EPP

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Curriculum Reform Activity

Science and Mathematics

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PREFACE

The Educational Policy and Planning (EPP) Project is a seven year project conducted jointly by the Indonesia Ministry of Education (MOEC) and the United States Agency for International Development (USAID). The overall project objective is to improve the quality of education in Indonesia by assisting the MOEC, through the Office of Educational and Cultural Research and Development (Balitbang Dikbud), to formulate better policies and long-term plans. The project aims to improve policy formulation and long-term planning by improving the timeliness, relevance and accuracy of educational data collection, the subsequent analyses of such data, and their ultimate use for policy and decisionmaking.

There are three major components of the EPP Project: (1) development of an integrated management informations system (MIS) within the MOEC, (2) enhancement of MOEC policy research and analysis capacity, and (3) support for MOEC institutional development at the national and provincial level through training and technical assistance. EPP technical advisory staff work closely with counterpart Indonesian staff as part of a collaborative process of developing institutional capacity.

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The EPP Project in collaboration with the USAID Improving the Efficiency of Educational Systems (IEES) Project, publishes EPP documents in order to disseminate this knowledge and extend its usefulness. EPP has carried out a series of policy studies designed to provide answers to key questions facing Indonesian educators. These include:

The Quality of Basic Education
The Quality and Efficiency of Vocational/Technical Education
The Strengthening of Local Education Capacity
Developing Indicators of Educational Efficiency
Teacher Education Issues
Curriculum Reform and Textbook Production
Education, Economic, and Social Development

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INTRODUCTION

The purpose of this report was to provide a written appraisal of the 1994 curriculum, in particular the science and math sections.

The specific activities were to provide assistance to and work together with an appointed team of the Curriculum and Educational Facilities Development Center (CEFDC), Balitbang, on the following tasks:

* to discuss the masterplan of the 1994 curriculum designed by the CEFDC;
* to discuss fundamental issues related to the nine-year basic education and secondary education, including math and science curricula, and suggest several alternative recommendations for the development of their respective 1994 curriculum;
* to give special attention to the assessment and development of math and science curricula for the Primary and Secondary education, in accord with the demands of national development; and
* to formulate strategies of curriculum reform and implementation particular to science and math.

The report is divided into five sections:

1. Background, Conditions and Methodology of Work
2. Curriculum and Curriculum Reform
3. Science Curriculum
4. Mathematics Curriculum
5. Policy Recommendations for Curriculum Reform in Science and Mathematics

The first section discusses the setting and constraints for work of the consultant and the CEFDC team and the methods used by the consultant to work with the CEFDC team. The second section discusses curriculum and curriculum reform in general and sets forth some assumptions and problems relative to mathematics and science education. Sections three and four address specifically the science and mathematics curricula as presented in the second draft of the 1994 nine year basic cycle and the secondary cycle. Policy recommendations for curriculum reform in science and mathematics in relation to Repelita V and the second Twenty-five Year Plan are in section five.

Many people helped me during my stay at the Curriculum Center. I am particularly grateful to Gunadi, Faisal, Siskandar, and Andrian for their generous help in translation and discussion of the 1994 curriculum in science and mathematics. Any short comings of information or recommendations are attributable solely to me.

BACKGROUND, CONDITIONS AND METHODOLOGY OF WORK

Indonesia and Education System

The educational system in Indonesia is highly centralized with a well defined hierarchy of educational decision making in which separate directorates are often responsible for closely related activities. A centralized educational system for a large, populous country (fifth in the world) is not unusual in view of the planned development of education within the framework of national development.

Repelita V calls for a reorganization of the current education system to extend basic education to a 9 year cycle from the current 6 year cycle declared in 1984. The nine year basic cycle will be implemented in July 1994.

The term *universalization* is associated with the extension of education to grade 9 which means that education is available but not *compulsory*. This is an important distinction which has major implications for curriculum and the education system in general. The discussion and review of the science and mathematics curriculum for primary and lower secondary was done using *universalization* as the base.

The 1994 curriculum reform takes a step toward decentralization by placing 20% of the curriculum under local control. At this point, what this means is not clear. The lines of responsibility, content specifications, organization within the province/district/school, time allocations, etc., are open to a variety of interpretations. A set of guidelines (a policy statement) should be produced which defines "local content" and how it will be *implemented* and *assessed.*

The proposed science curriculum consistently makes reference to using materials from the everyday life of the child. The mathematics curriculum includes sections on social arithmetic. The intent is to alert the teacher to make concepts relevant to the child. However, according to feedback from teachers to the curriculum development team, some teachers believe this is what "local content" means. This confusion is likely not uncommon. Defining "local content" would be a step to help teachers gain an understanding of what it means for them in terms of instruction.

