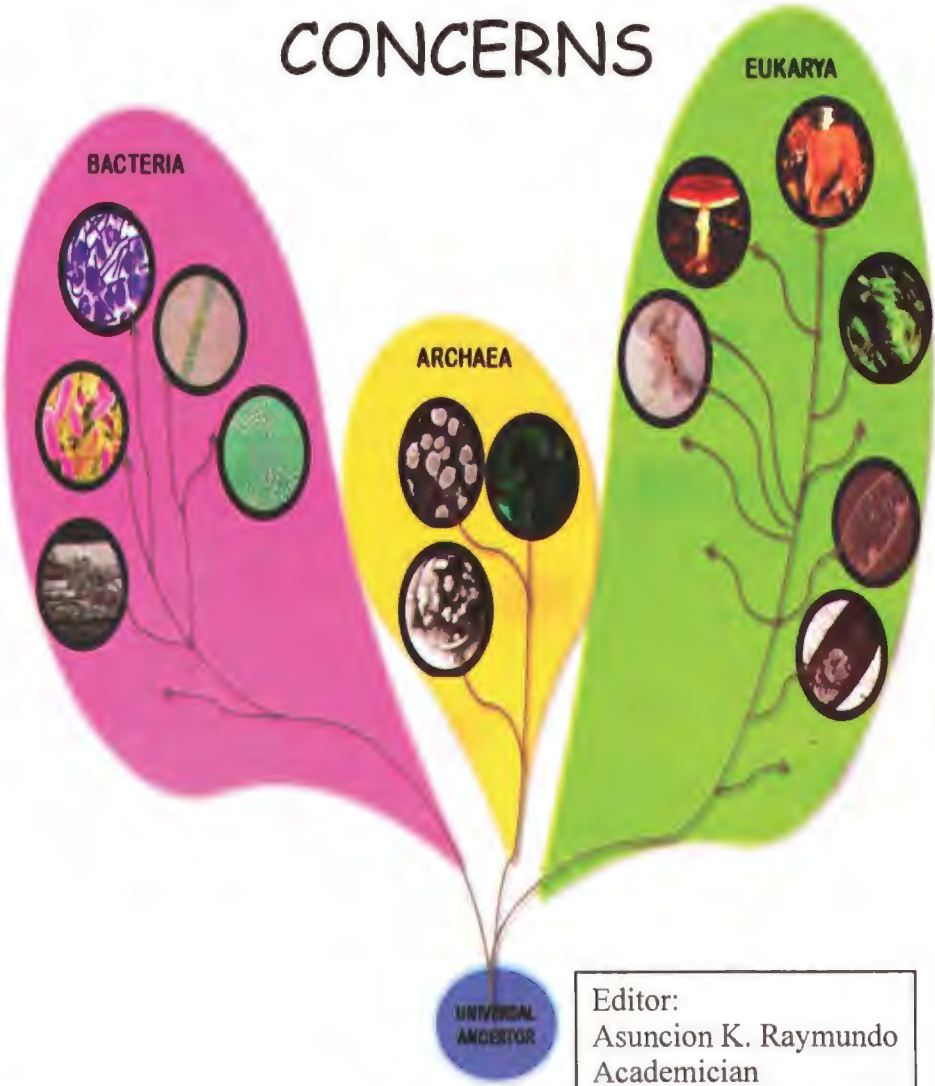
BIOLOGY EDUCATION: GAPS, ISSUES, AND CONCERNS



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The cover depicts the three domains of life as proposed by Carl Woese in 1980 based on rRNA gene sequences.

PROCEEDINGS OF THE ROUNDTABLE DISCUSSION ON BIOLOGY EDUCATION: GAPS, ISSUES, AND CONCERNS

23 April 2007
Traders Hotel
Roxas Boulevard, Manila

THE NATIONAL ACADEMY OF SCIENCE AND TECHNOLOGY (PHILIPPINES)

PREFACE

In the same manner that physics and chemistry heavily influenced the course of civilization during the past centuries, it is now increasingly accepted that the 21st century is the turn of the science of biology. Biology-driven technological developments are profoundly changing the way mankind goes about its many concerns. Witness the cloning of the sheep Dolly, the advent of genetically modified insect resistant crops, the mapping of the human genome, the widespread use of PCR and DNA fingerprinting and new drugs and products resulting from genetic engineering.

The looming global food crisis, the demand for renewable fuels to replace fossil fuels, increasing environment pollution and the spread of new exotic diseases accentuate further the need for progress in biology and its myriad applications.

Recognizing the vital role of science and technology in the progress of nations, the National Academy of Science and Technology has taken upon itself the task of building a culture of science among our people especially the young. Together with its principal partners- the Department of Education, the Commission of Higher Education, the Department o f Science and Technology and the National Research Council of the Philippines, the NAST organized a series of round-table discussions on how to promote a culture of science through basic education. This volume captures the deliberations on one of these dealing with the teaching of biology, the challenges and opportunities.

EMIL Q. JAVIER
President
National Academy of Science & Technology

FOREWORD

The National Academy of Science and Technology (NAST), in cooperation with the University of the Philippines Los Baños - Institute of Biological Sciences (UPLB-IBS), the Department of Education (DepEd), and the Commission on Higher Education (CHED), conducted a roundtable discussion last April 23, 2007 at the Traders Hotel as an avenue to tackle gaps, issues, and concerns about biology education.

The realization of the need to keep abreast with the numerous breakthroughs and advances in the life sciences has made it imperative that the basic, intermediate and advanced concepts in biology be correctly and effectively taught to elementary, high school and college students. By bringing together the leading people involved in science education at the elementary, secondary and tertiary levels, the roundtable discussion aimed to assess the current state of biology education in our country, identify the present gaps, issues, and concerns, find out which priorities need to be addressed, and hopefully come up with a preliminary course of action.

The roundtable discussion tried to bring together stakeholders in biology education from different levels and sectors in a roundtable discussion, identify the different issues and concerns of stakeholders and bring them to light in a broader context, identify gaps in the science curriculum at all levels, explore ways of addressing these in terms of national priorities, and promote interaction and collaboration among stakeholders.

The expected output was an overview of biology education at the primary, secondary and tertiary levels, identifying the gaps, issues, and concerns confronting the different stakeholders, and situating these within the context of educational and national priorities. Moreover, an action plan addressing these issues and concerns was formulated.

This monograph is a compilation of papers presented during the RTD and feedback from the participants.

ASUNCION K. RAYMUNDO, Ph.D.
Academician
National Academy of Science and Technology

WELCOME REMARKS

Acd. Ledivina V. Cariño
Vice President
National Academy of Science and Technology

Welcome to the Roundtable Discussion on Biology Education, this significant gathering of educators, scientists and administrators to tackle the crisis plaguing science education; specifically biology education.

For many years, we have been hearing complaints about problems with the quality of our science education, which has resulted in plunging scores in diagnostic examinations, and a low ranking in relation to our Asian neighbors. Compounding this emergency situation is the unabated migration of teachers, especially science teachers, to other countries, where pay is more lucrative. By organizing this roundtable discussion, we hope to do our bit to tackle the problem.

