force (including illiterate adults), and the educated section of the populace. The rationale for extending the concept of "all" to include target groups beyond the formal school population was based on a strong concerns to establish a mechanism capable of creating and maintaining a positive climate for the ideas
and endeavours of science, and any associated technology. Thus discussion centered both on the development of delivery systems for basic "scientific literacy" and on shifting the teaching emphasis in schools towards establishing and maintaining a positive attitude towards science and technology.

The other UNESCO meeting focussed on four specific topics judged to be crucial to national development in the future, namely, informatics (computer applications), genetic engineering and biotechnology, marine resources development, and remote sensing for assessment of natural resources. Beyond that delegates pressed for a more comprehensive examination of science and technology needs in each country so that other topics might become the concern in future meetings. "Popularization" in this forum had a very limited meaning -- the development of a "critical mass" of scientists, engineers and policy-makers to allow for national and regional infrastructural development and self-sufficiency in the above areas.

The above discussion on regional collaboration has been restricted to official meetings and regional institutions. Although such collaboration is perhaps useful in articulating themes and issues of common concern, there is also an unreal aspect to it -- it exists more in terms of rhetoric and formal gestures than in terms of actions and enforceable policies. Moreover, there is a strong "top-down" bias in all these forms of collaboration, science being defined by ruling elites and "delivered" without discussion to schools and villagers.

In addition, participation in the follow-up to any such meeting will inevitably involve government ministries, never a very innovative or creative force. Even if imaginative initiatives were to emerge from such meetings, it is unlikely that their vitality would survive the pressures of politicization and/or bureaucratization at the national level. Perhaps more promising in this regard are the less formal inter-
actions between scholars and activists through private channels or through such agencies as the Asian Institute of Technology (Bangkok), which promotes interdisciplinary research and training among scholars in the region emphasizing problem areas of recognized importance; activist organizations like the International Institute for Rural Reconstruction (IIRR) with its emphasis on "people schools", and grassroots organizations like the Rural Institute for Community Education (RICE) located in the Philippines, which is developing a regional network of action researchers.

7. Issues and Reflections

Science education in Southeast Asia is a serious matter, perceived as important to directions of future national growth and development, capacities for personal and national problem solving and the creation of humane and egalitarian societies. Recently educators in the region have emphasized integrated, socially relevant, process skill and values-oriented science. They have placed great faith and an enormous burden on science.

Reflecting upon such trends one wonders if in fact too much isn't being expected of science. Should it or can it be the vehicle through which problem solving skills are transmitted and creativity promoted? Aren't other fields of study (philosophy, social studies, the arts) and other activities (extra-curricular activities, social action) just as (or even more) appropriate for promoting such skills and attitudes. Aren't there possibilities and dangers that science may be "over sold", as perhaps is already the case in Singapore where achievement in science is used for screening the nation's leaders and corporate executives. Moreover, as a result of the activist's zeal to popularize science in rural village as a vehicle for problem solving, is it possible that people will begin to accept science as sort of a modern day magic only to become disillusioned later when it does not release them from poverty and deprivation?
One also wonders, after so many years of indigenous curriculum reform, whether there are any true examples of an indigenous science curriculum in Southeast Asian schools. Adopting an activity-oriented, discovery-based science is a significant reform, but in a sense it is simply exchanging an old imported model for a new one. Even when the trend is to tie science education to social issues, the issues raised (e.g., environmental pollution, consumerism, etc.) seem to have come out of the industrialized West. An even stronger point could be made of regionalizing curricula within nations. As much as Indonesia or the Philippines talks about science related to the local environment, such talk to date appears only to have resulted in the production of a few supplementary modules.

In short, it appears as if new science learning models have been adopted with little critical scrutiny or local adaptation. Whether this is a reflection of the perceived universal character of science, or a function of the sometimes subtle and difficult nature of the subject matter, or perhaps a commentary on "dependent" character of science curriculum creators is not clear and would be an interesting area for future investigation.