Work Setting and Methods

Prof. Dr. Moegiadi and Dr. Anwar Jasin provided a general introduction and background information for the 1994 Curriculum Reform and the move to provide a basic education for children in grades 1-9, regardless of where they live, from the densely populated cities to the remote sparsely populated areas of Irian Jaya.

My counterpart, Pak Gunadi, provided me with introductions to the curriculum team and set up a basic meeting schedule with a leader from each of the science teams of physics, chemistry, biology and mathematics.

Generally the content distribution for science is physics and biology in SMP (lower secondary), physics, biology and chemistry in upper secondary (SMA), and general science in elementary (SD). Earth and space science is incorporated into the physics curriculum.

The 1994 curriculum materials reviewed in science and mathematics were in the second draft stage. The goal is to produce one more draft after feedback from this consultancy and feedback from field visits to provinces outside of Jakarta. The fact that materials were in second draft form resulted in my working with the proposed 1994 curriculum as opposed to looking at the 1984 curriculum as indicated in the terms of reference.

This is an important point, for it is quite different to come into a curriculum reform at the beginning of work to comment and provide feedback as opposed to coming in at a next to final draft stage, when the curriculum team has expended great amounts of time and effort and has limited time available for revision. The specific recommendations and comments for science and mathematics follow in sections three and four, respectively. The comments and recommendations were done with the above in mind.

The curriculum documents are in Bahasa Indonesia. For each of the areas, a team leader went over the curriculum objectives, concepts and sub-concepts and information for the teacher. In addition, I translated much of the SD curriculum and most of the teacher information for biology and chemistry, checking with curriculum team members for accuracy of translation.

The earth and space science team was meeting during my first week of the consultancy, so I spent three days with them as they planned what concepts and sub-concepts to include in SMP and SMA. I also attended one day of a three day meeting held to review the mathematics curriculum by IKIP staff.

There is a great deal of material for the 1994 science and mathematics curriculum. Far more than one person can handle in one's native language, never mind in a second language in which one has limited proficiency. However, within the scope of time and individual limitations, all the materials are reviewed and feedback provided to the CEFDC team orally and in writing.

CURRICULUM AND CURRICULUM REFORM

In the United States, science and mathematics curricula have undergone major reform movements for the past 30 years. These efforts have been investigated and although many of the new courses developed and tested in the 60s were not widely accepted and institutionalized, they did affect the goals and content of textbooks and promoted the use of psychological principles in the teaching and the presentation of content.

The science courses that were implemented by well trained teachers produced student performance gains on conventional science tests, problem solving skills, science attitudes and interests. However, most of the courses were expensive, difficult and too theoretical for many students. Teachers had major problems with implementation. The massive teacher training that was necessary to help teachers improve such things as content, classroom management, questioning techniques, and alternative modes of assessment and evaluation did not occur. Frustrated teachers quickly reverted to whole class teaching to gain "control." The mode which put the teacher in dominant position rapidly replaced the open, less directive inquiry mode presented in the curricula.

Mathematics suffered from similar problems. The "new" math promoted understanding and higher level thinking, but the public soon became frustrated as the performance of students in mathematics, particularly in basic skills, consistently declined.

A hiatus in the reform movement allowed time to reflect on the problems and has produced new lists of characteristics for science and mathematics which describe the goals for the new reform effort in the United States. The new effort attempts a balance between content and process, a focus on scientific literacy, the integration of technology, personal and social relevance and the movement toward science and mathematics as a general education requirement for all students with the option of advanced or specialized courses for secondary students who might choose advanced study in science and/or mathematics. Accompanying these new reform efforts is a move toward national curricula. (The United Kingdom, moving in the same direction, is further ahead).

The current curriculum reform effort in Indonesia can benefit from the knowledge gained from past and current curriculum reform efforts. This does not mean that Indonesia should simply follow suit and adopt, or even adapt, approaches that are currently being advocated such as Project 2061. Problem solving, critical thinking and inquiry skills can be taught with a wide range of content which should be based upon what is most useful to most of the students.

It does mean, however, that as the move to change curriculum to support basic education in SD and SMP continues, what curriculum is should be kept in mind.

A curriculum is a plan for instruction which includes:

* what students need to know;
* how students will learn the material;
* what teachers will do to help students learn the material; and
* the context for teaching and learning.

One of the keys to curriculum reform is the translation of the curriculum into instruction. The most elegant document will make no difference unless the teachers can use it to help students acquire the knowledges, skills and attitudes specified.

Major efforts need to be undertaken to get materials into the hands of teachers and students. The experiments with low-cost teaching materials production and distribution in Ujung Pandang is definitely a step in the right direction.

The teacher training in CBSA also deserves scrutiny. The active learning techniques which stress problem solving, process skills and the active involvement of children in primary education have great promise. Even more critical is the system of professional support that is being developed which involves supervisors, head teachers and teachers.