Before this, there have been a number of efforts to evaluate and try to solve this huge challenge. But the present gathering differs from previous ones in that it is organized by no less than the National Academy of Science and Technology. At the same time, because it is also composed of practicing biology teachers on the elementary, secondary and tertiary levels, its recommendations will reflect actual, practical experiences by science educators and professionals. The combined inputs of the Philippine scientific community and of actual science educators in this affair, will, I hope, awaken the authorities and concerned sectors to the urgency of the situation, and stimulate real changes which will lead to the much-needed, drastic reforms in biology education. Which is about time, given the leading role that biology is about to play in the new millennium. Eventually, society as a whole will have to be conscious of, and oriented to science, more than previous generations ever have been. We need a paradigm shift in awareness and action if we are to survive, sustain the momentum, and seize the initiative.

I wish for the success of this affair, which will hopefully be the beginning of a new initiative for biology education, for Philippine science, and the larger Philippine society.

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BASIC EDUCATION CURRICULUM IN SCIENCE AND HEALTH

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In 2002, the Department of Education, through its head, Secretary Raul Roco, improved the Basic Education Curriculum. It has been five years now, and to assess its effectiveness and the students' competence and comprehension, the scores in the National Achievement Test for Science were evaluated. Table 1 presents these scores. Based on the table, a slight improvement was observed from 2003-2004 to 2004-2005. However, the year that followed showed decreased scores. It should be pointed out as well that the NAT scores never reached the 75% goal.

Table 1. Mean National Scores in National Achievement Test for Science

Year	2003-2004	2004-2005	2005-2006
Percentile	52.59	54.12	46.77

The Department of Education reevaluated the Basic Elementary Education (BEE) in consultation with the elementary teachers. Three major concerns or issues that contributed to the dismal performance in the NAT for science were identified. These include:

1. Overloaded Curriculum
   There were too many body parts included in the body systems. It was so detailed that information overload occurred.

2. Content treatment was not suited for elementary students
   In the topics about diseases, so many illnesses and symptoms were presented.

3. Topics on animal taxonomy were not easy for students to comprehend
   The Department of Education wanted to gear science towards a more taxonomic approach, but students were not ready for this because they could not comprehend it.

4. Teachers not fully equipped and trained to handle some topics

Most of the elementary teachers are non-science majors; they are generalists. Moreover, some teachers did not have the initiative to go beyond what the textbooks contained. Thus, what they knew and could impart to the students was bound by what was written in the prescribed textbooks.

The chalk-talk method seemed inadequate for the science topics. Teachers merely lectured, thinking that the students would comprehend the topics. More appropriate and effective teaching and learning strategies need to be employed.

In view of this dilemma, the Department of Education came up with the Basic Elementary Education (BEE) initiatives. The Philippine National University was asked to evaluate the curriculum. Along with these, consultations and meetings were made not only to convene the teachers, supervisors and master teachers, but also other agencies like NAST, DENR, EMB and DOH. These initiatives looked into the competencies so that they can be streamlined and finalized. Consequently, lesson guides and strategies were formulated in collaboration with UP-NISMED and master teachers.

Finally, the Department of Education consolidated the results of these BEE initiatives, and the contents used for science education for people, animals and plants are summarized in Tables 2-4.

Table 2. Content matrix for People

Grade III	Grade IV	Grade V	Grade VI
1. Sense organs	1. Skeletal system	1. Reproductive system	1. Circulatory system
2. Growth and development	2. Muscular system	• parts and function • puberty	2. Nervous system
3. Protection against abuse	3. Digestive system • parts • function • caring • first aid for muscle and bone injuries	• hygiene • ailments 2. Respiratory system • parts and function • ailments • caring	• parts and function • ailments • caring

Table 3. Content matrix for Animals

ANIMALS			
Grade III	Grade IV	Grade V	Grade VI
1. Body parts, movements and places where they live 2. Body parts for food getting and eating 3. Needs	1. Life cycle of common animals 2. Animal reproduction 3. Benefits derived from animals 4. Dangers posed by animals	1. Structural and behavioral adaptations 2. Vertebrates and invertebrates 3. Coral reefs 4. Endangered animals	ECOSYSTEM 1. Interrelationships • components • interdependence • food chain/food web • oxygen-carbon dioxide

Table 4. Content matrix for Plants

PLANTS			
Grade III	Grade IV	Grade V	Grade VI
1. Plant parts and function 2. Classifying plants (trees, shrubs, herbs, vines, grasses) 3. Uses of plant and plant parts 4. Caring	1. Sexual reproduction 2. Life cycle of flowering plants 3. Seed germination 4. Seed dispersal 5. Asexual reproduction 6. Harmful plants	1. Photosynthesis 2. Plant groups 3. Herbal plants used as medicine 4. Poisonous plants 5. Adaptation 6. Caring	ECOSYSTEM 1. Interrelationships • components • interdependence • food chain/food web • oxygen-carbon dioxide

These foregoing tables show that the content matrix for Basic Education in Science and Health have been refined and streamlined to address the issue and concerns earlier identified.

ANALYSIS OF CONCERNS IN ELEMENTARY SCIENCE EDUCATION

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Science occupies an eminent place from the elementary up to the tertiary curriculum in the Philippines. Advances in scientific and technological researches have led to an appreciation and assessment of the role of science and technology in contemporary society. Science education should develop in an individual the culture of a scientific temper – the ability to reason logically and judge opinions based on empirical evidence. Science education should also equip the individual with the skills needed in a scientific inquiry – skills that must be acquired at the primary level of education, and honed and refined as the individual pursues higher levels of education. Eventually, these skills will mold or shape the youth, who will actively participate in the creation of a better society. However, there are obstacles in achieving a society like this. Foremost is the dismal state of science education at the primary levels in public as well as private schools.

During the workshop for science education sponsored by the National Academy for Science and Technology last April 23, 2007, public and private school elementary science teachers from the NCR, Regions II and IV, identified the gaps, issues and concerns in basic science education. Along with these, the participants suggested possible solutions to address the identified problems. The results are discussed below.

GAPS IN THE BASIC SCIENCE EDUCATION

Teacher Factor

A science teacher must be scientifically as well as digitally literate. In this age of technology, access to scientific developments can be sourced through the Internet, journals and other readily available materials. Aside from the conventional chalk and talk delivery of the lesson, the utilization of digital slide presentations in creating lessons has been initiated. How can our science teachers become globally competitive if they lack basic computer skills?

Another quite disturbing issue identified was that some of these elementary

* Chair and Co-chair, respectively, workshop discussion group for Elementary Education

teachers do not know how to handle simple laboratory equipment, a skill that they should have learned when they were still undergraduates.

As a result of the scarcity of science teachers, many are teaching science courses in spite of inadequate academic training or certification, or even both. Thus, an English or a Social Science graduate who has only three units of basic science is made to teach science. There exists in our educational system a mismatch, or what is termed as an *out-of-field teaching.*

Science teaching is quite different and unique from language or arts teaching, as it should involve strategies like discovery and learning by doing – all pupil-centered approaches. These approaches serve to hone learners' skills, such as observing, predicting, inferring and the like. In this context, can we expect non-science majors to teach science content and the "processes of science" like science majors?