A number of questions can also be raised concerning the recent trend to focus on process skills with the intent to create critical-mindedness, logical thinking and problem solving abilities. These may be worthwhile objectives, but there are doubts in many minds whether classroom activities alone can create them and whether their acquisition is consistent with prevailing cultural norms and values.

Research reviewed by a science education in Indonesia, Ed van den Beng (1983), has indicated that in the West students who have been taught science with laboratory work have performed better on practical skills such as using lab equipment than students who have not done lab work, but have not performed better on tests of understanding of science concepts,
ability to think scientifically (e.g. interpret and evaluate data, solve problems experimentally, etc.) and interest and motivation in science. Similarly a participant in the recent "Science for All" Conference pointed out that most efforts around the world to use science courses in teaching process skills have failed (Fensham: 1983).

Van den Berg asserts that this apparent failure is to a large extent a result of the lab work is typically done. In a similar vein, Fensham contends that large class size, a condition in all Southeast Asian schools, have made it almost impossible for teachers to create the appropriate atmosphere for discovery learning to take place. In addition, he asserts that students as well as teachers have been unable to abandon their need for simple structure, i.e., knowing the answers to science questions. Thus he contends, a kind of catch 22 situation prevails: "If process skills are not associated with meaningful knowledge and content, they will lose value; if they are associated with meaningful knowledge content of science, they will be lost in the face of this content of worth and in any case they are not necessary aspects of its learning".

Others have pointed out the power of the school examination in subverting any attempt to make science more process than concept learning. In Singapore, for example, the pressure for a good showing on the academically-oriented Cambridge exams is so strong that even though an emphasis on process skills and active learning has been placed in the new curriculum, most teachers cannot resist the temptation to teach didactically "to the test". In Malaysia, where the use of Cambridge exams has been abandoned in favor of national exams, attempts have been made to restructure exams to test process skills and related intellectual growth. However, results on such tests have been so disastrous that gradually they have become predominantly content-oriented again. (It will be interesting,
to see what happens in Thailand in this regard, since exams there have been recently revised in the direction of process skills). Since process skills are really not well suited for testing through paper and pencil tests, it may be that as long as single exam results are crucial in student selection, process skills will never be emphasized in practice ("the actual curriculum").

Finally, just a brief (over simplified) note about culture. In most Southeast Asian cultures children are taught to respect their elders and acquiesce to authority. Those in authority are expected to know all the answers; not knowing the answer is cause for "losing face". Great value is placed on social harmony and conformity. All of these factors mitigate against the successful application of discovery learning and the acquisition of critical mindedness. As the current head of Singapore's Institute of Education, Sim Wong Kooi, said over 10 years ago, "if children are not expected to question their elders at home, if teachers are expected to follow directives and not use initiative and depart occasionally from stipulated practice ... the widespread adoption of curricula that insist upon discovery learning is likely to be an impossible task or else merely a farcical practice".

8. Possible future Research Directions

In relation to the issues raised above, a number of research questions have been formulated which should be considered for future action. Among them are the following:

1. What are important national and local problem areas to which science and science education could be applied/linked? Best addressed from the point of view of villagers or average workers (not university professors or ministry officials) perhaps through the use of participatory research.
2. What perceptions do villagers or urban workers (adults and children) have of science, its value and usefulness? Possibly addressed through qualitative research including in-depths, unstructured interviews.

3. To what extent are active or discovery learning methods actually being applied in the classroom? Requires direct observation.

4. Do children actually learn science process skills as a result of more active learning processes? A possible field experiment. Processes skills perhaps measured through interpretive essays or practical tasks.

5. To what extent do teachers actually understand the processes of science? Surveys might be used here, but better ethnographic interviews.

6. Are parents and teachers becoming less authoritarian? Survey research. To what extent has education (both its content and social environment) contributed to any such change? (Casual analysis) To what extent can educators capitalize on any such changes in order to make learning more student-centered? (Adaptive field testing).

7. What is more effective in promoting creative problem solving -- experiences with art or drama, group outings or projects, experiences with scientific experimentation, etc. A series of experiment, might be performed.
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13. Information available at the Institute of Education through Dr. Sim Wong Kooi, Director, Singapore.