Activity based curricula have been shown to benefit primary school children and students in low income countries. Inquiry methods, however, can waste time unless teachers carefully prepare and supervise the children's activities. The system in CBSA provides the needed support for the teachers and has the potential of sustaining teacher behavior.

Changes in pre-service education of teachers, particularly at the primary level, are another opportunity to do some small scale experimentation. Training in specific pedagogical techniques for pre-service teachers has yielded positive results in actual use on the job. Micro teaching has shown to produce substantial effects. The combination of lecture, modeling, practice and coaching have shown positive impact on teaching behaviors and student performance gains.

In a country as large and diverse as Indonesia, resources and management present major obstacles. Taking on large scale efforts in production of text materials for teachers and children, in-service training, and teacher preparation is costly and risky. Smaller scale implementation and evaluation is more rational. Unfortunately this means smaller, incremental changes over time which does not appeal to the demands for instant results.

In preparing to implement the 1994 curriculum and laying out the next 25 year plan, the opportunity is present to plan for well designed, small scale projects throughout the provinces which can provide feedback and data to guide improvements in the educational system in Indonesia.

CURRICULUM 1994/SCIENCE

Sekolah Dasar

The Science Curriculum for Sekolah Dasar (SD) follows the format of stating the broad curriculum goal, the instructional goals for each grade level, the concepts and sub-concepts associated with the instructional goals and suggestions for teachers. A suggested time allocation for each concept/sub-concept is also included.

The goal statement language is based on process, problem solving, and relating concepts (content) to the everyday life of the child. Phrases such as: through observing, asking questions, experiments, discussion of experimental results are used consistently. There is also an implied cooperative interaction among students as well as with the teacher. The intent is to foster a dynamic interaction between the child and the environment, among children, with materials and the teacher.

The content range includes life sciences, with a heavy emphasis on health in grade 3, physical sciences and earth sciences. The overall flavor is a "general science" approach with a minor spiral approach. For example, in grade 2 children examine characteristics of rocks and group them based on the characteristics. In grade 5 they examine rocks in more depth, classify them, and are introduced to the vocabulary which attaches names to the classification system. In grade 2 they examine air and wind, weather and seasons. These topics are revisited in greater depth in grade 4. The aim to have both vertical and horizontal development is evident.

There has been a concerted effort to create a basic science curriculum for SD that is experienced based, process oriented, "cooperative" and enriched with charts, pictures, diagrams and models. However, there are some areas that need serious attention as the next draft of the SD curriculum in science is undertaken.

A Scope and Sequence chart should be developed. The scope and sequence chart at a minimum should include grades 1-6. Ideally it would include grades 1-9, so that the SD and SMP curriculum could be looked at as a coherent package. Table I illustrates the sequence of major topics as presented in grades 1-6. This type of table needs to be completed in more detail by the curriculum team.

Such a table will allow the team to examine the SD science curriculum for overlaps, gaps and how it relates to the SMP science curriculum. (The relationship between SD and SMP is addressed in another section).

A long, unproductive debate could ensue about sequencing content. This would be futile. The sequence of content is not the issue. The important questions are: What is worth knowing in relationship to the life of the child? What concepts are relevant to children? What concepts lend themselves to concrete experiences? What concepts provide experiences that are just plain fun and intriguing to children?

Content selection should be judged on the basis of whether it will make sense to the child and place the child in a problem solving situation which leads to the asking of questions, planning and problem solving, etc. The content should help children understand the phenomena of their environment and gain an understanding of their relationship to that environment and their ability to effect changes and improvement in the environment.

The suggestions to the teacher are very important. The teacher is the individual who takes the curriculum and translates it into instruction. With the heavy burden of II subjects to teach, an overloaded time frame for instruction and an inadequate content background in science, it becomes important to either move the curriculum guides to a more instruction oriented approach or provide teachers with teacher's guides that help them plan instruction.

One of the fears expressed about including suggestions for the teacher is that the suggestions become prescriptive and teachers follow them exactly. On the other hand, if the teacher's background in science is poor (and no one seems to doubt this) and text materials are in short supply, it would appear that an investment in instructional support (in this case, more suggestions) is in order.

As mentioned earlier the language of the science curriculum reflects an orientation toward process. Process development can be sequenced. There are process sequences which can be found in various formats such as AAAS, Sciences 5/13, Australian Science Curriculum, etc. Process, perhaps more readily, lends itself to a sequential development than does science content. However, there is no pattern of process sequencing. Children are expected to observe, but there is no indication that they are helped in acquiring observational skills. It appears process "words" are used without the accompanying development.