Elementary Science Curriculum

A curriculum refers to the way content is organized and emphasized. A curriculum, therefore, has structure, organization, balance and presentation of the content. It is the content that pupils should learn.

The science curriculum differs in public and private schools. In both sectors, science teachers find it difficult and taxing to finish the whole prescribed curriculum. They attribute this to the lengthy and heavy coverage of the curriculum and the lack of focus. Even the set minimum learning competencies are too much for each grade level. Other factors to be considered are the individual learning abilities of each pupil and the large class size (50-70 in public schools).

The time allotment for a science subject is from 40-45 minutes and within this short period, science teaching at the primary level must be pupil-centered. Bound as it is to follow the curriculum and finish an activity within the prescribed time, science teaching becomes spoon-feeding. Instead of active inquirers, pupils become passive learners.

Instructional or Teaching Materials

Instructional materials refer to textbooks, audio-visual materials and other aids that will facilitate delivery of the lesson. The computer age has brought the use of Internet resources accessible to both learners and teachers. However, those in the very remote areas are deprived of this.

Textbooks errors and misconceptions have been observed in some elementary

science books. A non-science teacher most likely cannot correct these misconceptions and thus, errors are perpetuated.

Physical Infrastructure

Primary to the teaching of science is a laboratory where learners can explore and become curious. Curiosity can lead to inquiry, which is a basic scientific skill. The large number of students per class restricts the performance of science activities.

Learner-factor

To understand science, a student needs to be well-equipped with skills in communication and mathematics. The poor performance of our students in the Third International Mathematics and Science Study (TIMMS) was partly blamed on their comprehension and ability to communicate and express their ideas. Science teachers have observed the poor reading comprehension in grade school pupils. If this is not properly addressed, this problem will be magnified as they move to the next level of education.

The summary of identified gaps, issues and concerns is given in Table 1.

SUGGESTIONS/RECOMMENDATIONS TO ADDRESS THE IDENTIFIED GAPS AND ISSUES

Review the teacher education program

Graduates with an elementary education degree are extensively trained in formal classroom teaching methodology, pedagogy and concepts. Their field work consists of on-campus and off-campus teaching. However, they have very little opportunity for inquiry-based training. They must also learn basic laboratory techniques, which are very crucial. Science teaching should be a discovery type of learning for the pupils, but this cannot be achieved if the teachers themselves lack these skills.

Provide science training for teachers

Teachers must keep abreast with the developments in science and technology. Thus, there is a pressing need to provide content training. This could be a good venue for them to discuss major concepts erroneously written in their textbooks. Training on different teaching strategies should also be conducted especially for those non-majors handling science subjects. Training should also focus on the use of computers and other communication technologies and

how to integrate these technologies in the teaching of science.

Review the basic science education curriculum

The minimum learning competencies (MLCs) prescribed by the Department of Education, though already streamlined, still lacks focus. Thus, a review is needed so that the curriculum would be geared towards mastery of the fundamental concepts and hone inquiry skills among the learners.

There is a need to standardize and strengthen the public and private elementary school curricula.

Community Involvement

Educating the child is the role not only of the teachers, but that of the community as well. The learner's family and the local government units (LGU)are important support systems that shape the learner's behavior beyond the four walls of the classroom.
Parents should follow up on their child's reading skills and help the child in developing good study habits. Assistance can be asked from the PTA (Parents-Teachers Association), the LGUs and the non-government units for simple laboratory facilities and materials.

Table 1. Output of the workshop in elementary science education

GAPS	ISSUES	CONCERNS	STRATEGIES
Teacher Factor	Non-science majors teaching science subjects	Science concepts are not fully explained to the learners	• Conduct content training in science for non-science teachers • Provide peer mentoring • Re-tooling of teachers
	Some teachers lack computer literacy	• Instructional materials can be accessed thru the internet • Available interactive CDs to enhance science teaching	• Conduct in-house workshop for computer literacy • Conduct training on integrating communication technology
Textbooks	Presence of misconceptions or factual errors	• Errors are perpetuated especially if the teacher is a non-science major	• Use of multi-textbooks to verify facts
Basic Science Curriculum	Minimum learning competencies too tough or loaded	• Curriculum should be geared towards mastery of fundamental concepts and hone inquiry abilities of pupils	• Review and standardize the curriculum
Physical Infrastructure	Poor laboratory condition, if not, other schools lack such facility	• Students must be exposed to basic lab equipment or the use of such	Seek the help of the local government units (LGUs) and the Parent-Teachers Association
Student Factor	• Poor reading comprehension • Lack skills in English	• Memorandum on the use of English in teaching science	• Develop the learners' skills on reading and use of English as early as grade 1.

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GAPS, ISSUES AND CONCERNS IN HIGH SCHOOL BIOLOGY EDUCATION

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To the organizers of this activity and fellow biology educators, Good morning and *Mabuhay po sa ating lahat*! When I was requested to talk about gaps in biology education, I said "yes" without any hesitation, because this is an opportunity for me to share our problems and concerns that need immediate attention.

So you heard of gaps in biology education for high school? Are our students prepared to study high school biology? Or are there some areas that need be fixed before they can have a meaningful study of the subject? Teachers are one in saying that there are still some concerns that our students need to address before getting into the study of biology. Indeed, we found a hard time managing our class because of these needs.

Let me categorize the gaps in biology education into three domains: cognitive, psychomotor and affective. In the cognitive domain, we noticed that students lack the skill in the use of the English language. Many students are not prepared to understand and express their ideas in English as they remark: "*Maam pwede lang po i-Tagalog namin*?" (Can we have this in Tagalog, Maam?) They lack the skill in communicating. Sometimes, simple problems are already difficult for them because they don't understand the language.

Another gap is the lack of mastery of basic skills in mathematical operations, which are a prerequisite to solving biology problems. This is especially true in the case of subtraction and division. These basic operations are to be mastered in the elementary level. So how do you expect them to grasp the lesson? Understanding higher-order thinking skills is one big, difficult area for students. If you ask them to identify things requiring memory, it is all right, but if you want them to classify or categorize, it is really hard. That's the possible reason why our biology students have low scores in the National Achievement Test (NAT) for Biology. They find it difficult because they are not prepared.

As for psychomotor skills, I observed that they have difficulty in manipulating instruments like the microscope. According to some students, when they were

in elementary, the microscopes were just being displayed in cabinets because the teachers were afraid that the students would mishandle them. So they merely mastered the parts because these are seen in the drawing. But how to manipulate is a different story. They can identify the cell because they saw it in a drawing, but they did not actually see the cell under the microscope. They lack appreciation, because they only memorized the structures in the drawing.

If you want them to measure the mass of potato cubes first before placing these in different media, in an activity on osmosis, it would take some time, because you still have to teach them how to obtain the mass using an equal arm balance (when they are expected to know this before entering second year high school). Simply using the thermometer is already difficult for them. Sometimes, they just guess the reading.