Process lists vary slightly but usually include skills such as observing, classifying, measuring, communicating, inferring, predicting, experimenting, etc. If one looks at the process of observing, it can, on the surface, appear to be a "simple" one. But it is complex. For example, observing extends across making direct observations of the physical properties of objects and events, using instruments to extend the senses, distinguishing actual observations from personal interpretations, repeating observations to accumulate sufficient evidence upon which to base inferences, etc. A scope and sequence chart could be developed for the process skills. This may prove more productive for the SD curriculum than a content (concept) scope and sequence.

As it now stands, the SD science curriculum is developed mainly by persons prepared to teach secondary science content, with limited (if any) teaching experiences, and no experience with elementary teaching. This is a major concern for both SD *and* SMP (addressed later).

The lack of experience in SD teaching shows in the selection of content (concepts), heavy reliance on content (although the SD science curriculum is less theoretical than the mathematics curriculum), unrealistic time allocations, lack of numerous experiences to help children develop a concept, and the relationship to the student's own experiences and interests. The SD science curriculum should be enriching the lives of children because being a child is an important time of life and the science curriculum should not be solely to prepare children for future study of science.

Science is being treated as a separate, discrete content area. There needs to be more relationships built with other content areas in SD. Connections need to be made with mathematics, language, social sciences, etc. The work that is being done in CBSA is an excellent resource for connecting ideas across areas. A variable approach to SD curriculum would be to combine subject areas. This may not be possible for the entire curriculum (all subject areas) but it might be feasible to try some combinations in SD which integrate at least 2 content areas and last for 4-6 weeks. Integrating content for teaching is not an easy task. But by the nature of teaching in SD, one teacher per group of children, integration likely occurs on an informal level, if not at a formal one.

In class levels 1-3, prime candidates for integration are language and science. Children's natural interest in the world in which they live can provide an excellent base for activities that involve language. As children explain the characteristics of living and non living things, this can become the base for vocabulary development, story boards for teaching reading, writing exercises, communicating ideas, reading, etc. Maintaining science notebooks, keeping records, recording and interpreting data are important language skills.

Children can write stories, poems, even plays that other children can read and share. The desire to talk about, describe and communicate is based on experiencing something which promotes interest, excitement, curiosity, and personal discovery and involvement. For young children, science provides this arena. Combining science and language development in the lower levels of SD, also has the advantage of reducing the total number of content areas and preparations for the teacher.

Curriculum development can not occur in a vacuum. The professional staff support systems, curriculum development, resource materials (textbooks, etc.) production, and teacher education (pre-service and in-service) need to be coordinated so that each is supported and strengthened by the other. The opportunity exists to begin to make significant steps toward strengthening the science curriculum in SD and the SD curriculum in general.

RECOMMENDATIONS

1. Develop a Scope and Sequence Chart for Concepts and Sub-concepts.

2. Re-examine content in each grade of SD for relevance to child's life. Attempt to answer question: What is worth knowing for children in relation to everyday life?

3. Consider the context in which teacher operates. Are materials available? Are manipulatives arising from child's environment? Make suggestions that are practical.

4. Examine content in grades 4, 5, 6. Reduce number of topics in these grades. Content is too abstract.

5. Re-think time allocations for concepts.

6. Supply more suggestions for teachers. These could be in the form of lists - do not need to develop full-blown descriptions.

7. Take the curriculum to elementary teachers and find out if they can plan instruction using the curriculum.

8. Involve elementary teachers in developing *suggestions.*

9. Ownership of SD curriculum needs to be given to "someone."

10. For levels 1, 2, 3 integrate language and science.

11. Initiate the development of a Scope and Sequence for science processes.

12. Re-evaluate "spiral" design and make certain there is not needless repetition.

Grade Time	1 (64)	2 (68)	3 (78)	4 (136)	5 (136)	6 (116)
	Character-istics of living/non living things	Characteristics of air and wind	Water erosion	Properties of water	Characteristics and grouping living things	Plants make food
	Variation among living things	Rain/weather conditions related to seasons	Characteristics of flowers, fruits, seeds/classify	Compostion of land, erosion, weathering, ways to conserve/3 kinds of rocks	Natural resources and conservation	Interdepend-ence of plants/animals
		Solids, liquids, and gases				Characteristics of magnets
	Differences/ similarities of plants and animals	Characteristics of rocks and how to group	Health - need for food	Oil, coal as resources	Characteristics of light	Population growth
	Water and food are necessary for life	Fertile land Characteristics of sun	Importance of rest, etc. to maintain energy, health	Air, wind, atmosphere, characteristics, levels, etc.	Characteristics of kinds of energy	Current electricity resources and circuits
	Differences between solids and liquids	Shape of moon related to light of sun	Contagious diseases: ways of prevention	Sound and its properties	Simple machines	Food, digestion, health
					Forms of energy changing forms	Five senses (organs)
	Light and shadows		Day/night measure shadows and time/earth's shape and surface		Influence of heat conductors/ insulators	Understand-ing solar system, earth, moon movement & eclipses

CURRICULUM SCIENCE/SMP/SMA

Physics

The lower secondary science curriculum (SMP) focuses on biology and physics (physics includes earth and space science). The upper secondary science curriculum includes physics, biology and chemistry.

The physics curriculum for SMP is heavily based on mathematics, quite theoretical and appears more a preparation for advanced study in science than allowing all students to gain a basic understanding of science concepts and an appreciation of science. There is no clear connection between the science in the SD curriculum (primary school) and the SMP curriculum in physics.

Biology and physics are presented as separate subjects. The earth and space sciences are included in physics. They are add ons and not integrated with the concepts and ideas in physics. There are no connections made between the science disciplines. They are discrete areas taught by different teachers.

The students in SMP may not have the skills in mathematics which are called for in the physics curriculum. The calculations called for are note necessarily difficult, but are of the type that require understanding of relationships such as work = force x distance, where if any two of the three variables are known, the third can be calculated. The students will probably need to deal with this as three cases: (1) work = force x distance, (2) force = work/distance, (3) distance = work/force. This in itself is not a problem, if students gain an understanding of force, work, and energy relationships. This is presented as an example. Other calculations required involve Boyle's Laws, velocity, refraction, Ohm's Law, etc.

Fewer topics should be covered in physics, with more time spent on topics so that students can get a better understanding of a few ideas. Fewer topics with more in depth study horizontally would allow more explanation, examples, more project and group work by students.

Connections can be made to science outside the school context and greater use of community resources. The SMP level should include more career awareness, job opportunities and interests in science and technology, This level is an important decision making point in the child's life and school provides a place for expanding awareness.

Connections should be made to biology so that when sound is taught, it should include how we hear and the anatomy of the ear. Light should include the eye and more than just the lense, nearsighted and far sighted vision.

Topics that should be considered for deletion in SMP are:

* Boyle's Law;
* velocity;
* mathematical calculations and formulas with refraction (light) and electricity;
* selenoids;
* transformers;
* basic electronics;
* water pressure, hydraulics; and
* lenses (formulas and diagrams).

More emphasis in SMP needs to be placed on:

* energy sources and transformations;
* how different forms of energy are used, the changes that occur as we use energy;
* relationships between force and motion;
* systems and interactions;
* measurement, repeating measurements;
* communicating through graphs, tables, charts, diagrams;
* career awareness - science and technology; and
* how products of science and technology change society.

The curriculum in SMA for physics is dense and mathematically based. The use of functions and limits occurs in physics *before* it is taught in the mathematics curriculum. Streaming occurs in the third year of SMA so that not all students will take the third year of physics.

The first two years of SMA contain too much content for students not directed to a scientific field. They are preparation for *college science majors*. The intensity of the mathematics will be overwhelming for many students.

By the end of the second year of SMA, students are expected to deal with the first and second law of thermodynamics.

The question that consistently surfaces is, what is worth knowing? Do all students in SMA need to attain a conceptual and mathematical understanding of the ideas presented? The answer to that question is probably not.

The physics curriculum team needs to think about how material in physics can be presented with less emphasis on mathematics for those students who are not oriented towards a career in science (which is likely the majority). This does not mean that those students who are oriented towards science should be deprived of the opportunity for advanced study.

Selecting core ideas and concepts that all students should experience in SMA and providing enrichment experiences for those students who are science oriented is one way to accommodate this situation.

This is not an instructionally easy task for teachers. The promotion of core and enrichment activities in the same classroom places a burden on the teacher and will require the provision of more resources for teachers as well as professional support.

Biology

The biology curriculum for SMP follows a traditional pattern of general biology. It is content oriented with the acquisition of knowledge as the base. In class I, the content covers ecosystems, patterns of life on land and water, structures of organisms (cells, tissues, organs) and plant and animal classifications.

Class II deals with the systems of the human body (except reproductive) and comparative anatomy using the fish and frog.

Class III covers sustaining life (reproductive system), adaptation, biotic potential (food production), population, food and its relation to health.

Unlike physics, the biology curriculum for SMP does not contain large amounts of material which are abstract and theoretical. It is information oriented and does not appear to involve manipulations or active investigation. The instructional mode is more didactic and direct. This is not a criticism, but an inference.

This style of instruction can be well done and students have shown achievement (academic) on conventional assessment. Direct, didactic teaching also is a common practice that has been around a long time.

The SMA biology curriculum follows suit and presents a traditional biology curriculum. More emphasis is placed on environment, conservation, population growth and its impact, nutrition and health than in SMP.