In the affective domain, the students failed to appreciate the value of applying biological concepts in their daily lives. For example, a sincere love for nature and environment should urge them to solve ecological problems. However, they just scatter pieces of papers when the teacher is not around. They know the concepts, but they are not able to apply them. So they eat junk foods like tocino and longanisa sold in school canteens. Teachers and staff also buy these anyway.

The sense of responsibility needs to be developed among students, especially in the area of studying lessons in any subject, and in finding applications of the theories/concepts in real-life situations. We have to motivate students' interest, enrich their foundation, and involve them in varied activities, especially in higher-order thinking skills, such as research and investigatory projects. Games, debate and simulation can also be used in class, so that students will find biology meaningful and productive, yet enjoyable.

It is necessary to make students' learning active because we know that "what one hears, one forgets", "what one hears and sees, one remembers a little" and what one sees, hears and asks questions about or discusses with someone else, one begins to understand. In other words, what one teaches to another, one masters. In cooperative learning, the students will experience teaching their fellow members in the group, and by doing so, they master the subject and assignment that the teacher gave them. Thus, when they are in class, they are ready and prepared.

These are some of the important concerns or issues in high school biology education. Indeed we earnestly hope that they will be given immediate attention by our authorities. God bless!

ANALYSIS OF THE CONCERNS IN BIOLOGY EDUCATION AT THE SECONDARY LEVEL

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INTRODUCTION

The development of biology as a science has been so fast in recent decades that gaps have been created, raising important issues and concerns not only on the elementary and tertiary levels of biology education, but on the secondary one as well. The mission of biology education in the secondary curriculum is to arm the youth with the basic principles and to prepare him to eventually understand advances in the science. Accompanying the evident gaps in the teaching of biology is a lack of understanding among the youth, and a subsequent decrease in the number of high school graduates pursuing natural and applied sciences. Biology-based fields like agriculture, fisheries and forestry, among others, play a critical role in the development of human society. It is therefore imperative to address the gaps, issues and concerns in secondary biology education in order to produce high school graduates who are well-prepared and mature enough to pursue tertiary biology education, whether basic or applied, in response to the sustained demands for experts in this field.

WORKSHOP OUTPUT

During the workshop, a group of sixteen (16) teachers from various schools were tasked to identify the gaps, issues and concerns in secondary biology education. Of the sixteen (16), two (2) were tertiary biology teachers, one (1) was an elementary science teacher, and thirteen (13) were secondary biology teachers. A brainstorming session gave everyone the chance to identify, critique, discuss or explain gaps, issues and concerns, and offer the corresponding strategies to address such gaps in order to enhance secondary biology education, thus attaining the desired output.

The group identified several gaps in secondary biology education. However, following exhaustive discussions, these were lumped into eight (8) major gaps, issues and concerns (Table 1).

* Chair, workshop discussion group for Secondary Education

Lack of content knowledge for both teachers and students

The huge number of students flocking into public high schools each year demands a number of specialized teachers as well. However, more often than not, very few education graduates major in biology, or even science, for that matter. Hence, teachers with other major fields are forced by circumstances to teach biology. And worse, as pointed out by the workshop participants, some biology majors could not teach biology because they had previously been assigned to teach other courses, and any alteration would do more harm than good to class schedules, at least from the standpoint of management.

Lack of basic tools in understanding biology (i.e., Math and English)

Understanding biology requires basic skills in mathematics and English. Incidentally, many students lack the necessary mastery to adequately comprehend biological concepts. While rooted in elementary education, this problem is carried on to secondary and tertiary education. As a result, learning is very superficial, peripheral and weak).

Traditional method of teaching

When a teacher lacks content knowledge of a subject, he is most likely to resort to a traditional, teacher-centered classroom . Under such circumstances, there is hardly room for student interaction and creativity.

Lack of motivation for teachers

Today's biology teachers have numerous problems. Foremost of these is the low salary, which dampens their burning desire to achieve more or to aim high. Many are not focused solely on teaching , as they are forced by circumstances to resort to part-time activities that could somehow help them make both ends meet.

Lack of facilities

The large yearly increment of students exhausts the already meager resources available to our country's national high schools . It is discouraging on the part of high school biology teachers to see 10 to 20, or even more students, manipulating a single light microscope in a very cramped classroom. Some teachers opt to forego the inconvenience of such an activity, and simply discuss what the students are supposed to see or expect.

As a result, students are not exposed to important psychomotor skills that should have been developed, such as the proper use and operation of the microscope. thermometer or balance, among others . Consequently, students become withdrawn and less interactive.

Time allocation for Biology

The time allocated for Biology is 80 minutes/day (1.8 units), in accordance with current practice in Philippine high schools. This is the highest for all high school subjects, apparently because of the laboratory component. English and Math have 1.5 units each, Filipino 1.2 units; Social Studies 1.2 units; THE 1.2 units; MAPEH 1.2 units; and Values Education 0.6 units.

Nevertheless, what can the teacher do in a laboratory of 90 or so students, with only 80 minutes daily? The usual laboratory class is three hours in one setting to allow the completion of activities requiring sufficient time. With the current practice of 80 min/day alongside seven other subjects, it seems like an overload for the poor high school student (Table 2). And teachers have no choice but to comply with their teaching duties, but without depth.

Low performance in NAT

The National Achievement Test (NAT) is an annual national examination for all high school students usually administered in the month of February. It aims to assess the learning experience of the students per subject during the school year. The workshop participants reported a low performance of their students in NAT scores. Although the teachers said that low performance is partly due to premature administration of the examination, considering the aforementioned gaps, issues and concerns, it is not surprising to have very low NAT scores among biology students.

Affective domain is least emphasized by teachers.

Indeed, in a teacher-centered classroom, only the cognitive domain is readily emphasized, where students are taught to memorize and know the "whats", less of "hows" (psychomotor domain) and least, if ever, of the "whys". The last is the affective domain , where students learn how to appreciate, value and apply biological concepts and principles in everyday life. The simple examples that could have been done by high school students include proper waste disposal, right choice of snacks, care for plants and animals, cleanliness, orderliness and many more.

RECOMMENDATION

Capacity building

This lack of content knowledge among teachers could breed manifold problems. Misinformation or lack of information resulted, as the teachers' knowledge is just a night ahead of their students. If the ideal solution, which is producing qualified biology educators, is not possible, school administrators should at least conduct sustained in-service training workshops or peer mentoring, or grant scholarships to allow teachers to update themselves in regional, national or international training courses (Table 2). The Department of Science and Technology (DOST) and other concerned agencies may be tapped for this purpose, as well for a possible diploma or graduate scholarship in biology. A training workshop on teaching strategies is also very important, since each biology topic necessitates a corresponding unique strategy to maximize learning opportunities among the youth.

Curriculum development

Experts in curriculum development have to review the high school program and seek advice to separate the time allocation for biology lecture and laboratory, or any science subject, for that matter. What is being practiced now (80 minutes daily) is, according to the workshop participants, not enough to enable the students to complete all the activities of an experiment or an exercise.

It is also recommended to strengthen math and English, as both are important in understanding whatever subjects are being studied. In doing so, the workshop participants suggested integrating biology in math and English subjects. Remedial classes in math and English to enhance understanding of biological concepts may be conducted on a case-to-case basis. Knowing that gaps also exist in elementary biology education, it is best for teachers to administer a pretest to determine where their students are, as far as biology knowledge is concerned. This will allow them to really help enhance biology teaching.