Class III when streaming occurs in basically a course in genetics and evolution culminating with the ecosystem, the role of humans, science and technology and ethics of the environment.

Some of the ideas that are in class III should be moved to class II. Discussion of the responsibilities of humans toward ecosystems, ethics in relation to the environment and ethics in relation to genetics are topics all students need to confront. Some of these ideas should be moved from class III to class II or be treated in class II in less depth.

In the case of biology and physics, the SMP curriculum does not appear to focus on the level of the SMP child or the child's characteristics. No connections are made between the sciences, and chemistry is conspicuous by its absence.

The curricula do not promote how we know, evidence for why we believe or how we revise our thinking. This is important for developing critical thinking and logical reasoning skills. Important questions for the teacher to ask the students are: How do you know? What is the evidence? What do you infer?

There is no connection between SD and SMP. SMP appears to prepare students for SMA and SMA to prepare students for college. The package of SD and SMP in science needs to be looked at in light of what science content and process skills do we want children to possess at the end of grade 9 (class 3 of SMA). This question refers to *all* children and not the "elite" college bound.

Grades 4-9 (class 4 of SD through class 3 of SMP) should be the block looked at for concept, skill and attitude development. The curriculum teams in biology and physics should work together and focus on developing a scope and sequence for grades 4-9. Team members from the chemistry curriculum should also be brought into the discussion.

The present situation consists of the curriculum teams working independently at the SD and SMP levels. The lack of classroom experience of the team members and lack of interaction has resulted in a fragmented curriculum in science at SD and SMP. Long term the 4-9 science curriculum will be the foundation of further education and training on the job or in SMA. The skills and knowledge gained are critical to productivity in an increasingly technological society.

Chemistry

The chemistry curriculum is confined to SMA. Class I deals with matter, atoms, molecules, ions, elements, compounds, symbols, formulas, the periodic table, acids, bases, and simple chemical reactions. Class II takes the student through atomic models, spectral analysis, entropy, equilibrium, concentrations of solutions, acid/base reactions, solubility including calculations, redox reactions and electrochemistry.

Class III takes an indepth look at the Periodic Table and organic chemistry.

Chemistry tends to be very abstract and theoretical and to prepare students for future study of chemistry. In some cases, the ideas identified as concepts are more facts and not broad categories or generalized information.

Chemistry for class I and II of SMA needs to relate more to the life of the student. Chemical make-up of common, house hold substances, chemicals in the environment, chemistry related to make-up, etc. are topics more in line for the majority of students.

Career awareness and technological applications of chemistry need to be included. How does chemistry relate to other areas of science?

Science in SMA treats chemistry, physics and biology separately; there are no connections across the sciences (as in SMP).

Until the basic education cycle 1-9 is in place, it is difficult to look at the SMA curriculum. If all students coming into SMA have a basic, solid foundation in mathematics and science, then the curriculum in SMA becomes less formidable.

The background of the teacher is important in the SMA curricula areas. The teachers will need a strong content background in the subjects they teach. They will also require teaching techniques which allow them to effectively teach students with wide ranges of ability (aptitude).

In the SD and SMP curriculum in science, children should learn about matter and its properties, from where matter comes, the basic units of matter, the interactions of matter, and substance changes. With the exception of a few encounters at the lower levels of SD, and dealing with solids, liquids and gases in physics as forms of matter and its characteristics, chemical ideas are treated only in SMA. The compartmentalization of the subject areas produces a separatism where big ideas can fall through the partitions.

Students who complete SD and SMP only will miss out on major ideas in science such as the structure of matter and the interactions of matter and energy. The SD and SMP curriculum on science needs to be reviewed for concepts from chemistry which are considered essential knowledge for all and which are needed to understand other content areas.

Other Content Areas

The earth and space sciences are in the physics curriculum. Two areas that lack coverage (except for a small amount in SD for weather) are meteorology and oceanography. The topics are quite relevant to the children, and Indonesia is, and has been, greatly affected by oceans. Concepts from oceanography could be placed in the SMP curriculum.

MATHEMATICS CURRICULUM

Scope and sequence charts have been developed for each grade level in mathematics. The format of the curriculum guide includes concepts, subconcepts, suggestions for the teacher, examples and illustrations in detail.

The implementation plan proposes to provide a basic curriculum for grades 1-11 with enrichment material in grades 7-11 for those students interested and able to do work in greater depth. Surveys have been conducted of IKIP, UNIVERS (Bandung, Bogor) selected teacher to identify those concepts which are considered very essential and concepts which are considered enrichment. The curriculum at grade 12 (level 3 of SMA) has two tracks, one for the social sciences and one for the sciences.

The process of identifying essential ideas and concepts implies that thee is a common core of knowledge in mathematics that all children should possess. This approach has advantages in that it better prepares all the students, giving them equal access to mathematical ideas, allowing them to experience interesting mathematics, keeping doors open, and moving students beyond computation. However, teachers will need a great deal of help in instructional techniques for differentiating content.