It is desirable to have the right balance of the cognitive, psychomotor and affective domains in the teaching-learning process. Strategies such as integrating poetry writing, reflection journals, picture appreciation, singing, and other related activities to enhance the learning process were highly recommended.

Considering the aforementioned, there is no doubt that NAT scores for biology will become higher. There is an urgent need, though, to review the rationale

and objectives in NAT administration and their role in enhancing the teaching-learning environment.

Improve teaching-learning methodologies

Considering our country's economy, not one high school could be fully equipped with the basic and ideal facilities for the teaching-learning processes. Hence, teachers need to be resourceful in collaborating with neighboring institutes or farms known to have these basic instruments. This will further enhance the psychomotor skills of high school biology students. In an exercise on abiotic factors, for example, the teacher (through the school administrators) can volunteer student services to gather light, temperature, rainfall and related climatic data in a nearby plantation research laboratory. Or, in an exercise on microscopy, students may gather data on soil microbial populations.

It is best to maximize the use of every available resource in schools and nearby institutions. Higher order thinking skills (HOTS), such as analysis and synthesis can be improved under this circumstance. Group mentoring can be encouraged. The students become inquisitive and investigative. On top of these, students may be able to enhance their affective domains. They can appreciate the need to be resourceful and innovative from time to time.

Budgetary increase

The workshop participants recommended allocating a bigger portion of the budget relative to the yearly increment of students. Basic school services (classrooms, chairs, desks, tables, lighting and ventilation, laboratory equipment, etc.) are jeopardized due to insufficient funds. This results in crowded classrooms devoid of amenities conducive to teaching-learning processes. With an increase in the budget, class size can be reduced, especially in laboratory courses like biology and other sciences. The development of psychomotor skills can then be addressed properly. Large class size may be maintained only in lecture-discussion classes with audio-visual facilities provided like microphones, projectors, air-conditioning units or electric fans.

Moreover, it might be best to reassess the salary scale of our noble workers. Many teachers venture into various part-time activities to earn more for the family, since their salary is very low. Giving them higher pay could enhance their standard of living, and definitely boost their low morale.

CONCLUDING NOTE

The workshop participants were all hopeful that something positive could be done by our education leaders (DepEd), with the help of the science sector (DOST-NAST) and other related agencies, to address the gaps, issues and concerns in secondary biology education. High school graduates deserve a meaningful and holistic experience to prepare them for tertiary level biology education. However, this requires highly motivated, knowledgeable and student-centered teachers with the right number of students, in a classroom having basic teaching-learning facilities.

Table 1. Major gaps, issues and concerns in secondary biology education.

	GAPS	ISSUES	CONCERNS	STRATEGY	EXPECTED OUTPUT
1	Lack of content knowledge (both teachers and students)	Non-Bio teachers teaching Bio, while Bio teachers teach other subjects	Teachers' knowledge in biology is just a day ahead of their students'	Scholarships, Certificate and Diploma Courses in Bio, Meetings and sustained in-service trainings in Bio in the school, regional and national level Peer teaching/mentoring Bio subject should be the priority load of Bio majors	Updated knowledge in Bio
		Students have difficulty in linking new concepts with previous ones	Students do not learn basic concepts, no solid foundation	Pretest to identify prior knowledge Teachers should know the individual differences of the students	Meaningful learning
2	Lack of basic tools in understanding Biology (i.e. Math and English)	Lack of comprehension of biological concepts	Students do not learn the concepts	Remedial classes in math and English. Linkage with math and English teachers Use of biological science concepts as a springboard for math and English	Students gradually thinking comprehensive basic concepts
3	Traditional method of teaching	Teacher-centered classroom	Students are not motivated to become official thinkers	Appropriate use of teaching strategies such as cooperative learning, higher order thinking skills (HOTS) etc.	Student-centered classroom
4	Lack of motivation for teachers	Low salary	No focus in teaching	Re-examine the salary of teachers	Highly motivated teachers
5	Lack of facilities	Big class size Students are not exposed to instruments and other equipment	No interactive learning	Reduce class size, especially in laboratory Provide audiovisuals on large class size Linkage and collaboration with other institutions Identify and maximize the use of available resources. More budget	Enhanced manipulative and psychomotor skills
6	Time allocation for biology	Loaded curriculum	No in-depth teaching	Review the curriculum	Improved Bio curriculum
7	Low performance in NAT	Too early administration of National Achievement Test (NAT) Lack of comprehension of biological concepts	Low scores in NAT	Review by the DepEd of the NAT administration Teaching-learning environmental should be enhanced	Improved NAT results
8	Affective domain is least emphasized by teachers	Non-application of bio principles	Lack of appreciation in applying biological principles to their daily lives	Use of strategies such as poetry writing, reflection, journal, picture appreciation, singing, etc.	Holistic development of students

DEVELOPMENT INITIATIVES AND TREND-SETTING IN HIGHER BIOLOGY EDUCATION

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INTRODUCTION

The importance of the Biological Sciences has come to fore: vaccines for AIDS, bird flu, etc.; early detection and prevention of cancer; increased yield in crop production; management of diseases; population control; bioremediation; biodiversity; environmental management; global warming, etc. This enumeration is endless, since the information from the ever-diversified fields of the biological sciences impacts on our lives in many ways, and provides solutions to many present-day problems. As such, biology is the SCIENCE OF THE MILLENNIUM!

Like other sciences, biology has struggled in this part of the world to rise as a potential factor in uplifting the lives of Filipinos. Why so? For starters, our deeply rooted religious culture appears to show at the onset an apparent discordance between science and religion. Another reason is the perceived notion that science is purely for intellectuals and the academics, with people being unaware that whatever task they pursue, they are applying science.

This paper shall present a general view of the status, as well as the trends, in development initiatives in higher biology education. It shall also provide information on the efforts of the Commission on Higher Education (CHED) in the last decade, relative to the improvement of the biology discipline at the tertiary level.

STATUS AND TRENDS

Based on the CHED Management Information System database, 150 of 1761 higher education institutions or HEIs (8.5%) offer various biology programs. Of this number, 92 HEIs (61%) are private institutions; while, 58 (39%) are SUCs. A total of around 252 biology programs are offered at different levels: BS degrees are offered in 144 HEIs, MS in 26, and PhD in 5. Interestingly, not all HEIs offer a Bachelor of Science undergraduate program, but instead, a Bachelor of Arts, and not all are titled as BS Biology (Table 1).

The data on the distribution of these HEIs by region and program level show that most institutions with biology degree offerings across levels are concentrated in the NCR. The masteral program offerings are distributed in the NCR, Regions 7, 8, 10, and the Cordillera Administrative Region; while, the Doctor of Philosophy program offerings are in the NCR, Regions 8 and 10. It should be noted, however, that this distribution data contains some discrepancies, as in those from the UP System, which are a consolidation of data from all its Constituent Universities (CUs). The seven CUs are located throughout the country.

The available statistics on student enrolment reveal that biology offerings have greater popularity over other disciplinal offerings in the sciences. And, we know why. The 2004-2005 enrolment data alone gave the following figures: 16,860 for biology; 3,876 for chemistry; 1,287 for physics; 1,277 for marine science; and, 226 for geology. The graduation rates per level, based on data collected from 1990 to 2005, point to a weak performance rating, with a range of 14-42% for the BS degree; 2-22% for MS; and 0-18% for PhD. Thus, only one out of five freshmen in the BS Biology program earns the degree originally enrolled in, while one out of ten finishes an MS/PhD degree. The attrition rate for the BS program is mainly attributed to withdrawal from the roll due to academic or financial difficulties, and secondly, to shift or transfer to more preferred programs. The attrition rates for the MS and PhD programs are basically due to financial difficulties.

The information on the faculty profile indicates a total of about 1,175 faculty members, with the following statistics on their graduate degrees: 772 hold MS degrees or are enrolled in an MS program, of whom 252 are reported to have their MS degrees in biology and allied fields; 114 hold PhD degrees or are enrolled in the PhD program, of whom 42 have their PhD degrees in biology or in closely related fields.

DEVELOPMENT INITIATIVES

Since 1994, CHED has initiated the development of higher education through innovative programs and projects aimed at improving biology program offerings, among others. The Centers of Excellence (COEs) project was among the recommendations of the Congressional Commission on Education (EDCOM) in 1991. It was a means of providing support to HEIs with a track record for exemplary performance, with the end of enabling these institutions to participate more actively in national development. The COEs were intended to be: 1) the means for the country to catch up with its ASEAN neighbors; 2) the resource hubs from which other schools might draw strength; and, 3) the

core of Philippine graduate education and research. When CHED came into being in 1994, this project concept was applied. At that time, the project concept was still an intervening measure to support a select number of HEIs in specific fields, particularly those needed in nation building. This concept was eventually tailored to fit needs specific to the different fields. In science and mathematics, the support of the COEs was envisioned to be a follow-up to the Engineering and Science Project (ESEP) of the Department of Science and Technology. The CHED Technical Panel for Science and Mathematics (TPSM) believed that more gains could be achieved through continued support for initial efforts, such as those derived from the ESEP-DOST. At the same time, the CHED TPSM was cognizant of the fact that some HEIs demonstrated a potential for contributing to nation building efforts. These, however, had not yet attained the expected minimum core competencies for their disciplinal offerings. CHED came up with the concept of Centers of Development (CODs).

From 1998 to 2005, CHED supported 14 Centers, with 5 Centers of Excellence distributed as follows: 3 in the NCR (Ateneo de Manila, De La Salle University, and University of the Philippines in Diliman); 1 in Region 4 (UP Los Baños); 1 in Region 12 (Mindanao State University-IIT). The remaining 9 Centers of Development were located as follows: 2 in the NCR (University of Santo Tomas and UP Manila); 1 in the CAR (UP Baguio); 1 in Region 3 (Central Luzon State University); 1 in Region 6 (UP Visayas); 2 in Region 7 (University of San Carlos and Silliman University); 1 in Region 10 (Central Mindanao University); and, 1 in Region 11 (Ateneo de Davao University). These Centers, in particular the 5 COEs, produced 49%, 72%, and 76% of the total graduates from all the CHED Centers combined, for the BS, MS, and PhD degrees in biology, covering the period from 1998 to 2004. The percentage graduate output by the CHED Centers as compared to the overall graduation for the same six-year period came to: 26% for the BS; 64% for the MS; and, 80% for the PhD degrees. What this indicates is that the 14 CHED Centers, representing only 9% of the 150 HEIs that offer BS Biology, produced a quarter of the total graduates. Significantly, the information also indicates that the higher-level manpower (with postgraduate degrees) was generated mostly by these Centers.

Another CHED project was the development of Policies and Standards (PS) for Academic Programs in the basic sciences and mathematics. These are envisioned to serve as a set of minimum criteria for degree programs, providing for specifications such as administrator qualifications, teacher qualifications, and facilities requirements, among others. The PS for each discipline were developed separately by a group, each constituting a total of seven policy-recommending Technical Committees for Biology, Chemistry, Environmental Science, Geology, Marine Science, Mathematics, and Physics. The Technical

Committees oversee the developmental and curricular needs of each specialized area. The Chairs of each of these Technical Committees sit as members of the TPSM.

The Minimum Policies and Standards (PS) for Bachelor of Science in Biology (BS Biology) is embodied in the CHED Memorandum Order (CMO) No. 24, Series 2005. This document contains a set of Rules and Guidelines "...For the purpose of rationalizing the undergraduate biology education in the country with the end view of keeping apace with the advances in science and the demands of globalization...." A series of orientations on the PS for the BS Biology program were conducted in several venues in Luzon, Visayas, and Mindanao from 2005-2006. This is because the CMO was to take effect in the first semester of the academic year 2005-2006. (Note that prior to the completion of the document on the Minimum PS, CHED conducted a series of consultations and leveling off workshops in many parts of the country, starting around 1996 until such a period when the Technical Committee had assembled to draft the Minimum PS.) This 52-page document signed by the Honorable CHED Chairman, Dr. Carlito S. Puno, on 22 July 2005, ends with Article XX. Transitory Provision, stating that: HEIs with existing programs in Bachelor of Science in Biology shall be given a three-year grace period to comply with these policies and standards.

Briefly, the Minimum Policies and Standards provide for the following:

A. BS Biology Curriculum: The minimum range in total units per course category

•General Education Courses	39
•Non-biology Tool Courses	35
•Core Courses	40
•Science Electives	24
•Free Electives	6
•Undergraduate Thesis (or Special Problem)	6 (or 3)
TOTAL UNITS	150 or 147

B. The minimum units for each category

1. General Education Courses (39 Units)

•Language and Humanities	- 21 units
•Information Technology	- 3 units
•Social Sciences	- 12 units

•Life and Works of Rizal - 3 units

Note: Natural Sciences (6 units) and Mathematics (6 units) requirements are fulfilled by General Biology I & II in the Core Courses, and Mathematics, Chemistry, and Physics in the Non-Biology Tool Courses

2. Non-Biology Tool Courses (35 Units)

•Chemistry: General, Inorganic, Organic Chemistry, Biochemistry - 15 units
•Physics: General Physics and Modern Physics - 8 units
•Mathematics: College Algebra, Trigonometry, Calculus, and Analytical Geometry, Statistics - 12 units

3. Core Courses (40 Units)

•General Biology I & II (5 units each) = 10 units
•Morpho-anatomy I & II (Plant & Animal)
•Physiology I & II (Plant & Animal)
•Systematic Biology (Plant or Animal)
•Developmental Biology (Plant or Animal)
•Genetics
•Ecology
•Microbiology
•Cell and Molecular Biology

Note: Core courses except Gen Bio are of 3 u each = 2 u Lecture & 1 u Laboratory

4. Biology Electives (24 Units)

•Suggested are: Entomology, Evolution, Freshwater Biology, Marine Biology, Molecular Biology and Biotechnology, Immunology, Histology, Theoretical Biology, etc.