The mathematics curriculum is rigorous and academically oriented. It is abstract and theoretical and does not incorporate real world contexts using children's experiences and language to develop ideas.

The mathematical ideas that children learn in SD, particularly the first 3 levels, are very important for they will form the basis of further mathematics. It is critical that children understand mathematical ideas as opposed to gaining many skills.

Giving more time to helping children develop math concepts and relationships does not mean more rote practice. It means having children actively involved in doing mathematics through exploration, constructing, discussing, describing, investigating, etc.

Active learning by children implies that teachers need to create an environment in which children can explore, test, discuss, and apply ideas. Teachers need to *listen* to children and guide the development of ideas. Mathematical ideas need to be applied to real-world problems.

In the SD curriculum, the above ideas do not appear evident. A traditional content "hierarchy" is presented, well illustrated and with examples. But the examples use abstract ideas and with the exception of the sections on social arithmetic, the context of the examples has little to do with the child's world.

For example, in level 3 the topic of place value is treated (1000s, 100s, 10s, 1s) with no reference to money with which children will have had experience. Drill and practice with place value, number operations, number properties, etc., is the pattern. Terminology is introduced more as vocabulary than as concepts. There is a rapid progression through topics such as moving from computations, to geometry, to proportions, to fractions, to algebra, to the metric system, etc. These topics appear to receive equal treatment.

Throughout the curriculum document there are errors in the examples. Some of these are obviously typing errors, but for an inexperienced teacher (or an experienced one) with a poor background in mathematics, the errors will be a major problem. For example, the area of a right triangle is given as multiplying the 2 legs. Line segments are shown with "o" located incorrectly, plus, minus, equals signs are interchanged, etc. Very careful proof reading should be done.

In the SD curriculum, more emphasis should be placed on:

* estimation of quantities;
* mental computation;
* estimation of reasonableness of answers;
* selection of an appropriate computational method;
* process of measuring;
* estimation of measurements;
* word problems with a variety of structures;
* use of everyday problems;
* study of patterns and relationships;
* problem solving strategies;
* discussing, reading, writing, and listening to mathematical ideas;
* connecting mathematics to other subjects and the world outside the classroom;
* exploring relationships - whole numbers, fractions, decimals, integers, rational numbers;
* developing tables, graphs, rules to describe things and events;
* connecting topics in mathematics;
* representing situations in different ways - verbally, numerically, pictorially, symbolically, geometrically; and
* formulating questions.

Less emphasis should be placed on:

* questions which require only yes or no answers;
* paper and pencil computations in isolation;
* memorizing rules, algorithms, procedures without understanding;
* memorizing and manipulating formulas in geometry;
* doing one-step routine problems; and
* manipulating symbols (algebra).

Content topics to be reduced or eliminated from basic curriculum in SD:

* three dimensional geometry;
* two dimensional geometry without relevance to world of child;
* memorizing metric equivalents;
* complex square roots;
* Cartesian coordinates without meaning to child; and
* factors, multiples without real world application.

In the SD curriculum in mathematics, examples and illustrations should begin with manipulations. Presently, examples are abstract, occasionally manipulatives are shown as with place value but *after* abstraction. This should be revised. Experience with concrete materials should *precede* abstract ideas.

SMP

The SMP curriculum in intense and theoretical. It begins with set theory, moving into venn diagrams, and on to solid geometry. The characteristics of three-dimensional shapes are examined and then angles are treated with indepth treatment of angle measurement. This approach continues with treatment of fractions, decimals, and computations interspersed among coordinates, quadratic equations, and trigometric functions.

The SMP curriculum appears as a junior version of an SMA college track. The topics are treated in isolation and no connections are made. There is so much content included that there is little time for exploration, pursuing open-ended problems or project work that might extend over a period of time. Connections are not made within topics in mathematics. There is no model building, for example, creating a model for probability. Equation solving is more manipulating symbols and drill than developing an understanding of variables, expressions, and equations. Usually one method of solving linear equations is presented as opposed to investigating informally inequalities and non-linear equations.

Generalizing solutions and strategies to new problem situations is lacking. Situations for validating the student's own thinking need to be provided. Work with statistics in real-world situations needs to be provided so that students gain an understanding and appreciation of statistics as a tool (a powerful one, at that) in decision making. Probability should lead to compare experimental results with mathematical expectations.

In the SMP curriculum, more emphasis should be placed on:

* reasoning inductively and deductively;
* applying mathematics;
* connecting topics within mathematics;
* extended projects which involve problem solving;
* identifying and using functional relationships;
* using estimation where appropriate to solve problems;
* using estimation to check reasonableness of results;
* developing understandings of topics as opposed to memorizing vocabulary and procedures; and
* building on the base established in SD.

Less emphasis should be placed on:

* developing skills out of context;
* manipulating symbols;
* geometric vocabulary;
* routine, one-step problems;
* converting between measurement systems;
* simplifying radical expressions;
* using factoring to solve equations; and
* logarithmic calculations using tables and interpolation.

Content topics to be reduced or eliminated from the basic SMP curriculum:

* set theory;
* Venn diagrams;
* shapes (equations);
* three dimensional geometry calculating surface area, volume;
* transformation;
* vectors;
* functions - trigometric; and
* graphing equations using point plotting.

Real-world problems need to be the focus to motivate and help students apply theory. Until students have progressed through SD and SMP *and* go to SMA, it is difficult to predict what will happen at the SMA level. If students gain an understanding of mathematics through a basic curriculum in SD and SMP, have a good foundation in understanding concepts of algebra, and relationships in geometry and can deal with data and open problem situations, then the SMA curriculum will be less foreboding.

Coordination with science - physics in particular - needs to be done. The physics curriculum requires functions *before* the topic is presented in mathematics.

The proposal to provide a "core" curriculum in SMP and SMA for all students and enrichment activities for the more able students, academically and motivationally, is an interesting idea.

Teachers will need help in managing instruction which calls for multi-levels of teaching in the same class. This also calls for good content knowledge on the part of the teacher.

Implementing core and enrichment matter will take very careful planning and providing resources for the teachers. Differentiating instruction in a classroom has been, and is, done by good teachers, it has also been found that teachers get better at differentiating instruction with practice. As more students continue on in the education system, the patterns of diversity in knowledge, skills, and attitudes will increase.

SUMMARY

Individual meetings were held with members from each of the curriculum teams for SD, biology, chemistry, physics, and mathematics. General concerns discussed were:

* size of the curriculum guides;
* format (particularly placement of curriculum objectives);
* suggestions for teachers;
* implementation of curriculum;
* monitoring and assessment of curriculum;
* resource material for teachers and students (including primary teacher education);
* streaming and when it should occur in schools;

* overloaded curriculum;
* purpose of SMP curriculum; and
* local content and its meaning.

Specific concerns for each of the content areas for each curriculum area in science and mathematics (addressed in previous sections) were discussed.

RECOMMENDATIONS

Priority should be given to:

1. Developing a scope and sequence table for the content areas in science for SD and SMP. This should include the science concepts by grade level for classes one through nine that all students are expected to learn.
2. Matching the curriculum guides in science for SD and SMP with the scope and sequence tables and adjusting the curriculum guides where necessary.
3. Adding suggestions for teachers about activities and ways to present the content.
4. Defining what is meant by local content and a policy statement on how it will be implemented.
5. Developing a timeline for the implementation of the curriculum which includes a system for continuous monitoring and assessment.
6. Focusing on the SD and SMP curriculum in science and mathematics and giving less attention to SMA at this time.
7. Designing a plan for implementing a common core of activities for classes one through nine in science and mathematics with enrichment activities for students in SMP.
8. Getting curriculum guides and textbook materials in the hands of teachers.
9. Integrating curriculum development, Cara Belajar Siswa Aktif (CBSA), text development, and primary teacher education (pre-service and in-service).
10. Devising assessment strategies that promote problem solving, critical thinking, welcome curiosity, and reward creativity.
11. Supporting and monitoring multiple, small-scale, curriculum implementation at the local level accompanied by incentives for teacher.
12. Experimenting with incremental changes in the curriculum focused on SD then moving to SMP and finally SMA.

The early years in school are critical in the development of science and mathematics learning and serve as the base for future learning. When one learns a subject well early, the probability to continue learning is increased. *More time* in school at the SD level, particularly at the early class levels, *more resource material,* (particularly text materials for teachers and students), and *well-prepared primary teachers* are candidates for the major investment of resources over the next five to ten years.

Serious consideration should be given to combining language and science in grades 1-3 (SD). A language experience approach has great potential for promoting literacy in the broadest sense.

Time spent on learning is very important to achievement. The learning, of course, has to be at the appropriate level, neither too hard nor too easy. Primary children should be in school for a longer time period than 3 hours.

Teachers need to understand the content and how children learn. One cannot teach what one does not know.

Resources are necessary as the promotion and supplier of ideas. Individuals in isolation of materials and interaction with others (in this case teachers) soon run out of new ideas and ways of doing things.

The opportunity is present to bring several different forces to bear on the education system in Indonesia. Concentrating on primary education in terms of implementing the curriculum which includes the instructional parameters as well as the content/process parameters and simultaneously *planning* for the implementation of the SMP curriculum hold promise for improving education in Indonesia.