Note: Biotechnology is strongly suggested. Electives however, may concentrate on specific themes that the HEI may choose to offer.

5. Free Electives (6 Units)
Undergraduate Thesis (6 Units) or Special Problem (3 Units)

•Science, Technology, and Society (3 units) or its equivalent is strongly suggested as a Free Elective

•HEIs may choose between an undergraduate thesis (6 units) and a special problem (3 units) to comply with this requirement
•Both thesis and special problem options INCLUDE a seminar course, which shall be offered in any of the last two semesters/terms of the program

CHED NATIONAL HIGHER EDUCATION RESEARCH AGENDA (NHERA)

Recognizing the important role of research in developing higher education in the nation, CHED undertook the National Higher Education Research Agenda (NHERA), which was operationalized in 1998. The Commission offered various forms of financial assistance through this program by offering block grants, grants-in-aid, commissioned researches, and professorial chairs.

Block grants are available competitively to private and public universities. The institutions receiving this form of assistance must have: a proven track record in research; at least 5% of the total faculty force should have earned Ph.D. degrees; existing research facilities with updated computing equipment and an updated collection of research journals or easy electronic access to these. Unlike block grants, grants-in-aid are extended to institutions that have lower capacities, but show definite potential to undertake research. Commissioned researches, on the other hand, are given to individuals or institutions with a track record in leadership in the scientific and academic communities, and capabilities in these endeavors. In addition, professorial chairs are offered to prominent research faculty who are nominated by their own institutions. The type of research funded through NHERA is aggregate by nature. The program encompasses all fields and allows an equal opportunity for pursuing developmental goals through research.

If an institution or its academic staff were awarded any of these research grants, counterpart assistance from the recipient universities would be required. The Commission obligates these institutions to allow a reduction in teaching load or release time for the faculty researchers; and full access to the institution's facilities and other incentives that the institution may provide.

FACULTY DEVELOPMENT PROGRAM

The Faculty Development Program (FDP) is under the CHED flagship project, the Higher Education Development Project (HEDP), which started in 2004. The HEDP is a mechanism to implement some of the sectoral reforms suggested in the 1998 Philippine Education Sector Study of the World Bank, and the 2000 Presidential Commission on Education Reform (PCER). The FDP, as a

subcomponent of the HEDP, is envisioned to improve the quality of teaching by upgrading the qualifications of the faculty currently teaching in the HEIs. For biology, there are 13 delivering institutions offering the masteral program, and these are spread from North to South in the Philippines.

SELECTION OF CHED COES/CODS FOR BIOLOGY

The selection followed the general guidelines and procedures formulated by the TPSM, with focus on four general criteria:

- •Instructional Quality: Faculty, Curriculum, Administration, Facilities, and Students
- •Research and Publications: Personnel, Facilities and Equipment, Publications, other scientific activities
- •Extensions and Linkages
- •Institutional Qualifications: Mission, Vision, Institutional Policies, Strategies and Principles, Support from Higher Administration.

DIRECTION-SETTING

The first institutions selected as CHED Centers of Excellence and Centers of Development in Biology in 1998 were given three-year support to improve the level of instruction, research, and extension, based on the needs these institutions reflected in their proposals submitted to CHED for funding, in accordance with the development concept of the COE/COD Program. In 2006, a new set of HEIs was selected as CHED COEs and CODs in Biology.

The newly-awarded CHED COEs and CODs in Science and Mathematics are to perform functions in conjunction with national priorities. These identified COE/COD Institutions must play a bigger role in Manpower Development, Research and Development, Linkages and Extension Services. They must develop into world-class S&T Universities with the research culture in place, such that more refereed publications are generated, and ISI publications would become the norm. This mandate comes with an equally challenging task, which is to popularize science as part of the consciousness of the Filipino people.

CONCLUSION

On our part, we begin with standardizing the BS Biology curriculum. We consistently strive to instill, early on, a mindset with a research orientation, going beyond mere asking. We continue to self-assess in the light of developments and advances in biology. We participate in programs on: 1) the development of a scientific workforce, who shall remain doing science in the

country; 2) massive advocacy and promotional activities; 3) the improvement of educational institutions; and, 4) the establishment of science-and-technology-based industries. We thus benchmark ourselves based on performances and output. We continuously raise the bar!

Thank you!

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Table 1. Names of biology programs in different levels offered in Philippine Higher Education Institutions

Undergraduate Programs (16 Programs)[1]	Masters Program (12 Programs)[1]	Doctorate Programs (7 Programs)[1]
• A.B Biology	• M. S. in Biology	• PhD in Biology
• A.B. Major in Biology	• MS Zoology	• PhD in Botany
• B. S in Biology	• MS Botany	• PhD in Entomology
• Bachelor of Arts in Biology	• MS Genetics	• PhD in Genetics
• Bachelor of Science in Biochemistry	• Master of Science in Botany/Biology	• PhD in Microbiology
• Bachelor of Science in Botany	• MS Entomology	• Doctor of Philosophy (Biology)
• Bachelor of Science in Microbiology	• Master of Science Major in Entomology	• Doctor of Philosophy (Molecular Biology & Biotechnology)
• Bachelor of Science in Zoology	• MS in Entomology	
• Bachelor of Science-Biology (Preparatory Medicine)	• MS Microbiology	
• BS Applied Bio	• MS Molecular Biology	
• BS Biology (General)	• MS Plant Genetic Resources	
• BS Molecular Biology & Biotechnology	• Master of Science (Molecular Bio & Biotechnology)	
• BS in Applied Biology		
• BS in Aquatic Biology		
• BS Major in Biology		
• BS Human Biology		

[1]Similar names were grouped together.

BIOLOGY EDUCATION AT THE TERTIARY LEVEL: ISSUES AND RECOMMENDATIONS

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Biology teaching in tertiary education may share similar concerns with teaching the same at the elementary and secondary levels, in terms of the learning environment for both learners and teachers. However, it may differ completely in terms of conducting the course. This is primarily due to the fact that in tertiary education, biology is offered either as a degree program, or as one of the essential subjects in non-biology degree programs. Thus, the gaps, issues and concerns for biology education at the tertiary level have to be looked at from two different vantage points: (1) biology as a degree program; and, (2) biology as a subject for non-biology majors.

BIOLOGY AS A DEGREE PROGRAM

A. Issues or Concerns Identified

1. Declining number of major students

The participants pointed out the observable decrease in the number of students enrolling and graduating in BS Biology. There is an observed preference for information technology, nursing and other currently 'in-demand abroad' courses, perhaps due to family pressure and economic concerns. Associated with this is the issue that BS Biology seems to be intended not as a pre-medical course, but as a preparatory course for scientists and researchers who can contribute to the country's economic development. However, it appears that a high percentage of BS Biology graduates become medical doctors, dentists, nurses, medical representatives and teachers – careers that do not necessarily require research experience.

2. Lack of understanding of specialized biology courses

The participants identified several factors that seem to contribute to this problem. One is the persistent concern, as in elementary and secondary

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education, about deficient proficiency in basic learning tools, like English and mathematics, which are keys to better course comprehension and elucidation. There is also the shortage of faculty members who can competently teach specialized courses in biology, such as systematics, physiology and genetics, which results in subject matter omission or breezing through and, in some cases, relegation of subject matter discussion to the students under the guise of assigned readings/reports that do not necessarily ensure comprehension or learning. Another factor compounding this problem is the technological inadequacy and limitations of facilities for biology education (e.g., laboratory workroom, biology equipment and chemicals) which fail to provide for interactive understanding and learning of basic and specialized biological concepts.

B. Recommendations and Suggested Strategies

1. Re-invigoration of the program

Since student preference for the BS Biology program is a major concern, a possible remedy would be the reevaluation or re-invigoration of the program, either by updating the curriculum to include new and emerging biology-related disciplines, or by introducing novel courses, such as bio-entrepreneurship, bio-informatics and bio-communication. These courses can significantly help mainstream biology in the public mind and develop a "culture of biology" among our people.

2. Remedial classes and administrative support

To help ensure better learning and comprehension of basic and specialized biology concepts, foundation and tool courses for communication and learning should be strengthened in the elementary, secondary and tertiary levels. Remedial courses that can help bridge learning gaps should be required for both students and teachers. The administrators must offer opportunities for further teacher education that will help the latter gain greater competence in teaching specialized biology courses, as well as update them on advances in the field. Greater administrative support is also necessary to technologically enhance teaching facilities for biology courses towards interactive learning of basic and advanced biological concepts.

BIOLOGY AS A SUBJECT

A. Issues or Concerns Identified

1. Lack of a complementary holistic approach in teaching biology

Some participants remarked on the lack of an integrated biology subject, in certain tertiary schools, that will complement the teaching of distinct biology disciplines such as botany or zoology. Though not necessarily a drawback, it can promote the appreciation of biology as a unified science with certain principles and processes common to all life forms.

2. Lack of sustained interest in biology

Student perceptions that biology subjects are very difficult and uninteresting may be the root of seeming low student interest and appreciation of biology subjects. The plethora of technological distractions, such as interactive computer games, in the life of today's students, may be unduly drawing their attention away from biology subjects, which they probably consider "too cerebral".

B. Recommendations and Suggested Strategies

1. Offering an integrative biology subject

An integrative biology subject can complement student understanding of certain biological principles and processes that are common to all plants, animals and other life forms. This gives a generalist perspective of biology that complements learning in distinct biological disciplines such as botany, zoology and microbiology.

2. Inquiry-based approach to learning

The teaching of biology can be made more interesting by clearly relating theoretical concepts to practical and day-to-day life. The preparation and use of interesting but non-distracting instructional aids, and the formulation of innovative teaching strategies, can enhance student interest in the subject matter. The availability of technologically adequate interactive laboratories for teaching biology, where students can learn basic and advanced biological principles and processes, can stimulate

their interest and imagination towards inquiry-based learning. Biology teachers should be encouraged to attend seminars on innovative teaching methods, and be given ample time to devise new teaching strategies on their own. Minimization of non-teaching tasks assigned to them by administrators can significantly sustain their passion for teaching and nurture student learning.

SUMMARY AND CONCLUDING NOTE

A summary of the gaps, issues and concerns in biology education at the tertiary level, as well as the strategies recommended to resolve the gaps, together with the corresponding expected outputs, is presented in Table 1.

The root causes of the issues and concerns identified in biology education at the tertiary level include the following: (1) deficiencies in basic teaching/ learning tools among teachers/students; (2) limited teaching and learning strategies; (3) technological inadequacy and limitations of biology teaching laboratories; and, (4) need for greater administrative support. Most of the problems can be resolved at the administrative level, while the teachers themselves can work out some of the solutions in cooperation with their students. Teaching and learning biology should be made more relevant, interesting and interactive. Appropriate innovations in biology education will greatly benefit succeeding generations of Filipino students and scholars, and eventually help nurture a culture of science among our people.

Table 1. Gaps, issues and concerns in tertiary biology education

No.	GAPS	ISSUES	CONCERNS	STRATEGY	OUTPUT
	Biology as a Degree Program				
1	Low number of students taking up/finishing BS Biology	Students are attracted to "new/in-demand abroad" courses	High school graduates and college students perceive BS Biology as difficult, off the mainstream and not "hot" in the job market; BS Biology students shift to other courses	Greater participation in HS career orientations, production and distribution of BS Biology information materials	Greater awareness, better understanding and enhanced interest in BS Biology
				Mainstreaming of BS Biology program towards greater job-market relevance	Revitalized BS Biology program
		BS Biology designed not as a pre-medicine course but as a preparatory course for scientists/researchers	Students planning to pursue medicine are not inclined to take BS Biology as a preparatory course	Redesign the BS Biology program to include a medicine-tracked option	A medicine-tracked BS Biology program
2	Limited teacher/student understanding of specialized biology courses	Students lack proficiency in basic learning skills such as English and mathematics	Students find the courses extra difficult and content themselves with "passable" knowledge and understanding	Vibrant advocacy of basic learning skills strengthening in elementary, high school and college education Hold bridge/remedial classes for basic learning skills which students must attend, finish and pass	Active policy support and position papers on the strengthening of basic learning skills throughout the educational ladder Enhanced basic learning skills at par with the proficiency levels needed for BS Biology
		There is lack of faculty members who can competently teach specialized biology courses	Faculty members who are assigned to teach specialized biology courses have to "crash-learn" the subject, often on a-day-ahead-of-students basis	Provide greater opportunities for in-depth learning of specialized biology courses	Enhanced faculty proficiency in specialized biology courses
				Refresher courses for state-of-the-science updating of knowledge on the specialized biology courses	Up-to-date knowledge on specialized biology courses
				Greater and broader access to scientific/ technical publications, scientific conferences, etc.	Up-to-date information on specialized biology courses

		Technological limitations of facilities for biology education	Students find the concepts and principles too difficult, abstract and uninteresting Faculty members are severely handicapped in explaining concepts and principles	Use learning aids in-tune with the tech-savvy generation of students Use ICT-enabled interactive teaching aids	Easier, less abstract and more interesting learning of concepts and principles Enhanced facility in clearly explaining concepts and principles
	Biology as a Subject				
3	Lack of a complementary holistic approach to teaching biology	Students may mistakenly hold a fragmented understanding and appreciation of biological concepts and principles instead of as a unified science	Students may fail to grasp the closely-knit and causal interrelationships of all living organisms in the global ecosystem	Offering of an integrative biology subject	A more profound grasp of the interrelationships among various life forms
4	Lack of sustained interest in biology	Students satisfy themselves with a shallow and "passable" grasp of biology	Students do not even learn enough to know, understand and appreciate the simple biological concepts and principles that impinge on day-to-day living	Relate biological concepts and principles with commonplace concerns and points of interest Adopt the inquiry-based approach to learning Use interesting but not distracting teaching aids and develop interactive laboratories for teaching biology	An incipient or basic culture of biology Knowledge thirst or student-driven learning More effective and interesting learning environment

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APPENDIX 1. List of Participants in the Workshop Groups at the Round Table Discussion on Biology Education held at the Trader's Hotel, Manila, 23 April 2007.

Elementary	Secondary	Tertiary
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